ENCYCLOPÆDIA BRITANNICA.

Material, Materialists.

MATERIAL, denotes ſomething compoſed of *matter*. In which ſenſe the word ſtands oppoſed to *immaterial*. See MATTER and METAPHYSICS.

MATERIALISTS, a ſect in the ancient church, compoſed of perſons who, being prepoſſeſſed with that maxim in the ancient philoſophy, *Ex nihilo nihil fit*, "Out of nothing nothing can ariſe," had recourſe to an internal matter, on which they ſuppoſed God wrought in the creation; inſtead of admitting God alone as the ſole cauſe of the exiſtence of all things. Tertullian vigorouſly oppoſes the doctrine of the materialiſts in his treatiſe againſt Hermogenes, who was one of their number.

Materialiſts is alſo a name given to thoſe who maintain that the ſoul of man is material; or that the principle of perception and thought is not a ſubſtance diſtinct from the body, but the reſult of corporeal organization: See METAPHYSICS. There are others, called by this name, who have maintained that there is nothing but matter in the univerſe; and that the Deity himſelf is material. See SPINOZA.

MATHEMATICS.

Definition of mathematics.

MATHEMATICS is divided into two kinds, *pure* and *mixed*. In *pure mathematics* magnitude is conſidered in the abſtract; and as they are founded on the ſimpleſt notions of quantity, the concluſions to which they lead have the ſame evidence and certainty as the elementary principles from which theſe concluſions are deduced. This branch of mathematics comprehends, 1. *Arithmetic*, which treats of the properties of numbers. 2. *Geometry*, which treats of extenſion as endowed with three dimenſions, length, breadth, and thickneſs, without conſidering the phyſical qualities inſeparable from bodies in their natural ſtate. 3. *Algebra*, ſometimes called univerſal arithmetic, which compares together all kinds of quantities, whatever be their value. 4. The *direct and inverſe method of Fluxions*, (called on the continent, the *differential* and *integral calculi*), which conſider magnitudes as divided into two kinds, conſtant and variable, the variable magnitudes being generated by motion; and which determines the value of quantities from the velocities of the motions with which they are generated. *Mixed Mathematics* is the application of pure mathematics to certain eſtabliſhed phyſical principles, and comprehends all the phyſico-mathematical ſciences, namely, 1. *Mechanics*; 2. *Hydrodynamics*; 3. *Optics*; 4. *Aſtronomy*; 5. *Acouſtics*; 6. *Electricity*, and 7. *Magnetiſm*. The hiſtory of theſe various branches of ſcience having been given at full length, we ſhall at preſent direct the attention of the reader to the origin and progreſs of pure mathematics.

2. In attempting to diſcover the origin of arithmetic and geometry, it would be a fruitleſs taſk to conduct the reader into thoſe ages of fable which preceded the records of authentic hiſtory. Our means of information upon this ſubject are extremely limited and imperfect; and it would but ill accord with the dignity of a ſcience whoſe principles and concluſions are alike irreſiſtible, to found its hiſtory upon conjecture and fable. But notwithſtanding this obſcurity in which the early hiſtory of the ſciences is enveloped, one thing appears certain that arithmetic and geometry, and ſome of the phyſical ſciences, had made conſiderable progreſs in Egypt, when the myſteries and the theology of that favoured kingdom were tranſplanted into Greece. It is highly probable that much natural and moral knowledge was taught in the Eleuſinian and Dionyſian myſteries, which the Greeks borrowed from the Egyptians, and that ſeveral of the Grecian philoſophers were induced by this circumſtance to travel into Egypt, in ſearch of thoſe higher degrees of knowledge, which an acquaintance with the Egyptian myſteries had taught them to anticipate. We accordingly find Thales and Pythagoras ſucceſſively under the tuition of the Egyptian prieſts, and returning into Greece loaded with the intellectual treaſures of Egypt. By the eſtabliſhment of the Ionian ſchool at Miletus, Thales inſtructed his countrymen in the knowledge which he had received, and gave birth to that ſpirit of inveſtigation and diſcovery with which his followers were inſpired. He taught them the method of aſcertaining the height of the pyramids of Memphis by the length of their ſhadows; and there is reaſon to believe that he was the firſt

The ſciences originated in Egypt.

A. C. 640. A. C. 590.

Diſcoveries of Thales.

firſt who employed the circumference of a circle for the menſuration of angles. That he was the author of greater diſcoveries, which have been either loſt or aſcribed to others, there can be little doubt; but theſe are the only facts in the hiſtory of Thales which time has ſpared.

Diſcoveries of Pythagoras.

3. The ſcience of arithmetic was one of the chief branches of the Pythagorean diſcipline. Pythagoras attached ſeveral myſterious virtues to certain combinations of numbers. He ſwore by *four*, which he regarded as the chief of numbers. In the number *three* he ſuppoſed many wonderful properties to exiſt; and he regarded a knowledge of arithmetic as the chief good. But of all Pythagoras's diſcoveries in arithmetic, none have reached our times but his multiplication table. In geometry, however, the philoſopher of Samos ſeems to have been more ſucceſsful. The diſcovery of the celebrated propoſition which forms the 47th of the firſt book of Euclid's Elements, that in every right-angled triangle the ſquare of the ſide ſubtending the right angle is equal to the ſum of the ſquares of the other two ſides, has immortalized his name; and whether we conſider the inherent beauty of the propoſition, or the extent of its application in the mathematical ſciences, we cannot fail to claſs it among the moſt important truths in geometry. From this propoſition its author concluded that the diagonal of a ſquare is incommenſurate to its ſide; and thus gave occaſion to the diſcovery of ſeveral general properties of other incommenſurate lines and numbers.

4. In the time which elapſed between the birth of Pythagoras and the deſtruction of the Alexandrian ſchool, the mathematical ſciences were cultivated with great ardour and ſucceſs. Many of the elementary propoſitions of geometry were diſcovered during this period; but hiſtory does not enable us to refer each diſcovery to its proper author. The method of letting fall a perpendicular upon a right line from a given point (Euclid, B. I. prop. xi.);—of dividing an angle into two equal parts, (Euclid, B. I. prop. ix.); and of making an angle equal to a given angle, (Euclid B. I. prop. xxiii.) were invented by Oenopidus of Chios. About the ſame time Zenodorus, ſome of whoſe writings have been preſerved by Theon in his commentary on Ptolemy, demonſtrated, in oppoſition to the opinion then entertained, that iſoperimetrical figures have equal areas. Coeval with this diſcovery was the theory of regular bodies, for which we are indebted to the Pythagorean ſchool.

Diſcoveries of Oenopidus and Zenodorus.

The celebrated problem of the duplication of the cube propoſed and inveſtigated.

5. About this time the celebrated problem of the duplication of the cube began to occupy the attention of the Greek geometers. In this problem it was required to conſtruct a cube whoſe ſolid content ſhould be double that of a given cube; and the aſſiſtance of no other inſtrument but the rule and compaſſes was to be employed. The origin of this problem has been aſcribed by tradition to a demand of one of the Grecian deities. The Athenians having offered ſome affront to Apollo, were afflicted with a dreadful peſtilence; and upon conſulting the oracle at Delos, received for anſwer, *Double the altar of Apollo.* The altar alluded to happened to be cubical; and the problem, ſuppoſed to be of divine origin, was inveſtigated with ardour by the Greek geometers, though it afterwards baffled all their acuteneſs. The ſolution of this difficulty was attempted by Hippocrates of Chios. He diſcovered, that if

A C. 450.

two mean proportionals could be found between the ſide of the given cube, and the double of that ſide, the firſt of theſe proportionals would be the ſide of the cube ſought. In order to effect this, Plato invented an inſtrument compoſed of two rules, one of which moved in grooves cut in two arms at right angles to the other, ſo as always to continue parallel with it; but as this method was mechanical, and likewiſe ſuppoſed the deſcription of a curve of the third order, it did not ſatisfy the ancient geometers. The doctrine of conic ſections, which was at this time introduced into geometry by Plato, and which was ſo widely extended as to receive the name of the *higher geometry*, was ſucceſsfully employed in the problem of doubling the cube. Menechmus found that the two mean proportionals mentioned by Hippocrates, might be conſidered as the ordinates of two conic ſections, which being conſtructed according to the conditions of the problem, would interſect one another in two points proper for the ſolution of the problem. The queſtion having aſſumed this form, gave riſe to the theory of geometrical loci, of which ſo many important applications have been made. In doubling the cube, therefore, we have only to employ the inſtruments which have been invented for deſcribing the conic ſections by one continued motion. It was afterwards found, that inſtead of employing two conic ſections, the problem could be ſolved by the interſection of the circle of the parabola. Succeeding geometers employed other curves for this purpoſe, ſuch as the conchoid of Nicomedes and the ciſſoid of Diocles, &c. An ingenious method of finding the two mean proportionals, without the aid of the conic ſections, was afterwards given by Pappus in his mathematical collections.

Conic ſections diſcovered by Plato. A. C. 39[?]. A. C. 280. A. C. 460. A. D. 400.

The triſection of an angle.

6. Another celebrated problem, to triſect an angle, was agitated in the ſchool of Plato. It was found that this problem depended upon principles analogous to thoſe of the duplication of the cube, and that it could be conſtructed either by the interſection of two conic ſections, or by the interſection of a circle with a parabola. Without the aid of the conic ſections, it was reduced to this ſimple propoſition:—To draw a line to a ſemicircle from a given point, which line ſhall cut its circumference, and the prolongation of the diameter that forms its baſe, ſo that the part of the line comprehended between the two points of interſection ſhall be equal to the radius. From this propoſition ſeveral eaſy conſtructions may be derived. Dinoſtratus of the Platonic ſchool, and the cotemporary of Menechmus, invented a curve by which the preceding problem might be ſolved. It had the advantage alſo of giving the multiplication of an angle, and the quadrature of the circle, from which it derived the name of quadratrix.

Hippocrates's lunula. A. C. 450.

7. While Hippocrates of Chios was paving the way for the method of doubling the cube, which was afterwards given by Pappus, he diſtinguiſhed himſelf by the quadrature of the lunulæ of the circle; and had from this circumſtance the honour of being the firſt who found a curvilineal area equal to a ſpace bounded by right lines. He was likewiſe the author of Elements of Geometry, a work, which, though highly approved of by his cotemporaries, has ſhared the ſame fate with ſome of the moſt valuable productions of antiquity.

8. After the conic ſections had been introduced into geometry by Plato, they received many important additions from Eudoxus, Menechmus, and Ariſteus. The

latter

A. C. 380. A. C. 300.

latter of theſe philoſophers wrote *five* books on conic ſections, which, unfortunately for ſcience, have not reached our times.

Elements of Euclid.

9. About this time appeared Euclid's Elements of Geometry, a work which has been employed for 2000 years in teaching the principles of mathematics, and which is ſtill reckoned the moſt complete work upon the ſubject. Peter Ramus has aſcribed to Theon both the propoſitions and the demonſtrations in Euclid. It has been the opinion of others that the propoſitions belong to Euclid, and the demonſtrations to Theon, while others have given to Euclid the honour of both. It ſeems moſt probable, however, that Euclid merely collected and arranged the geometrical knowledge of the ancients, and that he ſupplied many new propoſitions in order to form that chain of reaſoning which runs through his elements. This great work of the Greek geometer conſiſts of fifteen books: the eleven firſt books contain the elements of pure geometry, and the reſt contain the general theory of ratios, and the leading properties of commenſurate and incommenſurate numbers.

Diſcoveries of Archimedes. A. C. 250.

10. Archimedes, the greateſt geometer among the ancients, flouriſhed about half a century after Euclid. He was the firſt who found the ratio between the diameter of a circle and its circumference; and, by a method of approximation, he determined this ratio to be as 7 to 22. This reſult was obtained by taking an arithmetical mean between the perimeters of the inſcribed and circumſcribed polygon, and is ſufficiently accurate for every practical purpoſe. Many attempts have ſince been made to aſſign the preciſe ratio of the circumference of a circle to its diameter; but in the preſent ſtate of geometry this problem does not ſeem to admit of a ſolution. The limits of this article will not permit us to enlarge upon the diſcoveries of the philoſopher of Syracuſe. We can only ſtate, that he diſcovered the ſuperficies of a ſphere to be equal to the convex ſurface of the circumſcribed cylinder, or to the area of four of its great circles, and that the ſolidity of the ſphere is to that of the cylinder as 3 to 2. He diſcovered that the ſolidity of the paraboloid is one half that of the circumſcribed cylinder, and that the area of the parabola is two thirds that of the circumſcribed rectangle; and he was the firſt who pointed out the method of drawing tangents and forming ſpirals. Theſe diſcoveries are contained in his works on the dimenſion of the circle, on the ſphere and cylinder, on conoids and ſpheroids, and on ſpiral lines. Archimedes was ſo fond of his diſcovery of the proportion between the ſolidity of the ſphere and that of the cylinder, that he ordered to be placed upon his tomb a ſphere inſcribed in a cylinder, and likewiſe the numbers which expreſs the ratio of theſe ſolids.

Diſcoveries of Apollonius. A. C 200.

11. While geometry was thus advancing with ſuch rapid ſteps, Apollonius Pergæus, ſo called from being born at Perga in Pamphylia, followed in the ſteps of Archimedes, and widely extended the boundaries of the ſcience. In addition to ſeveral mathematical works, which are now loſt, Apollonius wrote a treatiſe on the theory of the conic ſections, which contains all their properties with relation to their axes, their diameters, and their tangents. He demonſtrated the celebrated theorem, that the parallelogram deſcribed about the two conjugate diameters of an ellipſe or hyperbola is equal to the rectangle deſcribed round the two axes, and that the ſum or difference of the ſquares of the two conjugate diameters are equal to the ſum or difference of the ſquares of the two axes. In his fifth book he determines the greateſt and the leaſt lines that can be drawn to the circumferences of the conic ſections from a given point, whether this point is ſituated in or out of the axis. This work, which contains every where the deepeſt marks of an inventive genius, procured for its author the appellation of the *Great Geometer*.

Menelaus writes on ſpherical triangles. A. D. 55.

12. There is ſome reaſon to believe, that the Egyptians were a little acquainted with plane trigonometry; and there can be no doubt that it was known to the Greeks. Spherical trigonometry, which is a more difficult part of geometry, does not ſeem to have made any progreſs till the time of Menelaus, an excellent geometrician and aſtronomer. In his work on ſpherical triangles, he gives the method of conſtructing them, and of reſolving moſt of the caſes which were neceſſary in the ancient aſtronomy. An introduction to ſpherical trigonometry had already been given to the world by Theodoſius in his Treatiſe on Spherics, where he examines the relative properties of different circles formed by cutting a ſphere in all directions.

Theodoſius's ſpherics. A. C. 60.

Progreſs of analyſis.

13. Though the Greeks had made great progreſs in the ſcience of geometry, they do not ſeem to have hitherto conſidered quantity in its general or abſtract ſtate. In the writings of Plato we can diſcover ſomething like traces of geometrical analyſis; and in the ſeventh propoſition of Archimedes's work on the ſphere and the cylinder, theſe traces are more diſtinctly marked. He reaſons about unknown magnitudes as if they were known, and he finally arrives at an analogy, which, when put into the language of algebra, gives an equation of the third degree, which leads to the ſolution of the problem.

The analyſis of indeterminate problems invented by Diophantus. A. D. 350.

14. It was reſerved, however, for Diophantus to lay the foundation of the modern analyſis, by his invention of the analyſis of indeterminate problems; for the method which he employed in the reſolution of theſe problems has a ſtriking analogy to the preſent mode of reſolving equations of the 1ſt and 2d degrees. He was likewiſe the author of thirteen books on arithmetic, ſeveral of which are now loſt. The works of Diophantus were honoured with a commentary by the beautiful and learned Hypatia, the daughter of Theon. The ſame fanaticiſm which led to the murder of this accompliſhed female was probably the cauſe that her works have not deſcended to poſterity.

A. D. 410.

Mathematical collections of Pappus. A. D. 400.

15. Near the end of the fourth century of the Chriſtian era, Pappus of Alexandria publiſhed his mathematical collections, a work which, beſides many new propoſitions of his own, contains the moſt valuable productions of ancient geometry. Out of the eight books of which this work conſiſted, two have been loſt; the reſt are occupied with queſtions in geometry, aſtronomy and mechanics.

Diſcoveries of Diocles,

16. Diocles, whom we have already had occaſion to mention as the inventor of the ciſſoid, diſcovered the ſolution of a problem propoſed by Archimedes, viz. to cut a ſphere by a plane in a given ratio. The ſolution of Diocles has been conveyed to us by Eutocius, who wrote commentaries on ſome of the works of Archimedes and Apollonius, A. D. 520. About the time of

and Serenus.

of Diocles flouriſhed Serenus, who wrote two books on the cylinder and cone, which have been publiſhed at the end of Halley's edition of Apollonius.

Labours of Proclus. A. D. 500.

17. Geometry was likewiſe indebted to Proclus, the head of the Platonic ſchool at Athens, not only for his patronage of men of ſcience, but his commentary on the firſt book of Euclid. Mathematics were alſo cultivated by Marinus, the author of the Introduction to Euclid's Data;—by Iſidorus of Miletus, who was a diſciple of Proclus, and by Hero the younger, whoſe work, entitled Geodeſia, contains the method of determining the area of a triangle from its three ſides.

Deſtruction of the Alexandrian library.

18. While the mathematical ſciences were thus flouriſhing in Greece, and were ſo ſucceſsfully cultivated by the philoſophers of the Alexandrian ſchool, their very exiſtence was threatened by one of thoſe great revolutions with which the world has been convulſed. The dreadful ravages which were committed by the ſucceſſors of Mahomet in Egypt, Perſia, and Syria, the deſtruction of the Alexandrian library by the caliph Omar, and the diſperſion of a number of thoſe illuſtrious men who had flocked to Alexandria as the cultivators of ſcience, gave a deadly blow to the progreſs of geometry. When the fanaticiſm of the Mahometan religion, however, had ſubſided, and the termination of war had turned the minds of the Arabs to the purſuits of peace, the arts and ſciences engaged their affection, and they began to kindle thoſe very intellectual lights which they had ſo aſſiduouſly endeavoured to extinguiſh. The works of the Greek geometers were ſtudied with care; and the arts and ſciences reviving under the auſpices of the Arabs, were communicated in a more advanced condition to the other nations of the world.

Revival of ſcience.

A. D. 960.

19. The ſyſtem of arithmetical notation at preſent adopted in every civilized country, had its origin among the Arabs. Their ſyſtem of arithmetic was made known to Europe by the famous Gerbert, afterwards Pope Sylveſter II. who travelled into Spain when it was under the dominion of that nation.

20. The invention of algebra has been aſcribed to the Arabs by Cardan and Wallis, from the circumſtance of their uſing the words *ſquare*, *cube*, *quadrato-quadratum*, &c. inſtead of the 2d, 3d, 4th, &c. powers as employed by Diophantus. But whatever truth there may be in this ſuppoſition, it appears that they were able to reſolve cubic, and even biquadratic equations, as there is in the Leyden library, an Arabic MS. entitled "The Algebra of Cubic Equations, or the Solution of Solid Problems."

Progreſs of the Arabs in geometry.

21. The various works of the Greek geometers were tranſlated by the Arabs, and it is through the medium of an Arabic verſion, that the fifth and ſixth books of Apollonius have deſcended to our times. Mahomet Ben Muſa, the author of a work on Plane and Spherical Figures, and Geber Ben Aphla, who wrote a commentary on Plato, gave a new form to the plane and ſpherical trigonometry of the ancients. By reducing the theory of triangles to a few propoſitions, and by ſubſtituting, inſtead of the chords of double arcs, the ſines of the arcs themſelves, they ſimplified this important branch of geometry, and contributed greatly to the abridgement of aſtronomical calculation. A treatiſe on the art of ſurveying was likewiſe written by Mahomet of Bagdad.

22. After the deſtruction of the Alexandrian ſchool founded by Lagus, one of the ſucceſſors of Alexander, the diſperſed Greeks continued for a while to cultivate their favourite ſciences, and exhibited ſome marks of that genius which had inſpired their forefathers. The *magic ſquares* were invented by Moſchopulos, a diſcovery more remarkable for its ingenuity than for its practical uſe. The ſame ſubject was afterwards treated by Cornelius Agrippa in his work on occult philoſophy; by Bachet de Meziriac, a learned algebraiſt, about the beginning of the 17th century, and in later times by Frenicle de Beſſi, M. Poignard of Bruſſels, De la Hire, and Sauveur.

Moſchopulos's diſcovery of the magic ſquares.

23. The ſcience of pure mathematics advanced with a doubtful pace during the 13th, 14th, and 15th centuries. The algebra of the Arabians was introduced into Italy by Leonard of Piſa, who, in the courſe of his commercial ſpeculations in the eaſt, had conſiderable intercourſe with the Arabs. A work on the Planiſphere, and ten books on arithmetic, were written by Jordanus Nemorarius. The elements of Euclid were tranſlated by Campanus of Novara. A work on algebra, entitled *Summa de Arithmetica*, *Geometria*, *Proportione et Proportionalitate*, was publiſhed by Lucas Paccioli; and about the ſame time appeared Regiomontanus's treatiſe on trigonometry, which contains the method of reſolving ſpherical triangles in general, when the three angles or three ſides are known.

Algebra introduced into Italy by Leonard of Piſa. 1202, 1228.

A. D. 1230.

A. D. 1250.

A. D. 1494.

24. During the 16th century, algebra and geometry advanced with rapidity, and received many new diſcoveries from the Italian philoſophers. The formula for the ſolution of equations of the third degree was diſcovered by Scipio Ferrei profeſſor of mathematics at Bologna, and perhaps by Nicholas Tartalea of Breſcia; and equations of the fourth order were reſolved by Lewis Ferrari, the diſciple of Hieronymus Cardan of Bononia. This laſt mathematician publiſhed nine books of arithmetic in 1539; and in 1545 he added a tenth, containing the doctrine of cubic equations which he had received in ſecrecy from Tartalea, but which he had ſo improved as to render them in ſome meaſure his own. The common rule for ſolving cubic equations ſtill goes by the name of Cardan's Rule.

A. D. 1505.

A. D 1535.

Diſcoveries of Bombelli. A. D. 1579.

25. The irreducible caſe in cubic equations was ſucceſsfully illuſtrated by Raphael Bombelli of Bologna. He has ſhown in his algebra, what was then conſidered as a paradox, that the parts of the formula which repreſents each root in the irreducible caſe, form, when taken together, a real reſult; but the paradox vaniſhed when it was ſeen from the demonſtration of Bombelli that the imaginary quantities contained in the two numbers of the formula neceſſarily deſtroyed each other by their oppoſite ſigns. About this time Maurolycus, a Sicilian mathematician, diſcovered the method of ſumming up ſeveral ſerieſes of numbers, ſuch as the ſeries 1, 2, 3, 4, &c.; 1, 4, 9, 16, &c. and the ſeries of triangular numbers, 1, 3, 6, 10, 15, 21, &c.

Labours of Maurolycus. Born 1494. Died 1579.

Diſcoveries of Vieta. Born 1540. Died 1603.

26. The ſcience of analyſis is under great obligations to Francis Vieta, a native of France. He introduced the preſent mode of notation, called *literal*, by employing the letters of the alphabet to repreſent indefinite given quantities; and we are alſo indebted to him for the method of transforming one equation into another, whoſe roots are greater or leſs than thoſe of the original equation by a given quantity; for the method of multiplying or dividing their roots by any given number

ber, of depriving equations of the second term, and of freeing them from fractional coefficients. The method which he has given for resolving equations of the third and fourth degree is also new and ingenious, and his mode of obtaining an approximate solution of equations of every order is entitled to still higher praise. We are also indebted to Vieta for the theory of angular sections, the object of which is to find the general expressions of the chords or sines for a series of arcs that are multiples of each other.

Logarithms invented by Baron Napier. Born 1550 Died 1617.

27. While analysis was making such progress on the continent, Baron Napier of Merchiston in Scotland was bringing to perfection his illustrious discovery of the *logarithms*, a set of artificial numbers, by which the most tedious operations in multiplication and division may be performed merely by addition and subtraction. This discovery was published at Edinburgh in 1614 in his work entitled *Logarithmorum Canonis Descriptio, seu Arithmetica Supputationum Mirabilis Abbreviatio*. It is well known that there is such a correspondence between every arithmetical and geometrical progressions, viz. $\left\{\begin{matrix} 0, & 1, & 2, & 3, & 4, & 5, & 6, \\ 1, & 2, & 4, & 8, & 16, & 32, & 64, \end{matrix}\right\}$ that any terms of the geometrical progression may be multiplied or divided by merely adding or subtracting the corresponding terms of the arithmetical progression, thus the product of four and eight may be found by taking the sum of the corresponding terms in the arithmetical progression, viz. 2 and 3, for their sum 5 points out 32 as the product of 4 and 8. The numbers 0, 1, 2, 3, &c. are therefore the logarithms of 1, 2, 4, 8, &c. The choice of the two progressions being altogether arbitrary, Baron Napier took the arithmetical progression which we have given above, and made the term 0 correspond with the unit of the geometrical progression, which he regulated in such a manner that when its terms are represented by the abscissæ of an equilateral hyperbola in which the first abscis and the first ordinate are each equal to 1, the logarithms are represented by the hyperbolic spaces. In consequence, however, of the inconvenience of this geometrical progression, Baron Napier, after consulting upon the subject with Henry Briggs of Gresham College, substituted the decuple progression 1, 10, 100, 1000, of which 0, 1, 2, 3, 4, &c. are the logarithms. Nothing now remained but to construct tables of logarithms, by finding the logarithms of the intermediate numbers between the terms of the decuple progression. Napier, however, died before he was able to calculate these tables; but his loss was in some measure supplied by Mr Briggs, who applied himself with zeal to this arduous task, and published in 1618 a table of the logarithms of all numbers from 1 to 1000. In 1624 he published another table containing the logarithms from 1000 to 20,000, and from 90,000 to 100,000. The defects in Briggs's tables were filled up by his friends Gellibrand and Hadrian Vlacq, who also published new tables containing the logarithms of sines, tangents, &c. for 90 degrees.

Tables of logarithms computed by Mr Briggs.

A. D. 1618.

Discoveries of Harriot. Born 1560. Died 1621.

28. During the time when Napier and Briggs were doing honour to their country by completing the system of logarithms, algebra was making great progress in the hands of our countryman Harriot. His *Artis analyticæ Praxis*, which appeared in 1620, contains along with the discoveries of its author, a complete view of the state of algebra. He simplified the notation by substituting small letters instead of the capitals introduced by Vieta; and he was the first who showed that every equation beyond the first degree may be considered as produced by the multiplication of as many simple equations as there are units in the exponent of the highest power of the unknown quantity. From this he deduced the relation which exists between the roots of any equation, and the coefficients of the terms of which it consists.

Fernel first gives the measure of the earth.

29. About the same time, a foreign author named Fernel, physician to King Henry II. of France, had the merit of being the first who gave the measure of the earth. By reckoning the number of turns made by a coach wheel from Amiens to Paris, till the altitude of the pole star was increased one degree, he estimated the length of a degree of the meridian to be 56746 toises, which is wonderfully near the truth. He also wrote a work on mathematics, entitled *De Proportionibus*.— About this time it was shown by Peter Metius, a German mathematician, that if the diameter of a circle be 113, its circumference will be 355. This result, so very near the truth, and expressed in so few figures, has preserved the name of its author.

Metius finds more correct numbers for the diameter and circumference of a circle.

Discoveries of Descartes in algebra. Born 1596. Died 1650.

30. The next author, whose labours claim our attention, is the illustrious Descartes. We do not allude to those wild and ingenious speculations by which this philosopher endeavoured to explain the celestial phenomena; but to these great discoveries with which he enriched the kindred sciences of algebra and geometry. He introduced the present method of marking the powers of any quantity by numerical exponents. He first explained the use of negative roots in equations, and showed that they are as real and useful as positive roots, the only difference between them being founded on the different manner in which the corresponding quantities are considered. He pointed out the method of finding the number of positive and negative roots in any equation where the roots are real; and developed the method of indeterminates which Vieta had obscurely hinted at.

He extends the application of algebra to geometry.

31. Though Regiomontanus, Tartalea, and Bombelli, had resolved several geometrical problems by means of algebra, yet the general method of applying geometry to algebra was first given by Vieta. It is to Descartes, however, that we are indebted for the beautiful and extensive use which he made of his discovery. His method of representing the nature of curve lines by equations, and of arranging them in different orders according to the equations which distinguished them, opened a vast field of inquiry to subsequent mathematicians; and his methods of constructing curves of double curvature, and of drawing tangents to curve lines, have contributed much to the progress of geometry. The inverse method of tangents, which it was reserved for the fluxionary calculus to bring to perfection, originated at this time in a problem which Florimundus de Beaune proposed to Descartes. It was required to construct a curve in which the ratio of the ordinate and subtangent should be the same as that of a given line to the portion of the ordinate included between the curve and a line inclined at a given angle. The curve was constructed by Descartes, and several of its properties detected, but he was unable to accomplish the complete solution of the problem. These discoveries of Descartes were studied and improved by his successors, among whom

1647.

A. D. 1658.

whom we may number the celebrated Hudde, who published in Schooten's commentary on the geometry of Descartes, an excellent method of determining if an equation of any order contains several equal roots, and of discovering the roots which it contains.

Discoveries of Pascal. Born 1623. Died 1662.

32. The celebrated Pascal, who was equally distinguished by his literary and his scientific acquirements, extended the boundaries of analysis by the invention of his arithmetical triangle. By means of arbitrary numbers placed at the vertex of the triangle, he forms all the figurate numbers in succession, and determines the ratios between the numbers of any two cases, and the various sums resulting from the addition of all the numbers of one rank taken in any possible direction. This ingenious invention gave rise to the calculation of probabilities in the theory of games of chance, and formed the foundation of an excellent treatise of Huygens, entitled *De Ratiociniis in Ludo Aleæ*, published in 1657.

Discoveries of Fermat. Born 1590. Died 1663.

33. Several curious properties of numbers were at the same time discovered by Fermat at Toulouse. In the theory of prime numbers, particularly, which had first been considered by Eratosthenes, Fermat made great discoveries; and in the doctrine of indeterminate problems, he seems to have been deeply versed, having republished the arithmetic of Diophantus, and enriched it with many valuable notes of his own. He invented the method of discovering the *maxima* and *minima* of variable quantities, which serves to determine the tangents of geometrical curves, and paved the way for the invention of the fluxionary calculus.

Cavaleri's method of indivisibles. 1635.

34. Another step towards the discovery of fluxions was at this time made by Cavaleri in his geometry of indivisibles. In this work, which was published in 1635, its author supposes every plane surface to consist of an infinite number of planes; and he lays it down as an axiom, that these infinite sums of lines and surfaces have the same ratio when compared with the unit in each case as the superficies and solids to be measured. This ingenious method was employed by Cavaleri in the quadrature of the conic sections, and in the curvature of solids generated by their revolution, and in order to prove the accuracy of his theory, he deduced the same results from different principles.

The same subject discussed by Roberval. 1634.

35. Problems of a similar kind had been solved by Fermat and Descartes, and now occupied the attention of Roberval. The latter of these mathematicians began his investigation of this subject about a year before the publication of Cavaleri's work, and the methods which both of them employed were so far the same as to be founded on the principles of indivisibles. In the mode, however, which Roberval adopted, planes and solids were considered as composed of an infinite number of rectangles, whose altitudes and the thickness of their sections were infinitely small.—By means of this method, Roberval determined the area of the cycloid, the centre of gravity of this area, and the solids formed by its revolution on its axis and base. He also invented a general method for tangents, similar in metaphysical principles to that of fluxions, and applicable both to mechanical and geometrical curves. By means of this, he determined the tangents of the cycloid; but there were some curves which resisted its application. Considering every curve to be generated by the motion of a point, Roberval regarded this point as acted upon at every instant with two velocities ascertained from the nature of the curve. He constructed a parallelogram having its sides in the same ratio as the two velocities; and he assumes as a principle, that the direction of the tangent must fall on the diagonal, the position of which being ascertained, gives the position of the tangent.

Labours of Toricelli. 1644.

36. In 1644, solutions of the cycloidal problems formerly resolved by Roberval were published by Toricelli as invented by himself. The demonstrations of Roberval had been transmitted to Galileo the preceptor of Toricelli, and had also been published in 1637 in Mersennus's Universal Harmony. The Italian philosopher was consequently accused of plagiarism by Roberval, and the charge so deeply affected his mind as to bring him prematurely to the grave. It is obvious, however, from the demonstrations of Torricelli, that he had never seen those of Roberval, and that he was far from meriting that cruel accusation which deprived science of one of its brightest ornaments.

Farther discoveries of Pascal. 1658.

37. The cycloid having attracted the notice of geometers from the number and singularity of its properties, the celebrated Pascal proposed to them a variety of new problems relative to this curve, and offered prizes for their solution. These problems required the area of any cycloidal segment, the centre of gravity of that segment, the solids, and the centres of gravity of the solids, which are generated either by a whole revolution, a half or a quarter of a revolution of this segment round an abscissa or an ordinate. The resolution of these problems was attempted by Huygens, Sluze, Sir Christopher Wren, Fermat, and Roberval. Sluze discovered an ingenious method of finding the area of the curve. Huygens squared the segment comprised between the vertex, and as far as a fourth of the diameter of the generating circle; and Sir Christopher Wren ascertained the length of the cycloidal arc included between the vertex and the ordinate, the centre of gravity of this arc, and the surfaces of the solids generated during its revolution. These attempts were not considered by their authors as solutions of Pascal's problems, and therefore they did not lay claim to his prize. Our countryman Wallis, however, and Lallouere a Jesuit, gave in a solution of all the problems, and thought themselves entitled to the proffered reward. In the methods employed by these mathematicians, Pascal detected several sources of error; and it was reserved for that great genius to furnish a complete solution of his own problems. Extending his investigations to curtate and prolate cycloids, he proved that the length of these curves depends on the rectification of the ellipse, and assigned in each case the axis of the ellipse. From this method he deduced this curious theorem, that if two cycloids, the one curtate and the other prolate, be such, that the base of the one is equal to the circumference of the circle by which the other is generated, the length of these two cycloids will be equal.

Labours of Wallis. 1655

38. While these discoveries were making on the continent, the friends of science in Britain were actively employed in promoting its advancement. In 1655 Wallis published his *Arithmetica Infinitorum*, a work of great genius. He attempted to determine by the summation of infinite series, the quadrature of curves, and 1682. the curvature of solids, subjects which were afterwards investigated in a different manner by Ishmael Bullialdus. By Wallis's method, curves were squared when their ordinates are expressed by one term, and when their

their ordinates were complex quantities raifed to entire and pofitive powers, thefe ordinates were refolved into feries, of which each term is a monomial. Wallis attempted to extend his theory to curves whofe ordinates were complex and radical, by attempting to interpolate the feries of the former kind with a new feries; but he was unfuccefsful.

Difcoveries of Newton.

39. It was left to Newton to remove this difficulty. He folved the problem in a more direct and fimple manner by the aid of his new formula for expanding into an infinite feries any power of a binomial, whether its exponent was pofitive or negative, an integer or a fraction. Algebra is alfo indebted to this illuftrious mathematician for a fimple and extenfive method of refolving an equation into commenfurable factors; for a method of fumming up the powers of the roots of an equation, of extracting the roots of quantities partly commenfurable, and partly incommenfurable, and of finding by approximation the roots of literal and numerical equations of all orders.

Lord Brouncker difcovers continued fractions. Born 1620. Died 1684.

40. About this time, William Lord Brouncker, in attempting to demonftrate an expreffion of Wallis on the magnitude of the circle, difcovered the theory of continued fractions. When an irreducible fraction is expreffed by numbers too great and complicated to be eafily employed by the analyft, the method of Lord Brouncker enables us to fubftitute an expreffion much more fimple and nearly equivalent. This theory, which enables us to find a very accurate relation between the diameter and circumference of the circle, was employed by Huygens * in the calculation of his planetary automaton, for reprefenting the motions of the folar fyftem, and was enlarged and improved by other celebrated geometers. Lord Brouncker had likewife the merit of difcovering an infinite feries to reprefent the area of the hyperbola. The fame difcovery was made by Nicholas Mercator, who publifhed it in his *Logarithmotechnia* in 1668.

* *Opera Pofthuma*, tom. ii. *fub finem.*

Labours of James Gregory.

41. The fubject of infinite feries received confiderable addition from Mr James Gregory. He was the firft who gave the tangent and fecant in terms of the arc, and, inverfely, the arc in terms of the tangent and fecant. He conftructed feries for finding directly the logarithm of the tangent and fecant from the value of the arc, and the logarithm of the arc from that of the tangent and fecant; and he applied this theory of infinite feries to the rectification of the ellipfis and hyperbola.

Labours of Dr Barrow.

42. The differential triangle invented by the learned Dr Barrow, for drawing tangents to curves, may be regarded as another contribution towards the invention of fluxions. This triangle has for its fides the element of the curve and thofe of the abfcifs and ordinate, and thofe fides are treated as quantities infinitely fmall.

Theory of evolutes difcovered by Huygens, 1673.

43. The doctrine of evolutes had been flightly touched upon by Apollonius. It remained, however, for the illuftrious Huygens to bring it to perfection. His theory of evolutes is contained in his *Horologium Ofcillatorium*, publifhed in 1673, and may be regarded as one of the fineft difcoveries in geometry. When any curve is given, Huygens has pointed out the method of conftructing a fecond curve, by drawing a feries of perpendiculars to the firft, which are tangents to the fecond; and of finding the firft curve from the fecond. From this principle he deduces feveral theorems on the rectification of curves; and that remarkable property of the cycloid, in which an equal and fimilar cycloid is produced by evolution.

Hiftory of the difcovery of fluxions.

44. In contemplating the progrefs of analyfis from the beginning of the 17th century, to the invention of fluxions, we cannot fail to perceive the principles of that calculus gradually unfolding themfelves to view. The human mind feemed to advance with rapidity towards that great difcovery; and it is by no means unlikely that it would foon have arrived at the doctrine of fluxions, even if the fuperior genius of Newton had not accelerated its progrefs. In Cavalerius' *Geometria Indivifibilium*, we perceive the germ of the infinitefimal calculus; and the method of Roberval for finding the tangents of curves, bears a ftriking analogy to the metaphyfics of the fluxionary calculus. It was the glory of Newton, however, to invent and illuftrate the method of fluxions; and the obfcure hints which he received from preceding mathematicians, do not in the leaft detract from the merit of our illuftrious countryman.

General remarks on the difpute between Newton and Leibnitz.

45. On the claims of Leibnitz as a fecond inventor of fluxions, and the illiberal violence with which they have been urged by foreign mathematicians, we would wifh to fpeak with delicacy and moderation. Who that can appreciate the difcoveries of that celebrated mathematician, or is acquainted with that penetrating genius which threw light on every department of human knowledge, would willingly ftain his memory with an ungracious imputation? The accufation of plagiarifm is one of thofe charges which it is difficult either to fubftantiate or repel, and when directed againft a great man, ought never, without the cleareft evidence, to be wantonly preferred or willingly received. If charitable fentiments are ever to be entertained towards others,—to what clafs of beings fhould they be more cheerfully extended than to thofe who have been the ornaments of human nature? If fociety has agreed to regard as facred the failings and excentricities of genius,—when ought that reverence to be more ftrongly excited than when we are paffing judgement on its mightieft efforts? Inquiries into the motives and actions of the learned ought never to be wantonly indulged. When the honour of our country, or the character of an individual, requires fuch an inveftigation, a regard to truth, and a contempt of national prejudice, fhould guide the inquiry.—We fhould proceed with delicacy and forbearance.—We fhould tread lightly even on the afhes of genius. It is not uncommon to witnefs the indulgence of malicious pleafure, in detracting from the merits of a diftinguifhed character. The affailant raifes himfelf for a while to the level of his enemy, and acquires glory by his fall. But let him remember that the laurels thus won cannot flourifh long. The fame public opinion which conferred them will tear them from his brow, and configu the accufer to that infamy from which the brighteft abilities will be infufficient to raife him. The confequences of fuch conduct have been feen in the fall of Torricelli. It was the charges of plagiarifm, preferred by Roberval, that hurried this young and accomplifhed philofopher to an early grave.

46. We have been led into thefe obfervations by ftudying the difpute between the followers of Newton and Leibnitz. The claims of the Britifh, as well as thofe of the

the foreign mathematicians, have undoubtedly been too high; and victory rather than truth ſeems to have been the object of conteſt. Even the name of Newton has not eſcaped from ſerious imputations. The immenſity of the ſtake for which the different parties contended, may perhaps juſtify the commencement of the diſpute; and the brilliancy of the talents that were called into action, may leave us no cauſe to regret its continuance: But nothing can reconcile us to thoſe perſonal animoſities in which the good ſenſe and temper of philoſophy are loſt, and that violence of literary warfare where ſcience can gain nothing in the combat.—In giving an account, therefore, of that intereſting diſpute, we ſhall merely give a brief view of the facts that relate to the diſcovery of the higher calculus, and make a few obſervations on the concluſions to which they lead.

Newton publiſhes a tract containing the principles of fluxions.

47. In the year 1669, a paper of Sir Iſaac Newton's, entitled *De Analyſi per equationes numero terminorum infinitas*, was communicated by Dr Barrow to Mr Collins, one of the ſecretaries of the Royal Society. In this paper the author points out a new method of ſquaring curves, both when the expreſſion of the ordinate is a rational quantity, and when it contains complex radicals, by evolving the expreſſion of the ordinate into an infinite number of ſimple terms by means of the binomial theorem. In a letter from Newton to Collins, dated December 10. 1672, there is contained a method of drawing tangents to curve lines, without being obſtructed by radicals; and in both theſe works, an account of which was circulated on the continent by the ſecretaries of the Royal Society, the principles of the fluxional calculus are plainly exhibited; and it is the opinion of all the diſputants, that thoſe works at leaſt prove, that Newton muſt have been acquainted with the method of fluxions when he compoſed them.

48. Leibnitz came to London in 1673, and though there is no direct evidence that he ſaw Newton's paper *De Analyſi per Equationes*, &c. yet it is certain that he had ſeen Sir Iſaac's letter to Collins of 1672; and it is highly improbable that ſuch a man as Leibnitz ſhould have been ignorant of a paper of Newton's which had been four years in the poſſeſſion of the public, and which contained diſcuſſions at that time intereſting to every mathematician.

Correſpondence between Leibnitz and Oldenburg.

49. A letter from Newton to Oldenburg, one of the ſecretaries of the Royal Society, dated October 24. 1676, was communicated to Leibnitz. This letter contains ſeveral theorems without the demonſtrations, which are founded on the method of fluxions, and merely ſtates that they reſult from the ſolution of a general problem. The enunciation of this problem he expreſſes in a cypher, the meaning of which was, An equation containing any number of flowing quantities being given, to find the fluxions, and inverſely. In reply to this communication, Leibnitz tranſmitted a letter to Oldenburg, dated June 21. 1677, where he explains the nature of the differential calculus, and affirms, that he had long employed it for drawing tangents to curve lines.

Leibnitz publiſhes an account of the differential calculus.

50. The correſpondence between Leibnitz and Oldenburg having been broken off by the death of the latter, Leibnitz publiſhed in the *Acta Erudit. Lipſ.* for October 1684, the principles of the new analyſis, under the title of *Nova Methodus pro maximis et minimis, itemque tangentibus, quæ nec fractas, nec irrationales quantitates moratur, et ſingulare pro illis calculus.* This paper contains the method of differencing ſimple, fractional, and radical quantities, and the application of the calculus to the ſolution of ſome phyſical and geometrical problems. In 1685, he likewiſe publiſhed two ſmall pamphlets on the quadrature of curves, containing the principles of the *Calculus Summatorius*, or the *Inverſe Method of Fluxions*; and in 1686 there appeared another tract by the ſame author, *On the Recondite Geometry, and the Analyſis of Indiviſibles and Infinites*, containing the fundamental rule of the integral calculus.

Newton publiſhes his Principia.

51. Towards the cloſe of the year 1686, Sir Iſaac Newton gave to the world his illuſtrious work entitled *Philoſophiæ Naturalis Principia Mathematica*. Some of the moſt difficult problems in this work are founded on the fluxional calculus; and it is allowed by Boſſut, one of the defenders of Leibnitz, "that mathematicians did Newton the juſtice to acknowledge, that at the period when his *Principia* was publiſhed, he was maſter of the method of fluxions to a high degree, at leaſt with reſpect to that part which concerns the quadrature of curves." The claim of Leibnitz, as a ſeparate inventor of the differential calculus, is evidently allowed by Newton himſelf, when he obſerves, that Leibnitz had communicated to him a method ſimilar to his own for drawing tangents, &c. and differing from it only in the enunciation and notation.

Leibnitz propoſes the problem of the iſochronous curve; which is ſolved by Huygens in 1687.

52. About this time, it became faſhionable among geometers to perplex each other by the propoſal of new and difficult problems, a practice which powerfully contributed to the progreſs of mathematics. The diſpute in which Leibnitz was engaged with the Carteſians reſpecting the meaſure of active forces, which the former ſuppoſed to be as the ſimple velocity, while the latter aſſerted, that they were as the ſquare of the velocity, led him to propoſe the problem of the iſochronous curve, or "to find the curve which a heavy body muſt deſcribe equally, in order to approach or recede from a horizontal plane in equal times." This curve was found by Huygens to be the ſecond cubic parabola; but he gave only its properties and conſtruction without the demonſtrations. The ſame ſolution, along with the demonſtration, was given by Leibnitz in 1689, who, at the ſame time, propoſed to geometers to find the *paracentric iſochronal curve*, or the curve in which a body would equally approach or recede from a given point in equal times.

James Bernouilli alſo finds the iſochronous curve.

53. It was at this time that the two brothers, James and John Bernouilli, began to diſplay thoſe talents from which the phyſical and mathematical ſciences received ſuch immenſe improvements. James was born in 1654, and died in 1705; and John, who was his pupil, was born in 1667, and lived to the advanced age of 68 years. In 1690, James Bernouilli gave the ſame ſolution of the iſochronous curve that had been given by Huygens and Leibnitz; and propoſed the celebrated problem of the catenary curve, which had formerly perplexed the ingenuity of Galileo. In two memoirs, publiſhed in 1691, he determined, by means of the inverſe method of fluxions, the tangents of the parabolic ſpiral, the logarithmic ſpiral, and the loxodromic curve, and likewiſe the quadratures of their areas.

1691. Solution of the problem of the catenarian curve, and other analogous problems.

54. The problem of the catenary curve having occupied the attention of geometers, was reſolved by Huygens, Leibnitz,

Leibnitz, and John Bernouilli. In theſe ſolutions, however, the gravity of the catenary curve was ſuppoſed to be uniform; but James Bernouilli extended the ſolution to caſes where the weight of the curve varies from one point to another, according to a given law. From this problem he was alſo conducted to the determination of the curvature of a bended bow, and that of an elaſtic bar fixed at one extremity, and loaded at the other with a given weight. In the hopes of contributing to the progreſs of navigation, the ſame mathematician conſidered the form of a ſail ſwoln with the wind. When the wind, after ſtriking the ſail, is not prevented from eſcaping, the curvature of the ſail is that of the common catenarian curve; but when the ſail is ſuppoſed perfectly flexible, and filled with a fluid preſſing downwards on itſelf, as water preſſes on the ſides of a veſſel, the curve which it forms is one of thoſe denominated *lintearіæ*, which is expreſſed by the ſame equation as the common elaſtic curve, where the extenſions are reckoned proportional to the forces applied at each point.—The ſame problem was ſolved in the *Journal des Sçavans* for 1692, by John Bernouilli; but there is ſatisfactory evidence that it was chiefly borrowed from his brother James.

Labours of James Bernouilli.

1692.

55. The attention of James Bernouilli was now directed to the theory of curves produced by the revolution of one curve upon another. He conſiders one curve rolling upon a given curve, equal to the firſt, and immoveable. He determines the evolute and the cauſtic of the epicycloid, deſcribed by a point of the moving circle, and he deduces from it other two curves, denominated the *antievolute* and *pericauſtic*. He found alſo that the logarithmic ſpiral was its own evolute, cauſtic, antievolute, and pericauſtic; and that an analogous property belonged to the cycloid.

1692.

Problem of Viviani ſolved.

56. About this time Viviani, an Italian geometer, diſtinguiſhed as the reſtorer of Ariſteus's conic ſections, required the ſolution of the following problem, that there exiſted a temple of a hemiſpherical form, pierced with four equal windows, with ſuch ſkill, that the remainder of the hemiſphere might be perfectly ſquared. With the aid of the new analyſis, Leibnitz and James Bernouilli immediately found a ſolution, while that of Viviani was founded on the ancient geometry. He proved that the problem might be ſolved, by placing, parallel to the baſe of the hemiſphere, two right cylinders, the axes of which ſhould paſs through the centres of two radii, forming a diameter of the circle of the baſe, and piercing the dome each way.

Tſchirnhauſen on cauſtic curves.

James Bernouilli attends to the ſame ſubject,

1693.

57. Prior to ſome of theſe diſcuſſions, the curves called *cauſtic*, and ſometimes *Tſchirnhauſenian*, were diſcovered by Tſchirnhauſen. Theſe curves are formed by the croſſing of the rays of light, when reflected from a curved ſurface, or refracted through a lens ſo as not to meet in a ſingle point. With the aſſiſtance of the common geometry, Tſchirnhauſen diſcovered, that they are equal to ſtraight lines when they are formed by geometrical curves, and found out ſeveral other curious properties. By the aid of the higher calculus, James Bernouilli extended theſe reſearches, and added greatly to the theory of cauſtics produced by refraction.

And ſolves the problem of the paracentric iſochronal curve.

58. The problem of the paracentric iſochronal curve, propoſed by Leibnitz in 1689, was ſolved by James Bernouilli, who took for ordinates parallel ſtraight lines, and for abſciſſas the chords of an infinite number of concentric circles deſcribed about the given point. In this way he obtained a ſeparate equation, conſtructed at firſt by the rectification of the elaſtic curve, and afterwards by the rectification of an algebraic curve. The ſame problem was ſolved by John Bernouilli and Leibnitz. 1689.

The exponential calculus invented by Leibnitz and John Bernouilli.

59. In 1694, a branch of the new analyſis, called the *exponential calculus*, was invented ſeparately by John Bernouilli and Leibnitz. It conſiſts in differencing and integrating exponential quantities or powers with variable exponents. To Leibnitz, the priority in point of invention certainly belongs; but John Bernouilli was the firſt who publiſhed the rules and uſes of the calculus.

The Marquis l'Hoſpital publiſhes his analyſis of infinites.

60. The marquis l'Hoſpital, who, in 1695, had ſolved the problem about the curve of equilibration in draw-bridges, and ſhewn it to be an epicycloid, publiſhed in the following year his *Analyſis of Infinites for the underſtanding of curve lines*. In this celebrated work, the differential calculus, or the direct method of fluxions, was fully explained and illuſtrated; and as the knowledge of the higher geometry had been hitherto confined to a few, it was now deſtined to enlighten the different nations of Europe.

Newton finds the ſolid of leaſt reſiſtance.

61. The methods which were employed by Deſcartes, Fermat, &c. for finding the maxima and minima of quantities, yielded in point of ſimplicity and generality to that which was derived from the doctrine of fluxions. Another claſs of problems, however, of the ſame kind, but more complicated, from their requiring the inverſe method of fluxions, began now to exerciſe the ingenuity of mathematicians. A problem of this claſs for finding the ſolid of leaſt reſiſtance, was ſolved by Newton in the 34th propoſition of the 2d book of his *Principia*. After having determined the truncated right cone, which being moved in a fluid by the ſmalleſt baſe (which is unknown), experiences the leaſt reſiſtance, he gave without any demonſtration the ratio from which might be derived the differential equation of the curve that generates by a revolution of its axis the ſolid of leaſt reſiſtance. A general ſolution, however, was ſtill wanting, till the attention of geometers was directed to the ſubject by John Bernouilli, who propoſed, in 1697, the celebrated problem of the *Brachyſtochronon*, or the curve along the concave ſide of which if a heavy body deſcend, it will paſs in the leaſt time poſſible from one point to another, the two points not being in the ſame vertical line. This problem was reſolved by Leibnitz, Newton, the marquis de l'Hoſpital, and James Bernouilli, who demonſtrated that the curve of quickeſt deſcent is a cycloid reverſed. This reſult will appear at firſt ſurpriſing, when we conſider a line to be the ſhorteſt diſtance between two points; but the ſurpriſe will ceaſe when we reflect, that in a concave curve lying between the two given points the moving body deſcends at firſt in a more vertical direction, and therefore acquires a greater velocity than when it rolls down an inclined plane. This addition to its velocity, conſequently, at the commencement of its path may balance the increaſe of ſpace through which it has to move.

Diſpute between James and John Bernouilli on iſoperimetrical figures.

62. At the cloſe of this diſcuſſion commenced that celebrated diſpute about iſoperimetrical problems, between James and John Bernouilli, in which the qualities of the head were more conſpicuous than thoſe of the heart.

heart. Theſe illuſtrious characters, connected by the ſtrongeſt ties of affinity, were, at the commencement of their diſtinguiſhed career, united by the warmeſt affection. John was initiated by his elder brother into the mathematical ſciences; and a generous emulation, ſoftened by friendſhip in the one, and gratitude in the other, continued for ſome years to direct their ſtudies, and accelerate their progreſs. There are few men, however, who can ſupport at the ſame time the character of a rival and a friend. The ſucceſs of the one party is apt to awaken the envy of the other, and ſucceſs itſelf is often the parent of preſumption. A foundation is thus laid for future diſſenſion; and it is a melancholy fact in the hiſtory of learning, that the moſt ardent friendſhips have been ſacrificed on the altar of literary ambition.

1695.

Such was the caſe between the two Bernouillis. As ſoon as John was ſettled as profeſſor of mathematics at Groningen, all friendly intercourſe between the two brothers was at an end. Regarding John as the aggreſſor, and provoked at the ingratitude which he exhibited, his brother James challenged him by name to ſolve the following problems:

Problems propoſed by James to John Bernouilli.

1. "To find, among all the iſoperimetrical curves between given limits, ſuch a curve, that, conſtructing a ſecond curve, the ordinates of which ſhall be the functions of the ordinates or arcs of the former, the area of the ſecond curve ſhall be a maximum or a minimum.—2. "To find among all the cycloids which a heavy body may deſcribe in its deſcent from a point to a line, the poſition of which is given, that cycloid which is deſcribed in the leaſt poſſible time."—A prize of 50 florins was promiſed to John Bernouilli, if, within three months, he engaged to ſolve theſe problems, and publiſh within a year legitimate ſolutions of them.

63. In a ſhort time John Bernouilli produced his ſolution and demanded the prize. He ſucceeded in conſtructing the problem of ſwifteſt deſcent; but his ſolution of the other problem was radically defective. This failure mortified that vanity with which he gloried in his apparent ſucceſs. He acknowledged the miſtake in his ſolution, and, with the ſame imperious tone, tranſmitted a new reſult, and redemanded the prize. This new ſolution, which was ſtill defective, drew down the wit and ridicule of James Bernouilli, which his brother attempted to repel by a torrent of coarſe invective.

1700.

64. Leibnitz, Newton, and the marquis l'Hoſpital, being appointed arbiters in this diſpute, James Bernouilli publiſhed, in 1700, the formulæ of the iſoperimetrical problem, without any demonſtration; and John tranſmitted his ſolution to the French academy in February 1701, on condition that it ſhould not be opened till his brother's demonſtrations were publiſhed. In conſequence of this, James Bernouilli publiſhed his ſolution in May 1701, in the *Acta Eruditorum*, under the following title, *Analyſis magni Problematis Iſoperimetrici*, and gained great honour from the ſkill which it diſplayed. For five years John Bernouilli was ſilent upon the ſubject; but his brother dying in 1705, he publiſhed his ſolution in the Memoirs of the Academy for 1706. About 13 years afterwards, John Bernouilli having perceived the ſource of his error, confeſſed his miſtake, and publiſhed a new ſolution, not very different from that of his brother, in the Memoirs of the Academy for 1718.

65. In the problem relative to the cycloid of ſwifteſt deſcent, John Bernouilli obtained a reſult ſimilar to that of his brother, by a very ingenious method, which extended the bounds of the new analyſis.

John Bernouilli's ſolution of the ſecond problem. 1704.

In his inveſtigations he employed the ſynchronous curve, or that which cuts a ſeries of ſimilar curves placed in ſimilar poſitions, ſo that the arcs of the latter included between a given point and the ſynchronous curve, ſhall be deſcribed by a heavy body in equal times. He demonſtrated, that of all the cycloids thus interſected, that which is cut perpendicularly is deſcribed in leſs time than any other terminating equally at the ſynchronous curve. But being unable to give a general ſolution of the problem, he applied to Leibnitz, who eaſily reſolved it, and at that time invented the method of differencing *de curva in curvam*.

66. About a month after the death of the marquis de l'Hoſpital, John Bernouilli declared himſelf the author of a rule given by the marquis in his Analyſis of Infinites, for finding the value of a fraction, whoſe numerator and denominator ſhould vaniſh at the ſame inſtant, when the variable quantity that enters into it has a certain given value. The defence made by the marquis's friends only induced John Bernouilli to make greater demands, till he claimed as his own the moſt important parts of the Analyſis of Infinites: But it does not appear, from an examination of the ſubject, that there is any foundation for his claims.

Labours of Newton. 1704.

67. Towards the cloſe of 1704, Sir Iſaac Newton publiſhed, at the end of his Optics, his *Enumeratio linearum tertiæ ordinis*, and his treatiſe *De Quadratura Curvarum*. The firſt of theſe papers diſplays great ability; but is founded only on the common algebra, and the doctrine of ſeries which Newton had brought to ſuch perfection. His treatiſe, *De Quadratura Curvarum*, contains the reſolution of fluxional formulæ, with one variable quantity which leads to the quadrature of curves. By means of certain ſeries he obtains the reſolution of ſeveral complicated formulæ, by referring them to ſuch as are more ſimple; and theſe ſeries being interrupted in particular caſes, give the fluents in finite terms. From this ſeveral intereſting propoſitions are deduced, among which is the method of reſolving rational fractions.

1711.

In 1711 Newton publiſhed his *Method of Fluxions*. The object of this work is to determine, by ſimple algebra, the linear coefficients of an equation that ſatisfies as many conditions as there are coefficients, and to conſtruct a curve of the parabolic kind paſſing through any number of given points. Hence ariſes a ſimple method of finding the approximate quadrature of curves, in which a certain number of ordinates are determinable. It has been the opinion of ſome able mathematicians, that this treatiſe contains the firſt principles of the integral calculus with finite differences, afterwards invented by Dr Taylor.

1736.

A poſthumous work of Newton's, entitled the *Method of Fluxions, and of Infinite Series*, was publiſhed by Dr Pemberton about nine years after the death of its author; but it does not contain any new inveſtigations which accelerated the progreſs of the new analyſis.

Labours of Manfredi, Parent, and Saurin, 1707.

68. The mathematical ſciences were at this time indebted to the labours of Manfredi, Parent, and Saurin. The former of theſe geometers publiſhed a very able work, *De Conſtructione Equationum differentialium primi gradus*. To Parent we are indebted for the problem by which

which we obtain the ratio between the velocity of the power, and the weight for finding the *maximum* effect of machines; but his reputation was much injured by the obſcurity of his writings. Saurin was celebrated for his theoretical and practical knowledge of watchmaking, and was the firſt who elucidated the theory of tangents to the multiple points of curves.

Account of the diſpute between Newton and Leibnitz.

69. While the ſcience of analyſis was thus advancing with rapidity, the diſpute between Newton and Leibnitz began to be agitated among the mathematicians of Europe. Theſe illuſtrious rivals ſeemed to have been hitherto contented with ſharing the honour of having invented the fluxional calculus. But as ſoon as the priority of invention was attributed to Newton, the friends of Leibnitz came forward with eagerneſs to ſupport the claims of their maſter.

Facio de Duillier commences the diſpute in favour of Newton.

70. In a ſmall work on the curve of ſwifteſt deſcent, and the ſolid of leaſt reſiſtance, publiſhed in 1699, Nicholas Facio de Duillier, an eminent Genoeſe, attributed to Newton the firſt invention of fluxions, and hinted, that Leibnitz, as the ſecond inventor, had borrowed from the Engliſh philoſopher. Exaſperated at this improper inſinuation, Leibnitz came forward in his own defence, and appeals to the admiſſion of Newton in his *Principia*, that neither had borrowed from the other. He expreſſed his conviction, that Facio de Duillier was not authoriſed by Sir Iſaac, to prefer ſuch a charge, and threw himſelf upon the teſtimony and candour of the Engliſh geometer.

Leibnitz defends himſelf.

Dr Keill makes the ſame charge againſt Leibnitz. 1708.

71. The diſcuſſion reſted in this ſituation for ſeveral years, till our celebrated countryman, Dr Keill, inſtigated by an attack upon Newton in the Leipſic Journal, repeated the ſame charge againſt Leibnitz. The German philoſopher made the ſame reply as he did to his former opponent, and treated Dr Keill as a young man incapable of judging upon the ſubject. In 1711, Dr Keill addreſſed a letter to Sir Hans Sloane, ſecretary to the Royal Society, and accuſed Leibnitz of having adopted the differential notation, in order to have it believed, that he did not borrow his calculus from the writings of Newton.

1711.

Leibnitz appeals to the Royal Society. 1712.

72. Leibnitz was with reaſon irritated at this accuſation, and called upon the Royal Society to interfere in his behalf. A committee of that learned body was accordingly appointed to inveſtigate the ſubject, and their report was publiſhed in 1712, under the title of *Commercium Epiſtolicum de Analyſi promota*. In this report the committee maintain that Leibnitz was not the firſt inventor, and abſolve Dr Keill from all blame in giving the priority of invention to Newton. They were cautious, however, in ſtating their opinion upon that part of the charge in which Leibnitz was accuſed of plagiariſm.

Who appoint a committee to examine and report.

John Bernouilli replies to their report given in the *Commercium Epiſtolicum.*

73. In anſwer to the arguments advanced in the *Commercium Epiſtolicum*, John Bernouilli, the particular friend of Leibnitz, publiſhed a letter, in which he has the aſſurance to ſtate, that the method of fluxions did not precede the differential calculus, but that it might have taken its riſe from it. The reaſon which he aſſigns for this ſtrange aſſertion is, that the differential calculus was publiſhed before Newton had introduced an uniform algorithm into the method of fluxions. But it may as well be maintained that Newton did not diſcover the theory of univerſal gravitation, becauſe the attractive force of mountains and of ſmaller portions of matter was not aſcertained till the time of Maſkelyne and Cavendiſh. The principles of fluxions are allowed to have been diſcovered before thoſe of the differential calculus, and yet the former originated from the latter, becauſe the fluxional notation was not given at the ſame time!

Remarks on the controverſy.

74. Notwithſtanding the ridiculous aſſertion of John Bernouilli, it has been admitted by all the foreign mathematicians, that Newton was the firſt inventor of the method of fluxions. The point at iſſue therefore is merely this:—did Leibnitz ſee any of the writings of Newton that contained the principles of fluxions before he publiſhed in 1684 his *Nova Methodus pro maximis et minimis?* The friends of Leibnitz have adduced ſome preſumptive proofs, that he had never ſeen the treatiſe of Newton, *de Analyſi*, nor the letter to Collins, in both of which the principles of the new calculus were to be found; and in order to ſtrengthen their argument, they have not ſcrupled to aſſert, that the writings already mentioned contained but a vague and obſcure indication of the method of fluxions, and that Leibnitz might have peruſed them without having diſcovered it. This ſubſidiary argument, however, reſts upon the opinion of individuals; and the only way of repelling it is to give the opinion of an impartial judge. M. Montucla, the celebrated hiſtorian of the mathematics, who being a Frenchman, cannot be ſuſpected of partiality to the Engliſh, has admitted that Newton in his treatiſe *de Analyſi* "has diſcloſed in a very conciſe and obſcure manner his principles of fluxions," and "that the ſuſpicion of Leibnitz having ſeen this work is not deſtitute of probability, for Leibnitz admitted, that in his interview with Collins he had ſeen a part of the epiſtolary correſpondence between Newton and that gentleman." It is evident therefore that Leibnitz had opportunities of being acquainted with the doctrine of fluxions, before he had thought of the differential calculus; and as he was in London where Newton's treatiſe was publiſhed, and in company with the very men to whom the new analyſis had been communicated, it is very likely that he then acquired ſome knowledge of the ſubject. In favour of Leibnitz, however, it is but juſtice to ſay, that the tranſition from the method of tangents by Dr Barrow to the differential calculus is ſo ſimple, that Leibnitz might very eaſily have perceived it; and that the notation of his analyſis, the numerous applications which he made of it, and the perfection to which he carried the integral calculus, are conſiderable proofs that he was innocent of the charge which the Engliſh have attempted to fix upon his memory.

Works on the doctrine of chance. 1708.

75. In 1708, Remond de Montmort publiſhed a curious work entitled the Analyſis of Games of Chance, in which the common algebra was applied to the computation of probabilities, and the eſtimation of chances. Though this work did not contain any great diſcovery, yet it gave extent to the theory of ſeries, and admirably illuſtrated the doctrine of combinations. The ſame ſubject was afterwards diſcuſſed by M. de Moivre, a French proteſtant reſiding in England, in a ſmall treatiſe entitle *Menſura Sortis*, in which are given the elements of the theory of recurrent ſeries, and ſome very ingenious applications of it. Another edition was publiſhed in Engliſh in 1738, under the title of the *Doctrine of Chances.* 1711.

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Leibnitz proposes to English the problem of orthogonal trajectories.

76. A short time before his death, Leibnitz proposed to the English geometers the celebrated problem of orthogonal trajectories, which was to find the curve that cuts a series of given curves at a constant angle, or at an angle varying according to a given law. This problem was put into the hands of Sir Isaac Newton when he returned to dinner greatly fatigued, and he brought it to an equation before he went to rest. Leibnitz being recently dead, John Bernouilli assumed his place, and maintained, that nothing was easier than to bring the problem to an equation, and that the solution of the problem was not complete till the differential equation of the trajectory was resolved. Nicholas Bernouilli, the son of John resolved the particular case in which the intersected curves are hyperbolas with the same centre and the same vertex. James Hermann and Nicholas Bernouilli, the nephew of John, treated the subject by more general methods, which applied to the cases in which the intersected curves were geometrical. The most complete solution, however, was given by Dr Taylor in the Philosophical Transactions for 1717,
1717. though it was not sufficiently general, and could not apply to some cases capable of resolution. This defect was supplied by John Bernouilli, who in the Leipsic
1718. Transactions for 1718, published a very simple solution, embracing all the geometrical curves, and a great number of the mechanical ones.

Integration of rational fractions. 1719.

77. During these discussions, several difficult problems on the integration of rational fractions were proposed by Dr Taylor, and solved by John Bernouilli. This subject, however, had been first discussed by Roger Cotes, professor of mathematics at Cambridge, who died in 1710. In his posthumous work entitled *Harmonia Mensurarum*, published in 1716, he gave general and convenient formulæ for the integration of rational fractions; and we are indebted to this young geometer for his method of estimating errors in mixed mathematics, for his remarks on the differential method of Newton, and for his celebrated theorem for resolving certain equations.

Labours of Roger Cotes, born 1676.

Dr Taylor invents the integral calculus of finite differences.

78. In 1715, Dr Taylor published his learned work entitled *Methodus incrementorum directa et inversa*. In this work the doctor gives the name of increments or decrements of variable quantities to the differences, whether finite or infinitely small, of two consecutive terms in a series formed after a given law. When the differences are infinitely small, their calculus belongs to fluxions; but when they are finite, the method of finding their relation to the quantities by which they are produced forms a new calculus, called the integral calculus of finite differences. In consequence of this work, Dr Taylor was attacked anonymously by John Bernouilli, who lavished upon the English geometer all that dull abuse, and angry ridicule, which he had formerly heaped upon his brother.

Problem of reciprocal trajectories.

79. The problem of reciprocal trajectories was at this time proposed by the Bernouillis. This problem required the curves which, being constructed in two op-
1716. posite directions in one axis, given in position, and then moving parallel to one another with unequal velocities, should perpetually intersect each other at a given angle. It was long discussed between John Bernouilli and an anonymous writer, who proved to be Dr Pemberton. It was by an elegant solution of this problem that
1728. the celebrated Euler began to be distinguished among mathematicians. He was the pupil of John Bernouilli, and continued through the whole of his life, the friend and rival of his son Daniel. The great object of his labours was to extend the boundaries of analysis; and before he had reached his 21st year, he published a new and general method of resolving differential equations of the second order, subjected to certain conditions.

Resolved by Euler, born 1707, died 1783.

Labours of Count Fagnani.

80. The common algebra had been applied by Leibnitz and John Bernouilli to determine arcs of the parabola, the difference of which is an algebraic quantity, imagining that such problems in the case of the ellipse and hyperbola resisted the application of the new analysis. The Count de Fagnani, however, applied the integral calculus to the arcs of the ellipsis and hyperbola, and had the honour of explaining this new branch of geometry.

Problem of Count Riccati.

81. In the various problems depending on the analysis of infinites, the great difficulty is to resolve the differential equation to which the problems are reduced. Count James Riccati having been puzzled with a differential 1725.
equation of the first order, with two variable quantities, proposed it to mathematicians in the Leipsic Acts for 1725. This question baffled the skill of the most celebrated analysts, who were merely able to point out a number of cases in which the indeterminate can be separated, and the equation resolved by the quadrature of curves.

Problem of Offenburg.

82. Another problem suggested by that of Viviani was proposed in 1718 by Ernest von Offenburg. It was required to pierce a hemispherical vault with any number of elliptical windows, so that their circumferences should be expressed by algebraic quantities;—or in other words, to determine on the surface of a sphere, curves algebraically rectifiable. In a paper on the rectification of spherical epicycloids, Herman * imagined that these curves were algebraically rectifiable, and therefore satisfied the question of Offenburg; but John Bernouilli (Mem. Acad. Par. 1732.) demonstrated, that 1726.
as the rectification of these curves depended on the quadrature of the hyperbola, they were only rectifiable in certain cases, and gave the general method of determining the curves that are algebraically rectifiable on the surface of a sphere.

* Petersburgh Transactions.

Resolved by John Bernouilli.

Labours of Clairaut.

83. The same subject was also discussed by Nicole and Clairaut, (Mem. Acad. 1734). The latter of these mathematicians had already acquired fame by his *Recherches sur les Courbes à double Courbure*, published in 1730, before he was 21 years of age; but his reputation was extended by a method of finding curves whose property consists in a certain relation between these branches expressed by a given equation. In this research, Clairaut pointed out a species of paradox in the integral calculus, which led to the celebrated theory of particular integrals which was afterwards fully illustrated by Euler and other geometers.

Problem of isochronous curves.

84. The celebrated problem of isochronous curves began at this time to be reagitated among mathematicians. The object of this problem is to find such a curve that a heavy body descending along its concavity shall always reach the lowest point in the same time, from whatever point of the curve it begins to descend. Huygens had already shewn that the cycloid was the isochronous curve *in vacuo*. Newton had demonstrated the same curve to be isochronous when the descending body experiences from the air a resistance proportional to its velocity,

Memoirs of Petersburgh, 1729, and †*Mem. Par.* 1730.

locity; and Euler * and John Bernouilli †, had separately found the isochronous curve when the resistance was as the square of the velocity. These three cases, and even a fourth in which the resistance was as the square of the velocity added to the product of the velocity by a constant coefficient, were all resolved by Fontaine, by means of an ingenious and original method; and it is very remarkable that the isochronous curve is the same in the third and fourth cases.—The method of Fontaine was illustrated by Euler, who solved a fifth case, including all the other four, when the resistance is composed of three terms, the square of the velocity, the product of the velocity by a given coefficient, and a constant quantity. He found also an expression of the time which the body employs to descend through any arc of the curve.

Solved by Fontaine.

Algebra of sines and cosines.

85. The application of analytical formulæ to the physico-mathematical sciences was much facilitated by the algebra of sines and cosines with which Frederick Christian Mayer, and Euler, enriched geometry. By the combination of arcs, sines, and cosines, formulæ are obtained which frequently yield to the method of resolution, and enable us to solve a number of problems which the ordinary use of arcs, sines, and cosines, would render tedious and complicated.

Improvement in the resolution of differential equations.

86. About this time a great discovery in the theory of differential equations of the first order was made separately by Euler, Fontaine, and Clairaut. Hitherto geometers had no direct method of ascertaining if any differential equation were resolvable in the state in which it was presented, or if it required some preparation prior to its resolution. For every differential equation a particular method was employed, and their resolution was often effected by a kind of tentative process, which displayed the ingenuity of its author, without being applicable to other equations. The conditions under which differential equations of the first order are resolvable were discovered by the three mathematicians whom we have mentioned. Euler made the discovery in 1736, but did not publish it till 1740. Fontaine and Clairaut lighted upon it in 1739. Euler afterwards extended the discovery to equations of higher orders.

Discovery of the integral calculus with partial differences.

87. The first traces of the integral calculus with partial differences appeared in a paper of Euler's in the Petersburgh Transactions for 1734; but d'Alembert, in his work *Sur les Vents*, has given clearer notions of it, and was the first who employed it in solution of the problem of vibrating cords proposed by Dr Taylor, and investigated by Euler and Daniel Bernouilli. The object of this calculus is to find a function of several variable quantities, when we have the relation of the coefficients which affect the differentials of the variable quantities of which this function is composed. Euler exhibited it in various points of view, and shewed its application to a number of physical problems; and he afterwards, in his paper entitled *Investigatio Functionum ex data Differentialium conditione* *, he completely explained the nature, and gave the algorithm of the calculus.

* *Petersburgh Transactions*, 1762.

The principles of fluxions attacked by Dr Berkeley, 1734.

88. While the analysis of infinites was making such rapid progress on the continent, it was attacked in England by the celebrated Dr Berkeley, bishop of Cloyne, in a work called the *Analyst, or a discourse addressed to an Infidel Mathematician, 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.* In this work the doctor admits the truth of the conclusions, but maintains that the principles of fluxions are not founded upon reasoning strictly logical and conclusive. This attack called forth Robins and Maclaurin. The former proved that the principles of fluxions were consistent with the strictest reasoning, while Maclaurin, in his *Treatise of Fluxions*, gave a synthetical demonstration of the principles of the calculus after the manner of the ancient geometricians, and establishes it with such clearness and satisfaction that no intelligent man could refuse his assent. The differential calculus had been attacked at an earlier period by *Nieuwentiet* and *Rolle*, but the weapons wielded by these adversaries were contemptible when compared with the ingenuity of Dr Berkeley.

Works of Thomas Simpson.

89. Notwithstanding this attack upon the principles of the new analysis, the science of geometry made rapid advances in England in the hands of Thomas Simpson, Landen and Waring. In 1740, Mr Simpson published his *Treatise on Fluxions*, which, besides many original researches, contains a convenient method of resolving differential equations by approximation, and various means of hastening the convergency of slowly converging series. We are indebted to the same geometer for several general theorems for summing different series, whether they are susceptible of an absolute or an approximate summation. His *Mathematical Dissertations*, published in 1743, his *Essays on several Subjects in Mathematics*, published in 1740, and his *Select Exercises for Young Proficients in the Mathematics*, published in 1752, contain ingenious and original researches which contributed to the progress of geometry.

1740.

1743.

The residual analysis invented by Landen. Died in 1777.

90. In his *Mathematical Lucubrations*, published in 1755, Mr Landen has given several ingenious theorems for the summation of series; and the Philosophical Transactions for 1775 contain his curious discovery of the rectification of a hyperbolic arc, by means of two arcs of an ellipsis, which was afterwards more simply demonstrated by Legendre. His invention of a new calculus, called the *residual analysis*, and in some respects subsidiary to the method of fluxions, has immortalized his name. It was announced and explained in a small pamphlet published in 1715, entitled a *Discourse concerning the Residual Analysis*.

Labours of Waring, *Phil. Trans.* 1784, and 1791, p. 146.

91. The progress of geometry in England was accelerated by the labours of Mr Edward Waring, professor of mathematics at Cambridge. His two works entitled *Meditationes Analyticæ*, published in 1769, and *Meditationes Algebraicæ*, and his papers in the Philosophical Transactions on the summation of forces, are filled with original and profound researches into various branches of the common algebra, and the higher analysis.

Discoveries of Lagrange.

92. It was from the genius of Lagrange, however, that the higher calculus has received the most brilliant improvements. This great man was born in Piedmont. He afterwards removed to Berlin, and hence to Paris, where he still resides. In addition to many improvements upon the integral analysis, he has enriched geometry with a new calculus called the *method of variations*. The object of this calculus is, when there is given an expression or function of two or more variable quantities whose relation is expressed by a certain law, to find what this function becomes when that law suffers any variation infinitely

His method of variations.

small,

small, occasioned by the variation of one or more of the terms which express it. This calculus is as much superior to the integral calculus, as the integral calculus is above the common algebra. It is the only means by which we can resolve an immense number of problems *de maximis et minimis*, and is necessary for the solution of the most interesting problems in mechanics.

His theory of analytical functions. His theory of analytical functions is one of the most brilliant specimens of human genius. In the Memoirs of Berlin for 1772 he had touched upon this interesting subject, but the theory was completely developed in 1797 in his work entitled *Theorie des fonctions analytiques, contenant les principes du calcul differentiel, degagees de toute consideration d'infiniments petits, ou evanouissements, ou des limites, ou des fluxions; et reduit à l'analyse algebrique des quantites finies*. In a great number of memoirs which are to be found in the Memoirs of the Academy of Paris, in those of the Academy of Berlin, and in those of the French Academy, Lagrange has thrown light on every branch both of the common algebra and the new analysis.

Labours of La Place. 93. The new geometry has likewise been much indebted to the celebrated Laplace. His various papers in the *Memoires des Sçavans Etrangers*,* and the Memoirs of the French Academy, have added greatly to the higher calculi, while his application of analysis to the celestial phenomena, as exhibited in the *Mecanique Celeste*, and his various discoveries in physical astronomy, entitle him to a high rank among the promoters of science.

* Tom. 6. 7.

Works of Cousin, Lacroix, Bossut, and Legendre. 94. Among the celebrated French mathematicians of the last and present century, we cannot omit the names of Cousin, Lacroix, and Bossut; all of whom have written large works on the differential and integral calculi, and illustrated the new analysis by their discoveries. The *Elemens de Geometrie* by Legendre is one of the best and most original works upon elementary geometry, and his papers in the Memoirs of the Academy contain several improvements upon the new analysis.

Agnesi's analytical institutions. 1748. 95. In Italy the mathematical sciences were destined to be improved and explained by a celebrated female. Donna Maria Gaetana Agnesi was professor of mathematics in the university of Bologna, and published a learned work entitled *Analytical Institutions*, containing the common analysis, and the differential and integral calculi. It has been translated into English by Professor Colson, and was published at the expence of Baron Maseres.

Mascheroni on the circle. A few years ago several curious properties of the circle have been discovered by Mascheroni, another Italian mathematician, who has published them in his interesting work *sur le Geometrie du Compas*.

English mathematicians. 96. In England the mathematical sciences have been successfully cultivated by Emerson, Baron Maseres, Dr M. Young, Dr Hutton, Professor Vince, and Professor Robertson of Oxford.

Emerson. The *Doctrine of Fluxions* by Emerson, and his *Method of Increments*, are good introductions to the higher geometry.

Baron Maseres. The *Scriptores Logarithmici* of Baron Maseres; his *Tracts on the Resolution of Equations*; his *Principles of Life Annuities*, and his other mathematical papers, do the highest honour to his talents as a mathematician; while his zeal for the promotion of the mathematical sciences, and his generous attention to those who cultivate them, entitle him to the noble appellation of the friend and patron of genius.

Dr M. Young. Dr Mathew Young, bishop of Clonfert, has given a synthetical demonstration of Newton's rule for the quadrature of simple curves; and has written on the extraction of cubic and other roots.

Dr Hutton and Dr Vince. Dr Hutton and Dr Vince have each published several elementary treatises on mathematics, and have invented ingenious methods for the summation of series.

Mr Robertson. Mr Robertson of Oxford is the author of an excellent treatise on conic sections.

110 Scottish mathematicians. 97. The ancient geometry was assiduously cultivated in Scotland by Dr Robert Simpson and Dr Matthew Stewart.

Dr Simpson. Dr Simpson's edition of Euclid and his treatise on conic sections have been much admired.

Dr M. Stewart. The *Tracts Physical and Mathematical* of Dr Matthew Stewart, and his *Propositiones Geometricæ more veterum demonstratæ*, contain fine specimens of mathematical genius. In the present day the names of Professor Playfair and Professor Leslie of the university of Edinburgh, Mr Wallace and Mr Ivory now of the Royal Military College at Great Marlow, are well known to mathematicians.

Mr Playfair. Mr Playfair's Elements of Geometry, and his papers on *the Arithmetic of Impossible Quantities* and on *Porisms*, are proofs of his great talents as a mathematician and a philosopher.

Mr Leslie. Mr Leslie, well known for his great discoveries on heat, has found a very simple principle, capable of extensive application, by which the complicated expressions in the solution of indeterminate problems may be easily resolved.

Mr Wallace. Mr Wallace's papers on *Geometrical Porisms* in the 4th vol. of the Edinburgh Transactions, display much genius;

Mr Ivory. and Mr Ivory's Treatises in the last vol. of Baron Maseres's *Scriptores Logarithmici*, and his paper on *A New Series for the Rectification of the Ellipsis*, Edin. Transf. vol. 4th. entitle him to a high rank among modern mathematicians.

Mathematical. MATHEMATICAL, any thing belonging to the science of mathematics.

Mathematical Instruments, such instruments as are usually employed by mathematicians, as compasses, scales, quadrants, &c.

Machine for dividing Mathematical Instruments. See Ramsden's *Machine*.

Matlock. MATLOCK, a town or village of Derbyshire, near Wickfworth, situated on the very edge of the Derwent; noted for its bath, the water of which is milk-warm; and remarkable for the huge rocks in its environs, particularly those called the *Torr*, on the east side of the Derwent, over against it, which seem to be piled one upon another. It is an extensive straggling village, built in a very romantic style, on the steep side of a mountain, rising irregularly from the bottom to nearly the summit. Near the bath are several small houses, whose situation is on the little natural horizontal

tal parts of the mountain, a few yards above the road, and in ſome places the roofs of ſome almoſt touch the floors of others. There are excellent accommodations for company who reſort to the bath; and the poorer inhabitants are ſupported by the ſale of petrifactions, cryſtals, &c. and notwithſtanding the rockineſs of the ſoil, the cliffs produce an immenſe number of trees, whoſe foliage adds greatly to the beauty of the place.

MATRASS, Cucurbit, or Bolthead, among chemiſts. See Chemistry, Explanation of Plates.

MATRICARIA, Feverfew; a genus of plants, belonging to the ſyngeneſia claſs; and in the natural method ranking under the 49th order, *Compoſitæ*. See Botany *Index*.

MATRICE, or Matrix. See Matrix.

Matrice, or matrix, in *Dyeing*, is applied to the five ſimple colours, whence all the reſt are derived or compoſed. Theſe are, the black, white, blue, red, and yellow or root colour.

Matrice, or matrices, uſed by the letter-founders, are thoſe little pieces of copper or braſs, at one end whereof are engraven, dentwiſe, or *en creux*, the ſeveral characters uſed in the compoſing of books. Each character, virgula, and even each point in a diſcourſe, has its ſeveral matrix; and of conſequence its ſeveral puncheon to ſtrike it. They are the engravers on metal that cut or grave the matrices.

When types are to be caſt, the matrice is faſtened to the end of a mould, ſo diſpoſed as that when the metal is poured on it, it may fall into the creux or cavity of the matrice, and take the figure and impreſſion thereof. See *Letter Foundery*.

Matrices, uſed in coining, are pieces of ſteel in form of dies, whereon are engraven the ſeveral figures, arms, characters, legends, &c. wherewith the ſpecies are to be ſtamped. The engraving is performed with ſeveral puncheons, which being formed in relievo, or prominent, when ſtruck on the metal, make an indented impreſſion, which the French call *en creux*.

MATRICULA, a regiſter kept of the admiſſion of officers and perſons entered into any body or ſociety whereof a liſt is made. Hence thoſe who are admitted into our univerſities are ſaid to be matriculated. Among eccleſiaſtical authors, we find mention made of two kinds of matricule; the one containing a liſt of the eccleſiaſtics, called *matricula clericorum:* the other of the poor ſubſiſted at the expence of the church, called *matricula pauperum*.

Matricula was alſo applied to a kind of almshouſe, where the poor were provided for. It had certain revenues appropriated to it, and was uſually built near the church, whence the name was alſo frequently given to the church itſelf.

MATRIMONY. See Marriage.

MATRIX, in *Anatomy*, the womb, or that part of the female of any kind, wherein the fœtus is conceived and nouriſhed till the time of its delivery. See Anatomy, N° 108.

Matrix is alſo applied to places proper for the generation of vegetables, minerals, and metals. Thus the earth is the matrix wherein ſeeds ſprout; and marcaſites are by many conſidered as the matrices of metals.

The matrix of ores is the earthy and ſtony ſubſtances in which theſe metallic matters are enveloped: theſe are various, as lime and heavy ſpar, quartz, fluors, &c.

MATRON, an elderly married woman.

Jury of Matrons. When a widow feigns herſelf with child in order to exclude the next heir, and a ſuppoſititious birth is ſuſpected to be intended, then, upon the writ *de ventre inſpiciendo*, a jury of women is to be impannelled to try the queſtion whether the woman is with child or not. So, if a woman is convicted of a capital offence, and, being condemned to ſuffer death, pleads in ſtay of execution, that ſhe is pregnant, a jury of matrons is impannelled to inquire into the truth of the allegation; and, if they find it true, the convict is reſpited till after her delivery.

MATRONA, in *Ancient Geography*, a river ſeparating Gallia Celtica from the Belgica (Ceſar). Now the Marne; which, riſing in Champagne near Langres, runs north-weſt, and then weſt, and paſſing by Meaux falls into the Seine at Charenton, two leagues to the eaſt of Paris.

MATRONALIA, a Roman feſtival inſtituted by Romulus, and celebrated on the kalends of March, in honour of Mars. It was kept by matrons in particular, and bachelors were entirely excluded from any ſhare in the ſolemnity. The men during this feaſt ſent preſents to the women, for which a return was made by them at the Saturnalia: And the women gave the ſame indulgence to their ſervants now which the men gave to theirs at the feaſt of Saturn, ſerving them at table, and treating them as ſuperiors.

MATROSSES, are ſoldiers in the train of artillery, who are next to the gunners, and aſſiſt them in loading, firing, and ſpunging the great guns. They carry firelocks, and march along with the ſtore waggons, both as a guard, and to give their aſſiſtance in caſe a waggon ſhould break down.

MATSYS, Quintin, painter of hiſtory and portraits, was born at Antwerp in 1460, and for ſeveral years followed the trade of a blackſmith or farrier, at leaſt till he was in his 20th year. Authors vary in their accounts of the cauſe of his quitting his firſt occupation, and attaching himſelf to the art of painting. Some affirm, that the firſt unfolding of his genius was occaſioned by the ſight of a print which accidentally was ſhown to him by a friend who came to pay him a viſit while he was in a declining ſtate of health from the labour of his former employment, and that by his copying the print with ſome degree of ſucceſs, he was animated with a deſire to learn the art of painting. Others ſay, he fell in love with a young woman of great beauty, the daughter of a painter, and they allege that love alone wrought the miracle, as he could have no proſpect of obtaining her except by a diſtinguiſhed merit in the profeſſion of painting: for which reaſon he applied himſelf with inceſſant labour to ſtudy and practiſe the art, till he became ſo eminent as to be entitled to demand her in marriage, and he ſucceeded. Whatever truth may be in either of theſe accounts, it is certain that he appeared to have an uncommon genius; his manner was ſingular, not reſembling the manner of any other maſter; and his pictures were ſtrongly coloured and carefully finiſhed, but yet they are ſomewhat dry and hard. By many competent judges it was believed, when they obſerved the ſtrength of expreſſion in ſome of his compoſitions, that if he had ſtudied in Italy to acquire ſome knowledge of the antiques and the great maſters of the Roman ſchool, he would have proved one of the moſt eminent painters of the Low Countries. But he only imitated ordinary life; and ſeemed more inclined, or at leaſt more qualified, to imitate the defects than the beauties of nature. Some hiſtorical compoſitions of this maſter deſerve commendation; particularly a Deſcent from the Croſs, which is in the cathedral at Antwerp; and it is juſtly admired for the ſpirit, ſkill, and delicacy of the whole. But the moſt remarkable and beſt known picture of Matſys, is that of the Two Miſers in the gallery at Windſor. He died in 1529.

MATT, in a ſhip, is a name given to rope-yarn, junk, &c. beat flat and interwoven; uſed in order to preſerve the yards from galling or rubbing, in hoiſting or lowering them.

MATTER, in common language, is a word of the ſame import with *body*, and denotes that which is tangible, viſible, and extended; but among philoſophers it ſignifies that ſubſtance of which all bodies are compoſed; and in this ſenſe it is ſynonymous with the word ELEMENT.

It is only by the ſenſes that we have any communication with the external world; but the immediate objects of ſenſe, philoſophers have in general agreed to term *qualities*, which they conceive as inhering in ſomething which is called their *ſubject* or *ſubſtratum.* It is this ſubſtratum of ſenſible qualities which, in the language of philoſophy, is denominated *matter;* ſo that *matter* is *not* that which we immediately ſee or handle, but the *concealed ſubject* or *ſupport* of viſible and tangible qualities. What the moderns term *qualities*, was by Ariſtotle and his followers called *form;* but ſo far as the two doctrines are intelligible, there appears to be no eſſential difference between them. From the moderns we learn, that body conſiſts of *matter* and *qualities;* and the Peripatetics taught the ſame thing, when they ſaid that body is compoſed of *matter* and *form.*

How philoſophers were led to analyze body into matter and form, or, to uſe modern language, into matter and qualities; what kind of exiſtence they attribute to each; and whether *matter* muſt be conceived as ſelf-exiſtent or created—are queſtions which ſhall be conſidered afterwards (See METAPHYSICS). It is ſufficient here to have defined the term.

MATTHEW, or *Goſpel of St MATTHEW*, a canonical book of the New Teſtament.

St MATTHEW wrote his goſpel in Judea, at the requeſt of thoſe he had converted; and it is thought he began in the year 41, eight years after Chriſt's reſurrection. It was written, according to the teſtimony of all the ancients, in the Hebrew or Syriac language; but the Greek verſion, which now paſſes for the original, is as old as the apoſtolical times.

St MATTHEW the Evangeliſt's Day, a feſtival of the Chriſtian church, obſerved on September 21ſt.

St MATTHEW, the ſon of Alpheus, was alſo called *Levi.* He was of Jewiſh original, as both his names diſcover, and probably a Galilean. Before his call to the apoſtolate, he was a publican or toll-gatherer to the Romans; an office of bad repute among the Jews, on account of the covetouſneſs and exaction of thoſe who managed it; St Matthew's office particularly conſiſting in gathering the cuſtoms of all merchandiſe that came by the ſea of Galilee, and the tribute that paſſengers were to pay who went by water. And here it was that Matthew ſat at the receipt of cuſtoms, when our Saviour called him to be a diſciple. It is probable, that, living at Capernaum, the place of Chriſt's uſual reſidence, he might have ſome knowledge of him before he was called. Matthew immediately expreſſed his ſatisfaction in being called to this high dignity, by entertaining our Saviour and his diſciples at a great dinner at his own houſe, whither he invited all his friends, eſpecially thoſe of his own profeſſion, hoping, probably, that they might be influenced by the company and converſation of Chriſt. St Matthew continued with the reſt of the apoſtles till after our Lord's aſcenſion. For the firſt eight years afterwards, he preached in Judea. Then he betook himſelf to propagating the goſpel among the Gentiles, and choſe Ethiopia as the ſcene of his apoſtolical miniſtry; where it is ſaid he ſuffered martyrdom, but by what kind of death is altogether uncertain. It is pretended, but without any foundation, that Hyrtacus, king of Ethiopia, deſiring to marry Iphigenia, the daughter of his brother and predeceſſor Æglippus, and the apoſtle having repreſented to him that he could not lawfully do it, the enraged prince ordered his head immediately to be cut off. Baronius tells us, the body of St Matthew was tranſported from Ethiopia to Bithynia, and from thence was carried to Salernum in the kingdom of Naples in the year 954, where it was found in 1080, and where Duke Robert built a church bearing his name.

St MATTHEW, a town of Spain, in the kingdom of Arragon, ſeated in a pleaſant plain, and in a very fertile country watered with many ſprings. W. Long. 0. 15. N. Lat. 40. 22.

MATTHEW of Paris. See PARIS.

MATTHEW of Weſtminſter, a Benedictine monk and accompliſhed ſcholar, who wrote a hiſtory from the beginning of the world to the end of the reign of Edward I. under the title of *Flores Hiſtoriarum;* which was afterwards continued by other hands. He died in 1380.

St MATTHIAS, an apoſtle, was choſen inſtead of Judas. He preached in Judæa and part of Ethiopia, and ſuffered martyrdom. See the *Acts of the Apoſtles*, chap. i. There was a goſpel publiſhed under Matthias's name, but rejected as ſpurious; as likewiſe ſome traditions, which met with the ſame fate.

St MATTHIAS's Day, a feſtival of the Chriſtian church, obſerved on the 24th of February. St Matthias was an apoſtle of Jeſus Chriſt, but not of the number of the twelve choſen by Chriſt himſelf. He obtained this high honour upon a vacancy made in the college of the apoſtles by the treaſon and death of Judas Iſcariot. The choice fell on Matthias by lot; his competitor being Joſeph called *Barſabas*, and ſurnamed *Juſtus.* Matthias was qualified for the apoſtleſhip, by having been a conſtant attendant upon our Saviour all the time of his miniſtry. He was, probably, one of the 70 diſciples. After our Lord's reſurrection, he preached the goſpel firſt in Judæa.

 Afterwards

Afterwards it is probable he travelled eaſtwards, his reſidence being principally near the irruption of the river Apſarus and the haven Hyſſus. The barbarous people treated him with great rudeneſs and inhumanity; and, after many labours and ſufferings in converting great numbers to Chriſtianity, he obtained the crown of martyrdom; but by what kind of death, is uncertain.—They pretend to ſhow the relics of St Matthias at Rome; and the famous abbey of St Matthias near Treves boaſts of the ſame advantage: but doubtleſs both without any foundation. There was a goſpel aſcribed to St Matthias; but it was univerſally rejected as ſpurious.

MATTIACÆ Aquæ, or Mattiaci Fontes, in *Ancient Geography*, now Wiſbaden, oppoſite to Mentz, in Weteravia. E. Long. 8. N. Lat. 50. 6.

MATTIACUM, or Mattium, in *Ancient Geography*, a town of the Mattiaci, a branch of the Catti in Germany. Now Marpurg in Heſſe. E. Long. 8. 40. N. Lat. 50. 40.

MATTINS, the firſt canonical hour, or the firſt part of the daily ſervice, in the Romiſh church.

MATTHIOLUS, Peter Andrew, an eminent phyſician in the 16th century, born at Sienna, was well ſkilled in the Greek and Latin tongues. He wrote learned commentaries on Dioſcorides, and other works which are eſteemed; and died in 1577.

MATURANTS, in *Pharmacy*, medicines which promote the ſuppuration of tumors.

MATY, Matthew, M. D. an eminent phyſician and polite writer, was born in Holland in the year 1718. He was the ſon of a clergyman, and was originally intended for the church; but in conſequence of ſome mortifications his father met with from the ſynod, on account of the peculiar ſentiments he entertained about the doctrine of the Trinity, turned his thoughts to phyſic. He took his degree of M. D. at Leyden; and in 1740 came to ſettle in England, his father having determined to quit Holland for ever. In order to make himſelf known, he began in 1749 to publiſh in French an account of the productions of the Engliſh preſs, printed at the Hague under the name of the *Journal Britannique*. This journal, which continues to hold its rank amongſt the beſt of thoſe which have appeared ſince the time of Bayle, anſwered the chief end he intended by it, and introduced him to the acquaintance of ſome of the moſt reſpectable literary characters of the country he had made his own. It was to their active and uninterrupted friendſhip he owed the places he afterwards poſſeſſed. In 1758 he was choſen fellow, and in 1765, on the reſignation of Dr Birch, who died a few months after, and had made him his executor, ſecretary to the Royal Society. He had been appointed one of the under librarians of the Britiſh muſeum at its firſt inſtitution in 1753, and became principal librarian at the death of Dr Knight in 1772. Uſeful in all theſe ſituations, he promiſed to be eminently ſo in the laſt, when he was ſeized with a languiſhing diſorder, which in 1776 put an end to a life which had been uniformly devoted to the purſuit of ſcience and the offices of humanity. He was an early and active advocate for inoculation; and when there was a doubt entertained that one might have the ſmallpox this way a ſecond time, tried it upon himſelf unknown to his family. He was a member of the medical club (with the Drs Parſons, Templeman, Fothergill, Watſon and others), which met every fortnight in St Paul's Churchyard. He was twice married, viz. the firſt time to Mrs Elizabeth Boiſragon; and the ſecond to Mrs Mary Deners. He left a ſon and three daughters. He had nearly finiſhed the Memoirs of the earl of Cheſterfield; which were completed by his ſon-in-law Mr Juſtamond, and prefixed to that nobleman's Miſcellaneous Works, 1777, 2 vols. 4to.

Maty, *Paul Henry*, M. A. F. R. S. ſon of the former, was educated at Weſtminſter and Trinity college Cambridge, and had their travelling fellowſhip for three years. He was afterwards chaplain to Lord Stormont at Paris in 17—, and ſoon after vacated his next fellowſhip by marrying one of the three daughters of Joſeph Clerk, Eſq. ſiſter of the late Captain Charles Clerk (who ſucceeded to the command on the death of Captain Cook). On his father's death in 1776, he was appointed to the office of one of the under librarians of the Britiſh muſeum, and was afterwards preferred to a ſuperior department, having the care of the antiquities, for which he was eminently qualified. In 1776 he alſo ſucceeded his father in the office of ſecretary to the Royal Society. On the diſputes reſpecting the reinſtatement of Dr Hutton in the department of ſecretary for foreign correſpondence in 1784, Mr Maty took a warm and diſtinguiſhed part, and reſigned the office of ſecretary; after which he undertook to aſſiſt gentlemen or ladies in perfecting their knowledge of the Greek, Latin, French, and Italian claſſics. Mr Maty was a thinking conſcientious man; and having conceived ſome doubts about the articles he had ſubſcribed in early life, he never could be prevailed upon to place himſelf in the way of eccleſiaſtical preferment, though his connexions were amongſt thoſe who could have ſerved him eſſentially in this point; and ſoon after his father's death he withdrew himſelf from miniſtering in the eſtabliſhed church, his reaſons for which he publiſhed in the 47th volume of the Gent. Magazine, p. 466. His whole life was thenceforwards taken up in literary purſuits. He received 100l. from the duke of Marlborough, with a copy of that beautiful work, the *Gemmæ Marlburienſes*, of which only 100 copies were worked off for preſents; and of which Mr Maty wrote the French account, as Mr Bryant did the Latin. In January 1782 he ſet on foot a Review of publications, principally foreign, which he carried on, with great credit to himſelf and ſatisfaction to the public, for near five years, when he was obliged to diſcontinue it from ill health. He had long laboured under an aſthmatic complaint, which at times made great ravages in his conſtitution, and at laſt put a period to his life in Jan. 1787, at the age of 42; leaving behind him one ſon.—Mr Maty was eminently acquainted with ancient and modern literature, and particularly converſant in critical reſearches. The purity and probity of his nature were unqueſtionable; and his humanity was as exquiſite as it would have been extenſive, had it been ſeconded by his fortune.

MAUBEUGE, a town of the Netherlands, in Hainault, with an illuſtrious abbey of canoneſſes, who muſt be noble both by the father and mother's ſide. This place was ceded to France in 1678; and fortified after the manner of Vauban. In September 1793, the

Austrians formed the blockade of this place, but were driven from their position in the following month. It is seated on the river Sambre, in E. Long. 5. 0. N. Lat. 50. 15.

MAUCAUCO, Macaco, or *Maki*, a genus of quadrupeds belonging to the order *Primates*. See Mammalia *Index*.

MAVIS, a species of turdus. See Ornithology *Index*.

MAUNCH, in *Heraldry*, the figure of an ancient coat sleeve, born in many gentlemen's escutcheons.

MAUNDY thursday, is the Thursday in passion week; which was called *Maunday* or *Mandate Thursday*, from the command which our Saviour gave his apostles to commemorate him in the Lord's supper, which he this day instituted; or from the new commandment which he gave them to love one another, after he had washed their feet as a token of his love to them.

MAUPERTUIS, Peter Louis Morceau de, a celebrated French academician, was born at St Malo in 1698; and was there privately educated till he arrived at his 16th year, when he was placed under the celebrated professor of philosophy M. le Blond, in the college of La Marche, at Paris. He soon discovered a passion for mathematical studies, and particularly for geometry. He likewise practised instrumental music in his early years with great success; but fixed on no profession till he was 20, when he entered into the army. He first served in the Grey Musqueteers; but in the year 1720, his father purchased for him a company of cavalry in the regiment of La Rocheguyon. He remained but five years in the army, during which time he pursued his mathematical studies with great vigour; and it was soon remarked by M. Freret and other academicians, that nothing but geometry could satisfy his active soul and unbounded thirst for knowledge. In the year 1723, he was received into the Royal Academy of Sciences, and read his first performance, which was a memoir upon the construction and form of musical instruments, November 15. 1724. During the first years of his admission, he did not wholly confine his attention to mathematics; he dipt into natural philosophy, and discovered great knowledge and dexterity in observations and experiments upon animals. If the custom of travelling into remote climates, like the sages of antiquity, in order to be initiated into the learned mysteries of those times, had still subsisted, no one would have conformed to it with greater eagerness than M. de Maupertuis. His first gratification of this passion was to visit the country which had given birth to Newton; and during his residence at London he became as zealous an admirer and follower of that philosopher as any one of his own countrymen. His next excursion was to Basil in Switzerland, where he formed a friendship with the famous John Bernouilli and his family, which continued to his death. At his return to Paris, he applied himself to his favourite studies with greater zeal than ever:—And how well he fulfilled the duties of an academician, may be gathered by running over the memoirs of the academy from the year 1724 to 1736; where it appears that he was neither idle nor occupied by objects of small importance. The most sublime questions in geometry and the relative sciences received from his hands that elegance, clearness, and precision, so remarkable in all his writings. In the year 1736, he was sent by the king of France to the polar circle, to measure a degree, in order to ascertain the figure of the earth, accompanied by Messrs Clairault, Camus, Le Monnier, l'Abbe Outhier, and Celsius the celebrated professor of astronomy at Upsal. This distinction rendered him so famous, that at his return he was admitted a member of almost every academy in Europe.

In the year 1740 Maupertuis had an invitation from the king of Prussia to go to Berlin; which was too flattering to be refused. His rank among men of letters had not wholly effaced his love for his first profession, namely, that of arms. He followed his Prussian majesty into the field, and was a witness of the dispositions and operations that preceded the battle of Molwitz; but was deprived of the glory of being present, when victory declared in favour of his royal patron, by a singular kind of adventure. His horse, during the heat of the action, running away with him he fell into the hands of the enemy; and was at first but roughly treated by the Austrian soldiers, to whom he could not make himself known for want of language; but being carried prisoner to Vienna, he received such honours from their Imperial majesties as were never effaced from his memory. From Vienna he returned to Berlin; but as the reform of the academy which the king of Prussia then meditated was not yet mature, he went again to Paris, where his affairs called him, and was chosen in 1742 director of the Academy of Sciences. In 1743 he was received into the French academy; which was the first instance of the same person being a member of both the academies at Paris at the same time. M. de Maupertuis again assumed the soldier at the siege of Fribourg, and was pitched upon by Marshal Cogny and the Count d'Argenson to carry the news to the French king of the surrender of that citadel.

He returned to Berlin in the year 1744, when a marriage was negotiated and brought about by the good offices of the queen-mother, between our author and Mademoiselle de Borck, a lady of great beauty and merit, and nearly related to M. de Borck at that time minister of state. This determined him to settle at Berlin, as he was extremely attached to his new spouse, and regarded this alliance as the most fortunate circumstance of his life.

In the year 1746, M. de Maupertuis was declared by his Prussian majesty president of the Royal Academy of Sciences at Berlin, and soon after by the same prince was honoured with the order of Merit: However, all these accumulated honours and advantages, so far from lessening his ardour for the sciences, seemed to furnish new allurements to labour and application. Not a day passed but he produced some new project or essay for the advancement of knowledge. Nor did he confine himself to mathematical studies only: metaphysics, chemistry, botany, polite literature, all shared his attention, and contributed to his fame. At the same time, he had, it seems, a strange inquietude of spirit, with a morose temper, which rendered him miserable amidst honours and pleasures.—Such a temperament did not promise a very pacific life; and he was engaged in several quarrels. He had

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a quarrel with Koenig the profeſſor of philoſophy at Franeker, and another more terrible with Voltaire. Maupertuis had inſerted into the volume of Memoirs of the Academy of Berlin for 1746, a diſcourſe upon the laws of motion; which Koenig was not content with attacking, but attributed to Leibnitz. Maupertuis, ſtung with the imputation of plagiariſm, engaged the academy of Berlin to call upon him for his proof; which Koenig failing to produce, he was ſtruck out of the academy, of which he was a member. Several pamphlets were the conſequence of this; and Voltaire, for ſome reaſon or other, engaged againſt Maupertuis. We ſay, for ſome reaſon or other; becauſe Maupertuis and Voltaire were apparently upon the moſt amicable terms; and the latter reſpected the former as his maſter in the mathematics. Voltaire, however, exerted all his wit and ſatire againſt him; and on the whole was ſo much tranſported beyond what was thought right, that he found it expedient in 1753 to quit the court of Pruſſia.

Our philoſopher's conſtitution had long been conſiderably impaired by the great fatigues of various kinds in which his active mind had involved him; though from the amazing hardſhips he had undergone in his northern expedition, moſt of his future bodily ſufferings may be traced. The intenſe ſharpneſs of the air could only be ſupported by means of ſtrong liquors, which ſerved to increaſe his diſorder, and bring on a ſpitting of blood, which began at leaſt 12 years before he died. Yet ſtill his mind ſeemed to enjoy the greateſt vigour; for the beſt of his writings were produced, and moſt ſublime ideas developed, during the time of his confinement by ſickneſs, when he was unable to occupy his preſidial chair at the academy. He took ſeveral journeys to St Malo, during the laſt years of his life, for the recovery of his health: And though he always received benefit by breathing his native air, yet ſtill, upon his return to Berlin, his diſorder likewiſe returned with greater violence.—His laſt journey into France was undertaken in the year 1757; when he was obliged, ſoon after his arrival there, to quit his favourite retreat at St Malo, on account of the danger and confuſion which that town was thrown into by the arrival of the Engliſh in its neighbourhood. From thence he went to Bourdeaux, hoping there to meet with a neutral ſhip to carry him to Hamburgh, in his way back to Berlin; but being diſappointed in that hope, he went to Thoulouſe, where he remained ſeven months. He had then thoughts of going to Italy, in hopes a milder climate would reſtore him to health: but finding himſelf grow worſe, he rather inclined towards Germany, and went to Neufchatel, where for three months he enjoyed the converſation of Lord Mariſchal, with whom he had formerly been much connected. At length he arrived at Baſil, October 16. 1758, where he was received by his friend Bernouilli and his family with the utmoſt tenderneſs and affection. He at firſt found himſelf much better here than he had been at Neufchatel: but this amendment was of ſhort duration; for as the winter approached, his diſorder returned, accompanied by new and more alarming ſymptoms. He languiſhed here many months, during which he was attended by M. de la Condamine; and died in 1759.

He wrote in French, 1. The figure of the earth determined. 2. The meaſure of a degree of the meridian. 3. A diſcourſe on the parallax of the moon. 4. A diſcourſe on the figure of the ſtars. 5. The elements of geography. 6. Nautical aſtronomy. 7. Elements of aſtronomy. 8. A phyſical diſſertation on a white inhabitant of Africa. 9. An eſſay on coſmography. 10. Reflections on the origin of languages. 11. An eſſay on moral philoſophy. 12. A letter on the progreſs of the ſciences. 13. An eſſay on the formation of bodies. 14. An eulogium on M. de Monteſquieu. 15. Letters, and other works.

MAUR, St, was a celebrated diſciple of St Benedict. If we can believe a life of St Maur aſcribed to Fauſtus his companion, he was ſent by Benedict on a miſſion to France. But this life is conſidered as apocryphal. In rejecting it, however, as well as the circumſtances of the miſſion, we muſt beware of denying the miſſion itſelf. It is certain that it was believed in France as early as the 9th century; and notwithſtanding the ſilence of Bede, Gregory of Tours, and others, there are ſeveral documents which prove this, or at leaſt render it extremely probable. A celebrated ſociety of Benedictines, took the name of *St Maur* in the beginning of the laſt century, and received the ſanction of Pope Gregory XV. in 1621. This ſociety was early diſtinguiſhed by the virtue and the knowledge of its members, and it ſtill ſupports the character. There are perhaps fewer eminent men in it than formerly; but this muſt be aſcribed to the levity of the age, and partly to the little encouragement for the reſearches of learned men. The chief perſons of ingenuity which this ſociety has produced are, the Fathers Menard, d'Acheri, Mabillon, Ruinart, Germain, Lami, Montfaucon, Martin, Vaiſſette, le Nourri, Martianay, Martenne, Maſſuet, &c. &c. See *L'Hiſtoire Litteraire de la Congregation de St Maur*, publiſhed at Paris under the title of *Bruſſels*, in 4to, 1770, by Dom. Taſſin.

MAURICEAU, Francis, a French ſurgeon, who applied himſelf with great ſucceſs and reputation to the theory and practice of his art for ſeveral years at Paris. Afterwards he confined himſelf to the diſorders of pregnant and lying-in-women, and was at the head of all the operators in this way. His *Obſervations ſur la groſſeſſe* and *ſur l'accouchement des femmes, ſur leurs maladies, et celles des enfans nouveaux*, 1694, in 4to, is reckoned an excellent work, and has been tranſlated into ſeveral languages, German, Flemiſh, Italian, Engliſh: and the author himſelf tranſlated it into Latin. It is illuſtrated with cuts. He publiſhed another piece or two, by way of ſupplement, on the ſame ſubject; and died at Paris in 1709.

MAURICE, St, commander of the Theban legion, was a Chriſtian, together with the officers and ſoldiers of that legion, amounting to 6600 men.—This legion received its name from the city Thebes in Egypt, where it was raiſed. It was ſent by Diocleſian to check the Bagaudac, who had excited ſome diſturbances in Gaul. Maurice having carried his troops over the Alps, the emperor Maximinian commanded him to employ his utmoſt exertions to extirpate Chriſtianity. This propoſal was received with horror both by the commander and by the ſoldiers. The emperor, enraged at their oppoſition, commanded the legion to be decimated; and when they ſtill

Maurice. declared that they would ſooner die than do any thing prejudicial to the Chriſtian faith, every tenth man of thoſe who remained was put to death. Their perſeverance excited the emperor to ſtill greater cruelty; for when he ſaw that nothing could make them relinquiſh their religion, he commanded his troops to ſurround them, and cut them to pieces. Maurice, the commander of theſe Chriſtian heroes, and Exuperus and Candidus, officers of the legion, who had chiefly inſtigated the ſoldiers to this noble reſiſtance, ſignalized themſelves by their patience and their attachment to the doctrines of the Chriſtian religion. They were maſſacred, it is believed, at Agaune, in Chablais, the 22d of September 286.—Notwithſtanding many proofs which ſupport this tranſaction, Dubordier, Hottinger, Moyle, Burnet, and Moſheim, are diſpoſed to deny the fact. It is defended, on the other hand, by Hickes an Engliſh writer, and by Dom Joſeph de Liſle a Benedictine monk *de la congregation de Saint Vannes*, in a work of his, entitled *Defence de la Verité du Martyre de la Legion Thebenne*, 1737. In defence of the ſame fact, the reader may conſult *Hiſtoria di S. Mauritie*, by P. Roſſignole a Jeſuit, and the *Acta Sanctorum* for the month of September. The martyrdom of this legion, written by St Eucherius biſhop of Lyons, was tranſmitted to poſterity in a very imperfect manner by Surius. P. Chifflet a Jeſuit, diſcovered, and gave to the public, an exact copy of this work. Don Ruinart maintains, that it has every mark of authenticity. St Maurice is the patron of a celebrated order in the king of Sardinia's dominions, created by Emanuel Philibert duke of Savoy, to reward military merit, and approved by Gregory XIII. in 1572. The commander of the Theban legion muſt not be confounded with another *St Maurice*, mentioned by Theodoret, who ſuffered martyrdom at Apamea in Syria.

Maurice, (*Mauritius Tiberius*), was born at Arabiſſus in Cappadocia, A. D. 539. He was deſcended from an ancient and honourable Roman family.—After he had filled ſeveral offices in the court of Tiberius Conſtantine, he obtained the command of his armies againſt the Perſians. His gallantry was ſo conſpicuous that the emperor gave him his daughter Conſtantina in marriage, and inveſted him with the purple the 13th Auguſt 582. The Perſians ſtill continued to make inroads on the Roman territories, and Maurice ſent Philippicus, his brother-in-law, againſt them. This general conducted the war with various ſucceſs. At firſt he gained ſeveral ſplendid victories, but he did not continue to have a decided ſuperiority. As there was a great uſe for ſoldiers in theſe unfortunate times, the emperor iſſued a mandate in 592, forbidding any ſoldier to become a monk till he had accompliſhed the term of his military ſervice. Maurice acquired much glory in reſtoring Choſroes II. king of Perſia, to the throne, after he had been depoſed by his ſubjects. The empire was in his reign haraſſed by the frequent inroads of the Arabian tribes. He purchaſed peace from them, by granting them a penſion nearly equal to 100,000 crowns; but theſe barbarians took frequent opportunities to renew the war. In different engagements the Romans deſtroyed 50,000, and took 17,000 priſoners. Theſe were deſtroyed, on condition that the king of the Abari ſhould return all the Roman captives in his dominions. Regardleſs of his promiſe, he demanded a ranſom of 10,000 crowns. Maurice, full of indignation, refuſed the ſum: and the barbarian, equally enraged, put the captives to the ſword. While the emperor, to revenge this cruelty, was making preparations againſt the Abari, Phocas, who from the rank of centurion had attained the higheſt military preferment, aſſumed the purple, and was declared emperor. He purſued Maurice to Chalcedon, took him priſoner, and condemned him to die. The five ſons of this unfortunate prince were maſſacred before his eyes, and Maurice, humbling himſelf under the hand of God, was heard to exclaim, *Thou art juſt, O Lord, and thy judgements are without partiality*. He was beheaded on the 26th November 602, in the 63d year of his age and 20th of his reign. Many writers have eſtimated the character of this prince by his misfortunes inſtead of his actions. They believed him guilty without evidence, and condemned him without reaſon. It cannot be denied, however, that he allowed Italy to be haraſſed; but he was father to the reſt of the empire. He reſtored the military diſcipline, humbled the pride of his enemies, ſupported the Chriſtian religion by his laws, and piety by his example. He loved the ſciences, and was the patron of learned men.

Maurice, elector of Saxony, ſon of Henry le Pieux, was born A. D. 1521. He was early remarkable for his courage, and during his whole life he was engaged in warlike purſuits. He ſerved under the emperor Charles V. in the campaign of 1544 againſt France; and in the year following againſt the league of Smalkalde; with which, although a Proteſtant, he would have no manner of connexion. The emperor, as a reward for his ſervices, in the year 1547, made him elector of Saxony, having deprived his couſin John Frederick of that electorate. Ambition had led him to ſecond the views of Charles, in the hope of being elector, and ambition again detached him from that prince. In 1551 he entered into a league againſt the emperor, together with the elector of Brandenburgh, the Count Palatine, the duke of Wirtemburg, and many other princes. This league, encouraged by the young and enterpriſing Henry II. of France, was more dangerous than that of Smalkalde. The pretext for the aſſociation was the deliverance of the landgrave of Heſſe, whom the emperor kept priſoner. Maurice and the confederates marched, in 1552, to the defiles of Tyrol, and put to flight the Imperial troops who guarded them. The emperor and his brother Ferdinand narrowly eſcaped, and fled from the conquerors in great diſorder. Charles having retired into Paſſau, where he had collected an army, brought the princes of the league to terms of accommodation. By the famous peace of Paſſau, which was finally ratified the 12th of Auguſt 1552, the emperor granted an amneſty without exception to all thoſe who had carried arms againſt him from the year 1546. The Proteſtants not only obtained the free exerciſe of their religion, but they were admitted into the imperial chamber, from which they had been excluded ſince the victory of Mulberg.—Maurice ſoon after united himſelf with the emperor againſt the margrave of Brandenburg, who laid waſte the German provinces. He engaged him in 1553, gained

Maurice. ed the battle of Siverſhauſen, and died of the wounds he had received in the engagement two days after. He was one of the greateſt protectors of the Lutherans in Germany, and a prince equally brave and politic. After he had profited by the ſpoils of John Frederick, the chief of the Proteſtants, he became himſelf the leader of the party, and by theſe means maintained the balance of power againſt the emperor in Germany.

Maurice de Naſſau, prince of Orange, ſucceeded to the government of the Low Countries after the death of his father William, who was killed in 1584 by the fanatic Gerard. The young prince was then only eighteen years of age, but his courage and abilities were above his years. He was appointed captain general of the United Provinces, and he reared that edifice of liberty of which his father had laid the foundation. Breda ſubmitted to him in 1590; Zutphen, Deventer, Hulſt, Nimeguen, in 1591. He gained ſeveral important advantages in 1592, and in the year following he made himſelf maſter of Gertrudenburg. When he had performed theſe ſplendid ſervices, he returned to the Low Countries by the way of Zealand. His fleet was attacked by a dreadful tempeſt, in which he loſt forty veſſels, and he himſelf had very nearly periſhed. His death would have been conſidered by the Hollanders as a much greater calamity than the loſs of their veſſels. They watched over his ſafety with exceeding care. In 1594, one of his guards was accuſed of an intention to take away his life; and it was generally believed that he was bribed to this ſervice by the enemies of the republic. He fell a ſacrifice at Bruges, either to his own fanaticiſm or to the jealous anxiety of the friends of Maurice. The prince of Orange, increaſing in reputation, defeated the troops of the archduke Albert in 1597, and drove the Spaniards entirely out of Holland. In 1600 he was obliged to raiſe the ſiege of Dunkirk; but he took ample vengeance on Albert, whom he again defeated in a pitched battle near Nieuport. Before the action, this great general ſent back the ſhips which had brought his troops into Flanders: *My brethren* (ſaid he to his army), *we muſt conquer the enemy or drink up the waters of the ſea. Determine for yourſelves; I have determined I ſhall either conquer by your bravery, or I ſhall never ſurvive the diſgrace of being conquered by men in every reſpect our inferiors.* This ſpeech elevated the ſoldiers to the higheſt pitch of enthuſiaſm, and the victory was complete. Rhinberg, Grave, and Ecluſe, cities in Flanders, ſubmitted to the conqueror the following year. Maurice, however, not only laboured for the commonwealth, but alſo for himſelf. He coveted the ſovereignty of Holland, and was oppoſed in the proſecution of his deſign by the penſioner Barneveldt. The zeal and activity of this wiſe republican coſt him his life. He was an Arminian; and at this time Maurice defended Gomar againſt Arminius.—Taking advantage of the general odium under which the Arminians lay, he found means to get Barneveldt condemned in 1619. His death, wholly owing to the cruel ambition of the prince of Orange, made a deep impreſſion on the minds of the Hollanders. The truce with Spain being expired, Spinola laid ſiege to Breda in 1624, and in ſix months, by the proper direction of his great talents, though with great ſlaughter of his troops, he took the place. The prince of Orange, unſucceſsful in every attempt to raiſe the ſiege, died of vexation in 1625, aged 55 years, with the reputation of the greateſt warrior of his time.—"The life of this ſtadtholder (ſays the abbe Raynal) was almoſt an uninterrupted ſeries of battles, of ſieges, and of victories. Of moderate abilities in every thing elſe, he ſhone conſpicuous in his military capacity. His camp was the ſchool of Europe; and thoſe who received their military education in his armies augmented, perhaps, the glory of their maſter.—Like Montecuculi, he diſcovered inimitable ſkill in his marches and encampments; like Vauban, he poſſeſſed the talent of fortifying places, and of rendering them impregnable; like Eugene, the addreſs of finding ſubſiſtence for great armies in countries barren by nature, or ravaged by war; like Vendome, the happy talent of calling forth, in the moment they became neceſſary, greater exertions from his ſoldiers than could reaſonably be expected; like Condé, that infallible quickneſs of eye which decides the fortune of battles; like Charles XII. the art of rendering his troops almoſt invincible to cold, hunger, and fatigue; like Turenne, the ſecret of making war with the leaſt poſſible expence of human blood." The Chevalier Folard maintains, that Maurice was the greateſt commander of infantry ſince the time of the Romans. He ſtudied the military art of the ancients, and applied their rules with great exactneſs in the various occurrences of war. He not only took advantage of the inventions of others, but he enriched the ſcience of war with ſeveral improvements. Teleſcopes were firſt uſed by him for a military purpoſe; and, beſides a kind of gallery in conducting a ſiege, and the plan of blockading a ſtrong place, which were of his invention, he greatly improved the whole art by his method of puſhing an attack with great vigour, and of defending, for the greateſt length of time, and in the beſt manner, a place beſieged. In ſhort, the many uſeful things which he practiſed or invented, placed him in the higheſt rank among men of a military character. On one occaſion, a lady of quality aſked him, *Who was the firſt general of the age?* *Spinola* (replied he) *is the ſecond.* It was his conſtant practice, during ſleep, to have two guards placed by his bedſide, not only to defend him in caſe of danger, but to awake him if there ſhould be the leaſt occaſion. The war betwixt Spain and Holland was never carried on with greater keenneſs and animoſity than during his adminiſtration.—The Grand Signior, hearing of the vaſt torrents of blood ſhed in this conteſt, thought that a great empire muſt depend on the deciſion. The object of ſo many battles was pointed out to him on a map, and he ſaid coldly, *If it were my buſineſs, I would ſend my pioneers, and order them to caſt this little corner of earth into the ſea.* Maurice, like many great men, was impatient under contradiction, and too much devoted to women. He was ſucceeded by Frederick Henry his brother.

Maurice, Mauritania.

MAURITANIA, an ancient kingdom of Africa, bounded on the weſt by the Atlantic ocean, on the ſouth by Getulia or Libya Interior, and on the north by the Mediterranean; comprehending the greater part of the kingdoms of Fez and Morocco—Its ancient limits are not exactly mentioned by any hiſtorian; neither

neither can they now be aſcertained by any modern obſervations, theſe kingdoms being but little known to Europeans.

This country was originally inhabited by a people called *Mauri*, concerning the etymology of which name authors are not agreed. It is probable, however, that this country, or at leaſt a great part of it, was firſt called *Phut*, ſince it appears from Pliny, Ptolemy, and St Jerome, that a river and territory not far from Mount Atlas went by that name. From the Jeruſalem Targum it likewiſe appears, that part of the Mauri may be deemed the offspring of Lud the ſon of Miſraim, ſince his deſcendants, mentioned Geneſis x. are there called מרוטאי, *Mauri*, or *Mauritani*. It is certain, that this region, as well as the others to the eaſtward of it, had many colonies planted in it by the Phœnicians. Procopius tells us, that in his time two pillars of white ſtone were to be ſeen there, with the following inſcription in the Phœnician language and character upon them: "We are the *Canaanites*, that fled from *Joſhua* the ſon of Nun, that notorious robber." *Ibnu Rachic*, or *Ibnu Raquig*, an African writer cited by Leo, together with Evagrius and Nicephorus Calliſtus, aſſert the ſame thing.

The Mauritanians, according to Ptolemy, were divided into ſeveral cantons or tribes. The *Metagonitæ* were ſeated near the ſtraits of Hercules, now thoſe of Gibraltar. The *Saccoſii*, or *Cocoſii*, occupied the coaſt of the Iberian ſea. Under theſe two petty nations the *Maſices*, *Verues*, and *Verbicæ* or *Vervicæ*, were ſettled. The *Saliſæ* or *Salinſæ*, were ſituated lower, towards the ocean; and, ſtill more to the ſouth, the *Volubiliani*. The *Maurenſii* and *Herpiditani* poſſeſſed the eaſtern part of this country, which was terminated by the *Mulucha*. The *Angaucani*, or *Jangacaucani*, *Nectiberes*, *Zagrenſii*, *Baniubæ*, and *Vacuntæ*, extended themſelves from the ſouthern foot of Ptolemy's Atlas Minor to his Atlas Major. Pliny mentions the *Baniuræ*, whom Father Hardouin takes to be Ptolemy's Baniubæ; and Mela the Atlantes, whom he repreſents as poſſeſſed of the weſtern parts of this diſtrict.

The earlieſt prince of Mauritania mentioned in hiſtory is Neptune; and next to him were Atlas and Antæus his two ſons, both famous in the Grecian fables on account of their wars with Hercules. Antæus, in his contention with that hero, ſeems to have behaved with great bravery and reſolution. Having received large reinforcements of Libyan troops, he cut off great numbers of Hercules's men. But that celebrated commander, having at laſt intercepted a ſtrong body of Libyans ſent to the relief of Antæus, gave him a total overthrow, wherein both he and the beſt part of his forces were put to the ſword. This deciſive action put Hercules in poſſeſſion of Libya and Mauritania, and conſequently of the riches of all theſe kingdoms. Hence came the fable, that Hercules, finding Antæus, a giant of an enormous ſize with whom he was engaged in ſingle combat, to receive freſh ſtrength as often as he touched his mother earth when thrown upon her, at laſt lifted him up in the air and ſqueezed him to death. Hence likewiſe may be deduced the fable intimating that Hercules took the globe from Atlas upon his own ſhoulders, overcame the dragon that guarded the orchards of the Heſperides, and made himſelf maſter of all the golden fruit there. Bochart thinks that the fable alluded chiefly to naval engagements, wherein Hercules, for the moſt part, was victorious; though Antæus from time to time received ſuccours by ſea. But at laſt Hercules, coming up with one of his ſquadrons which had a ſtrong reinforcement on board, made himſelf maſter of it, and thus rendered Antæus incapable for the future of making head againſt him. The ſame author likewiſe inſinuates, that the notion of Antæus's gigantic ſtature prevailing for ſo many centuries amongſt the Tingitanians, pointed out the ſize of the veſſels of which his fleets and ſquadrons were compoſed. As for the golden apples ſo frequently mentioned by the old mythologiſts, they were the treaſures that fell into Hercules's hands upon the defeat of Antæus; the Greeks giving the oriental word מאל, *riches*, the ſignification affixed to their own term *μηλα*, *apples*.

With regard to the age in which Atlas and Antæus lived, the moſt probable ſuppoſition ſeems to be that of Sir Iſaac Newton. According to that illuſtrious author, Ammon the father of Seſac was the firſt king of Libya, or that vaſt tract extending from the borders of Egypt to the Atlantic ocean; the conqueſt of which country was effected by Seſac in his father's lifetime. Neptune afterwards excited the Libyans to a rebellion againſt Seſac, and ſlew him; and then invaded Egypt under the command of Atlas or Antæus, the ſon of Neptune, Seſac's brother and admiral. Not long after, Hercules, the general of Thebais and Ethiopia for the gods or great men of Egypt, reduced a ſecond time the whole continent of Libya, having overthrown and ſlain Antæus near a town in Thebais, from that event called *Antæa* or *Antæopolis*: this, we ſay, is the notion advanced by Sir Iſaac Newton, who endeavours to prove, that the firſt reduction of Libya, by Seſac, happened a little above a thouſand years before the birth of Chriſt, as the laſt, by Hercules, did ſome few years after. Now, though we do not pretend to adopt every particular circumſtance of Sir Iſaac Newton's ſyſtem, yet we cannot forbear obſerving, that it appears undeniably plain from Scripture, that neither the weſtern extremity of Libya, nor even the other parts of that region, could poſſibly have been ſo well peopled before the time of David or Solomon, as to have ſent a numerous army to invade Egypt. For Egypt and Phœnicia, from whence the greateſt part of the anceſtors of the Libyans came, and which were much nearer the place from whence the firſt diſperſion of mankind was made, could not themſelves have been greatly overſtocked with inhabitants any conſiderable time before the reign of Saul. And that ſuch an invaſion happened in the reign of Neptune, or at leaſt of his ſon Antæus, has been moſt fully evinced by this moſt excellent chronologer.

From the defeat of Antæus, nothing remarkable occurs in the hiſtory of Mauritania till the times of the Romans, who at laſt brought the whole kingdom under their juriſdiction; for which ſee the article Rome. 1. With regard to the cuſtoms, &c. of this people, it would ſeem from what Hyginus inſinuates, that they fought only with clubs, till one Belus, the ſon of Neptune, as that author calls him, taught them

Mauritania.

them the uſe of the ſword. Sir Iſaac Newton makes this Belus to have been the ſame perſon with Seſoſtris king of Egypt, who overran a great part of the then known world. 2. All perſons of diſtinction in Mauritania went richly attired, wearing much gold and ſilver in their clothes. They took great pains in cleanſing their teeth, and curled their hair in a curious and elegant manner. They combed their beards, which were very long, and always had their nails pared extremely cloſe. When they walked out in any numbers, they never touched one another, for fear of diſconcerting the curls into which their hair had been formed. 3. The Mauritanian infantry, in time of action, uſed ſhields made of elephants ſkins, being clad in thoſe of lions, leopards, and bears, which they kept on both night and day. 4. The cavalry of this nation was armed with broad ſhort lances, and carried targets or bucklers, made likewiſe of the ſkins of wild beaſts. They uſed no ſaddles. Their horſes were ſmall and ſwift, had wooden collars about their necks, and were ſo much under the command of their riders, that they would follow them like dogs. The habit of theſe horſemen was not much different from that of the foot above mentioned, they conſtantly wearing a large tunic of the ſkins of wild beaſts. The Phutæi, of whom the Mauritanians were a branch, were eminent for their ſhields, and the excellent uſe they made of them, as we learn from Homer, Xenophon, Herodotus, and Scripture. Nay, Herodotus ſeems to intimate, that the ſhield and helmet came from them to the Greeks. 5. Notwithſtanding the fertility of their ſoil, the poorer ſort of the Mauritanians never took care to manure the ground, being ſtrangers to the art of huſbandry; but roved about the country in a wild ſavage manner, like the ancient Scythians or Arabes Scenitæ. They had tents, or *mapalia*, ſo extremely ſmall, that they could ſcarce breathe in them. Their food was corn, herbage, &c. which they frequently did eat green, without any manner of preparation, being deſtitute of wine, oil, and all the elegancies as well as many neceſſaries of life. Their habit was the ſame both in ſummer and winter, conſiſting chiefly of an old tattered, though thick garment, and over it a coarſe rough tunic; which anſwered probably to that of their neighbours the Numidians. Moſt of them lay every night upon the bare ground; though ſome of them ſtrewed their garments thereon, not unlike the preſent African Kabyles and Arabs, who, according to Dr Shaw, uſe their hykes for a bed and covering in the night. 6. If the moſt approved reading of Horace may be admitted, the Mauritanians ſhot poiſoned arrows; which clearly intimates, that they had ſome ſkill in the art of preparing poiſons, and were excellent dartmen. This laſt obſervation is countenanced by Herodian and Ælian, who entirely come into it, affirming them to have been in ſuch continual danger of being devoured by wild beaſts, that they durſt not ſtir out of their tents or mapalia without their darts. Such perpetual exerciſe muſt render them exceedingly ſkilful in hurling that weapon. 7. The Mauritanians ſacrificed human victims to their deities, as the Phœnicians, Carthaginians, &c. did.

The country people were extremely rude and barbarous; but thoſe inhabiting cities muſt undoubtedly have had at leaſt ſome ſmattering in the literature of the ſeveral nations they deduced their origin from. That the Mauritanians had ſome knowledge in naval affairs, ſeems probable, not only from the intercourſe they had with the Phœnicians and Carthaginians, as well as the ſituation of their country; but likewiſe from Orpheus, or Onomacritus, who aſſerts them to have made a ſettlement at the entrance into Colchis, to which place they came by ſea. Magic, ſorcery, divination, &c. they appear to have applied themſelves to in very early times. Cicero and Pliny ſay, that Atlas was the inventor of aſtrology, and the doctrine of the ſphere, i. e. he firſt introduced them into Mauritania. This, according to Diodorus Siculus, gave riſe to the fable of Atlas's bearing the heavens upon his ſhoulders. The ſame author relates, that Atlas inſtructed Hercules in the doctrine of the ſphere and aſtrology, or rather aſtronomy, who afterwards brought thoſe ſciences into Greece.

Mauritia, Mauritius.

MAURITIA, the GINKGO, or *Maidenhair tree*: A genus of plants belonging to the natural order of palmæ. See BOTANY *Index*.

MAURITIUS, or MAURICE, an iſland of Africa, about 400 miles eaſt of Madagaſcar, lying in the latitude of 20 and 21 degrees ſouth. It is about 150 miles in circumference. In the beginning of the 16th century it was diſcovered by the Portugueſe, who knowing that Pliny and other ancient writers had mentioned the iſland of Çerne in theſe ſeas, took it for granted that this muſt be it; and accordingly we find it ſtyled *Cerne* or *Sirne*, in their maps: but, notwithſtanding this, they did not think fit to ſettle it; and indeed their force was ſo ſmall, in compariſon of the vaſt dominions they graſped, that it was very excuſable. However, according to their laudable cuſtom, they put ſome hogs, goats, and other cattle, upon it, that in caſe any of their ſhips either going to the Indies or returning to Portugal ſhould be obliged to touch there, they might meet with refreſhments. The Dutch, in the ſecond voyage they made to the Eaſt Indies under their admiral James Cornelius Vanneck, came together with five ſhips on the 15th of September 1568; anchored in a commodious port, to which they gave the name of *Warwick Haven*; and gave a very good account of the place in their journals. Captain Samuel Caſtleton, in the Pearl, an Engliſh Eaſt India ſhip, arrived there on the 27th of March 1612; and taking it to be an iſland undiſcovered before, beſtowed upon it the name of *England's Foreſt*, though others of his crew called it *Pearl Iſland*; and in the account of their voyage, written by John Tatton the maſter of the ſhip, celebrated it as a place very convenient for ſhipping, either outward or homeward bound, to refreſh at. This they ſometimes accordingly did, and brought ſome cargoes of ebony, and rich wood from thence, but without fixing any ſettlement.

At length, in 1638, the Dutch ſeated themſelves here: and it is highly remarkable, that at the very time they were employed in making their firſt ſettlement, the French ſent a veſſel to take poſſeſſion of it, who found the Dutch beforehand with them, and refuſed the aſſiſtance of an Engliſh Indiaman, wooding and watering in another port of the iſland, who very frankly offered it, to drive the Dutch from their half-ſettled poſts. They continued for ſome time in quiet

poſſeſſion.

Mauritius. possession of the places they fortified in this island, to which they gave the name of *Mauritius*, in honour of Prince Maurice their stadtholder. But having engaged the French, who were settled on Madagascar, to steal 50 of the natives, and sell them for slaves, for the improvement of the Dutch settlements here, this proved the ruin of both colonies; for the negroes surprised and massacred the French in Madagascar; and the slaves in Mauritius fled into the centre of the island; from whence they so much and so incessantly molested those who had been formerly their masters, that they chose to quit a country where they could no longer remain in any tolerable degree of safety. The East India Company, however, from motives of conveniency, and a very imperfect notion of its value, disapproved this measure, and therefore ordered it to be resettled; which was accordingly done, and three forts erected at the principal havens. Things now went on somewhat better than they did before; but they were still very much disturbed by the revolted negroes in the heart of the isle, whom they could never subdue. One principal use that the company made of this place, was to send thither state prisoners, who, as they were not men of the best morals, quickly corrupted the rest of the inhabitants, and rendered them such a race of outrageous smugglers, the situation of the place concurring with their bad disposition, that, after various ineffectual attempts made to reform them, orders were at length given to abandon Mauritius a second time, which, after some delays, were put in execution in the year 1710.

Two years after this, the French took possession of it, and named it the *isle de France*. This name has obtained among themselves, but the Europeans in general continue to call it Mauritius. It lies in S. Lat. 20. 15. E. Long. 6. 15. The inconveniences arising from the want of a port at the island of Bourbon, induced the French to take possession of Mauritius, it having two very good harbours, to fortify which no expence has been spared. That on the north-west is called *Port Louis*, that on the south-east side of the island is called *Port Bourbon*. The trade-wind from the south-east in these latitudes blows all the year round, excepting for a few days at the summer solstice, when it is interrupted by hard gales and hurricanes from the north. The ease with which this wind enables ships to enter the port of Bourbon, caused the French, when they first took possession of this spot, to esteem it the best port in the island; but experience pointing out to them, that the same wind often rendered the passage out of the harbour so difficult, that a ship was sometimes obliged to wait a considerable time before the weather admitted of her putting to sea, this harbour is in a great measure abandoned, and the principal town and seat of government is now fixed at Port Louis, which is nearly in the middle of the north side of the island, and its entrance is through a channel formed by two shoals, which advance about two miles into the sea. When a ship arrives opposite to this channel, the south-east wind hinders her from entering the port under sail, and she must either warp in with cables or be towed in with boats. The necessity of this operation, joined to the extreme narrowness of the channel, which does not admit of two ships abreast of each other entering at the same time, is one of the best defences the harbour has against an attack by sea; for, from these obstacles, an enemy would find it a matter of the greatest difficulty to force the port; and in addition to this natural strength, they have built two forts and as many batteries, which are mounted with heavy cannon, and entirely command the approach to the harbour, should ships presume to force an entry under sail. This port is capable of containing 100 sail of ships, and is well provided with every requisite for repairing and even building of ships. This port has proved of the greatest advantage to France in the several wars which have been carried on between Great Britain and her; and has proved of great utility to the French East India Company's commerce; for here their ships and crews were sure to meet with all necessary refreshment after a long voyage. The port of Bourbon is also fortified; and an army landed here would find it an extremely difficult task to pass the mountains to the different parts of the island. There are several places between the north-east extremity and Port Louis where boats may land, but all these are defended by batteries; and the country behind them is a continued thicket: The rest of the coast is inaccessible. In the north-eastern quarter is a plain extending about 10 miles from east to west, and in some places five miles inland from the northern coast. All the rest of the island is full of high and steep mountains, lying so near to one another, and the intervals between them so narrow, that, instead of valleys, they rather resemble the beds of torrents; and these are choked with huge fragments of rocks which have fallen from the steep sides of the impending mountains. On the summits of the mountains ice is frequently to be found, and they are covered with forests of ebony and other large trees. The ground they shade produces herbage, shrubs, and plants of various sorts, from the common grass to the strongest thorn, and that in such profusion, that they form a thicket so closely interwoven, that no progress can be made but by means of a hatchet. Notwithstanding these difficulties, plantations have been formed on these mountains, and very considerable progress has been made in the plains; but the productions, although mostly of the same kind, are not only in less quantity, but of an inferior quality to those produced at Bourbon island.

In a course of years, however, the settlement cost so much, and was considered in every light worth so little, that it had been more than once under deliberation, whether, after the example of the Dutch, they should not leave it again to its old negro inhabitants; which sooner or later in all likelihood would have been its fate, if, in 1735, the famous M. de la Bourdonnais had not been sent thither with the title of *governor general of the French islands*.

He found this isle in the worst state possible, thinly inhabited by a set of lazy people, who equally hated industry and peace, and who were continually flattering this man to his face, and belying him wherever and as far as they durst. He gave himself no trouble about this, having once found the means to make himself obeyed; he saw the vast importance of the island; he conceived that it might be settled to great advantage; and, without so much as expecting the thanks of those for whom he laboured, he began to execute this great design. His first step was to bring over black

Mauritius. Maurua || Maxentius.

black boys from Madagafcar, whom he carefully trained up in good principles, and in continual exercife; by which he rendered them fo good foldiers, that he very quickly obliged the Marones, or wild negroes, either to fubmit or to quit the ifland: he taught the planters to cultivate their lands to advantage; he, by an aqueduct, brought freih water to the fea fide; and whereas they had not fo much as a boat at his coming thither, he made a very fine dock, where he not only built floops and large veffels, but even a fhip of the burden of 500 tons. However incredible it may feem, yet it is certainly fact, that in the fpace of five years he converted this country into a paradife, that had been a mere wildernefs for 5000; and this in fpite of the inhabitants, and of the company, who being originally prejudiced by them, behaved ill to him at his return. He foon made the cardinal de Fleury, however, fenfible of the true ftate of things; and compelled the company to acknowledge, though they did not reward, his fervices. He afterwards returned into the Indies, and perfected the work he had begun, and to him it is owing that the ifle of France was rendered one of the fineft and moft important fpots upon the globe. Here no coffee is raifed; but by the indefatigable induftry of M. de Bourdonnais, fugar, indigo, pepper, and cotton (which are not at Bourbon), came to be cultivated with fuccefs. Since the departure of that moft excellent governor, the plantations have been neglected, and are fallen off; but if a proper fpirit of activity was raifed among the inhabitants, they might foon be made to refume their flourifhing appearance. Mines of iron have been difcovered in the mountains near the great plain, in the north-eaft part of the ifland; and thefe mountains affording in great abundance the neceffary fuel, forges have been erected: but the iron produced is of a very inferior quality, it being brittle, and only fit for making cannon-balls and bomb-fhells. Black cattle, fheep, and goats, are preferved with difficulty; the firft generally die before they have been a year in the ifland, and this occafions frequent importations of them from Madagafcar and other parts. Common domeftic poultry breed in great plenty; and, with fifh and turtle, furnifh a great part of the food of the European inhabitants.

The approach to the ifland is extremely dangerous, it being furrounded with ledges of rocks, and many of them covered by the fea. The fhore abounds with coral and fhells. This ifland is faid to contain 60 rivers: fome are confiderable ftreams, and moft of them have their fources from lakes, of which there are feveral in the middle part of the ifland. The rivers afford plenty of various kinds of fifh, particularly eels. Thefe are of an enormous fize, fome having been found that were fix feet long, and fix inches in circumference, and fo extremely voracious, that it is dangerous to bathe in thofe parts of the river where they lie, as they will feize a man without fear, and have ftrength fufficient to keep him under water till he is drowned. Here is a great variety of birds, and bats as large as a young kitten: the inhabitants efteem them a delicate morfel. The air is both hot and moift, but not unwholefome. The place abounds with infects, which are very troublefome; but there are no ferpents. It has been difcovered, that off Port Louis the fouth-eaft wind generally blows with leaft ftrength about funrife; and it alfo happens, on four or five days, at intervals, in the courfe of a month, that early in the morning the wind ceafes in the northern part of the ifland for an hour or two, when a breeze rifes, although but faintly, from the north-weft; during which, a fhip ftationed at the entrance of the channel to avail herfelf of this breeze, may enter the harbour and attack the forts.

This ifland, during the period of the French revolution, did not entirely efcape from the ftorm which then agitated the parent country. In the year 1799, a confpiracy was formed, and broke out, for the purpofe of refifting the government which had been eftablifhed under the authority of the republic. It was, however, foon fuppreffed by the activity of the municipality and governor-general, fupported by the majority of the inhabitants, and order and tranquillity were again reftored.

The population of this ifland in 1799 amounted to 65,000, viz. 55,000 flaves, and 10,000 whites and mulattoes. The following is a ftate of the produce of this ifland in 1800.

Coffee, 6000 bales, of 100 lbs. French.
Indigo, 300,000 lbs. from 2s. to 8s. per lb.
Cotton, 2000 bales, of 250 lbs.
Raw fugar, 20,000,000 lbs.
Cloves, 20,000 lbs.

MAURUA, one of the Society iflands in the South fea. It is a fmall ifland, entirely furrounded with a ridge of rocks, and without any harbour for fhipping. It is inhabited, and its productions are the fame with thofe of the neighbouring iflands. A high round hill rifes in the middle of it, which may be feen at the diftance of 10 or 12 leagues. W Long. 152 32. S. Lat. 16. 25.

MAUSOLEUM, a magnificent tomb or fepulchral monument. The word is derived from Maufolus king of Caria, to whom Artemifia his widow erected a moft ftately monument, efteemed one of the wonders of the world, and called it, from his own name, *Maufoleum*.

St MAWES, a town of Cornwall, in England, feated on the eaft fide of Falmouth haven, in W. Long. 4. 56 N. Lat. 50. 6. Though but a hamlet of the parifh of St Juft, two miles off, without a minifter, or either church, chapel, or meeting-houfe, it has fent members to parliament ever fince 1562 who are returned by its mayor or portreve. It confifts but of one ftreet, under a hill, and fronting the fea, and its inhabitants fubfift purely by fifhing. K. Henry VIII. built a caftle here, oppofite to Pendennis, for the better fecurity of Falmouth haven. It has a governor, a deputy, and two gunners, with a platform of guns. Here is a fair the Friday after St Luke's day.

MAXENTIUS, Marcus Aurelius Valerius, a fon of the emperor Maximianus Hercules, was, by the voluntary abdication of Dioclefian, and of his father, raifed to the empire A. D. 306. He afterwards incited his father to reaffume his imperial authority; and in a perfidious manner deftroyed Severus, who had delivered himfelf into his hands, and relied upon his honour for the fafety of his life. His victories and fucceffes were impeded by Galerius Maximianus, who oppofed him with a powerful force. The defeat and

and voluntary death of Galerius ſoon reſtored peace to Italy; and Maxentius paſſed into Africa, where he rendered himſelf odious by his cruelty and oppreſſion. He ſoon after returned to Rome, and was informed that Conſtantine was come to dethrone him. He gave his adverſary battle near Rome, and, after he had loſt the victory, he fled back to the city. The bridge over which he croſſed the Tiber was in a decayed ſituation, and he fell into the river, and was drowned, A. D. 312. The cowardice and luxuries of Maxentius were as conſpicuous as his cruelties. He oppreſſed his ſubjects with heavy taxes, to gratify the cravings of his pleaſures, or the avarice of his favourites. He was debauched in his manners, and neither virtue nor innocence were ſafe whenever he was inclined to voluptuous purſuits. His body was deformed and unwieldy. To viſit a pleaſure ground, or to exerciſe himſelf under a marble portico, or walk on a ſhady terrace, was to him a Herculean labour, which required the greateſt exertions of ſtrength and reſolution.

MAXILLA, the JAW. See ANATOMY, N° 20—26.

MAXIM, an eſtabliſhed propoſition or principle; in which ſenſe it denotes much the ſame with axiom.

MAXIMILIAN I. emperor of Germany, ſignalized himſelf againſt the French while he was king of the Romans, and after he was emperor entered into the army of Henry VIII. of England as a volunteer againſt that nation: he was a protector of learned men, and aboliſhed an iniquitous tribunal, ſtyled *Judicium occultum Weſtphaliæ;* he compoſed ſome poems, and the memoirs of his own life. He died in 1519, aged 60.

MAXIMUM, in *Mathematics*, denotes the greateſt quantity attainable in any given caſe.

If a quantity conceived to be generated by motion increaſes or decreaſes till it arrives at a certain magnitude or poſition, and then, on the contrary, grows greater or leſſer, and it be required to determine the ſaid magnitude or poſition, the queſtion is called a *problem de maximis et minimis.*

MAXIMUS, a celebrated Cynic philoſopher, and magician, of Epheſus. He inſtructed the emperor Julian in magic; and, according to the opinion of ſome hiſtorians, it was in the converſation and company of Maximus that the apoſtaſy of Julian originated. The emperor not only viſited the philoſopher, but he even ſubmitted his writings to his inſpection and cenſure. Maximus refuſed to live in the court of Julian; and the emperor, not diſſatisfied with the refuſal, appointed him high pontiff in the province of Lydia, an office which he diſcharged with the greateſt moderation and juſtice. When Julian went into the eaſt, the philoſopher promiſed him ſucceſs, and even ſaid that his conqueſts would be more numerous and extenſive than thoſe of the ſon of Philip. He perſuaded his imperial pupil, that, according to the doctrine of metempſychoſis, his body was animated by the ſoul which once animated the hero whoſe greatneſs and victories he was going to eclipſe. After the death of Julian, Maximus was almoſt ſacrificed to the fury of the ſoldiers; but the interpoſition of his friends ſaved his life, and he retired to Conſtantinople. He was ſoon after accuſed of magical practices, before the emperor Valens, and beheaded at Epheſus, A. D. 366. He wrote ſome philoſophical and rhetorical treatiſes, ſome of which were dedicated to Julian. They are all now loſt.

MAXIMUS of Tyre, a Platonic philoſopher, went to Rome in 146, and acquired ſuch reputation there, that the emperor Marcus Aurelius became his ſcholar, and gave him frequent proofs of his eſteem. This philoſopher is thought to have lived till the reign of the emperor Commodus. There are ſtill extant 41 of his diſſertations; a good edition of which was printed by Daniel Heinſius, in 1624, in Greek and Latin, with notes.

MAXIMUS MARIUS. See *MARIUS.*

MAY, the fifth month in the year, reckoning from our firſt, or January; and the third, counting the year to begin with March, as the Romans anciently did. It was called Maius by Romulus, in reſpect to the ſenators and nobles of his city, who were named *majores;* as the following month was called *Junius*, in honour of the youth of Rome, *in honorem juniorum*, who ſerved him in the war; though ſome will have it to have been thus called from *Maia*, the mother of Mercury, to whom they offered ſacrifice on the firſt day of it; and Papius derives it from *Madius*, *eo quod tunc terra madeat.* In this month the ſun enters Gemini, and the plants of the earth in general begin to flower.—The month of May has ever been eſteemed favourable to love; and yet the ancients, as well as many of the moderns, look on it as an unhappy month for marriage. The original reaſon may perhaps be referred to the feaſt of the Lemures, which was held in it. Ovid alludes to this in the fifth of his Faſti, when he ſays,

> *Nec viduæ tædis eadem, nec virginis apta*
> *Tempora; quae nupſit, non diuturna fuit;*
> *Hac quoque de cauſa, ſi te proverbia tangunt,*
> *Menſe malum* Maio *nubere vulgus ait.*

MAY-dew. See DEW.

MAY-duke, a ſpecies of cherry, See PRUNUS, BOTANY *Index.*

MAY, *Iſle of*, a ſmall iſland at the mouth of the frith of Forth, in Scotland, about a mile and a half in circumference, and ſeven miles from the coaſt of Fife, almoſt oppoſite to the rock called the *Baſs.* It formerly belonged to the priory of Pittenweem; and was dedicated to St Adrian, ſuppoſed to have been martyred in this place by the Danes; and hither, in times of Popiſh ſuperſtition, barren women uſed to come and worſhip at his ſhrine, in hopes of being cured of their ſterility. Here is a tower and lighthouſe built by Mr Cunningham of Barns, to whom King Charles I. granted the iſland in fee, with power to exact twopence per ton from every ſhip that paſſes, for the maintenance of a lighthouſe. In the middle of it there is a freſh-water ſpring, and a ſmall lake.—The ſoil produces paſturage for 100 ſheep and 20 black cattle. On the weſt ſide the ſteep rocks render it inacceſſible; but to the eaſt there are four landing places and good riding. It was here that the French ſquadron, having the chevalier de St George on board, anchored in the year 1708, when the vigilance of Sir George Byng obliged him to relinquiſh his deſign, and bear away for Dunkirk. The ſhores all round

round the island abound with fish, and the cliffs with water fowl.

MAY, *Thomas*, an eminent English poet and historian in the 17th century, was born of an ancient but decayed family in Sussex, educated at Cambridge, and afterwards removed to London, where he contracted a friendship with several eminent persons, and particularly with Endymion Porter, Esq. one of the gentlemen of the bedchamber to King Charles I. While he resided at court, he wrote the five plays now extant under his name. In 1622, he published a translation of Virgil's Georgics, with annotations; and in 1635 a poem on King Edward III. and a translation of Lucan's Pharsalia; which poem he continued down to the death of Julius Cæsar, both in Latin and English verse. Upon the breaking out of the civil wars he adhered to the parliament; and in 1647, he published, "The history of the parliament of England, which began November the third, MDCXL. With a short and accessary view of some precedent years." In 1649, he published, *Historiæ Parliamenti Angliæ Breviarium*, in three parts; which he afterwards translated into English. He wrote the History of Henry II. in English verse. He died in 1642. He went well to rest over night, after a cheerful bottle as usual, and died in his sleep before morning: upon which his death was imputed to his tying his nightcap too close under his fat cheeks and chin, which caused his suffocation; but the facetious Andrew Marvel has written a poem of 100 lines, to make him a martyr of Bacchus, and die by the force of good wine. He was interred near Camden in Westminster Abbey; which caused Dr Fuller to say, that "if he were a biassed and partial writer, yet he lieth buried near a good and true historian indeed." Soon after the restoration, his body, with those of several others, was dug up, and buried in a pit in St Margaret's churchyard; and his monument, which was erected by the appointment of parliament, was taken down and thrown aside.

MAYER, TOBIAS, one of the greatest astronomers and mechanics the 18th century produced, was born at Maspach, in the duchy of Wirtemberg 1723. He taught himself mathematics, and at the age of fourteen designed machines and instruments with the greatest dexterity and justness. These pursuits did not hinder him from cultivating the belles lettres. He acquired the Latin tongue, and wrote it with elegance. In 1750, the university of Gottingen chose him for their mathematical professor; and every year of his short life was thenceforward marked with some considerable discoveries in geometry and astronomy. He published several works in this way, which are all reckoned excellent; and some are inserted in the second volume of the "Memoirs of the university of Gottingen." His labours seem to have exhausted him; for he died worn out in 1762.

MAYERNE, SIR THEODORE DE, baron of Aulbone, was the son of Lewis de Mayerne, the celebrated author of the General History of Spain, and of the *Monarchie aristo-democratique*, dedicated to the states-general. He was born in 1573, and had for his godfather Theodore Beza. He studied physic at Montpelier, and was made physician in ordinary to Henry IV. who promised to do great things for him, provided he would change his religion. James I. of England invited him over, and made him first physician to himself and his queen, in which office he served the whole royal family to the time of his death in 1655. His works were printed at London in 1700, and make a large folio, divided into two books; the first containing his *Consilia, Epistolæ, et Observationes*; the second his *Pharmacopœia variæque medicamentorum formulæ*.

MAYHEM. See MAIM.

MAYNE, JASPER, an eminent English poet and divine in the 17th century, who was bred at Oxford, and entered into holy orders. While his majesty resided at Oxford, he was one of the divines appointed to preach before him. He published in 1647 a piece entitled ΟΧΛΟΜΑΧΙΑ, or *The people's war examined according to the principles of reason and scripture, by Jasper Mayne*. In 1648 he was deprived of his studentship at Christ church, and two livings he had; but was restored with the king, who made him his chaplain and archdeacon of Chichester; all which he held till he died. Dr Mayne was held in very high esteem both for his natural parts and his acquired accomplishments. He was an orthodox preacher, and a man of severe virtue and exemplary behaviour; yet of a ready and facetious wit, and a very singular turn of humour. From some stories that are related of him, he seems to have borne some degree of resemblance in his manner to the celebrated Dr Swift; but if he did not possess those very brilliant parts that distinguished the Dean, he probably was less subject to that capricious and those unaccountable whimsies which at times so greatly eclipsed the abilities of the latter. Yet there is one anecdote related of him, which, although it reflects no great honour on his memory, as it seems to carry some degree of cruelty with it, yet is it a strong mark of his resemblance to the Dean, and a proof that his propensity for drollery and joke did not quit him even in his latest moments. The story is this: The Doctor had an old servant, who had lived with him some years, to whom he had bequeathed an old trunk, in which he told him he would find *something that would make him drink after his death*. The servant, full of expectation that his master, under this familiar expression, had left him somewhat that would be a reward for the assiduity of his past services, as soon as decency would permit, flew to the trunk; when, behold, to his great disappointment, the boasted legacy proved to be a red herring. The doctor, however, bequeathed many legacies by will to pious uses; particularly 50 pounds towards the rebuilding of St Paul's cathedral, and 200 pounds to be distributed to the poor of the parishes of Cassington and Pyrton, near Wattington, of both which places he had been vicar. In his younger years he had an attachment to poetry; and wrote two plays, the latter of which may be seen in the tenth volume of Dodsley's Collection, viz. 1. Amorous war, a tragicomedy. 2. The city-match, a comedy. He published a poem upon the naval victory by the duke of York over the Dutch, printed in 1665. He also translated into English from the Greek part of Lucian's Dialogues.

Maynooth || Mayo.

MAYNOOTH, or MANOOTH, a poſt town in the county of Kildare, and province of Leinſter, in Ireland, near 12 miles from Dublin. Though not very large, it is regularly laid out, and conſiſts of good houſes. Here is a charter ſchool, which was opened 27th July 1759.

MAYNWARING, ARTHUR, an eminent political writer in the beginning of the 18th century, ſtaid ſeveral years at Oxford, and then went to Cheſhire, where he lived ſome time with his uncle Mr Francis Cholmondeley, a very honeſt gentleman, but extremely averſe to the government of King William III. to whom he refuſed the oaths. Here he proſecuted his ſtudies in polite literature with great vigour; and coming up to London, applied to the ſtudy of the law. He was hitherto very zealous in antirevolutional principles, and wrote ſeveral pieces in favour of King James II.; but upon being introduced to the duke of Somerſet and the earls of Dorſet and Burlington, began to entertain very different notions in politics. His father left him an eſtate of near 800l. a year, but ſo encumbered, that the intereſt money amounted to almoſt as much as the revenue. Upon the concluſion of the peace he went to Paris, where he became acquainted with Mr Boileau. After his return he was made one of the commiſſioners of the cuſtoms, in which poſt he diſtinguiſhed himſelf by his ſkill and induſtry. He was a member of the Kit-cat club, and was looked upon as one of the chief ſupports of it by his pleaſantry and wit. In the beginning of Queen Anne's reign, the lord treaſurer Godolphin engaged Mr Donne to quit the office of auditor of the impreſts, and made Maynwaring a preſent of a patent for that office worth about 2000l. a-year in a time of buſineſs. He had a conſiderable ſhare in the Medley, and was author of ſeveral other pieces. The Examiner, his antagoniſt in politics, allowed that he wrote with tolerable ſpirit, and in a maſterly ſtyle. Sir Richard Steele dedicated the firſt volume of the Tatler to him.

MAYO, one of the Cape de Verd iſlands, lying in the Atlantic ocean, near 300 miles from Cape Verd in Africa, about 17 miles in circumference. The ſoil in general is very barren, and water ſcarce; however, they have ſome corn, yams, potatoes, and plantains, with plenty of beeves, goats, and aſſes. What trees there are, grow on the ſides of the hills, and they have ſome figs and water melons. The ſea round about the iſland abounds with fiſh. The chief commodity is ſalt, with which many Engliſh ſhips are loaded in the ſummer time. The principal town is Pinoſa, inhabited by negroes, who ſpeak the Portugueſe language, and are ſtout, luſty, and fleſhy. They are not above 200 in number, and many of them go quite naked. W. Long. 23. 5. N. Lat. 15. 10.

MAYO, a county of Ireland, in the province of Connaught, having Sligo and the ſea on the north, Roſcommon on the ſouth, Leitrim and Roſcommon on the eaſt, and the Atlantic ocean on the weſt. It contains 724,640 Iriſh plantation acres, 75 pariſhes, nine baronies, and one borough. It gives title of earl to the family of Bourke. This county takes its name from an ancient city, built in 664; the ruins of the cathedral, and ſome traces of the ſtone walls which encompaſſed the city, yet remain on the plains of Mayo. It was a univerſity, founded for the education of ſuch of the Saxon youths as were converted to the Chriſtian faith: it was ſituated a little to the ſouth of Lough Conn; and is to this day frequently called *Mayo of the Saxons*, being celebrated for giving education to Alfred the Great king of England. As this town has gone to decay, Balinroke is reckoned the chief town. The county by the ſea is mountainous; but inland has good paſtures, lakes, and rivers. It is about 62 miles long, and 52 broad. Caſtlebar is the aſſizes town. —Mayo was formerly a biſhop's ſee, which is now united to TUAM.

Mayor.

MAYOR, the chief magiſtrate of a city or town, choſen annually out of the aldermen. The word, anciently wrote *meyr*, comes from the Britiſh *miret*, i. e. *cuſtodire*, or from the old Engliſh *maier*, viz. *poteſtas*, and not from the Latin *major*. King Richard I. in 1189, changed the bailiff of London into a mayor, and from that example King John made the bailiff of King's Lynn a mayor anno 1204: Though the famous city of Norwich obtained not this title for its chief magiſtrate till the ſeventh year of King Henry V. anno 1419; ſince which there are few towns of note but have had a mayor appointed for government.

Mayors of corporations are juſtices of peace *pro tempore*, and they are mentioned in ſeveral ſtatutes; but no perſon ſhall bear any office of magiſtracy concerning the government of any town, corporation, &c. who hath not received the ſacrament according to the church of England within one year before his election, and who ſhall not take the oaths of ſupremacy, &c.

If any perſon intrudes into the office of mayor, a *quo warranto* lies againſt him, upon which he ſhall not only be ouſted, but fined. And no mayor, or perſon holding an annual office in a corporation for one year, is to be elected into the ſame office for the next; in this caſe, perſons obſtructing the choice of a ſucceſſor are ſubject to 100l. penalty. Where the mayor of a corporation is not choſen on the day appointed by charter, the next officer in place ſhall the day after hold a court and elect one; and if there be a default or omiſſion that way, the electors may be compelled to chooſe a mayor, by a writ of mandamus out of the king's bench. Mayors, or other magiſtrates of a corporation, who ſhall voluntarily abſent themſelves on the day of election, are liable to be impriſoned, and diſqualified from holding any office in the corporation.

MAYOR's Courts. To the lord mayor and city of London belong ſeveral courts of judicature. The higheſt and moſt ancient is that called the *huſtings*, deſtined to ſecure the laws, rights, franchiſes, and cuſtoms of the city. The ſecond is a court of *requeſt*, or of *conſcience*; of which before. The third is the court of the lord mayor and aldermen, where alſo the ſheriffs ſit; to which may be added two courts of ſheriffs, and the court of the city orphans, whereof the lord mayor and aldermen have the cuſtody. Alſo the court of common council, which is a court or aſſembly, wherein are made all by-laws which bind the citizens of London. It conſiſts, like the parliament, of two houſes: an upper, conſiſting of the lord mayor and aldermen; and a lower, of a number of common council men, choſe by the ſeveral wards as repreſentatives

Maza || Mazarine.

tatives of the body of the citizens. In the court of common council are made laws for the advancement of trade, and committees yearly appointed, &c. But acts made by them are to have the aſſent of the lord mayor and aldermen, by ſtat. 11 Geo. I. Alſo the chamberlain's court, where every thing relating to the rents and revenues of the city, as alſo the affairs of ſervants, &c. are tranſacted. Laſtly, To the lord mayor belong the courts of coroner and of eſcheator; another court for the conſervation of the river Thames; another of gaol-delivery, held uſually eight times a-year, at the Old Bailey, for the trial of criminals, whereof the lord mayor is himſelf the chief judge. There are other courts called *wardmotes* or meetings of the wards; and courts of halymote or aſſemblies of the ſeveral guilds and fraternities.

MAZA, among the Athenians, was a ſort of cake made of flour boiled with water and oil, and ſet, as the common fare, before ſuch as were entertained at the public expence in the common hall or *Prytaneum*.

MAZAGAN, a ſtrong place of Africa in the kingdom of Morocco, and on the frontiers of the province of Duguela. It was fortified by the Portugueſe, and beſieged by the king of Morocco with 200,000 men in 1562, but to no purpoſe. It is ſituated near the ſea. W. Long. 8. 15. N. Lat. 33. 12.

MAZARA, an ancient town of Sicily, and capital of a conſiderable valley of the ſame name, which is very fertile, and watered with ſeveral rivers. The town is a biſhop's ſee, and has a good harbour; is ſeated on the ſea coaſt, in E. Long. 12. 30. N. Lat. 37. 53.

MAZARINE, Julius, a famous cardinal and prime miniſter of France, was born at Piſcina in the province of Abruzzo, in Naples, in 1602. After having finiſhed his ſtudies in Italy and Spain, he entered into the ſervice of Cardinal Sachetts, and became well ſkilled in politics, and in the intereſts of the princes at war in Italy; by which means he was enabled to bring affairs to an accommodation, and the peace of Queiras was ſhortly concluded. Cardinal Richlieu being taken with his conduct, did from thenceforward highly eſteem him; as did alſo Cardinal Antonio, and Louis XIII. who procured him a cardinal's hat in 1641. Richlieu made him one of the executors of his will; and during the minority of Louis XIV. he had the charge of affairs. At laſt he became the envy of the nobility, which occaſioned a civi war; whereupon Mazarine was formed to retire, a price was ſet on his head, and his library ſold. Notwithſtanding, he afterwards returned to the court in more glory than ever; concluded a peace with Spain, and a marriage treaty betwixt the king and the infanta. This treaty of peace paſſes for the maſter-piece of Cardinal de Mazarine's politics, and procured him the French king's moſt intimate confidence: but at laſt his continual application to buſineſs threw him into a diſeaſe, of which he died at Vinciennes in 1661.—Cardinal Mazarine was of a mild and affable temper. One of his greateſt talents was his knowing mankind, and his being able to adapt himſelf, and to aſſume a character conformable to the circumſtances of affairs. He poſſeſſed at one and the ſame time the biſhopric of Metz, and the abbeys of St Arnauld, St Clement, and St Vincent, in the ſame city; that of St Dennis, Clugny, and Victor, of Marſeilles; of St Michel at Soiſſons, and a great number of others. He founded Mazarine college at Paris; which is alſo called the *college of the four nations*. There has been publiſhed a collection of his letters, the moſt copious edition of which is that of 1745, in 2 vols. duodecimo.

Mazzuoli, Mead.

MAZZUOLI. See Parmigiano.

MEAD, a wholeſome, agreeable liquor, prepared with honey and water.

One of the beſt methods of preparing mead is as follows: Into twelve gallons of water put the whites of ſix eggs; mixing theſe well together, and to the mixture adding twenty pounds of honey. Let the liquor boil an hour, and when boiled, add cinnamon, ginger, cloves, mace, and roſemary. As ſoon as it is cold, put a ſpoonful of yeſt to it, and turn it up, keeping the veſſel filled as it works; when it has done working, ſtop it up cloſe; and, when fine, bottle it off for uſe.

Thorley ſays, that mead not inferior to the beſt of foreign wines may be made in the following manner: Put three pounds of the fineſt honey to one gallon of water, and two lemon peels to each gallon; boil it half an hour, well ſcummed; then put in, while boiling, lemon peel: work it with yeſt; then put it in your veſſel with the peel, to ſtand five or ſix months, and bottle it off for uſe. If it is to be kept for ſeveral years, put four pounds to a gallon of water.

The author of the Dictionary of Chemiſtry directs to chooſe the whiteſt, pureſt, and beſt taſted honey, and to put it into a kettle with more than its weight of water: a part of this liquor muſt be evaporated by boiling, and the liquor ſcummed, till its conſiſtence is ſuch, that a freſh egg ſhall be ſupported on its ſurface without ſinking more than half its thickneſs into the liquor; then the liquor is to be ſtrained, and poured through a funnel into a barrel; this barrel, which ought to be nearly full, muſt be expoſed to a heat as equable as poſſible, from 20 to 27 or 28 degrees of Mr Reaumur's thermometer, taking care that the bung-hole be ſlightly covered, but not cloſed. The phenomena of the ſpirituous fermentation will appear in this liquor, and will ſubſiſt during two or three months, according to the degree of heat; after which they will diminiſh and ceaſe. During this fermentation, the barrel muſt be filled up occaſionally with more of the ſame kind of liquor of honey, ſome of which ought to be kept apart, on purpoſe to replace the liquor which flows out of the barrel in froth. When the fermentation ceaſes, and the liquor has become very vinous, the barrel is then to be put into a cellar, and well cloſed; a year afterwards the mead will be fit to be put into bottles.

Mead is a liquor of very ancient uſe in Britain. See Feast.

Mead, *Dr Richard*, a celebrated Engliſh phyſician, was born at Stepney near London, where his father, the Reverend Mr Matthew Mead, had been one of the two miniſters of that pariſh; but in 1662 was ejected for nonconformity, but continued to preach at Stepney till his death. As Mr Mead had a handſome fortune, he beſtowed a liberal education upon 13 children, of whom Richard was the eleventh; and for that purpoſe kept a private tutor in his houſe, who

Mead.

who taught him the Latin tongue. At 16 years of age Richard was ſent to Utrecht, where he ſtudied three years under the famous Græviuſ; and then chooſing the profeſſion of phyſic, he went to Leyden, where he attended the lectures of the famous Pitcairn on the theory and practice of medicine, and Herman's botanical courſes. Having alſo ſpent three years in theſe ſtudies, he went with his brother and two other gentlemen to viſit Italy, and at Padua took his degree of doctor of philoſophy and phyſic in 1695. Afterwards he ſpent ſome time at Naples and at Rome; and returning home the next year, ſettled at Stepney, where he married, and practiſed phyſic, with a ſucceſs that laid the foundation of his future greatneſs.

In 1703, Dr Mead having communicated to the Royal Society an analyſis of Dr Bonomo's diſcoveries relating to the cutaneous worms that generate the itch, which they inſerted in the Philoſophical Tranſactions; this, with his account of poiſons, procured him a place in the Royal Society, of which Sir Iſaac Newton was then preſident. The ſame year he was elected phyſician of St Thomas's hoſpital, and was alſo employed by the ſurgeons to read anatomical lectures in their hall, which obliged him to remove into the city. In 1707 his Paduan diploma for doctor of phyſic was confirmed by the univerſity of Oxford; and being patronized by Dr Radcliffe, on the death of that famous phyſician he ſucceeded him in his houſe at Bloomſbury-ſquare, and in the greateſt part of his buſineſs. In 1727 he was made phyſician to King George II. whom he had alſo ſerved in that capacity while he was prince of Wales; and he had afterwards the pleaſure of ſeeing his two ſons-in-law, Dr Nichols and Dr Wilmot, his coadjutors in that eminent ſtation.

Dr Mead was not more to be admired for the qualities of the head than he was to be loved for thoſe of his heart. Though he was himſelf a hearty whig, yet, uninfluenced by party principles, he was a friend to all men of merit, by whatever denomination they might happen to be diſtinguiſhed. Thus he was intimate with Garth, with Arbuthnot, and with Freind; and long kept up a conſtant correſpondence with the great Boerhaave, who had been his fellow ſtudent at Leyden: they communicated to each other their obſervations and projects, and never loved each other the leſs for being of different ſentiments. In the mean time, intent as Dr Mead was on the duties of his profeſſion, he had a greatneſs of mind that extended itſelf to all kinds of literature, which he ſpared neither pains nor money to promote. He cauſed the beautiful and ſplendid edition of Thuanus's hiſtory to be publiſhed in 1713, in ſeven volumes folio: and by his interpoſition and aſſiduity, Mr Sutton's invention of drawing foul air from ſhips and other cloſe places was carried into execution, and all the ſhips in his majeſty's navy provided with this uſeful machine. Nothing pleaſed him more than to call hidden talents into light; to give encouragement to the greateſt projects, and to ſee them executed under his own eye. During almoſt half a century he was at the head of his buſineſs, which brought him one year above ſeven thouſand pounds, and for ſeveral years between five and ſix thouſand; yet clergymen, and in general all men of learning, were welcome to his advice. His library conſiſted of 10,000 volumes, of which his Latin, Greek, and oriental manuſcripts, made no inconſiderable part. He had a gallery for his pictures and antiquities, which coſt him great ſums. His reputation, not only as a phyſician, but as a ſcholar, was ſo univerſally eſtabliſhed, that he correſponded with all the principal literati in Europe: even the king of Naples ſent to deſire a complete collection of his works; and in return made him a preſent of the two firſt volumes of Signior Bajardi, which may be conſidered as an introduction to the collection of the antiquities of Herculaneum. At the ſame time that prince invited him to his palace, that he might have an opportunity of ſhowing him thoſe valuable monuments of antiquity; and nothing but his great age prevented his undertaking a journey ſo ſuited to his taſte. No foreigner of learning ever came to London without being introduced to Dr Mead; and on theſe occaſions his table was always open, and the magnificence of princes was united with the pleaſures of philoſophers. It was principally to him that the ſeveral counties of England and our colonies abroad applied for the choice of their phyſicians, and he was likewiſe conſulted by foreign phyſicians from Ruſſia, Pruſſia, Denmark, &c. He wrote, beſides the above works, 1. A Treatiſe on the Scurvy, 2. *De variolis et morbillis diſſertatio.* 3. *Medica ſacra: ſive de Morbis inſignioribus, qui in Bibliis memorantur, Commentarius.* 4. *Monita et Præcepta medica.* 5. A Diſcourſe concerning peſtilential contagion, and the methods to be uſed to prevent it. The works he wrote and publiſhed in Latin were tranſlated into Engliſh, under the Doctor's inſpection, by Thomas Stack, M. D. and F. R. S. This great phyſician, naturaliſt, and antiquarian, died on the 16th of February 1754.

Meadow, Meal.

MEADOW, in its general ſignification, means paſture or graſs lands, annually mown for hay: but it is more particularly applied to lands that are ſo low as to be too moiſt for cattle to graze upon them in winter without ſpoiling the ſward. For the management and watering of meadows, ſee AGRICULTURE, p. 435.

MEAL, the flour of grain. The meal or flour of Britain is the fineſt and whiteſt in the world. The French is uſually browner, and the German browner than that. Our flour keeps well with us; but in carrying abroad it often contracts damp, and becomes bad. All flour is ſubject to breed worms; theſe are white in the white flour, and brown in that which is brown; they are therefore not always diſtinguiſhable to the eye: but when the flour feels damp, and ſmells rank and muſty, it may be conjectured that they are there in great abundance.

The colour and the weight are the two things which denote the value of meal or flour; the whiter and the heavier it is, others things being alike, the better it always is. Pliny mentions theſe two characters as the marks of good flour; and tells us, that Italy in his time produced the fineſt in the world. This country indeed was famous before his time for this produce; and the Greeks have celebrated it; and Sophocles in particular ſays, that no flour is ſo white or ſo good as that of Italy. The corn of this country has, however, loſt much of its reputation ſince that time;

time; and the reaſon of this ſeems to be, that the whole country being full of ſulphur, alum, vitriol, marcaſites, and bitumens, the air may have in time affected them ſo far as to make them diffuſe themſelves through the earth, and render it leſs fit for vegetation; and the taking fire of ſome of theſe inflammable minerals, as has ſometimes happened, is alone ſufficient to alter the nature of all the land about the places where they are.

The flour of Britain, though it pleaſes by its whiteneſs, yet wants ſome of the other qualities valuable in flour; the bread that is made of it is brittle and does not hold together, but after keeping a few days becomes hard and dry as if made of chalk, and is full of cracks in all parts; and this muſt be a great diſadvantage in it when intended for the ſervice of an army, or the like occaſions, where there is no baking every day, but the bread of one making muſt neceſſarily be kept a long time.

The flour of Picardy is very like that of Britain; and after it has been kept ſome time, is found improper for making into paſte or dough. The French are forced either to uſe it immediately on the grinding, or elſe to mix it with an equal quantity of the flour of Brittany, which is coarſer but more unctuous and fatty; but neither of theſe kinds of flour keep well.

The flour of almoſt any country will do for the home conſumption of the place, as it may be always freſh ground; but the great care to be uſed in ſelecting it, is in order to the ſending it abroad, or furniſhing ſhips for their own uſe. The ſaline humidity of the ſea air ruſts metals, and fouls every thing on board, if great care be not taken in the preſerving them. This alſo makes the flour damp and mouldy, and is often the occaſion of its breeding inſects, and being wholly ſpoiled.

The flour of ſome places is conſtantly found to keep better at ſea than that of others; and when that is once found out, the whole caution needs only be to carry the flour of thoſe places. Thus the French find that the flour of Poitou, Normandy, and Guienne, all bear the ſea carriage extremely well; and they make a conſiderable advantage by carrying them to their American colonies.

The choice of flour for exportation being thus made, the next care is to preſerve it in the ſhips: the keeping it dry is the grand conſideration in regard to this; the barrels in which it is put up ought to be made of dry and well ſeaſoned oak, and not to be larger than to hold two hundred weight at the moſt. If the wood of the barrels have any ſap remaining in it, it will moiſten and ſpoil the flour; and no wood is ſo proper as oak for this purpoſe, or for making the bins and other veſſels for keeping flour in at home, ſince when once well dried and ſeaſoned it will not contract humidity afterwards. The beech wood, of which ſome make their bins for flour, is never thoroughly dry, but always retains ſome ſap. The fir will give the flour a taſte of turpentine; and the aſh is always ſubject to be eaten by worms. The oak is preferable, becauſe of its being free from theſe faults; and when the ſeveral kinds of wood have been examined in a proper manner, there may be others found as fit, or poſſibly more ſo, than this for the purpoſe. The great teſt is their having more or leſs ſap. See FLOUR and WOOD.

MEAN, in general, denotes the middle between two extremes: thus we ſay the mean diſtance, mean proportion, &c.

MEAN, *Arithmetical*, is half the ſum of the two extremes, as 4 is the arithmetical mean between 2 and 6; for $\frac{2+6}{2}=4$.

MEAN, *Geometrical*, is the ſquare root of the rectangle, or product of the two extremes: thus,

$$\sqrt{1\times 9}={}^{2}\sqrt{9}=3$$

To find two mean proportionals between two extremes: multiply each extreme by the ſquare of the other, then extract the cube root out of each product, and the two roots will be the mean proportionals required.

Required two proportionals between 2 and 16,

$$\overline{2\times 2}\times 16=64,\text{ and }\sqrt[3]{64}=4.\ \text{Again,}$$

$\sqrt[3]{2\times 16^{2}}=\sqrt[3]{512}=8$. 4 and 8 therefore are the two proportionals ſought.

MEARNSSHIRE, a county of Scotland. See KINCARDINESHIRE.

MEASLES, a cutaneous diſeaſe attended with a fever, in which there is an appearance of eruptions that do not tend to a ſuppuration. See MEDICINE *Index*.

MEASURE *of an angle*, is an arch deſcribed from the vertex in any place between its legs. Hence angles are diſtinguiſhed by the ratio of the arches, deſcribed from the vertex between the legs to the peripheries. Angles then are diſtinguiſhed by thoſe arches; and the arches are diſtinguiſhed by their ratio to the periphery. Thus an angle is ſaid to be ſo many degrees as there are in the ſaid arch.

MEASURE of a ſolid, is a cube whoſe ſide is an inch, a foot, or a yard, or any other determinate length. In geometry it is a cubic perch, divided into cubic feet, digits, &c.

MEASURE of velocity, in *Mechanics*, is the ſpace paſſed over by a moving body in a given time. To meaſure a velocity, therefore, the ſpace muſt be divided into as many equal parts as the time is conceived to be divided into; the quantity of ſpace anſwering to ſuch a part of time is the meaſure of the velocity.

MEASURE, in *Geometry*, denotes any quantity aſſumed as one, or unity, to which the ratio of the other homogeneous or ſimilar quantities is expreſſed.

MEASURE, in a legal and commercial ſenſe, denotes a certain quantity or proportion of any thing bought, ſold, valued, or the like.

It is neceſſary, for the convenience of commerce, that an uniformity ſhould be obſerved in weights and meaſures, and regulated by proper ſtandards. A foot-rule may be uſed as a ſtandard for meaſures of length, a buſhel for meaſures of capacity, and a pound for weights. There ſhould be only one authentic ſtandard of each kind, formed of the moſt durable materials, and kept with all poſſible care. A ſufficient number of copies, exactly correſponding to the principal ſtandard, may be diſtributed for adjuſting the weights and meaſures that are made for common uſe. There are ſeveral ſtandards of this kind both in

Meafure. England and Scotland. See the article *Weights and Meafures*.

If any one of the ftandards above mentioned be juftly preferved, it will ferve as a foundation for the others, by which they may be corrected if inaccurate, or reftored if entirely loft. For inftance, if we have a ftandard foot, we can eafily obtain an inch, and can make a box which fhall contain a cubical inch, and may ferve as a ftandard for meafures of capacity. If it be known that a pint contains 100 cubical inches, we may make a veffel five inches fquare, and four inches deep, which will contain a pint. If the ftandard be required in any other form, we may fill this veffel with water, and regulate another to contain an equal quantity. Standards for weights may be obtained from the fame foundation; for if we know how many inches of water it takes to weigh a pound, we have only to meafure that quantity, and the weight which balances it may be affumed as the ftandard of a pound.

Again, If the ftandard of a pound be given, the meafure of an inch may be obtained from it; for we may weigh a cubical inch of water, and pour it into a regular veffel; and having noticed how far it is filled, we may make another veffel of like capacity in the form of a cube. The fide of this veffel may be affumed as the ftandard for an inch; and ftandards for a foot, a pint, or a bufhel, may be obtained from it. Water is the moft proper fubftance for regulating ftandards; for all other bodies differ in weight from others of the fame kind; whereas it is found by experience that fpring and river water, rain, and melted fnow, and all other kinds, have the fame weight; and this uniformly holds in all countries when the water is pure, alike warm, and free from falt and minerals.

Thus, any one ftandard is fufficient for reftoring all the reft. It may further be defired to hit on fome expedient, if poffible, for reftoring the ftandards, in cafe that all of them fhould ever fall into diforder, or fhould be forgotten, through the length of time, and the viciffitudes of human affairs. This feems difficult, as no words can convey a precife idea of a foot-rule, or a pound weight. Meafures, affumed from the dimenfions of the human body, as a foot, a hand-breadth, or a pace, muft nearly be the fame in all ages, unlefs the fize of the human race undergo fome change; and therefore, if we know how many fquare feet a Roman acre contained, we may form fome judgement of the nature of the law which reftricted the property of a Roman citizen to feven acres; and this is fufficient to render hiftory intelligible; but it is too inaccurate to regulate meafures for commercial purpofes. The fame may be faid of ftandards, deduced from the meafure of a barley-corn, or the weight of a grain of wheat. If the diftance of two mountains be accurately meafured and recorded, the nature of the meafure ufed will be preferved in a more permanent manner than by any ftandard; for if ever that meafure fall into difufe, and another be fubftituted in its place, the diftance may be meafured again, and the proportion of the ftandards may be afcertained by comparing the new and ancient diftances.

But the moft accurate and unchangeable manner of eftablifhing ftandards is, by comparing them with the length of pendulums. The longer a pendulum is, it vibrates the flower; and it muft have one precife length in order to vibrate in a fecond. The flighteft difference in length will occafion a difference in the time; which will become abundantly fenfible after a number of vibrations, and will be eafily obferved if the pendulum be applied to regulate the motion of a clock. The length of a pendulum which vibrates feconds in London is about $39\frac{1}{8}$ inches, is conftantly the fame at the fame place, but it varies a little with the latitude of the place, being fhorter as the latitude is lefs. Therefore, though all ftandards of weights and meafures were loft, the length of a fecond pendulum might be found by repeated trials: and if the pendulum be properly divided, the juft meafure of an inch will be obtained; and from this all other ftandards may be reftored. See *Whitehurft on Invariable Measures*.

Meafures are various, according to the various kinds and dimenfions of the things meafured.—Hence arife lineal or longitudinal meafures, for lines or lengths; fquare meafures, for areas or fuperfices; and folid or cubic meafures, for bodies and their capacities; all which again are very different in different countries and in different ages, and even many of them for different commodities. Whence arife other divifions of ancient and modern meafures, domeftic and foreign ones, dry meafures, liquid meafures, &c.

I. *Long Meafures, or Meafures of Application.*

1.] The *Englifh* and *Scotch* Standards.

The Englifh lineal ftandard is the yard, containing 3 Englifh feet; equal to 3 Paris feet 1 inch and $\frac{3}{12}$ of an inch, or $\frac{7}{9}$ of a Paris ell. The ufe of this meafure was eftablifhed by Henry I. of England, and the ftandard taken from the length of his own arm. It is divided into 36 inches, and each inch is fuppofed equal to 3 barleycorns. When ufed for meafuring cloth, it is divided into four quarters, and each quarter fubdivided into 4 nails. The Englifh ell is equal to a yard and a quarter, or 45 inches, and is ufed in meafuring linens imported from Germany and the Low Countries.

The Scots *elwand* was eftablifhed by King David I. and divided into 37 inches. The ftandard is kept in the council chamber of Edinburgh, and being compared with the Englifh yard, is found to meafure $37\frac{1}{5}$ inches; and therefore the Scots inch and foot are larger than the Englifh, in the proportion of 180 to 185; but this difference being fo inconfiderable, is feldom attended to in practice. The Scots ell, though forbidden by law, is ftill ufed for meafuring fome coarfe commodities, and is the foundation of the land meafure of Scotland.

Itinerary meafure is the fame both in England and Scotland. The length of the chain is 4 poles, or 22 yards; 80 chains make a mile. The old Scots computed miles were generally about a mile and a half each.

The reel for yarn is $2\frac{1}{2}$ yards, or 10 quarters, in circuit; 120 threads make a cut, 12 cuts make a hafp or hank, and 4 hanks make a fpindle.

2.] The *French* ftandard was formerly the aune or ell, containing 3 Paris feet 7 inches 8 lines, or 1 yard $\frac{2}{7}$ Englifh; the Paris foot royal exceeding the Englifh by $\frac{68}{1000}$ parts, as in one of the following tables. This ell

Measure. ell is divided two ways: viz. into halves, thirds, sixths, and twelfths; and into quarters, half-quarters, and sixteenths.

The French, however, have also formed an entirely new system of weights and measures, according to the following table. Measure.

Proportions of the measures of each species to its principal measure or unity.	First part of the name which indicates the proportion to the principal measure or unity.	Length.	Capacity.	Weight.	Agrarian.	For firewood.
10,000 1,000 100 10 0 0.1 0.01 0.001	Myria Kilo Hecto Deca —— Deci Centi Milli	Metre.	Litre.	Gramme.	Are.	Stere.
Proportion of the principal measures between themselves and the length of the meridian.		10,000,000th part of the distance from the pole to the equator.	A decimetre cube.	Weight of a centimetre cube of distilled water.	100 square metres.	One cubic metre.
Value of the principal measures in the ancient French measures.		3 feet 11 lines and $\frac{1}{2}$ nearly.	1 pint and $\frac{1}{20}$ or 1 litron and $\frac{1}{4}$ nearly.	18 grains and 841,000 parts.	Two square perches des eaux et forêt.	1 demi-voie, or $\frac{1}{4}$ of a cord des eaux et forêt.
Value in English measures.		Inches 39.383.	61.083 inches, which is more than the wine, and less than the beer quart.	22,966 grains.	11.968 square yards.	

The English avoirdupois pound weighs troy grains 7004; whence the avoirdupois ounce, whereof 16 make a pound, is found equal to 437.75 troy grains. —And it follows that the troy pound is to the avoirdupois pound as 88 to 107 nearly; for as 88 to 107, so is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce, as 80 to 73 nearly; for as 80 to 73, so is 480 to 438. And, lastly, That the avoirdupois pound and ounce is to the Paris two marc weight and ounce, as 63 to 68 nearly; for as 63 to 68, so is 7004 to 7559.873. See WEIGHT. The Paris foot expressed in decimals, is equal to 1.0654 of the English foot, or contains 12.785 English inches. See FOOT.

3.] The standard in *Holland*, *Flanders*, *Sweden*, a good part of *Germany*, many of what were formerly called the *Hans-towns*, as *Dantzick* and *Hamburgh*, and at *Geneva*, *Franckfort*, &c. is likewise the ell: but the ell, in all these places, differs from the Paris ell. In Holland, it contains one Paris foot eleven lines, or four-sevenths of the Paris ell. The Flanders ell contains two feet one inch five lines and half a line; or seven-twelfths of the Paris ell. The ell of Germany, Brabant, &c. is equal to that of Flanders.

4.] The *Italian* measure is the branchio, brace, or fathom. This obtains in the states of Modena, Venice, Florence, Lucca, Milan, Mantua, Bologna, &c. but is of different lengths. At Venice, it contains one Paris foot eleven inches three lines, or eight fifteenths of the Paris ell. At Bologna, Modena, and Mantua, the brace is the same as at Venice. At Lucca it contains one Paris foot nine inches ten lines, or half a Paris ell. At Florence, it contains one foot nine inches four lines, or forty-nine hundredths of a Paris ell. At Milan, the brace for measuring of silks is one Paris foot seven inches four lines, or four-ninths of a Paris ell: that for woollen cloths is the same with the ell of Holland. Lastly, at Bergama, the brace is one foot seven inches six lines, or five-ninths of a Paris ell. The usual measure at Naples, however, is the canna, containing six feet ten inches and two lines, or one Paris ell and fifteen seventeenths.

5.] The *Spanish* measure is the vara or yard, in some places called the barra; containing seventeen twenty-fourths of the Paris ell. But the measure in Castile and Valencia is the pan, span, or palm; which is used, together with the canna, at Genoa. In Arragon, the vara is equal to a Paris ell and a half, or five feet five inches six lines.

6.] The *Portuguese* measure is the cavedos, containing two feet eleven lines, or four-sevenths of a Paris ell; and the vara, an hundred and six whereof make an hundred Paris ells.

7.] The *Piedmontese* measure is the ras, containing one

Measure. one Paris foot nine inches ten lines, or half a Paris ell. In Sicily, their measure is the canna, the same with that of Naples.

8.] The *Muscovy* measures are the cubit, equal to one Paris foot four inches two lines; and the arcin, two whereof are equal to three cubits.

9.] The *Turkish* and *Levant* measures are the picq, containing two feet two inches and two lines, or three-fifths of the Paris ell. The Chinese measure, the cobre; ten whereof are equal to three Paris ells. In Persia, and some parts of the Indies, the gueze, whereof there are two kinds; the royal gueze, called also the *gueze monkelser*, containing two Paris feet ten inches eleven lines, or four fifths of the Paris ell; and the shorter gueze, called simply *gueze*, only two thirds of the former. At Goa and Ormuz, the measure is the vara, the same with that of the Portuguese, having been introduced by them. In Pegu, and some other parts of the Indies, the cando or candi, equal to the ell of Venice. At Goa, and other parts, they use a larger cando, equal to seventeen Dutch ells; exceeding that of Babel and Balsora by $\frac{7}{8}$ per cent. and the vera by $6\frac{1}{2}$. In Siam, they use the ken, short of three Paris feet by one inch. The ken contains two soks, the sok two keubs, the keub twelve nious or inches, the niou to be equal to eight grains of rice, i. e. to about nine lines. At Camboia, they use the haster; in Japan, the tatam; and the span on some of the coasts of Guinea.

Tables of Long Measure.

1. English.

Barley-corn											
3	Inch										
9	3	Palm									
27	9	3	Span								
36	12	4	$1\frac{1}{3}$	Foot							
54	18	6	2	$1\frac{1}{2}$	Cubit						
108	36	12	4	3	2	Yard					
180	60	20	$6\frac{2}{3}$	5	$3\frac{1}{3}$	$1\frac{2}{3}$	Pace				
216	72	24	8	6	4	2	$1\frac{1}{5}$	Fathom			
594	198	66	22	$16\frac{1}{2}$	11	$5\frac{1}{2}$	$3\frac{3}{10}$	$2\frac{3}{4}$	Pole		
23760	7920	2640	880	660	440	220	132	110	40	Furlong	
190080	63360	21120	7040	5280	3520	1760	1056	880	320	8	Mile.

2. Scripture *Measures reduced into English.*

								Eng. feet.	Inch Dec.
Digit								0	0.912
4	Palm							0	3.648
12	3	Span						0	10.944
24	6	2	Cubit					1	9.888
96	24	8	4	Fathom				7	3.552
144	36	12	6	$1\frac{1}{2}$	Ezekiel's reed			10	11.328
192	48	16	8	2	$1\frac{1}{3}$	Arabian pole		14	7.104
1920	480	160	80	20	$13\frac{1}{3}$	10	Schœnus, or measuring line	145	11.04

3. The

3. *The* SCRIPTURE *Itinerary Measures.*

						Eng. Miles.	Paces.	Feet.
Cubit						0	0	1.824
400	Stadium					0	145	4.6
2000	5	Sabbath day's journey				0	729	3.000
4000	10	2	Eastern mile			1	403	1.000
12000	30	6	3	Parasan		4	153	3.000
96000	240	48	24	8	A day's journey	33	172	4.000

4. GRECIAN.

												Paces.	Feet.	Dec.
Dactylus, digit												0	0	0.7554 $\frac{11}{16}$
4	Doron, dochme											0	0	3.0218 $\frac{3}{4}$
10	$2\frac{1}{2}$	Lichas										0	0	7.5546 $\frac{7}{8}$
11	$2\frac{3}{4}$	$1\frac{1}{10}$	Orthodoron									0	0	8.3101 $\frac{9}{16}$
12	3	$1\frac{1}{5}$	$1\frac{1}{11}$	Spithame								0	0	9.0656 $\frac{1}{4}$
16	4	$1\frac{6}{10}$	$1\frac{5}{11}$	$1\frac{1}{3}$	Foot							0	1	0.0875
18	$4\frac{1}{2}$	$1\frac{4}{5}$	$1\frac{7}{11}$	$1\frac{1}{2}$	$1\frac{1}{8}$	Cubit						0	1	1.5984 $\frac{3}{8}$
20	5	2	$1\frac{9}{11}$	$1\frac{2}{3}$	$1\frac{1}{4}$	$1\frac{1}{9}$	Pygon					0	1	3.109 $\frac{3}{8}$
24	6	$2\frac{2}{5}$	$2\frac{2}{11}$	2	$1\frac{1}{2}$	$1\frac{1}{3}$	$1\frac{1}{5}$	Cubit larger				0	1	6.13125
96	24	$9\frac{3}{5}$	$8\frac{8}{11}$	8	6	$5\frac{1}{3}$	$4\frac{4}{5}$	4	Pace			0	6	0525
9600	2400	960	$872\frac{8}{11}$	800	600	$533\frac{1}{3}$	480	400	100	Furlong		100	4	4.5
76800	19200	7680	$6981\frac{9}{11}$	6400	6800	$4266\frac{2}{3}$	3840	3200	800	8	Mile	805	5	0

5. ROMAN.

										Paces.	Feet.	Dec.
Digitus transversus										0	0	0.725 $\frac{1}{4}$
$1\frac{1}{3}$	Uncia									0	0	0.967
4	3	Palmus minor								0	0	2.901
16	12	4	Pes							0	0	11.604
20	15	5	$1\frac{1}{4}$	Palmipes						0	1	2.505
24	18	6	$1\frac{1}{2}$	$1\frac{1}{5}$	Cubitus					0	1	5.406
40	40	10	$2\frac{1}{2}$	2	$1\frac{2}{3}$	Gradus				0	2	5.01
80	60	20	5	4	$3\frac{1}{3}$	2	Passus			0	4	10.02
10000	7500	2500	625	500	$416\frac{2}{3}$	250	125	Stadium		120	4	4.5
80000	60000	20000	5000	4000	$3333\frac{1}{3}$	2000	1000	8	Milliare	967	0	0.

Meaſure.

6. *Proportion of ſeveral Long Meaſures to each other, by M. Picard.*

The Rhinland or Leyden foot (12 whereof make the Rhinland perch) ſuppoſed	696
The Engliſh foot - -	$675\frac{1}{2}$
The Paris foot - -	720
The Amſterdam foot, from that of Leyden, by Snellius - - -	629
The Daniſh foot (two whereof make the Daniſh ell) - - -	$701\frac{8}{10}$
The Swediſh foot - -	$658\frac{1}{4}$
The Bruſſels foot - - -	$609\frac{3}{5}$
The Dantzick foot, from Hevelius's Selenographia - - -	636
The Lyons foot, by M. Auzout -	$757\frac{2}{5}$
The Bologna foot, by the ſame -	843
The braccio of Florence, by the ſame, and Father Marſenne - -	1290
The palm of the architects at Rome, according to the obſervations of Meſſrs Picard and Auzout - - -	$494\frac{1}{4}$
The Roman foot in the Capitol, examined by Meſſrs Picard and Auzout -	653 or $653\frac{1}{2}$
The ſame from the Greek foot -	652
From the vineyard Mattei - -	$657\frac{1}{2}$
From the palm - - -	$658\frac{3}{4}$
From the pavement of the Pantheon, ſuppoſed to contain 10 Roman feet -	653
From a ſlip of marble in the ſame pavement, ſuppoſed to contain three Roman feet -	650
From the pyramid of Ceſtius, ſuppoſed to contain 95 Roman feet - -	$653\frac{1}{2}$
From the diameters of the columns in the arch of Septimius Severus. - -	$653\frac{1}{3}$
From a ſlip of porphyry in the pavement of the Pantheon - -	$653\frac{1}{3}$

See on this ſubject Phil. Tranſ. vol. iv. art. 69. p. 774.

7. *Proportions of the Long Meaſures of ſeveral nations to the Engliſh foot, taken from Meſſrs Greaves, Auzout, Picard, and Eiſenchmid.* See FOOT.

The Engliſh ſtandard foot being divided into 1000 equal parts, the other meaſures will have the proportions to it, which follow.

	Feet.	Inches.
Engliſh foot - -	1000	12
Paris foot - -	1068	12.816
Venetian foot - -	1161	13.944
Rhinland foot - -	1033	12.396
Straſburgh foot - -	952	14.424
Norimberg foot - -	1000	12
Dantzick foot - -	944	11.328
Daniſh foot - -	1042	12.504
Swediſh foot - -	$977\frac{3}{4}$	11 733
Derahor cubit of Cairo -	1824	12.888
Perſian ariſh - -	3197	38.364
Greater Turkiſh pike -	2200	26.4
Leſſer Turkiſh pike -	2131	25.572
Braccio at Florence -	1913	22.956
Braccio for woollen at Sienna -	1242	14.904
Braccio for linen at Sienna -	1974	23.688
Canna at Naples - -	6880	82.56
Vera at Almaria and Gibraltar	2760	33.12
Palmo di Archtetti at Rome -	732	87.84
Canna di Archtetti - -	7320	87.84
Palmo di braccio di mercantia	$695\frac{1}{2}$	83.46
Genoa palm - -	815	9.78
Bolognian foot - - -	1250	15
Antwerp ell - -	2283	27.396
Amſterdam ell - -	2268	27.216
Leyden ell - -	2260	27.12
Paris draper's ell - -	3929	47.148
Paris mercer's ell - -	3937	47.244

8. *Different Itinerary Meaſures.*

A French league is about	$2\frac{3}{4}$	Engliſh miles
A German mile	4	ditto
A Dutch mile	$3\frac{1}{4}$	ditto
An Italian mile	$\frac{11}{12}$	ditto
A Spaniſh league	$3\frac{2}{3}$	ditto
A Ruſſian verſt	$\frac{3}{4}$	ditto.

II. *SQUARE, SUPERFICIAL, or LAND Meaſure.*

1. *Engliſh* ſquare meaſures are raiſed from the yard of 36 inches multiplied into itſelf, and thus producing 1296 ſquare inches in the ſquare yard; the diviſions of this are ſquare feet and inches; and the multiples, poles, roods, and acres. Becauſe the length of a pole is $5\frac{1}{2}$ yards, the ſquare of the ſame contains $30\frac{1}{4}$ ſquare yards. A ſquare mile contains 640 ſquare acres. In meaſuring fens and woodlands, 18 feet are generally allowed to the pole, and 21 feet in foreſt lands.

A hide of land, frequently mentioned in the earlier part of the Engliſh hiſtory, contained about 100 arable acres; and 5 hides were eſteemed a knight's fee. At the time of the Norman conqueſt, there were 243,600 hides in England.

2. *Scotch* ſquare or land meaſure is regulated by the Scotch ell: 36 ſquare ells = 1 fall, 40 falls = 1 rood, 4 roods = 1 acre.—The proportion between the Scotch and Engliſh acre, ſuppoſing the feet in both meaſures alike, is as 1369 to 1089, or nearly as 5 to 4. If the difference of the feet be regarded, the proportion is as 10,000 to 7869. The length of the chain for meaſuring land in Scotland is 24 ells, or 74 feet —A huſband-land contains 6 acres of ſock and ſcythe land, that is, of land that may be tilled with a plough or mown with a ſcythe; 13 acres of arable land make one ox-gang, and four ox-gangs make a pound-land of old extent.

3. *French* ſquare meaſures are regulated by 12 ſquare lines in the inch ſquare; 12 inches in the foot, 22 feet in the perch, and 100 perches in the arpent or acre.

TABLES

Tables of Square Meaſure.

1. English.

Inches						
144	Feet					
1296	9	Yards				
3600	25	$2\frac{7}{9}$	Paces			
39204	$272\frac{1}{4}$	$30\frac{1}{4}$	10.89	Poles		
1568160	10890	1210	435.6	40	Rood	
6272640	43560	4840	1743.6	160	4	Acre.

2. *Grecian* ſquare meaſures were the plethron or acre, by ſome ſaid to contain 1444, by others 10,000 ſquare feet; and aroura, the half of the plethron. The aroura of the Egyptians was the ſquare 100 cubits.

3. *Roman* ſquare meaſure reduced to Engliſh. The integer was the jugerum or acre, which the Romans divided like the libra or as: thus the jugerum contained

	Square feet.	Scruples.	Engliſh roods.	Sq. poles.	Square feet.
As	28800	288	2	18	250.05
Deunx	26400	264	2	10	183.85
Dextans	24000	240	2	2	117.64
Dodrans	21600	216	1	34	51.42
Bes	19200	192	1	25	257.46
Septunx	16800	168	1	17	191.25
Semis	14400	144	1	9	125.03
Quincunx	12000	120	1	1	58.82
Triens	9600	96	0	32	264.85
Quadrans	7200	72	0	24	198.64
Sextans	4800	48	0	16	132.43
Uncia	2400	24	0	8	66.21

Note, Actus major was 14,400 ſquare feet, equal to a ſemis; clima, 3600 ſquare feet, equal to ſeſcuncia; and actus minimus equal to a ſextans.

III. *Cubical Meaſures*, or Meaſures of Capacity, for Liquids.

1. The *Engliſh* meaſures were originally raiſed from troy weight: it being enacted by ſeveral ſtatutes, that eight pounds troy of wheat, gathered from the middle of the ear, and well dried, ſhould weigh a gallon of wine meaſure, the diviſions and multiples whereof were to form the other meaſures; at the ſame time it was alſo ordered, that there ſhould be but one liquid meaſure in the kingdom: yet cuſtom has prevailed; and there having been introduced a new weight, viz. the avoirdupois, we have now a ſecond ſtandard gallon adjuſted thereto, and therefore exceeding the former in the proportion of the avoirdupois weight to troy weight. From this latter ſtandard are raiſed two ſeveral meaſures, the one for ale, the other for beer. The ſealed gallon at Guildhall, which is the ſtandard for wines, ſpirits, oils, &c. is ſuppoſed to contain 231 cubic inches; and on this ſuppoſition the other meaſures raiſed therefrom will contain as in the table underneath: yet, by actual experiment, made in 1688, before the lord mayor and the commiſſioners of exciſe, this gallon was found to contain only 224 cubic inches: it was, however, agreed to continue the common ſuppoſed contents of 231 cubic inches: ſo that all computations ſtand on their old footing. Hence, as 12 is to 231, ſo is $14\frac{12}{20}$ to $281\frac{1}{2}$ the cubic inches in the ale gallon: but in effect the ale quart contains $70\frac{1}{2}$ cubic inches, on which principle the ale and beer gallon will be 282 cubic inches. The ſeveral diviſions and multiples of theſe meaſures, and their proportions, are exhibited in the tables underneath.

The barrel for ale in London is 32 gallons, and the barrel for beer 36 gallons. In all other places of England, the barrel, both for ale and beer, is 34 gallons.

2. *Scotch* liquid meaſure is founded on the pint. The Scotch pint was formerly regulated by a ſtandard jug of caſt metal, the cuſtody of which was committed to the borough of Stirling. This jug was ſuppoſed to contain 105 cubic inches; and though, after ſeveral careful trials, it has been found to contain only about $103\frac{1}{2}$ inches; yet, in compliance with eſtabliſhed cuſtom, founded on that opinion, the pint *ſtoups* are ſtill regulated to contain 105 inches, and the cuſtomary ale meaſures are about $\frac{1}{18}$ above that ſtandard. It was enacted by James I. of Scotland, that the pint ſhould contain 41 ounces trone weight of the clear water of Tay, and by James VI. that it ſhould contain 55 Scots troy ounces of the clear water of Leith. This affords another method of regulating the pint, and alſo aſcertains the ancient ſtandard of the trone weight. As the water of Tay and Leith are alike, the trone weight muſt have been to the Scots troy weight as 55 to 41; and therefore the pound trone muſt have contained about $21\frac{1}{2}$ ounces Scots troy.

4 gills	=	1 mutchkin.
2 mutchkins	=	1 chopin.
2 chopins	=	1 pint.
2 pints	=	1 quart.
4 quarts	=	1 gallon.

The Scotch quart contains 210 inches; and is, therefore, about $\frac{1}{10}$ leſs than the Engliſh wine gallon, and about $\frac{1}{4}$ leſs than the ale gallon.

3. As to the liquid meaſures of foreign nations, it is to be obſerved, that their ſeveral veſſels for wine, vinegar, &c. have alſo various denominations according to their different ſizes and the places wherein they are uſed. The woeders of Germany, for holding Rheniſh and Moſelle wines, are different in their gauges; ſome containing 14 aumes of Amſterdam meaſure, and others more or leſs. The aume is reckoned at Amſterdam for 8 ſteckans, or 20 verges, or for $\frac{1}{5}$ of a tun of 2 pipes, or 4 barrels, of French or Bourdeaux, which $\frac{1}{6}$ at this latter place is called *tierçon*, becauſe

Measure.

because 3 of them make a pipe or 2 barrels, and 6 the said tun. The steckan is sixteen mingles, or 32 pints; and the verge is, in respect of the said Rhenish and Moselle, and some other sorts of wine, 6 mingles; but, in measuring brandy it consists of $6\frac{1}{8}$ mingles. The aume is divided into 4 anckers, and the ancker into 2 steckans, or 32 mingles. The ancker is taken sometimes for $\frac{1}{24}$ of a tun, or 4 barrels; on which footing the Bourdeaux barrel ought to contain at Amsterdam (when the cask is made according to the just gauge) $12\frac{1}{2}$ steckans, or 200 mingles, wine and lees; or 12 steckans, or 192 mingles, racked wine; so that the Bourdeaux tun of wine contains 50 steckans, or 800 mingles, wine and lees; and 48 steckans, or 768 mingles, of pure wine. The barrels or poinçons of Nantes and other places on the river Loire, contain only 12 steckans, Amsterdam measure. The wine tun of Rochelle, Cogniac, Charente, and the isle of Rhé, differs very little from the tun of Bourdeaux, and consequently from the barrels and pipes. A tun of wine of Chalosse, Bayonne, and the neighbouring places, is reckoned 60 steckans, and the barrel 15, Amsterdam measure.

The muid of Paris contains 150 quarts or 300 pints, wine and lees; or 280 pints clear wine; of which muids 3 make a tun, and the fractions are,

The muid	containing	36 setiers
The setier		4 quarts
The quart		2 pints
The pint		2 chopins
The chopin		2 demi-setiers
The demi-setier		2 poissons

The muid is also composed of pipes or poinçons, quarteaux, queves, and demiqueves; those poinçons of Paris and Orleans contain about 15 steckans Amsterdam measure, and ought to weigh with the cask 666lb. a little more or less. In Provence they reckon by milleroles, and the millerole of Toulon contains 66 Paris pints, or 100 pints of Amsterdam nearly, and the Paris pint is nearly equal to the English wine quart (A).

The butts or pipes from Cadiz, Malaga, Alicant, Benecarlo, Saloe, and Mataro, and from the Canaries, from Lisbon, Oporto, and Fayal, are very different in their gauges, though in affreightments they are all reckoned two to the tun.

Vinegar is measured in the same manner as wine; but the measures for brandies are different: these spirits from France, Spain, Portugal, &c. are generally shipped in large casks called *pipes*, *butts*, and *pieces*, according to the places from whence they are imported, &c. In France, brandy is shipped in casks called *pieces* at Bourdeaux, and *pipes* at Rochelle, Cogniac, the isle of Rhé, and other neighbouring places, which contain some more and some less, even from 60 to 90 Amsterdam verges or veertels, according to the capacity of the vessels, and the places they come from, which, being reduced into barrels, will stand as follows, viz.

At Rochelle, Cogniac, the isle of Rhé, and the country of Aunis, -	27 Veertels	per barrel.
At Nantes, and several places of Bretagne and Anjou - -	29 Veertels	
At Bourdeaux, and different parts of Guienne - -	32 Verges	
At Amsterdam, and other cities of Holland - -	30 Veertels	
At Hamburgh and Lubeck -	30 Verges	
At Embden - -	27 Verges	

In Provence and Languedoc, brandy is sold by the quintal, the casks included; and at Bruges in Flanders, the verges are called *festers* of 16 stops each, and the spirits is sold at so much per stop.

Olive oil is also shipped in casks of various sizes, according to the custom of the places where it is embarked, and the conveniency of stowage. In England it is sold by the tun of 236 gallons; and at Amsterdam by the tun of 717 mingles, or 1434 pints. In Provence it is sold by milleroles of 66 Paris pints; from Spain and Portugal it is brought in pipes or butts, of different gauges; at the first place it is sold by roves, where 40 go to the butt; and at the latter place by almoudas, whereof 26 make a pipe. Train oil is sold in England by the tun, at Amsterdam by the barrel.

Tables of Liquid Measure.

1. English.

[*Wine.*]

Solid inches									
$28\frac{7}{8}$	Pint								
231	8	Gallon							
4158	144	18	Rundlet						
$7276\frac{1}{2}$	252	$31\frac{1}{2}$	$1\frac{3}{4}$	Barrel					
9702	336	42	$2\frac{1}{3}$	$1\frac{2}{3}$	Tierce				
14553	504	63	$3\frac{1}{2}$	2	$1\frac{1}{2}$	Hogshead			
19279	672	84	$4\frac{2}{3}$	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Puncheon		
29106	1008	126	7	4	3	2	$1\frac{1}{2}$	Butt or pipe	
58212	2016	252	14	8	6	4	3	2	Tun.

[*Ale.*]

Pints					
8	Gallon				
64	8	Firkin			
128	16	2	Kilderkin		
256	32	4	2	Barrel	
512	64	8	4	2	Hogsh.

[*Beer.*]

Pints					
8	Gallon				
72	9	Firkin			
144	18	2	Kilderkin		
288	36	4	2	Barrel	
576	72	8	4	2	Hogsh.

2. Jewish

(A) These are the old measures of France, the account of which, for the sake of comparison, is here retained.

2. JEWISH reduced to Englifh Wine Meafure.

Measure							Gall.	Pints	Solid inches.
Caph							0	$0\frac{5}{8}$	0.177
Log	$1\frac{1}{3}$						0	$0\frac{5}{6}$	0.211
Cab	$5\frac{1}{3}$	4					0	$3\frac{1}{3}$	0.844
Hin	16	12	3				1	2	2.533
Seah	32	24	6	2			2	4	5.067
Bath, or Epha	96	72	18	6	3		7	4	15.2
Coron, or Chomer	960	720	180	60	30	10	75	5	7.625

3. ATTIC reduced to Englifh Wine Meafure.

Measure										Gal.	Pints.	Sol. inch. · Dec.
Cochliarion										0	$\frac{1}{120}$	$0.0356\frac{5}{12}$
Cheme	2									0	$\frac{1}{60}$	$0.0712\frac{5}{6}$
Myftrone	$2\frac{1}{2}$	$1\frac{1}{4}$								0	$\frac{1}{48}$	$0.089\frac{11}{48}$
Conche	5	$2\frac{1}{2}$	2							0	$\frac{1}{24}$	$0.178\frac{11}{24}$
Cyathos	10	5	4	2						0	$\frac{1}{12}$	$0.356\frac{11}{12}$
Oxybaphon	15	$7\frac{1}{2}$	6	3	$1\frac{1}{2}$					0	$\frac{1}{8}$	$0.535\frac{3}{8}$
Cotyle	60	30	24	12	6	4				0	$\frac{1}{2}$	$2.141\frac{1}{2}$
Xeftes	120	60	48	24	12	8	2			0	1	4.283
Chous	720	360	288	144	72	48	12	6		0	6	25.698
Metretes	8640	4320	3456	1728	864	576	144	72	12	10	2	19.629

4. ROMAN reduced to Englifh Wine Meafure.

Measure										Gal.	Pints.	Sol. inch. · Dec.
Ligula										0	$0\frac{1}{48}$	$0.117\frac{5}{12}$
Cyathus	4									0	$0\frac{1}{12}$	$0.469\frac{2}{3}$
Acetabulum	6	$1\frac{1}{2}$								0	$0\frac{1}{8}$	$0.704\frac{1}{2}$
Quartarius	12	3	2							0	$0\frac{1}{4}$	1.40
Hemina	24	6	4	2						0	$0\frac{1}{2}$	2.818
Sextarius	48	12	8	4	2					0	1	5.636
Congius	288	72	48	24	12	6				0	7	4.942
Urna	1152	288	192	96	48	24	4			3	$4\frac{1}{2}$	5.33
Amphora	2304	576	384	192	96	48	8	2		7	1	10.66
Culeus	46080	11520	7680	3840	1920	960	160	40	20	143	3	11.095

IV. *Meafures*

Measure.

IV. *Measures of Capacity for things Dry.*

1.] *English* dry or corn measure. The standard for measuring corn, salt, coals, and other dry goods, in England, is the Winchester gallon, which contains $272\frac{1}{4}$ cubic inches. The bushel contains 8 gallons, or 2178 inches. A cylindrical vessel, $18\frac{1}{2}$ inches diameter, and 8 inches deep, is appointed to be used as a bushel in levying the malt tax. A vessel of these dimensions is rather less than the Winchester bushel of 8 gallons, for it contains only 2150 inches; though probably there was no difference intended. The denominations of dry measure commonly used, are given in the first of the subjoined tables. Four quarters corn make a chaldron, 5 quarters make a wey or load, and 10 quarters make a ton. In measuring sea coal, 5 pecks make a bushel, 9 bushels made a quarter or vatt, 4 quarters make a chaldron, and 21 chaldrons make a score.

40 feet hewn timber make a load.
50 feet unhewn timber make a load.
32 gallons make a herring barrel.
42 gallons make a salmon barrel.
1 cwt. gunpowder makes a barrel.
256 lbs. soap make a barrel.
10 dozen candles make a barrel.
12 barrels make a last.

2.] *Scotch* dry measure. There was formerly only one measure of capacity in Scotland; and some commodities were heaped, others *straiked*, or measured exactly to the capacity of the standard. The method of heaping was afterwards forbidden as unequal, and a larger measure appointed for such commodities as that custom had been extended to.

The wheat firlot, used also for rye, pease, beans, salt, and grass seeds, contains 21 pints 1 mutchkin, measured by the Stirling jug. The barley firlot, used also for oats, fruit, and potatoes, contains 31 pints. A different method of regulating the firlot was appointed from the dimensions of a cylindrical vessel. The diameter for both measures was fixed at $19\frac{1}{8}$ inches, the depth $7\frac{1}{5}$ inches for the wheat firlot, and $10\frac{1}{2}$ for the barley firlot. A standard constructed by these measures is rather less than when regulated by the pint; and as it is difficult to make vessels exactly cylindrical, the regulation by the pint has prevailed, and the other method gone into disuse.

If the Stirling jug contains $103\frac{1}{5}$ inches, the wheat firlot will contain 2109 inches; which is more than 2 per cent. larger than the legal malt bushel of England, and about 1 per cent. larger than the Winchester bushel: and the barley firlot will contain 3208 inches. The barley boll is nearly equal to six legal malt bushels.

In Stirlingshire, 17 pecks are reckoned to the boll: in Invernessshire, 18 pecks: in Ayrshire, the boll is the same as the English quarter. And the firlots, in many places, are larger than the Linlithgow standard.

3.] *French dry*, are, the litron, bushel, minot, mine, septier, muid, and tun. The litron is divided into two demilitrons, and four quarter litrons, and contains 36 cubic inches of Paris. By ordonnance, the litron is to be three inches and a half high, and three inches 10 lines broad. The litron for salt is larger, and is divided into two halves, four quarters, eight demi-quarters, and 16 mesurettes. The French bushel is different in different jurisdictions. At Paris it is divided into demibushels; each demibushel into two quarts; the quart into two half quarts; and the half quart into two litrons: so that the bushel contains 16 litrons. By ordonnance the Paris bushel is to be eight inches two lines and a half high, and ten inches broad, or in diameter within-side. The minot consists of three bushels, the mine of two minots or six bushels, the septier of two mines or 12 bushels, and the muid of 12 septiers or 144 bushels. The bushel of oats is estimated double that of any other grain; so that there go 24 bushels to make the septier, and 288 to make the muid. It is divided into four picotins, the picotin containing two quarts, or four litrons. The bushel for salt is divided into two half bushels, four quarters, eight half quarters, and 16 litrons; four bushels make a minot, 16 a septier, and 192 a muid. The bushel for wood is divided into halves, quarters, and half quarters. Eight bushels make the minot, 16 a mine; 20 mines or 320 bushels, the muid. For plaster, 12 bushels make a sack, and 36 sacks a muid. For lime, three bushels make a minot, and 48 minots a muid. The minot is by ordonnance to be 11 inches 9 lines high, and 14 inches 8 lines in diameter. The minot is composed of three bushels, or 16 litrons; four minots make a septier, and 48 a muid. The French mine is no real vessel, but an estimation of several others. At Paris the mine contains six bushels, and 24 make the muid; at Rouen the mine is four bushels; and at Dieppe 18 mines make a Paris muid. The septier differs in different places: at Paris it contains two mines, or eight bushels, and 12 septiers the muid. At Rouen the septier contains two mines or 12 bushels. Twelve septiers make a muid at Rouen as well as at Paris; but 12 of the latter are equal to 14 of the former. At Toulon the septier contains a mine and a half; three of which mines make the septier of Paris. The muid or muy of Paris consists of 12 septiers; and is divided into mines, minots, bushels, &c. That for oats is double that for other grain, i. e. contains twice the number of bushels. At Orleans the muid is divided into mines, but those mines only contain two Paris septiers and a half. In some places they use the tun in lieu of the muid; particularly at Nantes, where it contains 10 septiers of 16 bushels each, and weighs between 2200 and 2250 pounds. Three of these tuns make 28 Paris septiers. At Rochelle, &c. the tun contains 42 bushels, and weighs two per cent. less than that of Nantes. At Brest it contains 20 bushels, is equal to 10 Paris septiers, and weighs about 2240 pounds. See Tun.

4.] *Dutch*, *Swedish*, *Polish*, *Prussian*, and *Muscovite*. In these places, they estimate their dry things on the foot of the *last*, *lest*, *leth*, or *lecht*; so called according to the various pronunciations of the people who use it. In Holland, the last is equal to 19 Paris septiers, or 38 Bourdeaux bushels, and weighs about 4560 pounds; the last they divide into 27 mudes, and the mude into four schepels. In Poland, the last is 40 Bourdeaux bushels, and weighs about 4800 Paris pounds. In Prussia, the last is 133 Paris septiers. In Sweden and Muscovy they measure by the great and little last; the first containing 12 barrels, and the second half as many. See Last.

Measure.

Last. In Muscovy, they likewise use the chefford, which is different in various places: that of Archangel is equal to three Rouen bushels.

5.] *Italian.* At Venice, Leghorn, and Lucca, they estimate their dry things on the foot of the staro or staio; the staro of Leghorn weighs 54 pounds: 112 staros and seven-eighths are equal to the Amsterdam last. At Lucca, 119 staros make the last of Amsterdam. The Venetian staro weighs 128 Paris pounds: the staro is divided into four quarters. Thirty-five staros and one-fifth, or 140 quarters and four-fifths, make the last of Amsterdam. At Naples and other parts, they use the tomolo or tomalo, equal to one-third of the Paris septier. Thirty-six tomoli and a half make the carro, and a carro and a half, or 54 tomoli, make the last of Amsterdam. At Palermo, 16 tomoli make the salma, and four mondili the tomolo. Ten salmas and three-sevenths, or 171 tomoli and three sevenths, make the last of Amsterdam.

6.] *Flemish.* At Antwerp, &c. they measure by the viertel; 32 and one-half whereof make 19 Paris septiers. At Hamburgh, the schepel; 90 whereof make 19 Paris septiers.

7.] *Spanish* and *Portuguese.* At Cadiz, Bilboa, and St Sebastian, they use the fanega; 23 whereof make the Nantes or Rochelle tun, or nine Paris septiers and a half: though the Bilboa fanega is somewhat larger, insomuch that 21 fanegas make a Nantes tun. At Seville, &c. they use the anagoras, containing a little more than the Paris mine; 36 anagoras make 19 Paris septiers. At Bayonne, &c. the concha; 30 whereof are equal to nine Paris septiers and a half. At Lisbon, the alquiver, a very small measure, 240 whereof make 19 Paris septiers, 60 the Lisbon muid.

Tables of Dry Measure.

1. English.

Solid inches					
33.6	Pint				
268.8	8	Gallon.			
537.6	16	2	Peck		
2150.4	64	8	4	Bushel	
17203.2	512	64	32	8	Quarter.

2. Scripture Dry, reduced to English.

							Peck.	Gall.	Pint.	Dec. Sol. inch
Gachal							0	0	0 $\frac{17}{120}$	0.031
20	Cab						0	0	2 $\frac{5}{6}$	0.073
36	$1\frac{4}{5}$	Gomor					0	0	5 $\frac{1}{10}$	1.211
120	6	$3\frac{1}{3}$	Seah				1	0	1	4.036
360	18	10	3	Epha			3	0	3	12.107
1800	90	50	15	5	Leteeh		16	0	0	26.500
3600	180	100	30	10	2	Chomer, or coron	32	0	1	18.969

3. Attic

 Meafure.

3. Attic Meafures of Capacity for Things dry, reduced to Englifh Corn Meafure.

							Peck.	Gal.	Pint.	Dec. Sol. inch
Cochliarion							0	0	0	0.276 $\frac{7}{20}$
10	Cyathos						0	0	0	2.763 $\frac{1}{2}$
15	$1\frac{1}{2}$	Oxybaphon					0	0	0	4.144 $\frac{3}{4}$
60	6	4	Cotyle				0	0	0	16.579
120	12	8	2	Xeftes			0	0	0	33.158
180	18	12	3	$1\frac{1}{2}$	Choenix		0	0	1	15.705 $\frac{1}{4}$
8640	864	576	144	72	48	Medimnos	4	0	6	3.501

4. Roman Meafures of Capacity for Things dry, reduced to Englifh Corn meafure.

							Peck.	Gall.	Pint.	Dec. Sol. inch
Ligula							0	0	0 $\frac{1}{48}$	0.01
4	Cyathus						0	0	0 $\frac{1}{12}$	0.04
6	$1\frac{1}{2}$	Acetabulum					0	0	0 $\frac{1}{8}$	0.06
24	6	4	Hemina				0	0	8 $\frac{1}{2}$	0.24
48	12	8	2	Sextarius			0	0	1	0.48
384	96	64	16	8	Semimodius		0	1	0	3.84
768	192	128	32	16	2	Modius	1	0	0	7.68

Measure *of Wood for Firing*, is ufually the cord four feet high, and as many broad, and eight long; this is divided into two half cords, called *ways*, and by the French *membrures*, from the pieces ftuck upright to bound them; or *voyes*, as being fuppofed half a waggon load.

Measure *for Horfes*, is the hand, which by ftatute contains four inches.

Measure, among *Botanifts*. In defcribing the parts of plants, Tournefort introduced a geometrical fcale, which many of his followers have retained. They meafured every part of the plant; and the effence of the defcription confifted in an accurate menfuration of the whole.

As the parts of plants, however, are liable to variation in no circumftance fo much as that of dimenfion, Linnæus very rarely admits any other menfuration than that arifing from the refpective length and breadth of the parts compared together. In cafes that require actual menfuration, the fame author recommends, in lieu of Tournefort's artificial fcale, the following natural fcale of the human body, which he thinks is much more convenient, and equally accurate.

The fcale in queftion confifts of 11 degrees, which are as follow: 1. A hair's breadth, or the diameter of a hair, (*capillus*). 2. A line, (*linea*), the breadth of the crefcent or white appearance at the root of the finger (not thumb), meafured from the fkin towards the body of the nail; a line is equal to 12 hairbreadths, and is the 12th part of a Parifian inch. 3. A nail (*unguis*), the length of a finger nail; equal to fix lines, or half a Parifian inch. 4. A thumb (*pollex*), the length of the firft or outermoft joint of the thumb; equal to a Parifian inch. 5. A palm (*palmus*), the breadth of the palm exclufive of the thumb; equal to three Parifian inches. 6. A fpan (*fpithama*) the diftance between the extremity of the thumb and that of the firft finger when extended; equal to feven Parifian inches. 7. A great fpan (*dodrans*), the diftance between the extremity of the thumb and that of the little finger, when extended; equal to nine inches. 8. A foot (*pes*), meafuring from the elbow to the bafis of the thumb; equal to 12 Parifian inches. 9. A cubit (*cubitus*), from the elbow to the extremity of the middle finger; equal to 17 inches. 10. An arm length (*brachium*), from the armpit to the extremity of the middle finger; equal to 24 Parifian inches, or two feet. 11. A fathom (*orgya*), the meafure of the human ftature; the diftance between the extremities of the two middle fingers, when the arms are extended; equal, where greateft, to fix feet.

Measure is alfo ufed to fignify the cadence and time obferved in poetry, dancing, and mufic, to render them regular and agreeable.

The different meafures or metres in poetry, are the different

Meaſure.

different manners of ordering and combining the quantities, or the long and ſhort ſyllables. Thus, hexameter, pentameter, iambic, ſapphic verſes, &c. conſiſt of different meaſures.

In Engliſh verſes, the meaſures are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleaſes. The moſt uſual are the heroic, generally conſiſting of five long and five ſhort ſyllables; and verſes of four feet; and of three feet and a cæſura, or ſingle ſyllable.

The ancients, by variouſly combining and tranſpoſing their quantities, made a vaſt variety of different meaſures. Of words, or rather feet of two ſyllables, they formed a ſpondee, conſiſting of two long ſyllables; a pyrrhic, of two ſhort ſyllables; a trochee, of a long and a ſhort ſyllable; and an iambic, of a ſhort and a long ſyllable.

Of their feet of three ſyllables they formed a moloſſus, conſiſting of three long ſyllables; a tribrach, of three ſhort ſyllables; a dactyl, of one long and two ſhort ſyllables; and an anepæſt, of two ſhort and one long ſyllable. The Greek poets contrived 124 different combinations or meaſures, under as many different names, from feet of two ſyllables to thoſe of ſix.

Measure, in *Muſic*, the interval or ſpace of time which the perſon who beats time takes between the riſing and falling of his hand or foot, in order to conduct the movement, ſometimes quicker, and ſometimes ſlower, according to the kind of muſic, or the ſubject that is ſung or played.

The meaſure is that which regulates the time we are to dwell on each note. See Time.

The ordinary or common meaſure is one ſecond, or 60th part of a minute, which is nearly the ſpace between the beats of the pulſe or heart; the ſyſtole, or contraction of the heart, anſwering to the elevation of the hand; and its diaſtole, or dilatation, to the letting it fall. The meaſure uſually takes up the ſpace that a pendulum of two feet and a half long employs in making a ſwing or vibration. The meaſure is regulated according to the different quality or value of the notes in the piece; by which the time that each note is to take up is expreſſed. The ſemibreve, for inſtance, holds one riſe and one fall; and this is called the *meaſure* or *whole meaſure*, ſometimes the *meaſure note*, or *time note;* the minim, one riſe, or one fall; and the crotchet, half a riſe, or half a fall, there being four crotchets in a full meaſure.

Measure Binary, or *Double*, is that wherein the riſe and fall of the hand are equal.

Measure Ternary, or *Triple*, is that wherein the fall is double to the riſe; or where two minims are played during a fall, and but one in the riſe. To this purpoſe, the number 3 is placed at the beginning of the lines, when the meaſure is intended to be triple; and a C, when the meaſure is to be common or double. This riſing and falling of the hands was called by the Greeks *αρσις* and *θεσις*. St Auguſtine calls it *plauſus*, and the Spaniards *compas*. See Arsis and Thesis.

Powder Measures in Artillery, are made of copper, and contain from an ounce to 12 pounds: theſe are very convenient in a ſiege, when guns or mortars are loaded with looſe powder, eſpecially in ricochet firing, &c.

Meaſuring, Meat.

MEASURING, or Mensuration, is the uſing a certain known meaſure, and determining thereby the preciſe extent, quantity, or capacity of any thing.

Measuring, in general, includes the practical part of geometry. From the various ſubjects on which it is employed, it acquires various names, and conſtitutes various arts. See Geometry, Levelling, Mensuration, Trigonometry, &c.

MEAT. See Food, Diet, Drink, &c.

Amongſt the Jews, ſeveral kinds of animals were forbidden to be uſed as food. The fleſh with the blood, and the blood without the fleſh, were prohibited; the fat alſo of ſacrificed animals was not to be eaten. Roaſt meat, boiled meat, and ragouts, were in uſe among the Hebrews, but we meet with no kind of ſeaſoning except ſalt, bitter herbs, and honey.—They never mingled milk in any ragout or haſh, and never ate at the ſame meal both meat and milk, butter, or cheeſe. The daily proviſion for Solomon's table was 30 meaſures of fine wheat flour, 60 of common flour, 10 fat oxen, 20 paſture oxen, 100 ſheep, beſides veniſon and wildfowl. See Luxury.

The principal and moſt neceſſary food among the ancient Greeks, was bread, which they called *αρτος*, and produced in a wicker baſket called *κανεον*. Their loaves were ſometimes baked under the aſhes, and ſometimes in an oven. They alſo uſed a ſort of bread called *maza*. Barley meal was uſed amongſt the Greeks, which they called *αλφιτον*. They had a frequent diſh called *θριον*, which was a compoſition of rice, cheeſe, eggs, and honey, wrapped in fig-leaves. The *Μυττωτον* was made of cheeſe, garlic, and eggs, beaten and mixed together. Their bread, and other ſubſtitutes for bread, were baked in the form of hollow plates, into which they poured a ſauce. Garlic, onions, and figs, ſeem to have been a very common food amongſt the poorer Athenians. The Greeks, eſpecially in the heroical times, ate fleſh roaſted; boiled meat ſeldom was uſed. Fiſh ſeems not to have been uſed for food in the early ages of Greece. The young people only, amongſt the Lacedemonians, ate animal food; the men and the old men were ſupported by a black ſoup called *μελα ζωμος*, which to people of other nations was always a diſagreeable meſs. Graſshoppers and the extremities or tender ſhoots of trees were frequently eaten by the poor among the Greeks. Eels dreſſed with beet root were eſteemed a delicate diſh, and they were fond of the jowl and belly of ſalt-fiſh. Neither were they without their ſweet-meats; the deſſert conſiſted frequently of fruits, almonds, nuts, figs, peaches, &c. In every kind of food we find ſalt to have been uſed.

The diet of the firſt Romans conſiſted wholly of milk, herbs, and roots, which they cultivated and dreſſed with their own hands; they alſo had a kind of gruel, or coarſe groſs pap, compoſed of meal and boiling water; this ſerved for bread: And when they began to uſe bread, they had none for a great while but of unmixed rye. Barley-meal was eaten by them, which they called *Polenta*. When they began to eat animal food, it was eſteemed a piece of luxury, and an indulgence not to be juſtified but by ſome particular occasion. After animal food had grown into common use, the meat which they most frequently produced upon their tables was pork.

Method of Preserving Flesh-Meat without spices, and with very little salt. Jones, in his *Miscellanea Curiosa*, gives us the following description of the Moorish *Elcholle*, which is made of beef, mutton, or camel's flesh, but chiefly beef, which is cut in long slices, and laid for 24 hours in a pickle. They then remove it out of those jars or tubs into others with water; and when it has lain a night, they take it out, and put it on ropes in the sun and air to dry. When it is thoroughly dried and hard, they cut it into pieces of two or three inches long, and throw it into a pan or caldron, which is ready with boiling oil and suet sufficient to hold it, where it boils till it be very clear and red when cut. After this they take it out, and set it to drain; and when all is thus done it stands to cool, and jars are prepared to put it up in, pouring upon it the liquor in which it was fried; and as soon as it is thoroughly cold, they stop it up close. It will keep two years; will be hard, and the hardest they look upon to be the best done. This they dish up cold, sometimes fried with eggs and garlic, sometimes stewed, and lemon squeezed on it. It is very good any way, either hot or cold.

MEATH, commonly so called, or otherwise *East* Meath, to distinguish it from the county called *West* Meath: A county of Ireland, in the province of Leinster, bounded by the counties of Cavan and Louth on the north, the Irish channel on the east, Kildare and Dublin on the south, and West Meath and Longford on the west. It is a fine champaign country, abounding with corn, and well inhabited. It returns 14 members to parliament; and gives title of earl to the family of Brabazan. It contains 326,480 Irish plantation acres, 139 parishes, 12 baronies, and six boroughs; chief town, Trim. This district being the most ancient settlement of the Belgians in Ireland, the inhabitants were esteemed the eldest and most honourable tribe: from which seniority their chieftans were elected monarchs of all the Belgæ; a dignity that was continued in the Hy-n-Faillian without intermission. until the arrival of the Caledonian colonies, under the name of Tuath de Danan, when Conor-Mor, chieftan of these people, obtained, or rather usurped, the monarchial throne, obliged Eochy Failloch, with several of his people, to cross the Shannon, and establish themselves in the present county of Roscommon, where Crothar founded the palace of Atha or Croghan, a circumstance which brought on a long and bloody war between the Belgian and Caledonian races, which was not finally terminated until the close of the 4th century, when the Belgian line was restored in the person of O'Nial the Great, and continued until Briam Boromh usurped the monarchial dignity, by deposing Malachy O'Malachlin, about the year 1001. Tuathal Tetcthomar, by a decree of the Tarah assembly, separated certain large tracts of land from each of the four provinces, where the borders joined together; whence under the notion of adopting this spot for demesne lands to support the royal household, he formed the county or kingdom of Meath, which afterwards became the peculiar inheritance of the monarchs of Ireland. In each of the portions thus separated from the four provinces, Tuathal caused palaces to be erected, which might adorn them, and commemorate the name in which they had been added to the royal domain. In the tract taken out of Munster, he built the palace called Flachtaga, where the sacred fire, so called, was kindled, and where all the priests and druids annually met on the last day of October; on the evening of which day it was enacted, that no other fire should be used throughout the kingdom, in order that all the fires might be derived from this, which being lighted up as a fire of sacrifice, their superstition led them to believe would render all the rest propitious and holy; and for this privilege every family was to pay threepence, by way of acknowledgment to the king of Munster. The second royal palace was erected in the proportion taken out of Connaught, and was built for the assembly called the convocation of Visneach, at which all the inhabitants were summoned to appear on the 1st day of May, to offer sacrifice to *Beal*, or *Bel*, the god of fire, in whose honour two large fires being kindled, the natives used to drive their cattle between them, which was supposed to be a preservative for them against accidents and distempers, and this was called *Beal-Tinne*, or *Bel-Tine*, or the festival of the god of fire. The king of Connaught at this meeting claimed a horse and arms from every lord of a manor or chieftan, as an acknowledgement for the lands taken from that province, to add to the territory of Meath. The third was that which Tailtean erected in the part taken from Ulster, where the fair of that name was held, which was remarkable for this particular circumstance, that the inhabitants brought their children thither, males and females, and contracted them in marriage, where the parents having agreed upon articles, the young people were joined accordingly; every couple contracted at this meeting paid the king of Ulster an ounce of silver by way of acknowledgement. The royal mansion of Tarah, formerly destroyed by fire, being rebuilt by Tuathal, on the lands originally belonging to the king of Leinster, was reckoned as the fourth of these palaces; but as a fabric of that name had stood there before, we do not find that any acknowledgement was made for it to the king of Leinster.

Meath, with *Clonmacnois*, is a bishop's see, valued in the king's books at 373l. 7s. 0½d. sterling, by an extent returned anno 28th Elizabeth; but, by a former extent taken anno 30th Henry VIII. the valuation amounts to 373l. 12s. which being the largest and most profitable for the king, is the measure of the first fruits at this day. This see is reputed to be worth annually 3400l. There were formerly many Episcopal sees in Meath, as Clonard, Duleek, Kells, Trim, Ardbraccan, Donshaghlin, Slaine, and Foure, besides others of less note; all these, except Duleek and Kells, were consolidated, and their common see was fixed at Clonard, before the year 1152; at which time the divisions of the bishoprics in Ireland were made by John Paparo, cardinal priest, entitled Cardinal of St Lawrence in Damaso, then legate from Pope Eugene III. to the Irish. This division was made in a synod held on the 6th of March in the abbey of Mellifont, or, as some say, at Kells: and the two sees of Duleek and Kells afterwards submitted to the same fate. The constitution of this diocese is singular, having

ing no dean nor chapter, cathedral, or economy.—Under the biſhop, the archdeacon is the head officer, to whom, and to the clergy in general, the *congé d' elire* iſſued while biſhops were elective. The affairs of the dioceſe are tranſacted by a ſynod, in the nature of a chapter, who have a common ſeal, which is annually lodged in the hands of one of the body, by the appointment and vote of the majority. The dioceſe is divided into twelve rural deaneries.

Of Clonmacnois, now annexed to Meath: There is no valuation of this ſee in the king's books; but it is ſuppoſed to be included in the extent of the ſee of Meath, taken anno 30th Henry VIII. The chapter of this ſee conſiſted anciently of dean, chanter, chancellor, treaſurer, archdeacon, and twelve prebendaries, but moſt of their poſſeſſions have fallen into lay hands. At preſent the deanery is the only part of the chapter which ſubſiſts, to which the prebend of Cloghran is annexed, and he hath a ſeal of office, which appears to have been the ancient epiſcopal ſeal of this ſee. This ſee was founded by St Kiaran, or Ciaran, the younger, in 548 or 549; and Dermod, the ſon of Ceronill, king of Ireland, granted the ſite on which the church was built.

Weſt Meath. See Westmeith.

MEATUS auditorius. See Anatomy, N° 144.

MEAUX, an ancient town of France, in the department of the Seine and Marne, with a biſhop's ſee, ſeated in a place abounding in corn and cattle, on the river Marne, which divides it into two parts; and its trade conſiſts in corn, wool, and cheeſe. It ſuſtained a ſiege of three months againſt the Engliſh in 1421. E. Long. 2. 58. N. Lat. 48. 58.

MECÆNAS, or Mecoenas, C Cilnius, a celebrated Roman knight, deſcended from the kings of Etruria. He has rendered himſelf immortal by his liberal patronage of learned men and of letters; and to his prudence and advice Auguſtus acknowledged himſelf indebted for the ſecurity he enjoyed. His fondneſs for pleaſure removed him from the reach of ambition; and he preferred dying, as he was born, a Roman knight, to all the honours and dignities which either the friendſhip of Auguſtus or his own popularity could heap upon him. To the interference of Mecænas, Virgil owed the retribution of his lands; and Horace was proud to boaſt that his learned friend had obtained his forgiveneſs from the emperor, for joining the cauſe of Brutus at the battle of Philippi. Mecænas was himſelf fond of literature: and, according to the moſt received opinion, he wrote a hiſtory of animals, a journal of the life of Auguſtus, a treatiſe on the different natures and kinds of precious ſtones, beſides the two tragedies of Octavia and Prometheus, and other things, all now loſt. He died eight years before Chriſt; and on his deathbed he particularly recommended his poetical friend Horace to the care and confidence of Auguſtus. Seneca, who has liberally commended the genius and abilities of Mecænas, has not withheld his cenſure from his diſſipation, indolence, and effeminate luxury. From the patronage and encouragement which the princes of heroic and lyric poetry among the Latins received from the favourite of Auguſtus, all patrons of literature have ever ſince been called *Mecænates.* Virgil dedicated to him his Georgics, and Horace his Odes.

MECCA, an ancient and very famous town of Aſia, in Arabia Felix; ſeated on a barren ſpot, in a valley ſurrounded with little hills, about a day's journey from the Red ſea. It is a place of no ſtrength, having neither walls nor gates; and the buildings are very mean. That which ſupports it is the reſort of a great many thouſand pilgrims annually, for the ſhops are ſcarcely open all the year beſides. The inhabitants are poor, very thin, lean, and ſwarthy. The hills about the town are very numerous; and conſiſt of a blackiſh rock, ſome of them half a mile in circumference. On the top of one of them is a cave, where they pretend Mahomet uſually retired to perform his devotions, and hither they affirm the greateſt part of the Alcoran was brought him by the angel Gabriel. The town has plenty of water, and yet little garden-ſtuff; but there are ſeveral ſorts of good fruits to be had, ſuch as grapes, melons, water melons, and cucumbers. There are alſo plenty of ſheep brought thither to the ſold to the pilgrims. It ſtands in a very hot climate; and the inhabitants uſually ſleep on the tops of their houſes for the ſake of coolneſs. In order to protect themſelves from the heat through the day, they carefully ſhut the windows, and water the ſtreets to refreſh the air. There have been inſtances of perſons ſuffocated in the middle of the town by the burning wind called *Simoom.*

As a great number of the people of diſtinction in the province of Hedsjas ſtay in the city, it is better built than any other in Arabia. Amongſt the beautiful edifices it contains, the moſt remarkable is the famous *Kaba* or *Caaba*, "The houſe of God," which was held in great veneration by the Arabs even before Mahomet's time.

No Chriſtian dare go to Mecca; not that the approach to it is prohibited by any expreſs law, or that the ſenſible part of the Mahometans have any thing to object to it; but on account of the prejudices of the people, who regarding this ground as ſacred, think Chriſtians unworthy of ſetting their foot on it; it would be profaned, in the opinion of the ſuperſtitious, if it was trod upon by infidels. The people even believe, that Chriſtians are prevented from approaching by ſome ſupernatural power; and they tell the ſtory of an infidel, who having got ſo far as the hills that ſurround Mecca, all the dogs of the city came out, and fell upon him; and who, being ſtruck with this miracle, and the auguſt appearance of the Kaba, immediately became a muſſulman. It is therefore to be preſumed that all the Europeans who deſcribe Mecca as eye-witneſſes, have been renegadoes eſcaped from Turkey. A recent example confirms this ſuppoſition. On the promiſe of being allowed to preſerve his religion, a French ſurgeon was prevailed on to accompany the Emir Hadsji to Mecca, in quality of phyſician; but at the very firſt ſtation, he was forced to ſubmit to circumciſion, and then he was permitted to continue his journey.

Although the Mahometans do not allow Europeans to go to Mecca, they do not refuſe to give them deſcriptions of the Kaba, and information with regard to that building; and there are perſons who gain their bread by making deſigns and little pictures of the Kaba, and ſelling them to pilgrims. See Caaba.

The Mahometans have ſo high an opinion of the ſanctity

Mecca.

ſanctity of Mecca, that they extend it to the places in the neighbourhood. The territory of that city is held ſacred to certain diſtances, which are indicated by particular marks. Every caravan finds in its road a ſimilar mark, which gives notice to the pilgrims when they are to put on the modeſt garb in which they muſt appear in thoſe ſacred regions. Every muſſulman is obliged to go once in his life, at leaſt, to Mecca, to perform his devotions there. If that law was rigourouſly enforced, the concourſe of pilgrims would be prodigious, and the city would never be able to contain the multitudes from all the countries where the Mahometan religion prevails. We muſt therefore, ſuppoſe, that devotees alone perform this duty, and that the others can eaſily diſpenſe with it. Thoſe whoſe circumſtances do not permit a long abſence, have the liberty of going to Mecca by a ſubſtitute.—A hired pilgrim, however, cannot go for more than one perſon at a time; and he muſt, to prevent frauds, bring an atteſtation in proper form, from an Imam of Mecca, that he has performed the requiſite devotions on behalf of ſuch a perſon, either alive or dead; for, after the deceaſe of a perſon who has not obeyed the law during his life, he is ſtill obliged to perform the journey by proxy.

The caravans, which are not numerous, when we conſider the immenſe multitude of the faithful, are compoſed of many people who do not make the journey from purpoſes of devotion. Theſe are merchants, who think they can tranſport their merchandiſes with more ſafety, and diſpoſe of them more eaſily; and contractors of every kind, who furniſh the pilgrims and the ſoldiers who eſcort the caravans, with neceſſaries. Thus it happens, that many people have gone often to Mecca, ſolely from views of intereſt. The moſt conſiderable of thoſe caravans is that of Syria, commanded by the pacha of Damaſcus. It joins at ſome diſtance the ſecond from Egypt, which is conducted by a bey, who takes the title of Emir Hadsji. One comes from Yemen, and another, leſs numerous, from the country of Lachſa. Some ſcattered pilgrims arrived by the Red ſea from the Indies, and from the Arabian eſtabliſhments on the coaſts of Africa. The Perſians come in that which departs from Bagdad; the place of conductor to this laſt is beſtowed by the pacha, and is very lucrative, for he receives the ranſoms of the heretical Perſians.

It is of conſequence to a pilgrim to arrive early at the holy places. Without having been preſent from the beginning at all the ceremonies, and without having performed every particular act of devotion, a man cannot acquire the title of Hadsji: this is an honour very much coveted by the Turks, for it confers real advantages, and makes thoſe who attain it to be much reſpected. Its infrequency, however, in the Mahometan dominions, ſhows how much the obſervation of the law commanding pilgrimages is neglected. A ſimilar cuſtom prevails among the Oriental Chriſtians, who are alſo exceedingly emulous of the title of Hadsji, or Mokdaſi, which is given to pilgrims of their communion. In order to acquire this title, it is not ſufficient that the perſon has made the journey to Jeruſalem; he muſt alſo have kept the paſſover in that city, and have aſſiſted at all the ceremonies of the holy weeks.

After all the eſſential ceremonies are over, the pilgrims next morning move to a place where they ſay Abraham went to offer up his ſon Iſaac, which is about two or three miles from Mecca: here they pitch their tents, and then throw ſeven ſmall ſtones againſt a little ſquare ſtone building. This, as they affirm, is performed in defiance of the devil. Every one then purchaſes a ſheep, which is brought for that purpoſe, eating ſome of it themſelves, and giving the reſt to the poor people who attend upon that occaſion. Indeed theſe are miſerable objects, and ſuch ſtarved creatures, that they ſeem ready to devour each other. After all, one would imagine that this was a very ſanctified place; and yet a renegado who went in pilgrimage thither, affirms there is as much debauchery practiſed here as in any part of the Turkiſh dominions. It is 25 miles from Jodda, the ſea port town of Mecca, and 220 ſouth-eaſt of Medina. E. Long. 40. 55. N. Lat. 21. 45.

Mechanical.

MECHANICAL, an epithet applied to whatever relates to mechanics: Thus we ſay, mechanical powers, cauſes, &c. See the articles POWER, CAUSE, &c.

The mechanical philoſophy is the ſame with what is otherwiſe called *corpuſcular philoſophy*, which explains the phenomena of nature, and the operations of corporeal things, on the principles of mechanics, viz.; the motion, gravity, arrangement, diſpoſition, greatneſs or ſmallneſs, of the parts which compoſe natural bodies. See CORPUSCULAR.

This manner of reaſoning is much uſed in medicine; and, according to Dr Quincy, is the reſult of a thorough acquaintance with the ſtructure of animal bodies: for conſidering an animal body as a compoſition out of the ſame matter from which all other bodies are formed, and to have all thoſe properties which concern a phyſician's regard, only by virtue of its peculiar conſtruction; it naturally leads a perſon to conſider the ſeveral parts, according to their figures, contexture, and uſe, either as wheels, pulleys, wedges, levers, ſcrews, cords, canals, ſtrainers &c. For which purpoſe, continues he, it is frequently found helpful to deſign in diagrams, whatſoever of that kind is under conſideration, as is cuſtomary in geometrical demonſtrations.

For the application of this doctrine to the human body, ſee the article MEDICINE.

MECHANICAL, in mathematics, denotes a conſtruction of ſome problem, by the aſſiſtance of inſtruments, as the duplicature of the cube and quadrature of the circle, in contradiſtinction to that which is done in an accurate and geometrical manner.

Mechanical Curve, is a curve, according to Deſcartes, which cannot be defined by any algebraic equation; and ſo ſtands contradiſtinguiſhed from algebraic or geometrical curves.

Leibnitz and others call theſe mechanical curves *tranſcendental*, and diſſent from Deſcartes, in excluding them out of geometry. Leibnitz found a new kind of tranſcendental equations, whereby theſe curves are defined: but they do not continue conſtantly the ſame in all points of the curve, as algebraic ones do. See the article TRANSCENDENTAL.

Mechanical Solution of a problem is either when the thing is done by repeated trials, or when lines uſed in

Mechanical. in the solution are not truly geometrical, or by organical construction.

Mechanical Powers, are certain simple machines, which are used for raising greater weights, or overcoming greater resistances, than could be effected by the natural strength without them. See Mechanics.

MECHANICS.

Definition. 1. MECHANICS is the science which enquires into the laws of the equilibrium and motion of solid bodies; into the forces by which bodies, whether animate or inanimate, may be made to act upon one another; and into the means by which these may be increased so as to overcome such as are more powerful.—The term *mechanics* was originally applied to the doctrine of equilibrium. It has by some late writers been extended to the motion and equilibrium of all bodies, whether, solid, fluid, or aeriform; and has been employed to comprehend the sciences of hydrodynamics and pneumatics.

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Progress of practical mechanics among the ancients.

2. As the science of mechanics is intimately connected with the arts of life, and particularly with those which exist even in the rudest ages of society, the construction of machines must have arrived at considerable perfection before the theory of equilibrium, or the simplest properties of the mechanical powers, had engaged the attention of philosophers. We accordingly find that the lever, the pulley, the crane, the capstan, and other simple machines, were employed by the ancient architects in elevating the materials of their buildings, long before the dawn of mechanical science; and the military engines of the Greeks and Romans, such as the catapultæ and balistæ, exhibit an extensive acquaintance with the construction of compound machinery. In the splendid remains of Egyptian architecture, which in every age have excited the admiration of the world, we perceive the most surprising marks of mechanical genius. The elevation of immense masses of stone to the tops of their stupendous fabrics must have required an accumulation of mechanical power which is not in the possession of modern architects.

Aristotle the first who attended to the theory of mechanics. B. C. 320.

3. The earliest traces of any thing like the theory of mechanics are to be found in the writings of Aristotle. In some of his works we discover a few erroneous and obscure opinions, respecting the doctrine of motion, and the nature of equilibrium; and in his 28th mechanical question he has given some vague observations on the force of impulse, tending to point out the difference between impulse and pressure. He maintained that there cannot be two circular motions opposite to one another; that heavy bodies descended to the centre of the universe, and that the velocities of their descent were proportional to their weights.

Archimedes lays the foundation of theoretical mechanics. B. C. 250.

4. The notions of Aristotle, however, were so confused and erroneous, that the honour of laying the foundation of theoretical mechanics is exclusively due to the celebrated Archimedes, who, in addition to his inventions in geometry, discovered the general principles of hydrostatics. In his two books, *De Equiponderantibus*, he has demonstrated that when a balance with unequal arms, is in equilibrio, by means of two weights in its opposite scales, these weights must be reciprocally proportional to the arms of the balance. From this general principle, all the other properties of the lever, and of machines referable to the lever, might have been deduced as corollaries; but Archimedes did not follow the discovery through all its consequences. In demonstrating the leading property of the lever, he lays it down as an axiom, that if the two arms of the balance are equal, the two weights must also be equal when an equilibrium takes place; and then shows that if one of the arms be increased, and the equilibrium still continue, the weight appended to that arm must be proportionally diminished. This important discovery conducted the Syracusan philosopher to another equally useful in mechanics. Reflecting on the construction of his balance, which moved upon a fulcrum, he perceived that the two weights exerted the same pressure on the fulcrum as if they had both rested upon it. He then considered the sum of these two weights as combined with a third, and the sum of these three as combined with a fourth; and saw that in every such combination the fulcrum must support their united weight, and therefore that there is in every combination of bodies, and in every single body which may be conceived as made up of a number of lesser bodies, *a centre of pressure or gravity*. This discovery Archimedes applied to particular cases, and pointed out the method of finding the centre of gravity of plane surfaces, whether bounded by a parallelogram, a triangle, a trapezium or a parabola. The theory of the inclined plane, the pulley, the axis in peritrochio, the screw, and the wedge, which was first published in the eighth book of Pappus's mathematical collections, is generally attributed to Archimedes. It appears also from Plutarch and other ancient authors, that a greater number of machines which have not reached our times was invented by this philosopher. The military engines which he employed in the siege of Syracuse against those of the Roman engineer Appius, are said to have displayed the greatest mechanical genius, and to have retarded the capture of his native city.

Invention of water mills and wind mills.

5. Among the various inventions which we have received from antiquity, that of water mills is entitled to the highest place, whether we consider the ingenuity which they display, or the useful purposes to which they are subservient. In the infancy of the Roman republic the corn was ground by hand-mills consisting of two millstones, one of which was moveable, and the other at rest. The upper millstone was made to revolve either by the hand applied directly to a winch, or by means of a rope winding round a capstan. The precise time when the impulse or the weight of water was substituted in the place of animal labour, is not exactly known. From an epigram in the *Anthologia Græca* there is reason to believe that water mills were invented during the reign of Augustus; but it is strange that in the

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the defcription given of them by Vitruvius, who lived under that emperor, they are not mentioned as of recent origin. The invention of wind mills is of a later date. According to fome authors, they were firft ufed in France in the fixth century; while others maintain that they were brought to Europe in the time of the crufades, and that they had long been employed in the eaft, where the fcarcity of water precluded the application of that agent to machinery.

Stevinus difcovers the parallelogram of forces. Died in 1635.

6. The fcience of mechanics feems to have been ftationary till the end of the 16th century. In 1577 a treatife on mechanics was publifhed by Guidus Ubaldus, but it contained merely the difcoveries of Archimedes. Simon Stevinus, however, a Dutch mathematician, contributed greatly to the progrefs of the fcience. He difcovered the parallelogram of forces; and has demonftrated in his Statics, publifhed in 1586, that if a body is urged by two forces in the direction of the fides of a parallelogram, and proportional to thefe fides, the combined action of thefe two forces is equivalent to a third force acting in the direction of the diagonal of the parallelogram, and having its intenfity proportional to that diagonal. This important difcovery, which has been of fuch fervice in the different departments of phyfics, fhould have conferred upon its author a greater degree of celebrity than he has actually enjoyed. His name has fcarcely been enrolled in the temple of fame, but juftice may yet be done to the memory of fuch an ingenious man. He had likewife the merit of illuftrating other parts of ftatics; and he appears to have been the firft who, without the aid of the properties of the lever, difcovered the laws of equilibrium in bodies placed on an inclined plane. His works were reprinted in the Dutch language in 1605. They were tranflated into Latin in 1608, and into French in 1634; and in thefe editions of his works his Statics were enlarged by an appendix, in which he treats of the rope machine, and on pulleys acting obliquely.

Lucas Valerius writes on the centre of gravity of folids. 1661.

7. The doctrine of the centre of gravity, which had been applied by Archimedes only to plane furfaces, was now extended by Lucas Valerius to folid bodies. In his work entitled *De Centro Gravitatis Solidorum Liber*, publifhed at Bologna in 1661, he has difcuffed this fubject with fuch ability, as to receive from Galileo the honourable appellation of the *Novus noftræ ætatis Archimedes.*

Difcoveries of Galileo. Born 1564. Died 1642.

8. In the hands of Galileo the fcience of mechanics affumed a new form. In 1572 he wrote a fmall treatife on ftatics, which he reduced to this principle, that it requires an equal power to raife two different bodies to altitudes in the inverfe ratio of their weights, or that the fame power is requifite to raife 10 pounds to the height of 100 feet, and 20 pounds to the height of 50 feet. This fertile principle was not purfued by Galileo to its different confequences. It was left to Defcartes to apply it to the determination of the equilibrium of machines, which he did in his explanation of machines and engines, without acknowledging his obligations to the Tufcan philofopher. In addition to this new principle, Galileo enriched mechanics with his theory of local motion. This great difcovery has immortalized its author; and whether we confider its intrinfic value, or the change which it produced on the phyfical fciences, we are led to regard it as nearly of equally importance with the theory of univeral gravitation, to which it paved the way. The firft hints of this new theory were given in his SYSTEMA COSMICUM, *Dialogus* II. The fubject was afterwards fully difcuffed in another, entitled *Difcurfus et Demonftrationes Mathematicæ circa duas novas Scientias pertinentes ad Mechanicam et Motum Localem*, and publifhed in 1638. This work is divided into four dialogues; the firft of which treats of the refiftance of folid bodies before they are broken: The fecond points out the caufe of the cohefion of folids. In the third he difcuffes his theory of local motions, comprehending thofe which are equable, and thofe which are uniformly accelerated. In the fourth he treats of violent motion, or the motion of projectiles; and in an appendix to the work he demonftrates feveral propofitions relative to the centre of gravity of folid bodies. In the firft of thefe dialogues he has founded his reafoning on principles which are far from being correct, but he has been more fuccefsful in the other three. In the third dialogue, which contains his celebrated theory, he difcuffes the doctrine of equable motions in fix theorems, containing the different relations between the velocity of the moving body, the fpace which it defcribes, and the time employed in its defcription. In the fecond part of the dialogue, which treats of accelerated motion, he confiders all bodies as heavy, and compofed of a number of parts which are alfo heavy. Hence he concludes that the total weight of the body is proportional to the number of the material particles of which it is compofed, and then reafons in the following manner. As the weight of a body is a power always the fame in quantity, and as it conftantly acts without interruption, the body muft be continually receiving from it equal impulfes in equal and fucceffive inftants of time. When the body is prevented from falling by being placed on a table, its weight is inceffantly impelling it downwards, but thefe impulfes are inceffantly deftroyed by the refiftance of the table which prevents it from yielding to them. But where the body falls freely, the impulfes which it perpetually receives are perpetually accumulating, and remain in the body unchanged in every refpect excepting the diminution which they experience from the refiftance of air. It therefore follows, that a body falling freely is uniformly accelerated, or receives equal increments of velocity in equal times. Having eftablifhed this as a definition, he then demonftrates, that the time in which any fpace is defcribed by a motion uniformly accelerated from reft, is equal to the time in which the fame fpace would be defcribed by an uniform equable motion with half the final velocity of the accelerated motion; and that in every motion uniformly accelerated from reft, the fpaces defcribed are in the duplicate ratio of the times of defcription. After having proved thefe theorems, he applies the doctrine with great fuccefs to the afcent and defcent of bodies on inclined planes.

Labours of Toricelli. 1644.

9. The theory of Galileo was embraced by his pupil Toricelli, who illuftrated and extended it in his excellent work entitled *De motu gravium naturaliter accelerato*, publifhed in 1644. In his treatife *De motu projectorum*, publifhed in the Florentine edition of his works, in 1664, he has added feveral new and important propofitions to thofe which were given by his mafter on the motion of projectiles.

Invention of the fteam engine.

10. It was about this time that fteam began to be employed

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employed as the firſt mover of machinery. This great diſcovery has been aſcribed by the Engliſh to the marquis of Worceſter, and to Papin by the French; but it is almoſt certain, that about 34 years before the date of the marquis's invention, and about 61 years before the conſtruction of Papin's digeſter, ſteam was employed as the impelling power of a ſtamping engine by one Brancas an Italian, who publiſhed an account of his invention in 1629. It is extremely probable, however, that the marquis of Worceſter had never ſeen the work of Brancas, and that the fire-engine which he mentions in his Century of Inventions was the reſult of his own ingenuity. The advantages of ſteam as an impelling power being thus known, the ingenious Captain Savary invented an engine which raiſed water by the expanſion and condenſation of ſteam. Several engines of this conſtruction were actually erected in England and France, but they were incapable of raiſing water from depths which exceeded 35 feet. The ſteam-engine received great improvements from our countrymen Newcomen, Brighton, and Blakey; but it was brought to its preſent ſtate of perfection by Mr Watt of Birmingham, one of the moſt accompliſhed engineers of the preſent age. Hitherto it had been employed merely as a hydraulic machine for draining mines or raiſing water, but in conſequence of Mr Watt's improvements it has long been uſed as the impelling power of almoſt every ſpecies of machinery. It is a curious circumſtance, that the ſteam-engine was not only invented, but has received all its improvements, in our own country.

Diſcoveries of Huygens. 1673.

11. The ſucceſs of Galileo in inveſtigating the doctrine of rectilineal motion, induced the illuſtrious Huygens to turn his attention to curvilineal motion. In his celebrated work *De Horologio Oſcillatorio*, publiſhed in 1673, he has ſhown that the velocity of a heavy body deſcending along any curve, is the ſame at every inſtant in the direction of the tangent, as it would have been if it had fallen through a height equal to the correſponding vertical abſciſs; and from the application of this principle to the reverſed cycloid with its axis vertical, he diſcovered the iſochroniſm of the cycloid, or that a heavy body, from whatever part of the cycloid it begins to fall, always arrives at the lower point of the curve in the ſame ſpace of time. By theſe diſcuſſions, Huygens was gradually led to his beautiful theory of central forces in the circle. This theory may be applied to the motion of a body in any curve, by conſidering all curves as compoſed of an infinite number of ſmall arcs of circles of different radii, which Huygens had already done in his theory of evolutes. The theorems of Huygens concerning the centrifugal force and circular motions, were publiſhed without demonſtrations.

1700.

They were firſt demonſtrated by Dr Keill at the end of his Introduction to Natural Philoſophy. The demonſtrations of Huygens, however, which were more prolix than thoſe of the Engliſh philoſopher, were afterwards given in his poſthumous works.

The laws of colliſion diſcovered by Wallis, Huygens, and Wren. 1661.

12. About this time the true laws of colliſion or percuſſion were ſeparately diſcovered by Wallis, Huygens, and Sir Chriſtopher Wren in 1661, without having the leaſt communication with each other. They were tranſmitted to the Royal Society of London in 1668, and appeared in the 43d and 46th numbers of their Tranſactions. The rules given by Wallis and Wren are publiſhed in N° 43, pp. 864 and 867, and thoſe of Huygens in N° 46, p. 927. The foundation of all their ſolutions is, that in the mutual colliſion of bodies, the abſolute quantity of motion of the centre of gravity is the ſame after impact as before it, and that when the bodies are elaſtic, the reſpective velocity is the ſame after as before the ſhock.—We are indebted likewiſe to Sir Chriſtopher Wren for an ingenious method of demonſtrating the laws of impulſion by experiment. He ſuſpended the impinging bodies by threads of equal length, ſo that they might touch each other when at reſt. When the two bodies were ſeparated from one another, and then allowed to approach by their own gravity, they impinged againſt each other when they arrived at the poſitions which they had when at reſt, and their velocities were proportional to the chords of the arches through which they had fallen. Their velocities after impact were alſo meaſured by the chords of the arches through which the ſtroke had forced them to aſcend, and the reſults of the experiments coincided exactly with the deductions of theory. The laws of percuſſion were afterwards more fully inveſtigated by Huygens, in his poſthumous work *De Motu Corporum ex Percuſſione*, and by Wallis in his *Mechanica*, publiſhed in 1670.

Mechanical problems propoſed by Merſennus. 1635.

13. The attention of philoſophers was at this time directed to the two mechanical problems propoſed by Merſennus in 1635. The firſt of theſe problems was to determine the centre of oſcillation in a compound pendulum, and the ſecond to find the centre of percuſſion of a ſingle body, or a ſyſtem of bodies turning round a fixed axis. The centre of oſcillation is that point in a compound pendulum, or a ſyſtem of bodies moving round a centre, in which, if a ſmall body were placed and made to move round the ſame centre, it would perform its oſcillations in the ſame time as the ſyſtem of bodies. The centre of percuſſion, which is ſituated in the ſame point of the ſyſtem as the centre of oſcillation, is that point of a body revolving or vibrating about an axis, which being ſtruck by an immoveable obſtacle, the whole of its motion is deſtroyed.

Huygens ſolves the problem of the centre of oſcillation.

Theſe two problems were at firſt diſcuſſed by Deſcartes and Roberval, but the methods which they employed were far from being correct. The firſt ſolution of the problem on the centre of oſcillation was given by Huygens. He aſſumed as a principle, that if ſeveral weights attached to a pendulum deſcended by the force of gravity, and if at any inſtant the bodies were detached from one another, and each aſcended with the velocity it had acquired by its fall, they would riſe to ſuch a height that the centre of gravity of the ſyſtem in that ſtate would deſcend to the ſame height as that from which the centre of gravity of the pendulum had deſcended. The ſolution founded on this principle, which was not derived from the fundamental laws of mechanics, did not at firſt meet with the approbation of philoſophers; but it was afterwards demonſtrated in the cleareſt manner, and now forms the principle of the conſervation of active forces.—The problem of the centre of percuſſion was not attended with ſuch difficulties. Several incomplete ſolutions of it were given by different geometers; but it was at laſt reſolved in an accurate and general manner by James Bernouilli by the principle of the lever.

Works of Borelli. 1666.

14. In 1666, a treatiſe *De Vi Percuſſionis*, was publiſhed

History. 1686.

lished by J. Alphonso Borelli, and in 1686, another work, *De Motionibus Naturalibus à Gravitate Pendentibus*; but he added nothing to the science of mechanics. His ingenious work, *De Motu Animalium*, however, is entitled to great praise, for the beautiful application which it contains of the laws of statics to explain the various motions of living agents.

Labours of Varignon.

15. The application of statics to the equilibrium of machines, was first made by Varignon in his Project of a new System of Mechanics, published in 1687. The subject was afterwards completely discussed in his *Nouvelle Mecanique*, a posthumous work published in 1725. In this work are given the first notions of the celebrated principle of virtual velocities, from a letter of John Bernouilli's to Varignon in 1717. The virtual velocity of a body is the infinitely small space, through which the body excited to move has a tendency to describe in one instant of time. This principle has been successfully applied by Varignon to the equilibrium of all the simple machines. The resistance of solids, which was first treated by Galileo, was discussed more correctly by Leibnitz in the *Acta Eruditorum* for 1687. In the Memoirs of the Academy for 1702, Varignon has taken up the subject, and rendered the theory much more universal.

Parent on the maximum effect of machines.

16. An important step in the construction of machinery was about this time made by Parent. He remarked in general that if the parts of a machine, are so arranged, that the velocity of the impelling power becomes greater or less according as the weight put in motion becomes greater or less, there is a certain proportion between the velocity of the impelling power, and that of the weight to be moved, which renders the effect of the machine a *maximum* or a *minimum* *. He then applies this principle to undershot wheels, and shows that a maximum effect will be produced when the velocity of the stream is equal to *thrice* the velocity of the wheel. In obtaining this conclusion, Parent supposed that the force of the current upon the wheel is in the duplicate ratio of the relative velocity, which is true only when a single floatboard is impelled by the water. But when more floatboards than one are acted upon at the same time, it is obvious that the momentum of the water is directly as the relative velocity; and by making this substitution in Parent's demonstration, it will be found that a maximum effect is produced when the velocity of the current is double that of the wheel. This result was first obtained by the Chevalier Borda, and has been amply confirmed by the experiments of Smeaton. (See HYDRODYNAMICS, §. 279, 280, 281) The principle of Parent was also applied by him to the construction of windmills. It had been generally supposed that the most efficacious angle of weather was 45°; but it was demonstrated by the French philosopher that a maximum effect is produced when the sails are inclined $54\frac{3}{4}$ degrees to the axis of rotation, or, when the angle of weather is $35\frac{1}{4}$ degrees. This conclusion, however, is subject to modifications which will be pointed out in a subsequent part of this article.

* *Mem. de l'Acad.* 1704.

De la Hire writes on the teeth of wheels.

17. The *Traite de Mecanique* of De la Hire, published separately in 1695, and in the 9th volume of the Memoirs of the French Academy from 1666 to 1699, contains the general properties of the mechanical powers, and the description of several ingenious and useful machines. But it is chiefly remarkable for the *Traite des Epicycloides*, which is added to the edition published in the Memoirs of the Academy. In his interesting treatise, De la Hire considers the genesis and properties of exterior and interior epicycloids, and demonstrates, that when one wheel is employed to drive another, the one will move sometimes with greater and sometimes with less force, and the other will move sometimes with greater and sometimes with less velocity, unless the teeth of one or both of the wheels be parts of a curve generated like an epicycloid. The same truth is applicable to the formation of the teeth of rackwork, the arms of levers, the wipers of stampers, and the lifting cogs of forge hammers; and as the epicycloidal teeth when properly formed roll upon one another without much friction, the motion of the machine will be uniform and pleasant, its communicating parts will be prevented from wearing, and there will be no unnecessary waste of the impelling power. Although De la Hire was the first who published this important discovery, yet the honour of it is certainly due to Olaus Roemer, the celebrated Danish astronomer, who discovered the successive propagation of light. It is expressly stated by Leibnitz *, in his letters to John Bernouilli, that Roemer communicated to him the discovery 20 years before the publication of De la Hire's work; but still we have no ground for believing that De la Hire was guilty of plagiarism. Roemer's researches were not published; and from the complete discussion which the subject has received from the French philosopher, it is not unlikely that he had the merit of being the second inventor. Even Camus †, who about 40 years afterwards gave a complete and accurate theory of the teeth of wheels, was unacquainted with the pretensions of Roemer, and ascribes the discovery to De la Hire.

The discovery of epicycloidal teeth first made by Roemer.

* *Miscellan. Berolinens.* 1710. p. 315.

† *Cours de Mathematique*, Liv. x. et xi.

Discoveries of Newton.

18. The publication of Newton's Principia contributed greatly to the progress of mechanics. His discoveries concerning the curvilineal motion of bodies, combined with the theory of universal gravitation, enabled philosophers to apply the science of mechanics to the phenomena of the heavens, to ascertain the law of the force by which the planets are held in their orbits, and to compute the various irregularities in the solar system, which arise from the mutual action of the bodies which compose it. The *Mecanique Celeste* of La Place will be a standing monument of the extension which mechanics has received from the theory of gravity. The important mechanical principle of the conservation of the motion of the centre of gravity is also due to Newton. He has demonstrated in his Principia, that the state of the centre of gravity of several bodies, whether in a state of rest or motion, is not affected by the reciprocal action of these bodies, whatever it may be, so that the centre of gravity of the bodies which act upon one another, either by the intervention of levers, or by the laws of attraction, will either remain at rest, or move uniformly in a right line.

Principle of the conservation of active forces first discovered by Huygens.

19. We have already seen that the principle of the conservation of active forces was discovered by Huygens when he solved the problem of the centre of oscillation. The principle alluded to, consists in this that in all the actions of bodies upon each other, whether that action consists in the percussion of elastic bodies, or is communicated from one body to another by threads or inflexible rods, the sums of the masses multiplied by the squares of the absolute velocities remain always the same. This

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This important law is easily deducible from two simpler laws admitted in mechanics. 1. That in the collision of elastic bodies, their respective velocities remain the same after impact as they were before it; and 2. That the quantity of action, or the product of the masses of the impinging bodies, multiplied by the velocity of their centre of gravity, is the same after as before impact. The principle of the conservation of active forces, was regarded by its inventor only as a simple mechanical theorem. John Bernouilli, however, considered it as a general law of nature, and applied it to the solution of several problems which could not be resolved by direct methods; but his son Daniel deduced from it the laws of the motion of fluids from vessels, a subject which had been formerly treated in a very vague manner. He afterwards rendered the principle more general *, and showed how it could be applied to the motion of bodies influenced by their mutual attractions, or solicited towards fixed centres by forces proportional to any function of the distance.

Rendered general by Daniel Bernouilli.

* *Mem. de l'Acad. Berlin*, 1748.

Daniel Bernouilli and other philosophers demonstrate the parallelogram of forces.

20. After the parallelogram of forces had been introduced into statics by Stevinus, it was generally admitted upon the same demonstration which was given for the composition of motion. The first complete demonstration was given by Daniel Bernouilli in the Commentaries of Petersburgh for 1726, independent of the consideration of compound motion. This demonstration, which was both long and abstruse, was greatly simplified by D'Alembert in the Memoirs of the Academy for 1769. Fonseneix and Riccati have given a very ingenious one in the Memoirs of the Academy of Turin for 1761. This was also improved by D'Alembert, who gave another in the same Memoirs, and a third in his *Traite de Dynamique*, published in 1743. Dr Robison * has combined the demonstrations of Bernouilli and D'Alembert with one by Frisi, and produced one that is more expeditious and simple. La Place has likewise given a demonstration of the parallelogram of forces in his *Mecanique Celeste*.

* *Sup. Encycl.* § *Dynamics*.

Dispute about the measure of active forces.

21. About the beginning of the 18th century, the celebrated dispute about the measure of active forces was keenly agitated among philosophers. The first spark of this war, which for 40 years England maintained single-handed against all the genius of the continent, was excited by Leibnitz. In the Leipsic acts for 1686, he asserted that Descartes was mistaken in making the force of bodies proportional to their simple velocity, and maintained that it followed the ratio of the square of the velocity. He shewed, that a body, with a velocity of two feet, acquires the power of raising itself to a height four times as great as that to which a body could rise with a velocity of only one foot; and hence he concludes, that the force of that body is as the square of its velocity. The abbé de Cotilon, a zealous Cartesian, allowed the premises of Leibnitz, but denied his conclusion. The body, said he, which moves with a velocity of two feet, will certainly rise to quadruple the height of another body that has only the velocity of one foot; but it will take *twice the time* to rise to that height, and a quadruple effect, in a double time, is not a quadruple force, but only a double one. The theory of Leibnitz was supported by John Bernouilli, Herman, Gravesende, Muschenbroeck, Poleni, Wolff, and Bulfinger; and the opinion of Descartes by Maclaurin, Stirling, Clarke, Desaguliers, and other English philosophers. The question was at last involved in metaphysical reasoning; and if the dispute did terminate in favour of either party, the English philosophers were certainly victorious. It appears, in the clearest manner, that the force of a moving body, indicated by the space which it describes, is as the simple velocity, if we consider the space as described in a determinate time; but it is as the square of the velocity, if we do not consider the time in which the space is described. The question, therefore, comes to be this: In estimating the forces of bodies in motion, ought we to take time into consideration? If, with the followers of Leibnitz, we reject this element, then we may maintain that the force of a child is equal to that of a man carrying a load, because the child is also capable of carrying the same load, though in small parts and in a greater length of time.

D'Alembert's principle of dynamics.

22. In 1743, D'Alembert published his *Traité de Dynamique*, founded upon a new principle in mechanics. This principle was first employed by James Bernouilli in his solution of the problem of the centre of oscillation; but D'Alembert had the honour of generalising it, and giving it all that simplicity and fertility of which it was susceptible. He showed, that in whatever manner the bodies of one system act upon another, their motions may always be decomposed into two others at every instant, those of the one being destroyed the instant following, and those of the other retained, and that the motions retained are necessarily known from the conditions of equilibrium between those which are destroyed. This principle is evidently a consequence of the laws of motion and equilibrium, and has the advantage of reducing all the problems of dynamics to pure geometry and the principles of statics. By means of it D'Alembert has resolved a number of beautiful problems which had escaped his predecessors, and particularly that of the precession of the equinoxes, which had occupied the attention of Newton. In his *Traité de Dynamique*, D'Alembert has likewise reduced the whole of mechanics to three principles, the force of inertia, compound motion, and equilibrium; and has illustrated his views on this subject by that profound and luminous reasoning which characterises all his writings.

Euler, Daniel Bernouilli, and d'Arcy, discover the conservation of the momentum of rotatory motion.

1746.

23. Another general principle in dynamics was about this time discovered separately by Euler, Daniel Bernouilli, and the chevalier D'Arcy, and received the name of *the conservation of the momentum of rotatory motion*. According to the two first philosophers, the principle may be thus defined: In the motion of several bodies round a fixed centre, the sum of the products of the mass of each body multiplied by the velocity of its motion round the centre, and by its distance from that centre, is always independent of the mutual action which the bodies may exert upon each other, and always preserves itself the same, provided the bodies are not influenced by any external cause. This principle was given by Daniel Bernouilli in the Memoirs of the Academy of Berlin for 1746; and in the same year by Euler in the first volume of his works. They were both led to the discovery, while investigating the motion of several bodies in a tube of a given form, and which can only turn round a fixed point. The principle discovered by the chevalier D'Arcy was given in a memoir dated 1746, and published in the Memoirs of

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the Academy for 1747. He ſhewed, that the ſum of the products of the maſs of each body by the area which its radius vector deſcribes round a fixed point, is always proportional to the times. The identity of this principle, which is a generaliſation of Newton's theorem about the areas deſcribed by the planetary bodies, with that of Euler and Bernouilli, will be eaſily perceived, if we conſider that the element of the circular arc, divided by the element of the time, expreſſes the velocity of circulation, and that the element of the circular arc, multiplied by the diſtance from the centre, gives the element of the area deſcribed round that centre; ſo that the principle of Euler is only a differential expreſſion of the principle of D'Arcy, which he afterwards expreſſed in this form, that the ſum of the products of the maſſes of each body by their velocities, and by the perpendiculars drawn from the centre to their lines of direction, is a conſtant quantity.

The principle of leaſt action propoſed by Maupertuis.

24. The principle of leaſt action, which was firſt propoſed by Maupertuis in 1744, conſiſts in this, that when ſeveral bodies, acting upon one another, experience any change in their motion, this change is always ſuch, that the quantity of action (or the product of the maſs by the ſpace and the velocity) employed by nature to produce it, is the leaſt poſſible. From this principle Maupertuis deduced the laws of the reflection and refraction of light, and thoſe of the colliſion of bodies *. He afterwards extended its application to the laws of motion, and made the principle ſo general as to comprehend the laws of equilibrium, the uniform motion of the centre of gravity in the percuſſion of bodies, and the conſervation of active forces. This celebrated principle was attacked by Koenig, profeſſor of mathematics at the Hague, in the Leipſic acts for 1751, who not only attempted to ſhew its falſity, but aſſerted that Leibnitz had firſt deſcribed it in 1707 in a letter to Herman. The paper of Koenig gave riſe to a long and violent diſpute about the accuracy of the principle, and the authenticity of the letter of Leibnitz. The academy of Berlin interfered in behalf of their preſident, and gave importance to a controverſy which was too perſonal to merit the attention which it received.

* *Mem. Acad. Paris* 1744, and *Mem. Acad Berlin* 1746.

Euler and Lagrange generalize the principle of Maupertuis.

25. In his *Traité des Iſoperimetries*, printed at Lauſanne in 1744, Euler extended the principle of leaſt action, and ſhewed, "that in the trajectories deſcribed by means of central forces, the integral of the velocity multiplied by the element of the curve, is either a *maximum* or a *minimum*." This remarkable property, which Euler recogniſed only in the caſe of inſulated bodies, was generaliſed by Lagrange into this new principle, "that the ſum of the products of the maſſes by the integrals of the velocities, multiplied by the elements of the ſpaces deſcribed, is always a maximum or a minimum." In the memoirs of Turin, Lagrange has employed this principle to reſolve ſeveral difficult problems in dynamics; and he has ſhewn †, that when it is combined with the conſervation of active forces, and developed according to the rules of his method of variations, it furniſhes directly all the equations neceſſary for the ſolution of each problem, and gives riſe to a ſimple and general method of treating the various problems concerning the motion of bodies.

† *Mecanique Analytique*, p. 189, 1788.

Labours of Segner. 1765.

26. An important diſcovery in rotatory motion, was at this time made by Profeſſor Segner. In a paper, entitled *Specimen Theoriæ Turbinum*, he demonſtrated, that if a body of any form or magnitude, after it has received rotatory motions in all directions, be left entirely to itſelf, it will always have three principal axes of of rotation; or, in other words, all the rotatory motions with which it is affected, may be reduced to three, which are performed round three axes, perpendicular to each, paſſing through the centre of gravity of the revolving body, and preſerving the ſame poſition in abſolute ſpace, while the centre of gravity is either at reſt or moving uniformly in a ſtraight line.

Coulomb inquires into the force of torſion.

27. The force of torſion began at this time to be inveſtigated by Coulomb, who publiſhed two ingenious papers on the ſubject, in the Memoirs of the French Academy. He has ſucceſsfully employed this principle in ſeveral phyſical reſearches, but particularly in determining the law of magnetic action, and in finding the laws of the reſiſtance of fluids when the motions are extremely ſlow *. It was by means of an elegant experiment on the principle of torſion that Mr Cavendiſh determined the mutual attraction of two maſſes of lead, and thence deduced the mean denſity of the earth.—We are alſo indebted to Coulomb for a complete ſet of experiments on the nature and effects of friction. By employing large bodies and ponderous weights, and conducting his experiments on a large ſcale, he has corrected errors which neceſſarily aroſe from the limited experiments of preceding writers; he has brought to light many new and intereſting facts, and confirmed others which had hitherto been partially eſtabliſhed. The moſt curious reſult of theſe experiments is the effect of time in increaſing the friction between two ſurfaces. In ſome caſes the friction reaches its maximum after the rubbing ſurfaces have remained in contact for one minute; and in other caſes five or ſix days were neceſſary before this effect was produced. The increaſe of friction, which is generated by prolonging the time of contact, is ſo great, that a body, weighing 1650 pounds, was moved with a force of 64 pounds when firſt laid upon the correſponding ſurface. After remaining in contact for the ſpace of three ſeconds, 100 pounds were neceſſary to put it in motion; and when the time was prolonged to ſix days, it could ſcarcely be moved with a power of 622 pounds †.

* *Memoirs de l'Inſtitut. Nat.* tom. iii. p. 246.

And into the ſubject of friction.

† *Memoires Preſentées* tom. ix.

Works on mechanics.

28. One of the moſt important treatiſes on the ſcience of motion is the Mechanics of the celebrated Euler, publiſhed in 1736. It contains the whole theory of rectilineal and curvilineal motion in an inſulated body, affected by any accelerating forces, either in vacuo or in a reſiſting medium. He uniformly uſes the analytical method, and has employed the principle of the *vis inertiæ*, and that of compound motion, for putting his problems into equations. By the *vis inertiæ*, motion is at every moment of time rectilineal and uniform; and by the principle of compound motion, a body, expoſed to the action of any number of forces, tending to alter the quantity and the direction of its motion, will move in ſuch a direction as to reach the very point at which it would have arrived, had it obeyed ſucceſſively each of the forces which act upon it.—In the *Mecanique Analytique* of Lagrange, publiſhed in 1788, all the mechanical problems are reduced to general formulæ, which, being developed, furniſh us with the equations that are neceſſary for the ſolution of each problem; and the different principles which

Euler's mechanics.

Lagrange's Mecanique analytique.

which have been discovered for facilitating the solutions of mechanical questions, are brought under one point of view, and their connection and dependence clearly pointed out. The *Architecture Hydraulique*, by M. Prony, published in 1790, and the *Mecanique Philosophique*, of the same author, published in 1799, contains all the late improvements in mechanics, and a complete view both of the theory and application of that science. The first of these works is intended chiefly for the use of the engineer, though an extensive acquaintance with the higher geometry is necessary for perusing it with advantage. His *Mecanique Philosophique* is a profound work, in which, without the aid of a single diagram, he gives all the formulæ, and the various theorems and problems which belong to the sciences of mechanics and hydrodynamics. Every alternate page contains a methodical table of the results obtained in the preceding page, the description of the symbols, and the theorems, problems, and formulæ which may have been obtained.—The *Traité de Mecanique Elementaire*, by M. Franceur, published in 1802 in one volume octavo, is an excellent abridgement of the works of Prony, and is intended as an introduction to the *Mecanique Philosophique* of that author, to the *Mecanique Analytique* of Lagrange, and to the *Mecanique Celeste* of Laplace.—None of these works have been translated into English; but their place is well supplied by a *Treatise on Mechanics Theoretical*, *Practical*, and *Descriptive*, by Olinthus Gregory, A. M. published in 1806, and containing a complete view of the latest improvements, both in the theory and practice of mechanics.

Prony's *Architecture Hydraulique* and *Mecanique Philosophique*.

PART I. THEORY OF MECHANICS.

Objects of theoretical mechanics.

29. THE theory of mechanics properly comprehends, 1. Dynamics. 2. The motion of projectiles. 3. The theory of simple machines, or the mechanical powers. 4. The theory of compound machines, and their maximum effects. 5. The doctrine of the centre of gravity. 6. The centre of oscillation, gyration, &c. 7. The collision of bodies. 8. The theory of rotation. 9. The theory of torsion. 10. The strength of materials; and, 11. The equilibrium of arches, domes.—The subjects of DYNAMICS, PROJECTILES, ROTATION, and STRENGTH of MATERIALS having been already ably treated by Dr Robison, under their respective heads, we shall now direct the attention of the reader to the other branches of theoretical mechanics.

CHAP. I. *On Simple Machines*, or the *Mechanical Powers*.

Division of machines into simple and compound.

30. THE simple machines have been generally reckoned six in number. 1. The lever; 2. The wheel and axle, or *axis in peritrochio*; 3. The pulley; 4. The inclined plane; 5. The wedge; and, 6. The screw: to which some writers on mechanics have added the *balance*, and others the *rope-machine*. It is evident, however, that all these machines may be reduced to three, the *lever*, the *inclined plane*, and the *rope-machine*. The *pulley*, and the *wheel* and *axle*, are obviously composed of an assemblage of levers; the *balance* is a lever with equal arms; the *wedge* is composed of two inclined planes, with their bases in contact; and the *screw* is either a wedge or an inclined plane, wrapped round a cylinder.—Under the head of simple machines, therefore, we cannot, in strict propriety, include any of the mechanical powers, excepting the lever, the inclined plane, and the rope-machine.

DEFINITIONS.

Definitions.

31. DEF. 1. When two forces act against each other by the intervention of a machine, the one force is called the *power*, and the other the *weight*. The *weight* is the resistance to be overcome, or the effect to be produced. The *power* is the force, whether animate or inanimate, which is employed to overcome that resistance, or to produce the required effect.

32. DEF. 2. The power and weight are said to balance each other, or to be in equilibrio, when the effort of the one to produce motion in one direction, is equal to the effort of the other to produce motion in the opposite direction;—or when the weight opposes that degree of resistance which is precisely required to destroy the action of the power.

SECT. I. *On the Lever*.

Levers divided into three kinds.

33. DEFINITION. A *lever* is an inflexible bar or rod moving freely round a point called its *fulcrum*, or *centre of motion*.

Levers have been generally divided into *three* kinds. In levers of the first kind the fulcrum is situated between the power and the weight, as in steelyards, scissars, pincers, &c. Levers of the second kind have the weight between the power and the fulcrum, as in cutting knives fastened at the point of the blade, and in the oars of a boat where the water is regarded as the fulcrum. In levers of the third kind, the power is between the weight and the fulcrum, as in tongs, sheers for sheep, &c. The bones of animals are generally considered as levers of the third kind, for the muscles, by the contraction of which the power or moving force is generated, are fixed much nearer to the joints or centres of motion than the centre of gravity of the weight to be raised. On this subject, see Paley's Natural Theology, chap. 7, 8. and *Borelli de Motu Animalium*.

AXIOMS.

Axioms.

34. AXIOM 1. *Equal weights acting at the extremities of equal arms of a straight lever, and having the lines of the direction in which they act at equal angles to these arms, will exert the same effort to turn the lever round its fulcrum.* This axiom has been generally restricted to the particular case when the weights act perpendicularly to the arms of the lever; but no reason can be assigned for such a limitation. The truth in the axiom is as self-evident when the angles formed by the arms of the lever and the direction of the forces are 80°, as when they are 90°, for in each case the two weights exert

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exert their influence upon the lever in precisely the same circumstances.

35. Axiom 2. *If two equal weights are placed at the extremities of a lever supported by two fulcra; and if these fulcra are at equal distances from the weights, or the extremities of the lever; the pressure upon the fulcra will be equal to the sum of the weights, and the pressure upon each fulcrum will be equal to one of the weights.* The lever being supposed devoid of weight, it is obvious, that as each fulcrum is similarly situated with respect to both the weights, the pressure upon each must be equal; and as the fulcra support both the equal weights, the pressure upon each must be equal to one of the weights.

Proposition I.

36. If two weights or forces acting at equal angles upon a straight lever, devoid of weight, are in equilibrio, they are reciprocally proportional to their distances from the fulcrum.

37. Case 1. When the weights act on contrary sides of the fulcrum.

Plate CCCXVI. Fig. 1.

Let AB be a lever devoid of weight, and let it be supported upon the two fulcra f, F, situated in such a manner that $Af=fF=FB$. Then if two equal weights C, D of one pound each are suspended at the extremities A, B, so as to act in the directions AC, BD, making the angles CAB, DBA equal, these weights will be in equilibrio, for since $Af=FB$ (Axiom 1.) the effort of the weight D to turn the lever round the fulcrum F, will be equal to the effort of the weight C to turn it round the fulcrum f. Now (Axiom 2.) the pressure upon the fulcrum f is equal to one pound, therefore if that fulcrum be removed, and a weight E of one pound be made to act upward at the point F, the weights C and D will continue in equilibrio. Then it is obvious that since $FB=Ff$, the weight E of one pound acting upwards at the point f, so that the angle $DfF=DBA$, will have the same effect as an equal weight acting downwards at B. By removing the weight E, therefore, and suspending its equal C at the extremity B, the equilibrium will still be preserved. But the weights D, C, suspended at B, are equal to two pounds, and the weight C is only one pound; and as FA is double of FB, it follows that a weight of two pounds, placed at the end of one arm of a lever, will be in equilibrio with a weight of one pound placed at twice the distance of the former from the fulcrum. But $2:1=2$ FB or AF : FB, that is, when the distances are as 2 to 1, an equilibrium takes place if the weights are reciprocally proportional to these distances.

38. Case 2. When the weights act on the same side of the fulcrum.

Fig. 2.

Let AB be a lever in equilibrio upon the fulcrum F, and let FA be equal to FB, consequently (case 1.) we must have $C=D=1$ pound. Now as the fulcrum F supports a weight equal to $C+D=2$ pounds, the equilibrium will continue if a weight E of two pounds is made to act upwards at the point F, for in this case it supplies the place of the fulcrum. It is obvious also that a fulcrum placed at A or B will supply the place of the weights at these parts without affecting the equilibrium. Let, therefore, the weight D be removed, and let the extremity B rest upon a fulcrum; then since the lever is in equilibrio, we have a weight $E=C+D=2$ pounds acting at F, and balancing a weight C of one pound acting at A. But $2:1=AB:FB$, consequently when there is an equilibrium between two weights C, D acting at the distances 2 and 1 from the fulcrum, and on the same side of the fulcrum, the weights are reciprocally proportional to these distances.

39. Again, let AB be the same lever supported by the fulcra f, F, and let $Af=FB$ and $fF=2FB$. Then if two weights C, D of one pound each be suspended at the extremities A, B, they will be in equilibrio as before. But since the fulcrum f supports a pressure of one pound (Axiom 2.), the equilibrium will still continue when that fulcrum is removed and a weight of one pound made to act in a contrary direction fP at the point f, so that the angle PfF may be equal to DBA. Now, (Axiom 1.) a weight E of one pound acting upward at f will be in equilibrio with a weight E′ of one pound acting downwards at f'; Ff being equal to Ff', and therefore by removing E from the point f and substituting E at the point f', an equilibrium will still obtain. But since $Ff'=2FB$ a weight of one pound suspended from f will have the same influence in turning the lever round F as a weight of two pounds suspended at B (Case 2.). Let us remove, therefore, the weight E′ from f', and substitute a weight $G=2E'$, so as to act at B. Then since the equilibrium is not destroyed, we have a weight C of one pound acting at the distance FA, and the weights $D+G=3$ pounds acting at the distance FB. But $FA=3FB$ and $D+G=3C$, consequently $C:D+G=FB:FA$: That is, when the distances from the fulcrum are as 3 to 1, and when an equilibrium exists, the weights are reciprocally proportional to these distances. Fig. 3.

40. By making FA in fig. 2. equal to 2FB it may be shewn, as in Case 2. that the weights are reciprocally proportional to their distances from the fulcrum, when they act on the same side of the fulcrum, and when the distances are as 3 to 1. Fig. 2.

41. In the same way the demonstration may be extended to any commensurable proportion of the arms, by making EA to FB in that proportion, and keeping fA always equal to FB. Hence we may conclude in general, that when two weights acting at equal angles upon a straight lever devoid of weight, are in equilibrio, they are reciprocally proportional to their distances from the centre of motion. Q. E. D. Fig. 3.

Corollaries.

42. Cor. 1. If two weights acting at equal angles upon the arms of a straight lever devoid of weight are reciprocally proportional to their distances from the fulcrum, they will be in equilibrio.

For if an equilibrium does not take place, the proportion of the weights must be altered to procure an equilibrium, and then, contrary to the proposition, the weights would balance each other when they were not reciprocally proportional to their distances from the fulcrum.

43. Cor. 2. If a weight W be supported by a horizontal lever resting on the fulcra A, B, the pressure upon A is to the pressure upon B in the inverse ratio of their distances from the point where the weight is suspended, that is, as BF to FA. Fig. 4.

For if we suppose B to be the fulcrum, and if removing the

Theory. the fulcrum A, we support the extremity A of the lever by a weight E equivalent to the weight sustained by the fulcrum A, and acting upwards over the pulley P, then the weight E or that sustained by A : W=BF : BA (Prop. I.); and if we conceive A to be the fulcrum, and support the extremity B by a weight F equal to that which was supported by the fulcrum B, we shall have the weight F or the weight sustained by B : W=AF : AB. Hence *ex æquo* the weight sustained by A is to the weight sustained by B as BF is to FA.

Fig. 5. 44. Cor. 3. We may now call the two weights P and W, the power and the weight, as in fig. 5, and since P : W=FB : FA, we have (Geometry, Sect. iv. Theor. 8.) $P \times FA = W \times FB$, when an equilibrium takes place,

consequently $P = \frac{W \times FB}{FA}$; $W = \frac{P \times FA}{FB}$

$$FA = \frac{W \times FB}{P}$$

$$FB = \frac{P \times FA}{W}.$$

45. Cor. 4. We have already seen (Axiom 2.) that when the power and the weight are on contrary sides of the fulcrum, the pressure upon the fulcrum is equal to P+W or the sum of the weights; but it is obvious that when they act on the same side of the fulcrum, the pressure which it supports will be P—W, or the difference of their weights.

46. Cor. 5. If a weight P be shifted along the arm of a lever AD, the weight W, which it is capable of balancing at A, will be proportional to FA.

When the weights are in equilibrio (Cor. 3.) W : P=FA : FB, or by alternation W : FA=P : FB, and if w be another value of W and fa another value of FA, we shall also have $w : P = fa : FB$ or $w : fa = P : FB$, consequently (Euclid, Book v. Prop. xi. and xvi.) $W : w = FA : fa$, that is, W varies as FA.

Fig. 6. Cor. 6. It is obvious that the truths in the preceding proposition and corollaries, also hold when the lever has the form represented in figure 6. only the straight lines AF, FB are in that case the length of the arm.

Description of the steelyard or statera. 47. Cor. 7. Since by the last corollary $FA : fa = W : w$, it follows that in the *Roman statera* or *steelyard*, which is merely a lever with a long and short arm, having a weight moveable upon the long one, the distances at which the constant weight must be hung are as the

Fig. 7. weights suspended from the shorter arm. The steelyard is represented in fig. 7. where AB is the lever with unequal arms AF, FB, and F the centre of motion. The body W, whose weight is to be found, is suspended at the extremity B of the lever, and the constant weight P is moved along the divided arm FB till an equilibrium takes place. As soon as this happens, the number placed at the point of suspension D, indicates the weight of the body. If the lever is devoid of weight, it is obvious that the scale EB will be a scale of equal parts of which EB is the unit, and that the weight of the body W will be always equal to the constant weight P multiplied by the number of divisions between P and F. Thus if the equilibrium takes place when P is pulled out to the 12 division, we shall have W=12 P, and if P=1 pound, W=12 pounds. But when the gravity of the lever is considered, which must be done in the real steelyard, its arms are generally of unequal weight, and therefore the divisions of the scale must be ascertained by experiment. In order to do this, remove the weight P, and find the point C, at which a weight P′ equal to P being suspended, will keep the unequal arms in equilibrio, C will then be the point at which the equal divisions must commence. For when W and P are placed upon the steelyard and are in equilibrio, W balances P along with a weight which, placed at D, would support P placed at C: Therefore $W \times BF = P \times DF + P \times CF$; but $P \times DF + P \times CF = P \times DC$, consequently $W \times BF = P \times DC$, and (Geometry, Sect. iv. Theor. 8.) W : DC=P : BF. By taking different values of the variable quantities W and DC as w and dc, we shall have $w : dc = P : BF$, consequently (Euclid, B. V. Prop. xi. and xvi.) $W : w = DC : dc$, that is, the weight of W varies as DC, and therefore the divisions must commence at C. If the arm BF had been heavier than FA, which, however, can scarcely happen in practice, the point C would have been on the other side of F. In constructing steelyards, it might be advisable to make the unequal arms balance each other by placing a weight M at the extremity of the lighter arm, in which case the scale will begin at F. In the Danish and Swedish steelyard the body to be weighed and the constant weight are fixed at the extremities of the steelyard, but the point of suspension or centre of motion F moves along the lever till the equilibrium takes place. The point F then indicates the weight of the body required.— There are some steelyards in which the constant weight is fixed to the shorter arm, while the body to be weighed moves upon the longer arm. The method of dividing this and the preceding steelyard may be seen in De la Hire's *Traite de Mecanique*, Prop. 36, 37, 38. Danish and Swedish steelyard.

Prop. II.

48. To find the condition of equilibrium on a straight lever when its gravity is taken into the account.

49. Let us suppose the lever to be of uniform thickness and density, as AB, fig. 7. and let it be suspended by the points c, d to another lever ab, considered as without weight, so that $ac = cf = fd = db$. Then if f be the centre of motion or point of suspension, the cylinder AB will be in equilibrio; for the weight AB may be regarded as composed of a number of pairs of equal weights, equally distant from the centre of motion. For the same reason, if we conceive the cylinder to be cut through at F the equilibrium will continue, c, d being now the points at which the weights AF, FB act, and their distances cf, df from the centre of motion being equal. Consequently the arms AF, FB have the same energy in turning the lever round f as if weights equal to AF, FB were suspended at the distance of their middle points c, d from the fulcrum. Fig. 8.

Let P therefore, in fig. 5. be the power, W the weight, m the weight of the arm AF, and n the weight of FB. Then when there is an equilibrium we shall have (Prop. I. Cor. 3.) $P \times AF + m \times \frac{1}{2}AF = W \times FB + n \times \frac{1}{2}FB$; and since the weight m acting at half the distance AF is the same as half the weight m, acting at the Fig. 5.

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the whole diſtance AF, we may ſubſtitute $\frac{1}{2}m \times AF$ inſtead of $m \times \frac{1}{2}AF$, and the equation becomes $\overline{P+\frac{1}{2}m} \times AF = \overline{W+\frac{1}{2}n} \times FB$. Hence

$$P = \frac{\overline{W+\frac{1}{2}n} \times FB}{AF} - \frac{1}{2}m$$

$$W = \frac{\overline{P+\frac{1}{2}n} \times AF}{FB} - \frac{1}{2}n$$

$$m = \frac{\overline{W+\frac{1}{2}n} \times 2FB}{AF} - 2P$$

$$n = \frac{\overline{P+\frac{1}{2}n} \times 2AF}{FB} - 2W$$

$$AF = \frac{\overline{W+\frac{1}{2}n} \times FB}{P+\frac{1}{2}m}$$

$$FB = \frac{\overline{P+\frac{1}{2}m} \times AF}{W+\frac{1}{2}m}.$$

50. Cor. If the arms of the lever are not of uniform denſity and thickneſs, inſtead of the diſtance of their middle points, we muſt take the diſtance of their centre of gravity from the fulcrum.

Prop. III.

51. If two forces acting in any direction, and in the ſame plane, upon a lever of any form, are in equilibrio, they will be reciprocally proportional to the perpendiculars let fall from the fulcrum upon the directions in which they act.

Plate CCCXVII. Fig. 1. & 2.

52. Let AFB be a lever of any form, F its fulcrum, A, B the points to which the forces, or the power P and weight W, are applied, and AE, BK the directions in which theſe forces act. Make AE to BK as P is to W, and they will therefore repreſent the forces applied at A and B. Draw AC perpendicular to AF and EC parallel to it, and complete the parallelogram ADEC. In the ſame way form the parallelogram BGKH. Produce EA and KB towards m and n if neceſſary, and let fall Fm, Fn perpendicular to AE, BK produced. Then P ſhall be to W as Fn is to Fm. By the reſolution of forces (Dynamics, §. 140.) the force AE is equivalent to forces repreſented by AD and AC, and acting in theſe directions. But as AD acts in the direction of the arm AF, it can have no influence in turning the lever round F, and therefore AC repreſents the portion of the force AD which contributes to produce an angular motion round F. In the ſame way it may be ſhewn that BG is the part of the force BK which tends to move the lever round F. Now ſuppoſe AF produced to B, FB, being made equal to FB and B′G′=BG. Then by Prop. I. AC : B′G′ =FB′ : FA; but by Axiom 1. the effort of BG to turn the lever round F is equal to the effort of the equal force B′G′ to turn the lever round F; therefore AC : BG=FB : FA and AC×FA=BG×FB. Now the triangles ACE, AEm are ſimilar, becauſe the angles at F and M are both right, and on account of the parallels DF, AC, MAC=ADF; therefore AC : AE=Fm : FA, and AC×FA=AE×Fm. For the ſame reaſon in the ſimilar triangles BGK, BFn we have BG : BK=Fn : FB, and BK×Fn=BG×FB. Hence AE×Fm=BK×Fn, and AE : BK or P : W =Fn : Fm. Q. E. D.

Theory. Corollaries. Fig. 1. & 2.

53. Cor. 1. The forces P and W are reciprocally proportional to the ſines of the angles which their directions make with the arms of the lever, for Fm is evidently the ſine of the angle FAm, and Fn the ſine of the angle FBn, FA, FB being made the radii;—therefore P : W = Sin. FBn : Sin. FAm, or P : W $= \frac{1}{\text{Sin. FA}m} : \frac{1}{\text{Sin. FB}n}$. Since FA : F$m$ = Rad. : Sin. FAm, we have F$m = \frac{\text{FA} \times \text{Sin. FA}m}{\text{Rad.}}$; and ſince FB : F$n$=Rad. : Sin. FB$n$, we have F$m = \frac{\text{FB} \times \text{Sin.FB}n}{\text{Rad.}}$ but in the caſe of an equilibrium P : W=Fn : Fm, conſequently P : W $= \frac{\text{FB} \times \text{Sin. FB}n}{\text{Rad.}} : \frac{\text{FA} \times \text{Sin. FA}m}{\text{Rad.}}$; and ſince magnitudes have the ſame ratio as their equimultiples, P : W=EB × Sin. EBn : FA × Sin. FAm.

54. Cor. 2. The energies of the forces P, W to turn the lever round the fulcrum F is the ſame at whatever point in the directions mE, nK they are applied, for the perpendiculars to which theſe energies are proportional remain the ſame.—The truth of this corollary has been aſſumed as an axiom by ſome writers on mechanics, who have very readily deduced from it the preceding propoſition. But it is very obvious that the truth aſſumed as ſelf-evident is nearly equivalent to the truth which it is employed to prove. Thoſe who have adopted this mode of demonſtration illuſtrate their axiom by the caſe of a ſolid body that is either puſhed in one direction with a ſtraight rod, or drawn by a cord; in both of which caſes it is manifeſt that the effect of the force employed is the ſame, at whatever part of the rod or ſtring it is applied: But theſe caſes are completely different from that of a body moving round a fixed centre.

55. Cor. 3. If AE and BK the directions in which the forces P, W are exerted be produced till they meet at L; and if from the fulcrum E the line FS be drawn parallel to the direction AL of one force till it meets BL, the direction of the other; then LS, SF will repreſent the two forces. For as the ſides of any triangle are as the ſines of the oppoſite angles LS : SF= ſin. LFS : ſin. FLS; but on account of the parallels FS, AL the angle LFS=FLA, and FL being radius Fm is the ſine of FLA or LFS, and Fn the ſine of FLS, therefore by ſubſtitution LS : SF=Fm : Fn, that is as the force W : P.

56. Cor. 4. If ſeveral forces act upon a lever, and keep it in equilibrio, the ſum of the products ~~of the~~ forces and the perpendiculars from the fulcrum to the direction of the different forces on one ſide is equal to the ſum of the products on the other. For ſince the energy of each force to turn the lever is equal to the product of the force and the perpendicular from the fulcrum on the line of its direction; and ſince in the caſe of an equilibrium, the energy of all the forces on one ſide of the fulcrum muſt be equal to the energy of all the forces on the other ſide, the products proportional to their energies muſt alſo be equal.

57. Cor. 5. If two forces act in a parallel direction upon an angular lever whoſe fulcrum is its angular point,

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point, these forces will be in equilibrio when a line drawn from the fulcrum upon the line which joins the two points where the forces are applied, and parallel to the direction of the forces, cuts it in such a manner that the two parts are reciprocally proportional to the forces applied.

Fig. 3. Let AFB be the angular lever, whose fulcrum is F, and let the forces P, W be applied at A and B in the parallel directions P m, W n; then if the line FD, parallel to P m or W n, cut AB in such a manner that DB : DA=P : W, the forces will be in equilibrio. Draw F m perpendicular to P m, and produce it to n; then since A m, B n are parallel, $m n$ will also be perpendicular to B n, and by the proposition (Art. 51.) F n : F m = P : W. Now, if through F, there be drawn $m' n'$ parallel to AB, the triangles F $m m'$, F $n n'$ will be similar, and we shall have F n : F m=F n' : F m', but on account of the parallels AB, $m' n'$; F n' : F m' =DB : DA, therefore DB : DA=P : W.

Fig. 4. 58. Cor. 6. Let CB be a body moveable round its centre of gravity F, and let two forces P, W act upon it at the points A, B in the plane AFB, in the directions AP, BW; then since this body may be regarded as a lever whose fulcrum is F, the forces will be in equilibrio when P : W=F n : F m the perpendiculars on the directions in which the forces act.

59. Cor. 7. If AB be an inflexible rod moveable round F as a fulcrum, and acted upon by two forces P, W in the directions A m, A n, these forces will be

Fig. 5. in equilibrio when they are to one another as the perpendiculars F n, F m.—For by cor. 2. the forces may be considered as applied at m and n, and m F n may be regarded as the lever; but by the proposition (Art. 51.) P : W=F n : F m; F m, F n being perpendiculars upon A m, A n.

60. Cor. 8. Let DE be a heavy wheel, and FG an obstacle over which it is to be moved, by a force P,

Fig. 6. acting in the direction AH. Join AF and draw F m, F n perpendicular to CA and AH. The weight of the wheel is evidently the weight to be raised, and may be represented by W acting at the point A in the vertical direction AC. We may now consider AF as a lever whose fulcrum is F, and by cor. 7. there will be an equilibrium when P : W=F n : F m. Since F m represents the mechanical energy of the power P to turn the wheel round F, it is obvious that when FG is equal to the radius of the wheel, the weight P, however great, has no power to move it over the obstacle; for when FG=AC, F m =0, and F m × P=0.

61. Cor. 9. If a man be placed in a pair of scales

Fig. 7. hung at the extremities of a lever, and is in equilibrio with a weight in the opposite scale, then if he presses against any point in the lever, except that point from which the scale is suspended, the equilibrium will be destroyed. Let CB be the lever in equilibrio, F its fulcrum, and let the scales be suspended from A and B, AP being the scale in which the man is placed. Then if he presses with his hand or with a rod against D, a point nearer the centre than A, the scale will take the position AP′, and the same effect will be produced as if AD were a solid mass acting upon the lever in the direction of gravity. Consequently if P′ p be drawn perpendicular from the point P′ to FC, F p will be the lever with which the man in the scale tends to turn the lever round the fulcrum; and as F p is greater than FA, the man will preponderate. In the same way it may be shown, that if the man in the scale AP presses upwards against a point C, more remote from the fulcrum than A, he will diminish his relative weight, and the scale W will preponderate, for in this case the scale assumes the position AP″, and F p' becomes the lever by which it acts.

62. Cor. 10. If a weight W be supported by an inclined lever resting on the fulcra A, B, the pressure upon A is to that upon B inversely, as A f is to $f b$, the sections of a horizontal line by the vertical direction of the weight W. Fig. 8.

Remove the fulcrum A, and support the extremity A by a weight P, equal to the pressure upon A; then B being the centre of motion, and $m n$ being drawn through F perpendicular to the directions of the forces A m, E f, and consequently parallel to A b, we have (Art. 51.) P : W=F n : F m=$f b$: f A, that is, the pressure upon A is to the pressure upon B inversely as A f, is to $f b$.

Scholium.

63. Various attempts have been made by different writers on mechanics to give a complete and satisfactory demonstration of the fundamental property of the lever. The first of these attempts was made by Archimedes, who assumes as an axiom, that if two equal bodies be placed upon a lever, they will have the same influence in giving it a rotatory motion as if they were both placed in the middle part between them. This truth, however, is far from being self-evident, and on this account Mr Vince * has completed the demonstration by making this axiom a preliminary proposition. The demonstration of Galileo † is both simple and elegant, and does not seem to have attracted much notice, though in principle it is exactly the same as that of Archimedes completed by Mr Vince. Galileo suspends a solid cylinder or prism from a lever by several threads. When the lever is hung by its centre, the whole is in equilibrio. He then supposes the cylinder to be cut into two unequal parts, which from their mode of suspension still retain their position, and then imagines each part of the cylinder to be suspended by its centre from the lever. Here then we have two unequal weights hanging at unequal distances from the centre of suspension, and it follows from the construction, that these weights are in the reciprocal ratio of their distances from that centre. Mr Vince, on the other hand, employs a cylinder balanced on a fulcrum. He supposes this cylinder divided into unequal parts, and thus concludes from his preliminary proposition, that these unequal parts have the same effect in turning the lever as if the weight of these parts was placed in their centres; which is done by Galileo by suspending them from their centres. From this the fundamental property of the lever is easily deduced.—The next demonstration was given by Huygens, who assumes as an axiom, that if any weight placed upon a lever is removed to a greater distance from the fulcrum, its effort to turn the lever will be increased. This axiom he might have demonstrated thus, and his demonstration would have been completely satisfactory, though it applies only to cases where the arms of the lever are commensurable. Let AB be a lever with equal weights C, D, supported on the fulcra f, F, so that A f= Plate CCCXVI. Fig. 1.

* *Phil. Trans.* 1794. p. 33.

† *Discursus et Demonstrationes Mathemat* Dial. ii. p. 98.

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A f=FB; then, as was shown in Prop. I. the weights will be in equilibrio, and each fulcrum will support a weight equal to C or D. By removing the fulcrum f, the weight C must descend, as the equilibrium is destroyed by a weight equal to C acting at f; therefore the weight C, at the distance AF, has a greater effect in turning the lever than an equal weight D placed at a less distance FB.—In Sir Isaac Newton's demonstration, it is supposed that if a given weight act in any direction, and if several radii be drawn from the fulcrum to the line of direction, the effort of that weight to turn the lever will be the same to whatever of these radii it is applied. It appears, however, from Art. 54. that this principle is far from being self-evident, and therefore the demonstration which is founded upon it cannot be admitted as satisfactory. The demonstration given by Maclaurin * is simple and convincing, and has been highly approved of by Dr T. Young, and other writers on mechanics, though it extends only to any commensurable proportion of the arms. He supposes the lever AB with equal arms to be in equilibrio upon the fulcrum F, by means of the equal forces P, W, in which case the fulcrum F will evidently be pressed down with a weight equal to 2 P=P+W. He then substitutes, instead of the weight P, a fixed obstacle O, which will not destroy the equilibrium, and *considers the fulcrum as still loaded with a weight equal to* P+W. The pressure on F being therefore equal to 2 P or P+W, a weight E equal to 2 P, and acting upwards, is substituted in the room of that pressure, so that the equilibrium will still continue. Here then we have a lever AB of the second kind, influenced by two forces E and W acting at different distances from the fulcrum A; and since E=2 P=2 W, and AB=2 AF, we have E : W=AB : AF, which expresses the fundamental property of the lever. Without objecting to the circumstance that this demonstration applies only to the lever of the second kind, we may be allowed to observe, that it involves an axiom which cannot be called self-evident. It is certainly manifest that when P and W are in equilibrio, the pressure upon the fulcrum is =2 P=P+W; but it by no means follows that this pressure remains the same when the fixed obstacle O is substituted in the room of P. On the contrary, the axiom assumed is a result of the proposition which it is employed to prove, or rather it is the proposition itself. For if, when the extremity A bears against the obstacle O, the pressure upon F is equal to 2 W, the force W obviously produces a pressure =2W at half the distance AB, which is the property to be demonstrated.—The demonstrations given by Mr Landen and Dr Hamilton, the former in his Memoirs, and the latter in his Essays †, though in a great measure satisfactory, are long and tedious. In the demonstration of Dr Hamilton, he employs the following proposition; that when a body is at rest, and acted upon by three forces, they will be to one another as the three sides of a triangle parallel to the direction in which the forces act. When the three forces act on one point of a body, the proposition is true, but it is not applicable to the case of a lever where the forces are applied to three different points, and at all events the demonstration does not hold when any two of the forces act in parallel directions. The demonstration which we have given in Prop. I. is new, and different from any that have been noticed. The truths on which it is founded are perfectly axiomatic; and the only objection to which it seems liable is, that the demonstration extends only to a commensurate proportion of the arms of the lever.—An analytical demonstration of the fundamental property of the lever was given by Fonceneix in the Miscellan. Jour. tom. ii. p. 321. which was afterwards improved by D'Alembert in the Mem. de l'Acad. 1769. p. 283.

* *Account of Newton's Discoveries.*

Plate CCCXVII. Fig. 9.

† See also *Phil. Trans.* vol. xciii. p. 113.

PROP. IV.

64. When several levers AB, $a\,b$, $\alpha\,\beta$, whose fulcra are F, f, φ, are so combined as to act perpendicularly upon each other, or at equal angles; and if the directions in which the power and weight are applied, be also perpendicular to the arms, or at the same angles with them as those at which the levers act upon each other, there is an equilibrium when $P:W=\overline{BF\times bf\times\beta\varphi}:\overline{AF\times af\times\alpha\varphi}$.

Plate CCCXVIII. Fig. 1.

Let M be the force which is exerted by the first lever AB upon the second $a\,b$, and N the force which is exerted by the second lever $a\,b$ upon the third $\alpha\,\beta$, then by Prop. I.

$$P:M=BF:AF$$
$$M:N=bf:af$$
$$N:W=\beta\varphi:a\varphi$$

Consequently by composition

$$P:W=\overline{BF\times bf\times\beta\varphi}:\overline{AF\times af\times\alpha\varphi}.$$

PROP. V.

65. To explain the new property of the lever discovered by M. Æpinus, and extended by Van Swinden.

Let AFB be any lever whose fulcrum is F, and to whose extremities A, B are applied the forces P, W in the directions AY, BO. Join AB, and produce it on both sides towards E and I. Produce also the lines YA, VB till they met in H, and from H, through the fulcrum F, draw HFf, dividing AB into two parts Af, Bf. Let UM be a line given in position, and let α, β represent the angles which the direction of the forces YA, VB make with that line. Let YA and VB likewise represent the intensity of the forces P, W, and let VA be resolved into AE and YF; and the force VB into BI and VI.—Then the lever cannot be in equilibrium till

Fig. 2.

I. $\overline{EA\times fA}+\overline{IB\times fB}$ is a maximum.

II. Or putting φ for the angles formed by the lines AB, UT, which the lever, when in equilibrio, makes with the line UM given in position, there cannot be an equilibrium till

$$\overline{\text{Tang.}\,\varphi\times P\times Af\times \text{Cos.}\,\alpha}+\overline{\text{Tang.}\,\varphi\times W\times Bf\times \text{Cos.}\,\beta}=\overline{W\times Bf\times \text{Sin.}\,\beta}-\overline{P\times Af\times \text{Sin.}\,\alpha}.$$

III. And

Theory. III. And putting a, b for the arms AF, BF, and m, n for the angles EAB, EBA, there cannot be an equilibrium unless Theory.

$$\text{Tang. } \varphi = \frac{W.b\,(\overline{\text{Sin. }\beta \times \text{Cos. }n} - \overline{\text{Sin. }n \times \text{Cos. }\beta}) - P.a\,(\overline{\text{Sin. }\alpha \times \text{Cos. }m} - \overline{\text{Sin. }m \times \text{Cos. }\alpha.})}{P.a\,(\overline{\text{Cos. }\alpha \times \text{Cos. }m} + \overline{\text{Sin. }\alpha \times \text{Sin. }m}) + W.b\,(\overline{\text{Cos. }\beta \times \text{Cos. }n} + \overline{\text{Sin. }\beta \times \text{Sin. }n.})}.$$

As the demonstrations of these different cases are far from being elementary, we shall only refer the reader to the memoir upon this subject given by Æpinus in the *Nov. Comment. Petropol.* tom. viii. p. 271.

Scholium.

66. This property of the lever was only considered by Æpinus in the case of a rectilineal lever with equal arms; but was extended by J. H. Van Swinden. When the lever is rectilineal and with equal arms, we have $AF = FB = Af = Bf$, and also $m = n = 0$, so that, if the last formula is suited to these conditions, we shall have the formula of Æpinus.

Prop. VI.

67. If a power and weight acting upon the arms of any lever be in equilibrio, and if the whole be put in motion, the velocity of the power is to the velocity of the weight as the weight is to the power.

Fig. 3. Let AFB be any lever whose fulcrum is F, and let the power P and weight W be applied to its extremities A, B, so as to be in equilibrio. Draw Fm, Fn perpendicular to AD, BE the direction of the forces P, W. Then suppose an uniform angular motion to be given to the lever, so as to make it describe the small angle AFA′, the position of the lever will now be A′FB′, and the directions of the forces P, W will be A′D′, B′E′ parallel to AD, BE respectively, since the angle AEF is exceedingly small. Join AA′, BB′, and from A′ and B′ draw A′x, B′z perpendicular to AD and BE. Now it is obvious, that though the point A has moved through the space AA′ in the same time that the point B has described the space BB′, yet Ax is the space described by A in the direction AD, and Bz the space described by B in the direction BE. For if we suppose a plane passing through A at right angles to AD, and another through P parallel to the former plane, it is manifest that Ax measures the approach of the point A to the plane passing through P; and for the same reason Bz measures the approach of the point B to a plane passing through W at right angles to WB. Therefore Ax, Bz represent the spaces uniformly and simultaneously described by the points A, B, and may therefore be taken to denote the velocities of these points (Dynamics, § 14.); consequently the velocity of A : the velocity of B = Ax : Bz. Now, in the triangles AxA′, FmA, the exterior angle xAF = AmF + mF, A (Euclid. B. I. Prop. 32.) and A′AF = AmF, because AFA′ is so exceedingly small that A′A is sensibly perpendicular to AF; consequently xAA′ = AEm: and as the angles at x and m are right, the triangles AxA′, AmF are similar (Geometry, Theor. XX. Sect. IV.).

Therefore, Ax : AA′ = Fm : FA, and in the similar triangles AFA′, BFB′ AA′ : BB′ = FA : FB, and in the similar triangles BB′z, BFn, BB′ : Bz = FB : Fn, therefore by composition we have Ax : Bz = Fm : Fn. But by Proposition II. P : W = Fn : Fm, consequently Ax : Bz = W : P, that is, the velocity of the power is to the velocity of the weight as the weight is to the power. Q. E. D.

68. Cor. Since Ax : Bz = W : P we have Ax × P = Bz × W, that is, the momenta of the power and weight are equal.

Sect. II. *On the Inclined Plane.*

69. Definition. An *inclined plane* is a plane surface AB, supported at any angle ABC formed with the horizontal plane BC. The *inclination of the plane* is the angle which one line in the plane AB forms with another in the horizontal plane BC, both these lines being at right angles to the common intersection of the two planes.—The line BA is called the *length of the plane*, AC its *height*, and BC the *length of its base*. Plate CCCXVIII. Fig. 4.

70. In order to understand how the inclined plane acts as a mechanical power, let us suppose it necessary to elevate the weight D from C to A. If this weight is lifted by the arms of a man to the point A, he must support the whole of the load; but when it is rolled up the inclined plane, a considerable part of its weight is supported upon the plane, and therefore a much smaller force is capable of raising it to A.

Prop. I.

71. When any weight W is kept in equilibrio upon an inclined plane by a power P, the power is to the weight as the sine of the plane's inclination is to the sine of the angle which the direction of the power makes with a line at right angles to the plane. Fig. 5.

Let MN be the inclined plane, NO a horizontal line, and MNO the inclination of the plane, and let the weight W be sustained upon MN by means of the power P acting in the direction AE. From the point A, the centre of gravity of the weight, draw AB perpendicular to the horizontal plane ND, and AF perpendicular to MN; produce EA till it meets the plane in C, and from the point F where the body touches the plane draw Fm at right angles to AC, and Fn at right angles to AB. Then, since the whole body may be considered as collected in the centre of gravity A, AB will be the direction in which it tends to fall, or the direction of the weight, and EA is the direction of the power; but AF is a lever whose fulcrum is F, and since it is acted upon by two forces which are in equilibrio, we shall have (Art. 59.) P : W = Fn : Fm, that is, as the perpendiculars drawn from the fulcrum to the direction in which the forces act. Now FA being radius, Fn is the sine of the angle FAB, and Fm is the sine of the angle FAC; but FAB is equal to MNO the angle of the plane's inclination, on account of the right angles at F and B and the vertical angles at D; and FAC is the angle which the direction of the power makes with a line perpendicular to the plane; therefore P : W as

Theory.

as the fine of the plane's inclination, is to the fine of the angle formed by the direction of the power with a line at right angles to the plane.

72. Cor. 1. When the power acts parallel to the plane in the direction AE′, P is to W as EA to E n, that is, as radius is to the fine of the plane's inclination, or, on account of the fimilar triangles FA n, MNO, as the length of the plane is to its height. In this cafe the power acts to the greateft advantage.

73. Cor. 2. When the power acts in a vertical line A ε, F m becomes equal to or coincides with F n, and we have P : W=F n : F n, that is, the power in this cafe fuftains the whole weight.

74. Cor. 3. When the power acts parallel to the bafe of the plane in the direction A e, P : W=F n : F f =F n : A n.

75. Cor. 4. When the power acts in the direction AF e' perpendicular to the plane, it has no power to refift the gravity of the weight; for the perpendicular from the fulcrum F, to which its energy is proportional, vanifhes.

76. Cor. 5. Since the body W acts upon the plane in a direction AF perpendicular to the plane's furface, (for its force downwards may be refolved into two, one parallel to the plane, and the other perpendicular to it), and fince the reaction of the plane muft alfo be perpendicular to its furface (Dynamics, § 149.), that is, in the direction FA, then, when the direction of the power is A e parallel to the horizon, the power, the weight, and the preffure upon the plane, will be refpectively as the height, the bafe, and the length of the plane. The weight W is acted upon by three forces; by its own gravity in the direction A n, by the reaction of the plane in the direction AF, and by the power P in the direction AF. Therefore, fince thefe forces are in equilibrio, and fince A f is parallel to n F, and F f to A n, the three fides AF, A f, F f, will reprefent the three forces (Dynamics, §. 144.). But the triangle AF f is fimilar to A n F, that is, to MNO, for it was already fhewn that the angle n AF is equal to MNO, therefore, fince in the triangle AF f, AF reprefents the preffure on the plane, A f the weight of the body, and F f the energy of the power, thefe magnitudes will alfo be reprefented in the fimilar triangle MNO by the fides MN, MO, NO.

77. Cor. 6. If a power P and weight W are in equilibrio upon two inclined planes AB, AC; P : W=
Fig 6. AB : AC. Let p be the power, which acting on the weight W in a direction parallel to the plane would keep it in equilibrio, then we have p : W=AD : AC; but fince the ftring is equally ftretched at every point, the fame power p will alfo fuftain the power P, confequently P : p=AB : AD, and by compofition P : W =AB : AC.

Prop. II.

78 If a fpherical body is fupported upon two inclined planes, the preffures upon thefe planes will be inverfely as the fines of their inclination, while the abfolute weight of the body is reprefented by the fine of the angle formed by the two planes.

Fig. 7. Let AC, BC be the two inclined planes, and F the fpherical body which they fupport. The whole of its matter being fuppofed to be collected in its centre of gravity F, its tendency downwards will be in the vertical line FO. The reaction of the planes upon F is evidently in the direction MF, NF perpendicular to the furface of thefe planes, and therefore we may confider the body F as influenced by three forces acting in the directions FC, FM, FN; but thefe forces are reprefented by the fides of the triangle ABC perpendicular to their directions, (Dynamics, §. 144.), confequently the abfolute weight of the body F, the preffure upon the plane AC, and the preffure upon the plane BC, are refpectively as AB, AC, and BC, that is, as the fines of the angles ACD, ABC, BAC, for in every triangle the fides are as the fines of the oppofite angles, or, to exprefs it in fymbols, W being the abfolute weight of the body, w the preffure on AC, and w' the preffure on BC,

$$W : w : w' = AB : AC : BC, \text{ or}$$
$$W : w : w' = \text{fin. } ACB : \text{fin. } ABC : \text{fin. } BAC.$$

But on account of the parallels AB, DF, the angle ABC=BCF, and BAC=ACD, therefore the preffures upon the planes are inverfely as the fines of their inclination, the abfolute weight of the body being reprefented by the fine of the angle formed by the furfaces of the two planes.

79. Cor. 1. Since the two fides of a triangle are greater than the third, the fum of the relative weights fupported by the two planes is greater than the abfolute weight of the body. Corollaries.

80. Cor. 2. If the inclination of each plane is 60°, then ACB muft alfo be 60°, and the triangle ABC equilateral, confequently the preffure upon each plane is equal to the abfolute weight of the body.

81. Cor. 3. When the inclination of each plane increafes, the preffure which each fuftains is alfo increafed; and when their inclination diminifhes till it almoft vanifhes, the preffure upon each plane is one half of the abfolute weight of the body F.

Prop. III.

82. If a body is raifed with an uniform motion along an inclined plane, the velocity of the power is to the velocity of the weight as the weight is to the power.

Let the weight W be drawn uniformly up the inclined plane AB, from B to D, by a power whofe direction is parallel to DH. Upon DB defcribe the circle BFEDN, cutting BC in E, and having produced HD to F, join FP, FB, FE, and draw DC perpendicular to BD. Now the angles BFD, BED are right (Geometry, Sect. II. Theor. 17.), and therefore, though the power moves through a fpace equal to BD, yet its velocity in the direction DH is meafured by the fpace FD uniformly defcribed; and for the fame reafon, though the weight W defcribes the fpace BD, yet its velocity in the direction in which it acts, that is, in a vertical direction, is evidently meafured by the fpace DE uniformly defcribed. Then becaufe the triangle DBE is equal to DFE, (Geometry, Sect. II. Theor. 15.) and DBE=DCH, (Geometry, Sect. IV. Theor. 23.) and FDE=DHC, (Geometry, Sect. I. Theor. 21.) Fig. 8.

Theory. 21.) the triangles DFE, DHC are similar, and (GEOMETRY, Sect. IV. Theor. 20.) DF : DE=DH : HC. But DH : HC=sin. DCH : sin. HDC, that is, (art. 71.) DF : DE, or the velocity of the power to the velocity of the weight, as W : P. Q. E. D.

Scholium.

83. The inclined plane, when combined with other machinery, is often of great use in the elevation of weights. It has been the opinion of some writers, that the huge masses of stone which are found at great altitudes in the splendid remains of Egyptian architecture, were raised upon inclined planes of earth, with the aid of other mechanical powers. This supposition, however, is not probable, as the immense blocks of granite which compose the pyramids of Egypt could not possibly have been raised into their present situation by any combination of the mechanical powers with which we are acquainted.—The inclined plane has been very advantageously employed in the duke of Bridgewater's canal. After this canal has extended 40 miles on the same level, it is joined to a subterraneous navigation about 12 miles long by means of an inclined plane, and this subterraneous portion is again connected by an inclined plane with another subterraneous portion about 106 feet above it. This inclined plane is a stratum of stone which slopes one foot in four, and is about 453 feet long. The boats are conveyed from one portion of the canal to another by means of a windlass, so that a loaded boat descending along the plane turns the axis of the windlass, and raises an empty boat.—A pair of stairs, and a road that is not level, may be regarded as inclined planes; and hence it is a matter of great importance in carrying a road to the top of a hill, to choose such a line that the declivity may be the least possible. The additional length, which, in order to effect this purpose must sometimes be given to the line of road is a trifling inconvenience, when compared with the advantages of a gentle declivity.

Sect. III. *On the Rope Machine.*

84. Definition. When a body suspended by two or more ropes, is sustained by powers which act by the assistance of these ropes, this assemblage of ropes is called a *rope machine.*

Prop. I.

85. If a weight is in equilibrium with two powers acting on a rope machine, these powers are inversely as the sines of the angles which the ropes form with the direction of the weight.

Fig. 9. Let the weight W be suspended from the point B, where the ropes AB, BC are joined, and let the powers P, p acting at the other extremities of the ropes which pass over the pulleys A, C, keep this weight in equilibrio, we shall have P : p=sin. CBD : sin. ABD. Produce WB to F, and let BD represent the force exerted by W; then by drawing DE parallel to AB, the sides of the triangle BDE will represent the three forces by which the point B is solicited (DYNAMICS, §. 144), for AB, CB are the directions of the forces P and p. We have therefore P : p=DE : BE; but DE : BE= sin. DBE : sin. BDE, and on account of the parallels DE, AB, the angle BDE=ABD, consequently P : p=sin. DBE : sin. BDE. Theory.

86. Cor. 1. When the line joining the pulleys is horizontal, as AC, then P : p=FC : FA, for FC and FA are evidently the sines of the angles DBE, BDE.

87. Cor. 2. Any of the powers is to the weight, as the sine of the angle which the other makes with the direction of the weight, is to the sine of the angles which the power makes with one another. For since DB represents the weight, and BE the power P, we have BE : BD=sin. BDE : sin. BED; but on account of the parallels DE, AB, the angle DEB=ABC, the angle made by the direction of the powers, consequently BE : BD, that is, p : W=sin. ABF : sin. ABC. In the same way it may be shown that P : W=sin. CBF : sin. ABC. Hence we have P+p : W=sin. CBF+sin. ABF : sin. ABC, that is, the sum of the powers is to the weight, as the sum of the sines of the angles which the powers make with the direction of the weight is to the sine of the angle which the powers make with one another.

88. Cor. 3. The two powers P, p, are also directly proportional to the cosecants of the angles formed by the direction of the powers with the direction of the weight. For since P : p=sin. DBE : sin. BDE, and by the principles of trigonometry, sin. DBE : sin. DBE =cosec. BDE : cosec. DBE, we have P : p = cosec. ABF : cosec. CBF. It is also obvious that P : p as the secants of the angles which these powers form with the horizon, since the angles which they make with the horizon are the complements of the angles which they form with the direction of the weight, and the cosecant of any angle is just the secant of its complement, therefore P : p=sec. BAF : sec. BCF.

Chap. II. *On Compound Machines.*

89. Definition. Compound machines are those which are composed of two or more simple machines, either of the same or of different kinds. The number of compound machines is unlimited, but those which properly belong to this chapter, are, 1. The wheel and axle; 2. The pulley; 3. The wedge; 4. The screw; and 5. The balance.

Sect. I. *On the Wheel and Axle.*

90. The *wheel and axle*, or the axis in peritrochio, is represented in fig. 9. and consists of a wheel AB, and cylinder CD having the same axis, and moving upon pivots E, F placed at the extremity of the cylinder. The power P is most commonly applied to the circumference of the wheel, and acts in the direction of the tangent, while the weight W is elevated by a rope which coils round the cylinder CD in a plane perpendicular to its axis.—In this machine a winch or handle EH is sometimes substituted instead of the wheel, and sometimes the power is applied to the levers S, S fixed in the periphery of the wheel; but in all these forms the principle of the machine remains unaltered.—That the wheel and axle is an assemblage of levers will be obvious, by considering that the very same effect would be produced if a number of levers were to radiate Fig. 10.

Theory.

diate from the centre C, and if a rope carrying the power P were to paſs over their extremities, and extricate itſelf from the deſcending levers when they come into a horizontal poſition.

91. Axiom. The effect of the power to turn the cylinder round its axis, is the ſame at whatever point in the axle it is fixed.

Prop. I.

92. In the wheel and axle the power and weight will be in equilibrium, when they are to one another reciprocally as the radii of the circles to which they are applied, or when the power is to the weight as the radius of the axle is to the radius of the wheel.

Fig. 11. Let AD be a ſection of the wheel, and BE a ſection of the axle or cylinder, and let the power P and weight W act in the directions AP, WP, tangents to the circumferences of the axle and wheel in the points A, B, by means of ropes winding round theſe circumferences. As the effect is the ſame according to the *axiom*, let the power and weight act in the ſame plane as they appear to do in the figure, then it is obvious that the effort of the power P and weight W will be the ſame as if they were ſuſpended at the points A, B; conſequently the machine may be regarded as a lever AFB, whoſe centre of motion is F. But ſince the directions of the power and weight make equal angles with the arms of the lever, we have (Art. 36.) $P : W = FB : FA$, that is, the power is to the weight as the radius of the axle is to the radius of the wheel.

Corollaries. 93. Cor. 1. If the power and weight act obliquely to the arms of the lever in the directions Ap, Bw, draw Fm Fn perpendicular to Ap and Bw, and as in the caſe of the lever (Art. 51.) there will be an equilibrium when $P : W = Fn : Fm$. Hence the tangential direction is the moſt advantageous one in which the power can be applied, for FA is always greater than Fm, and the leaſt advantageous direction in which the weight can be applied, for it then oppoſes the greateſt reſiſtance to the power.

94. Cor. 2. If the plane of the wheel is inclined to the axle at any angle x, there will be an equilibrium when $P : W =$ ſemidiameter of the axle : ſin. x.

95. Cor. 3. When the thickneſs of the rope is of a ſenſible magnitude, there will be an equilibrium when the power is to the weight as the ſum of the radius of the axle, and half the thickneſs of its rope, is to the ſum of the radius of the wheel and half the thickneſs of its rope; that is, if T be the thickneſs of the rope of the wheel, and t the thickneſs of the rope of the axle, there will be an equilibrium when $P : W = \overline{FB + \frac{1}{2}t} : \overline{FA + \frac{1}{2}T}$.

96. Cor. 4. If a number of wheels and axles are ſo combined that the periphery of the firſt axle may act on the periphery of the ſecond wheel, either by means of a ſtring or by teeth fixed in the peripheries of each, and the periphery of the ſecond axle on the periphery of the third wheel, there will be an equilibrium when the power is to the weight as the product of the radii of all the axles is to the product of the radii of all the wheels. This corollary may be demonſtrated by the ſame reaſoning which is uſed in Art. 63. for the combination of Levers.

Theory.

97. Cor. 5. In a combination of wheels, where the motion is communicated by means of teeth, the axle is called the *pinion*. Since the teeth therefore muſt be nearly of the ſame ſize, both in the wheel and pinion, the number of teeth in each will be as their circumferences, or as their radii; and conſequently in the combination mentioned in the preceding corollary, the power will be to the weight, in the caſe of an equilibrium, as the product of the number of teeth in all the pinions is to the product of the number of teeth in all the wheels.

Prop. II.

98. In the wheel and axle the velocity of the weight is to the velocity of the power as the power is to the weight.

If the power is made to riſe through a ſpace equal to the circumference of the wheel, the weight will evidently deſcribe a ſpace equal to the circumference of the axle. Hence, calling V the velocity of the power, v that of the weight, C the circumference of the wheel, and c that of the axle, we have $V : v = C : c$. But by the propoſition $P : W = c : C$, therefore $P : W = v : V$.

Scholium.

99. The conſtruction of the main-ſpring box of the fuſee of a watch round which the chain is coiled, is a beautiful illuſtration of the principle of the wheel and axle. The ſpring-box may be conſidered as the wheel, and the fuſee the axle or pinion to which the chain communicates the motion of the box. The power reſides in the ſpring wound round an axis in the centre of the box, and the weight is applied to the lower circumference of the fuſee. As the force of the ſpring is greateſt when it is newly wound up, and gradually decreaſes as it unwinds itſelf, it is neceſſary that the fuſee ſhould have different radii, ſo that the chain may act upon the ſmalleſt part of the fuſee when its force is greateſt, and upon the largeſt part of the fuſee when its force is leaſt, for the equable motion of the watch requires that the inequality in the action of the ſpring ſhould be counteracted ſo as to produce an uniform effect. In order to accompliſh this, the general outline of the ſurface of the fuſee muſt be an Apollonian hyperbola in which the ordinates are inverſely as their reſpective abſciſſæ. For further information on this ſubject, ſee *Recherches des Mathemat. par M. Parènt.* tom. ii. p. 678.; *Traitè d'Horlogerie, par M. Berthoud*, tom. i. chap. 26.; and *Traitè de Mecanique, par M. de la Hire*, prop. 72.

On the fuſee of a watch.

Sect. II. *On the Pulley.*

100. Definition.—The pulley is a machine compoſed of a wheel with a groove in its circumference, and a rope which paſſes round this groove. The wheel moves on an axis whoſe extremities are ſupported on a kind of frame called the block, to which is generally ſuſpended the weight to be raiſed. A ſyſtem of pulleys is called a *muffle*, which is either fixed or moveable according as the block which contains the pulleys is fixed or moveable.

On the pulley.

Prop.

Prop. I.

101. In a ſingle pulley, or ſyſtem of pulleys where the different portions of the rope are parallel to each other, and where one extremity of it is fixed, there is an equilibrium when the power is to the weight as unity is to the number of the portions of the rope which ſupport the weight.

Fig. 12. 102. Case 1. In the ſingle fixed pulley AA let the power P and weight W be equal, and act againſt each other by means of the rope PBAW, paſſing over the pulley AA; then it is obvious that whatever force is exerted by P in the direction PBA, the ſame force muſt be exerted in the oppoſite direction WBA, conſequently theſe equal and oppoſite forces muſt be in equilibrio; and as the weight is ſupported only by one rope, the propoſition is demonſtrated, for P:W=1:1.

Fig. 13. 103. Case. 2. In the ſingle moveable pulley, where the rope, faſtened at H, goes beneath the moveable pulley D and over the fixed pulley C, the weight to be raiſed is ſuſpended from the centre of the pulley D by the block p, and the power is applied at P in the direction PE. Now it is evident that the portions CFp, HGD of the rope ſuſtain the weight W, and as they are equally ſtretched in every point, each muſt ſuſtain one half of W; but (Caſe 1.) in the ſingle pulley C the rope CEP ſuſtains a weight equal to what the rope CFp ſuſtains; that is, it ſuſtains one-half of W. Conſequently $P=\frac{1}{2}W$, or $W=2P$, when there is an equilibrium; and ſince the weight W is ſupported by *two* ſtrings, we have P : W=1 : 2.

Fig. 14. 15. 16. 104. Case 3. When the ſame rope paſſes round a number of pulleys, the ropes which ſupport the weight W are evidently equally ſtretched in every part, and therefore each of them ſuſtains the ſame weight. Conſequently if there be *ten* ropes ſupporting the weight, each ſuſtains $\frac{1}{10}$th part of the weight, and therefore $P=\frac{1}{10}W$, or W=10 P, which gives us P : W=1 : 10.—The pulley in fig. 15. is the patent pulley invented by Mr White, in which the lateral friction and ſhaking motion is conſiderably removed.

Prop. II.

105. In a ſyſtem of n moveable pulleys ſuſpended by ſeparate and parallel ropes, there is an equilibrium when $P:W=1:2^n$; that is, if there are 4 pulleys $n=4$, and $P:W=1:2\times2\times2\times2$, or P : W=1 : 16.

Fig. 17. This ſyſtem is repreſented in fig. 17. where the rope which carries the power P paſſes over the fixed pulley M, and beneath the moveable pulley A, to the hook E where it is fixed. Another rope fixed at A paſſes over B and is fixed at F, and ſo on with the reſt. Then by Art. 103.

P : the weight at A=1 : 2
The weight at A : the weight at B=1 : 2
The weight at B : the weight at C=1 : 2
The weight at C : the weight at D or W=1 : 2; and therefore by compoſition

$P:W=1:\overline{2\times2\times2\times2}$ or P : W=1 : 16. Q. E. D.

Prop. III.

106. In a ſyſtem of moveable pulleys whoſe number is n, ſuſpended by ſeparate and parallel ropes, whoſe extremities are fixed to the weight W, there is an equilibrium when $P:W:1:2^n-1$. Fig. 18.

In this ſyſtem of pulleys, the rope which ſuſtains the power P paſſes over the pulley C, and is fixed to the weight at D. Another rope attached to the pulley C paſſes over the pulley B and is fixed to the weight at E, and a third rope faſtened to B paſſes over A and is fixed at F. Then it is manifeſt that the rope CD ſuſtains a weight equal to P; and ſince the pulley C is pulled downward with a weight equal to 2P, the rope BC muſt ſupport a weight equal to 2 P, and the rope B the ſame weight; conſequently the rope AB ſuſtains 4 P. The whole weight therefore is P+2P+4P, and hence P : W=P : P+2P+4P, or P : W=1 : 1+2+4 &c. to n terms, ſo that $P:W=1:2^n-1$.

Prop. IV.

107. In the ſyſtem of pulleys repreſented in fig. 19. and called a Spaniſh barton, in which two pulleys are ſupported by one rope, there is an equilibrium when P : W=1 : 4. Fig. 19.

In this combination of pulleys, the rope AB which ſupports the power P paſſes over the moveable pulley A, and beneath C towards H, where it is fixed. Another rope, attached to the pulley A, paſſes over the fixed pulley B, and is faſtened at E to the pulley C, which ſupports the weight W. Then, ſince the rope AP ſupports 1 pound, the rope AC alſo ſupports 1 pound, and therefore the pulley A, or the rope BA, is pulled down with a force of 2 pounds. But the rope BDE is equally ſtretched with BA, conſequently the pulley C to which DE is attached, is pulled upwards with a force of 2 pounds. Now the rope AC ſupporting 1 pound, the rope GH muſt likewiſe ſupport 1 pound, conſequently, ſince DE ſuſtains 2 pounds, AC 1 pound, and HG 1 pound, they will together ſuſtain W=4 pounds, and therefore P : W=1 : 4.

Prop. V.

108. In the ſyſtem of pulleys repreſented in fig. 20. called a Spaniſh barton, where two pulleys are ſupported by one rope, there is an equilibrium when P : W=1 : 5. Fig. 20.

In this ſyſtem the rope PB paſſes over B round C, and is fixed at E. Another rope attached to B paſſes round AF and is fixed at I to the pulley CD, which carries the weight W. Now the rope BP being ſtretched with a force of 1 pound, the ropes BGC, CDE are alſo ſtretched with a force of 1 pound each, and the pulley CD is pulled upwards with a force of 2 pounds. But ſince the three ropes BP, ED, and GC, are each ſtretched with a force of 1 pound, the pulley B and the rope BA, upon which they all act in one direction, muſt be pulled down with a force of 3 pounds. Now the rope FI is equally ſtretched with BA, conſequently it will draw the pulley CD upwards with a force of 3 pounds,

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pounds, and since it is drawn upwards by the ropes CG, DF with a force of two pounds, the whole force will sustain W=5 pounds; but this force of 5 pounds is by the hypothesis in equilibrio with P or 1 pound, consequently P : W=1 : 5.

Plate CCCXIX. Fig. 1.

Prop. VI.

109. When the ropes are not parallel, and when two powers are in equilibrio with a weight by means of a pulley, and have their directions at equal angles to the direction of the weight, each of these powers is to the weight as the radius of the pulley is to the chord of that portion of the pulley's circumference with which the rope is in contact.

Let the weight W suspended from C be sustained in equilibrio by two powers P, p, which act by a rope PCFEp passing over the pulley CHEF, and touching the arch CFE of its circumference. Then since the angles PWD, pWD are equal, and the powers P, p in equilibrio, P must be equal to p; and making WA =WB, and drawing AI parallel to PW, and BI parallel to pW; WB, BI, WI will respectively represent the forces P, p, W or P : p : W=WB : BI : WI, Dynamics Art. 144. Now the triangles WBI, CDE having their respective sides at right angles to each other, are similar; consequently WB : BI : WI=CD : DE : EC, that is, P : p : W= CD : DE : EC; but CD, DE are equal to radius, and EC is obviously the chord of the arch CFE, therefore P : W or p : W as radius is to the chord of the arch with which the rope is in contact.

110. Cor. 1. Any of the powers is also to the weight as radius is to twice the cosine of the angle which either rope makes with the direction of the weight. For since CG is the cosine of DCG, and since CE is double of CG, CE is equal to 2 cosine DCG =2 Cos PWD; but P : W=CD : CE, hence we have by substituting the preceding value of CE, P : W=CD or radius : 2 Cos. PWD.

Scholium.

111. By means of this proposition and corollary, the proportion between the powers and the weight in the various systems of pulleys, represented in fig. 12, 13, 14, 15, 16. 17, 18, 19, 20. when the ropes are not parallel, may be easily found.

Prop. VII.

112. In a system of moveable pulleys, where each has a separate rope, and where the ropes are not parallel, there is an equilibrium when the power is to the weight as radius is to the cosines of half the angles made by the rope of each pulley, multiplied into that power of 2 whose exponent is the number of pulleys.

Fig. 2. Let the power P sustain the weight W by means of the pulleys A, B, C; let P, p, π be the different powers which support the pulleys A, B, C, and let MAP, NBA, RCB be the angles formed by the ropes. Then, by the last proposition,

Theory.

$P : p = \text{rad.} : 2 \text{ cos. } MAP$
$p : \pi = \text{rad.} : 2 \text{ cos. } NBA$
$\pi : W = \text{rad.} : 2 \text{ cos. } RCB$, consequently

$$P : W = \text{rad.} : \overline{2 \text{ cos. } MAP} \times \overline{2 \text{ cos. } NBA} \times \overline{2 \text{ cos. } RCB},$$

or, which is the same thing,

$$P : W = \text{rad.} : \overline{2 \times 2 \times 2} \times \text{cos. } MAP \times \text{cos. } NBA \times \text{cos. } RCB.$$

Prop. VIII.

113. In a single pulley, or in a combination of pulleys, the velocity of the power is to the velocity of the weight as the weight is to the power.

114. Case 1. In the single fixed pulley, it is obvious, that if the weight W is raised uniformly one inch, the power D will also describe one inch, consequently velocity of P : velocity of W=W : P. Fig. 12.

115. Case 2. In the single moveable pulley, when the weight W is raised one inch, the ropes become one inch shorter; and since the rope has always the same weight, the power must describe two inches, therefore velocity P : velocity W=W : P. Fig. 13.

116. Case 3. In the combination of pulleys, in figs. 14, 15, 16, when the weight rises one inch, each of the four strings becomes an inch shorter, so that P must describe four inches, as the length of the rope is invariable; consequently velocity P : velocity W = W : P. Figs. 14, 15, 16.

117. Case 4. In the system exhibited in fig. 17. it is evident, that when the weight W rises one inch, the rope DC is lengthened two inches, the rope CB four inches, the rope BA eight inches, and the rope AFP, to which the power is suspended, 16 inches; so that since the power of this pulley is as 16 to 1, we have velocity P : velocity W=W : P. Fig. 17.

118. Case 5. In the combination of pulleys, represented in fig. 18. when the weight W rises one inch, all the three ropes CD, BE, AF are each shortened one inch. But while CD shortens one inch, CP becomes *one inch longer;* while BE shortens one inch, BC becomes one inch longer, and CP *two inches* longer (art. 110.); and while AF shortens one inch, AB becomes one inch longer, BC two inches longer, and CP *four inches* longer; therefore CP is lengthened altogether seven inches, and as the power of the pulley is as 7 to 1, we have, as before, velocity P velocity W=W : P. Fig. 18.

119. Case 5. In the system of pulleys, called the Spanish barton, fig. 19. when the weight W rises one inch, the three ropes AC, DE, HG are each shortened one inch. By the shortening of HG, CA one inch each, the rope AP is lengthened *two inches;* and by the shortening of DE one inch, BA is lengthened one inch, and AP *two inches* (art. 115.); consequently, since AP is lengthened in all four inches, and since the power of the pulleys is four, we have velocity P : velocity W=W : P. Fig. 19.

120. Case 6. In the other Spanish barton, in fig. 20. when the weight is elevated one inch, the three ropes DE, IF, CG are each one inch shorter. While ED, and CG shorten one inch each, BP is lengthened *two* Fig. 20.

inches,

Theory. *inches*, and while IF becomes one inch ſhorter, AB becomes one inch longer; but when AB is lengthened one inch, BP becomes one inch longer, and ED, CG one inch ſhorter each, and by this ſhortening of ED, CG, the rope B is lengthened two inches, therefore, ſince the rope BP is lengthened altogether five inches, and ſince the pulleys have a power of five, we have, as formerly, velocity P : velocity W=W : P.

Sect. III. *On the Wedge.*

121. Definition. A wedge is a machine compoſed of two inclined planes with their baſes in contact; or, more properly, it is a triangular priſm, generated by the motion of a triangle, parallel to itſelf, along a ſtraight line paſſing through the vertex of one of its angles. The wedge is called *iſoſceles*, *rectangular*, or *ſcalene*, according as the triangle ABC by which the wedge is generated, is an iſoſceles, a rectangular or a ſcalene triangle. The part AB is called the head or back of the wedge, DC its altitude, and AC, BC its faces.—The wedge is generally employed for cleaving wood, or for quarrying ſtones; but all cutting inſtruments, ſuch as knives, ſwords, chiſels, teeth, &c. properly belong to this mechanical power, when they act in a direction at right angles to the cutting ſurface; for when they act obliquely, in which caſe their power is increaſed, their operation reſembles more the action of a ſaw.

Plate CCXIX. Fig. 3.

Prop. I.

122. If each of the faces of an iſoſceles wedge, which are perfectly ſmooth, meet with an equal reſiſtance from forces acting at equal angles of inclination to their faces, and if a power act perpendicularly upon the back, theſe forces will be in equilibrio, when the power upon the back is to the ſum of the reſiſtances upon the ſides, as the ſine of half the angle of the wedge, multiplied by the ſine of the angle at which the reſiſting forces act upon its faces, is to the ſquare of radius.

Fig. 3.

Let ABC be the wedge, AC, BC its acting faces, and MD, ND the directions in which the reſiſting forces act upon theſe faces, forming with them the equal angles DMA, DNB. Draw CD, DF, DE at right angles to three ſides of the wedge, and join F, E meeting CD in G. On account of the equal triangles CAD, CDB (Euclid, Book i. Prop. 26.) AD = DB; and in the equal triangles ADM, BDN, MD = ND. In the ſame way DF=DE and AF=BE, therefore CF=CE. But in the triangles CFG, CEG there are two ſides FC, CG equal to EC, CG, and the angle FCG=ECG, conſequently FG=GE, and FGC, ABC are both right angles, therefore FE is parallel to AB.—Now the force MD is reſolvable into DF, FM, of which FM has no effect upon the wedge. But, as the effective force FD is not in direct oppoſition to the perpendicular force exerted on the back of the wedge, we may reſolve it into the two forces FG, GD, of which GD acts in direct oppoſition to the power, while FG acts in a direction parallel to the back of the wedge. In the ſame way it may be ſhewn that EG, GD are the only effective forces which reſult from the force ND. But the forces FG, EG being equal and oppoſite, deſtroy each other; conſequently 2 GD is the force which oppoſes that which is exerted upon the back of the wedge, and the wedge will be kept at reſt if the force upon the back is equal to 2 GD, that is, when the force upon the back is to the ſum of the reſiſtances upon the faces as 2 GD is to MD+ND, or as 2 GD : 2 DM, or as GD is to DM. Now

DG : DF = ſin. DFG : radius, or as (Euclid, vi. 8.) ſin. DCF : radius, and

DF : MD=ſin. DMF : radius; therefore by compoſition,

DG : MD = ſin. DCF × ſin. DMF : rad. × rad. or $\overline{\text{rad.}}|^2$. But, DG : MD as the force upon the back is to the ſum of the reſiſtances, therefore the force upon the back is to the ſum of the reſiſtances as ſin. DCF × ſin. DMF is to the ſquare of the radius.

Corollaries.

123. Cor. 1. If the direction of the reſiſting forces is perpendicular to the faces of the wedge, DMF becomes a right angle, and therefore its ſine is equal to radius. Conſequently we have, in this caſe, the force upon the back to the ſum of the reſiſtances, as ſin. DCF × rad. is to $\overline{\text{radius}}|^2$, that is, as ſin. DCF is to radius, or as AD half the back of the wedge is to AC the length of the wedge.

124. Cor. 2. In the particular caſe in the propoſition, it is obvious that the forces MF, NE are not oppoſed by any other forces, and therefore the force upon the back will not ſuſtain the reſiſting forces; but in the caſe in cor. 2. the forces MF, NE vaniſh, and therefore the other forces will ſuſtain each other.

125. Cor. 3. If the reſiſting forces act in a direction perpendicular to AB, the angle DMF becomes equal to ACD, and therefore the force upon the back is to the ſum of the reſiſtances as $\overline{\text{ſin. ACD}}|^2$ is to $\overline{\text{radius}}|^2$, that is, as the ſquare of AD half the back of the wedge is to the ſquare of AC the length of the wedge.

126. Cor. 4. When the direction of the reſiſtances is parallel to the back of the wedge, the angle of inclination DMC becomes the complement of the ſemiangle of the wedge, and therefore the force upon the back is to the ſum of the reſiſtances as the ſin. ACD × coſ. ACD is to the ſquare of the radius, that is, as DA × DC is to $\overline{AC}^2$. But in the ſimilar triangles DAF, DAC, we have DF : DA=DC : AC, and DF × AC=DA × DC, conſequently the force upon the back of the wedge is to the ſum of the reſiſtances as DF × AC is to $\overline{AC}^2$, that is, as DF : AC.

Prop. II.

127. If, on account of the friction of the wedge, or any other cauſe, the reſiſtances are wholly effective, that is, if the reſiſting ſurfaces adhere to the places to which they are applied without ſliding, there will be an equilibrium, when the force upon the back is to the ſum of the reſiſtances, as the ſine of the acute angle which the direction of the reſiſting forces makes with the back of the wedge is to radius. Fig.

Join MN, which will cut DC perpendicularly at the point

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point H. Then, since the forces MD, ND are resolvable into MH, HD and into NH, HD, and since MH, HN destroy each other, the force upon the back is sustained by 2 HD. Consequently, the force upon the back is to the sum of the resistances as 2 HD is to 2 MD, or as HD is to MD. But the angle ADM, which the direction of the forces makes with the back of the wedge, is equal to DMN, and HD is the sine of that angle, MD being radius, therefore the force upon the back is to the sum of the resistances as sin. ADM : radius. Q. E. D.

Corollaries. 128. Cor. 1. Since the angle AMD=MDC+MCD, the angle MDC is the difference between MCD the semiangle of the wedge, and AMD the angle which the direction of the resisting forces makes with the face of the wedge, and since HD is the cosine of that angle, MD being radius, we have the force upon the back to the sum of the resistances, as the cosine of the difference between the semiangle of the wedge and the angle which the direction of the resisting forces makes with the face of the wedge, is to radius.

Prop. III.

129. When there is an equilibrium between three forces acting perpendicularly upon the sides of a wedge of any form, the forces are to one another as the sides of the wedge.

This is obvious from Dynamics, §. 144. Cor. 2. where it is shewn that when three forces are in equilibrio, they are proportional to the sides of a triangle, which are respectively perpendicular to their directions.

Prop. IV.

130. When the power acting upon the back of a wedge is in equilibrio with the resistances opposed to it, the velocity of the power is to the velocity of the resistance as the resistance is to the power.

Fig. 3. Produce DM to K, and draw CK perpendicular to DK. Then, by Art. 122. the power is to the resistance as MD : DH. Let the wedge be moved uniformly from D to C, and DK is the space uniformly described by the resisting force in the direction in which it acts; therefore, the velocity of the power is to the velocity of the resistance as DC : DK; that is, on account of the equiangular triangles DHM, DKC, as MD : DH; that is, as the resistance is to the power.

Sect. IV. *On the Screw.*

131. Definition. A screw is a cylinder with an inclined plane wrapped round it, in such a manner, that the surface of the plane is oblique to the axis of the cylinder, and forms the same angle with it in every part of the cylindrical surface. When the inclined plane winds round the exterior surface of a solid cylinder, it is called a male screw; but when it is fixed on the interior circumference of a cylindrical tube, it is called a female screw. In the female screw, the spiral grooves formed by the inclined plane on the surface of the cylindrical tube, must be equal in breadth to the inclined plane in the male screw, in order that the one may move freely in the other. By attending to the mode in which the spiral threads are formed by the circumvolution of the inclined plane, it will appear, that if one complete revolution of the inclined plane is developed, its altitude will be to its base as the distance between the threads is to the circumference of the screw. Thus, let *a b c* (fig. 4.) be the inclined plane, whose base is *a c* and altitude *b c*, and let it be wrapped round the cylinder MN (fig. 5.) of such a size that the points *a*, *c* may coincide. The surface *a b* of the plane (fig. 4.) will evidently form the spiral thread *a d c b* (fig. 5.), and *a b* the distance between the threads will be equal to *b c* (fig. 4.) the altitude of the plane, and the circumference of the screw MN will be equal to *a c* the base of the plane. If any body, therefore, is made to rise along the plane *a d c b* in fig. 5. or along the spiral thread of the screw, by a force acting in a direction parallel to *a d c b*, there will be the same proportion between the power and the resistance as if the body ascended the plane *a b c* (fig. 4.). Fig. 4

132. A male screw with triangular threads is represented by AB (fig. 6.), and its corresponding female screw by AB (fig. 7.). A male screw with quadrangular threads is exhibited in fig. 8. and the female screw in which it works in fig. 9. The friction is considerably less in quadrangular than in triangular threads, though, when the screw is made of wood, the triangular threads should be preferred. When the screws are metallic and large, the threads should be quadrangular; but the triangular form is preferable in small screws. When the screw is employed in practice, the power is always applied to the extremity of a lever fixed in its head. This is shewn in fig. 10. where AB is the lever acting upon the screw BC, which works in a female screw in the block F, and exerts its force in bending the spring CD. Fig. 6, 7. Fig. 8, 9. Fig. 10.

Prop. I.

133. If the screw is employed to overcome any resistance, there will be an equilibrium when the power is to the resistance as the distance between two adjacent threads is to the circumference described by the power.

Let FAK be a section of the screw represented in fig. 8. perpendicular to its axis; CD a portion of the inclined plane which forms the spiral thread, and P the power, which, when applied at C in the plane ACF, will be in equilibrium with a weight upon the inclined plane CD. Then, in the inclined plane, when the direction of the power is parallel to the base, we have (Art. 72.) P : W, as the altitude of the plane is to the base, or (Art. 131.) as the distance between two threads is to the whole circumference FKCF. If we suppose another power P′ to act at the end of the lever AB, and describe the arch HBG, and that this power produces the same effect at B as the power P did at C, then (Art. 36.), we have P′ : P=CA : BA, that is, as FKCF is to the circumference HBG; but it was shewn before, that P : W= as the distance between two contiguous threads is to FKCF; therefore, by composition, P′ : W as the distance between two threads is to HBG or the circumference of a circle whose radius is AB. Q. E. D. Fig. 11.

134. Cor. 1. It is evident from the proposition that the

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the power does not in the leaft depend upon the fize of the cylinder FCK, but that it increafes with the diftance of that point from the centre A, to which the power is applied, and alfo with the fhortnefs of the diftance between the threads. Therefore, if P, p be the powers applied to two different fcrews, D, d the diftances of thefe powers from the axis, and T, t the diftances between the threads; their energy in overcoming a given refiftance will be directly as their diftances from the axis, and inverfely as the diftances of their threads, that is, $P:p=\frac{D}{T}:\frac{d}{t}$, or P varies as $\frac{D}{T}$.

Prop. II.

135. In the endlefs fcrew, there will be an equilibrium when the power is to the weight, as the diftance of the threads multiplied by the radius of the axle, is to the diftance of the power from the axis of the fcrew multiplied by the radius of the wheel.

Fig. 12. The endlefs fcrew, which is reprefented in fig. 12. confifts of a fcrew EF, fo combined with the wheel and axle ABC, that the threads of the fcrew may work in teeth fixed in the periphery of the wheel, and thus communicate the power exerted at the handles or winches P, p. Let W' reprefent the power produced by the fcrew at the circumference of the wheel; then, by the laft propofition, $P:W'$ as the diftance between the threads is to the diftance of P from the axis of the fcrew; but (Art. 92.) in the wheel and axle $W':W$ as the radius of the axle is to the radius of the wheel; therefore, by compofition, $P:W$ as the diftances of the threads multiplied by the radius of the axle C, is to the diftance of the power P from the axis multiplied by the radius of the wheel AB.

Prop. III.

136. When there is an equilibrium in the fcrew, the velocity of the weight is to the velocity of the power, as the power is to the weight.

Fig. 11. It is obvious from fig. 11. that while the power defcribes the circumference of the circle HBG uniformly, the weight uniformly rifes through a fpace equal to the diftance between two adjacent threads; therefore, the velocity of the power is to the velocity of the weight as the diftance between the threads is to the arch defcribed by the power, that is, (by Art. 133.), as the weight is to the power.

Prop. IV.

137. To explain the conftruction and advantages of Mr Hunter's double fcrew *.

* See *Phil. Tranf.* vol. lxxi. p. 58.

Fig. 13. Let the fcrew CD work in the plate of metal BA, and have n threads in an inch: the cylinder CD, of which this fcrew is formed, is a hollow tube, which is alfo formed into a fcrew, having $\overline{n+1}$ threads in an inch, and into this female fcrew is introduced a male fcrew DE, having, of courfe, $\overline{n+1}$ threads in an inch. The fcrew DE is prevented from moving round with CD by the frame ABGF and the crofs bar $a\,b$, but is permitted to afcend and defcend without a motion of rotation. Then, by a revolution of the fcrew CD, the other fcrew DE will rife through a fpace equal to $\frac{1}{\overline{n+1}\times n}$, and if the circumference defcribed by the lever CK be m inches, we fhall have $P:W=\frac{1}{\overline{n+1}\times n}:m$; or $P:W=1:m\,n\times\overline{n+1}$.

138. This reafoning will be more perfpicuous by fuppofing n, or the number of threads in CD, to be 12, and, $\overline{n+1}$ or the number of threads in DE will confequently be 13. Let us fuppofe that the handle CK is turned round 12 times, the fcrew CD will evidently afcend through the fpace of an inch, and if the fcrew DE is permitted to have a motion of rotation along with CD, it will alfo advance an inch. Let the fcrew DE be now moved backwards by 12 revolutions, it will evidently defcribe a fpace of $\frac{12}{13}$ of an inch, and the confequence of both thefe motions will be that the point E is advanced $\frac{1}{13}$ of an inch. But, fince DE is prevented from moving round with CD, the fame effect will be produced as if it had moved 12 times round with CD, and had been turned 12 times backwards; that is, it will in both cafes have advanced $\frac{1}{13}$ of an inch. Since, therefore, it has advanced $\frac{1}{13}$ of an inch in 12 turns, it will defcribe only $\frac{1}{12}$ of $\frac{1}{13}$, or $\frac{1}{156}$ of an inch uniformly at one turn; but if the length of the lever CK is 8 inches, its extremity K will defcribe, in the fame time, a fpace equal to $16\times3.1416=50.2656$ inches, the circumference of the circle defcribed by K; therefore the velocity of the weight is to the velocity of the power, as $\frac{1}{156}$ of an inch is to 50.2656 inches, or as 1 is to 7841.4336, that is, (Art. 136.) $P:W=1:7841.4336$. Hence the force of this double fcrew is much greater than that of the common fcrew, for a common one with a lever 8 inches long muft have 156 threads in an inch to give the fame power, which would render it too weak to overcome any confiderable refiftance.

139. Mr Hunter propofes * to connect with his double fcrews, a wheel and a lantern, which are put in motion by a winch or handle. The power of this compound machine is fo great, that a man, by exerting a force of 32 pounds at the winch, will produce an effect of 172100 pounds; and if we fuppofe $\frac{2}{3}$ of this effect to be deftroyed by friction, there will remain an effect of 57600 pounds.—In fome fcrews it would be advantageous, inftead of perforating the male fcrew CD, to have two cylindrical fcrews of different kinds at different parts of the fame axis.

* *Phil. Tranf.* vol. lxxi. p. 65.

Scholium.

140. The fcrew is of extenfive ufe as a mechanical power, when a very great preffure is required, and is very fuccefsfully employed in the printing prefs. In the prefs which is ufed for coining money, the power of the fcrew is advantageoufly combined with an impulfive force, which is conveyed to the fcrew by the intervention of a lever. The fcrew is alfo employed for raifing water, in which form it is called the fcrew of Archimedes (Hydrodynamics, §. 328); and it has been lately employed in the flour mills in America for pufhing the flour which comes from the millftones, to the end of a long trough, from which it is conveyed to other parts of

Theory. of the machinery, in order to undergo the remaining processes. In this case, the spiral threads are very large in proportion to the cylinder on which they are fixed.

141. As the lever attached to the extremity of the screw moves through a very great space when compared with the velocity of its other extremity, or of any body which it puts in motion; the screw is of immense use in subdividing any space into a great number of minute parts. Hence it is employed in the engines for dividing mathematical instruments, and in those which have been recently used in the art of engraving. It is likewise of great use in the common wire micrometer, and in the divided object-glass micrometer, instruments to which the science of astronomy has been under great obligations. See MICROMETER.

SECT. V. *On the Balance.*

Plate CCCXX. Fig. 1. 142. DEFINITION. The balance, in a mathematical sense, is a lever of equal arms, for determining the weights of bodies.—The physical balance is represented in fig. 1. where FA, FB are the equal arms of the balance, F its centre of motion situated a little above the centre of gravity of the arms, FD the handle which always retains a vertical position, P, W the scales suspended from the points A, B, and CF the tongue or index of the balance, which is exactly perpendicular to the beam AB, and is continued below the centre of motion, so that the momentum of the part below F is equal and opposite to the momentum of that part which is above it. Since the handle FD, suspended by the hook H, must hang in a vertical line, the tongue CF will also be vertical when its position coincides with that of FD, and consequently the beam AB, which is perpendicular to CF, must be horizontal. When this happens, the weights in the scale are evidently equal. Theory.

PROP. I.

143. To determine the conditions of equilibrium in a physical balance. Fig. 2.

Let AOB be the beam, whose weight is S, and let P, Q be equal weights expressed by the letter p, and placed in the scales, whose weights are L and l. Let O be the centre of motion, and g the centre of gravity of the whole beam, when unloaded, we shall have in the case of an equilibrium.

I. $\overline{p+L}\times AC=\overline{p+l}\times BC+\overline{S\times Cc}$; for since S is the weight of the beam and g its centre of gravity, its mechanical energy in acting against the weights $p+L$ is $=S\times Cc$, the distance of its centre of gravity from the vertical line passing through the centre of motion O.

II. But since $AC=BC$; $\overline{p\times AC}-p\times BC=0$. Then, after transposition, take this from the equation in N° I. and we shall have,

III. $l\times BC-L\times AC+S\times Cc$; or $L-l=\frac{S\times Cc}{AC}$.

Let us now suppose that a small weight w is placed in the scale L, the line AB which joins the points of suspension will be no longer horizontal, but will assume an inclined position. Let $BA\lambda=\varphi$ be the angle which the beam makes with the direction of gravity. Then by resolving the weight of the beam which acts in the direction Oz, the parts $\frac{OG}{Og}$ and $\frac{Gg}{Og}$ will be in equilibrio, and we shall have,

$$\text{IV.}\quad \overline{p+L}\times AO\times \text{Sin.}\,\lambda AO+S\times OG\times \text{Sin.}\,\varphi=\overline{p+l+w}\times BO\times \text{Sin.}\,ABO+S\times Cc\times \text{Cos.}\,\varphi.$$

But since the sines and cosines of any angles, are the same as the sines and cosines of their supplement, we have,

$$\text{V.}\quad \overline{p+L}\times\overline{AC\times \text{Cos.}\,\varphi-Oc\times\text{Sin.}\,\varphi}+S\times OG\times \text{Sin.}\,\varphi=\overline{p+l+w}\times\overline{AC\times \text{Cos.}\,\varphi+OC\times\text{Sin.}\,\varphi}+S\times Cc\times\text{Cos.}\,\varphi.$$

Hence by N° III. we have,

$$\text{VI.}\quad \text{Tang.}\,\varphi=\frac{w\times AC}{\overline{2p+L+l+w}\times OC+S\times OG}$$

But the force v, with which the balance attempts to recover its horizontal situation, is the excess of the momenta with which one arm is moved, above the momenta with which the other arm is moved, therefore

$$v=\overline{2p+L+l}\times OC\times \text{Sin.}\,\varphi+S\times OG\times \text{Sin}\,\varphi.$$

144. A more extended illustration of these conditions of equilibrium will be found in an excellent paper by Euler, published in the *Comment. Petropol.* tom. x. p. i. and in another memoir upon the same subject by Kuhne in the *Versuche der naturforchende gesellschaft* in Dantzig, tom. i. p. 1.—See also Hennert's *Cursus Matheseos applicatæ*, tom. i. §. 123. From the preceding formulæ, the following practical corollaries may be deduced.

145. COR 1. The arms of the balance must be exactly equal in length, which is known by changing the weights in the scales; for if the equilibrium continues, the arms must be equal.

146. COR. 2. The sensibility of the balance increases with the length of the arms.

147. COR. 3. If the centre of motion coincides with the point C and the centre of gravity, the balance will be in equilibrio in any position, and the smallest weight added to one of the scales will bring the beam into a horizontal position. The centre of motion, therefore, should not coincide with the centre of gravity.

148. COR. 4. If the centre of motion is in the line which joins the points of suspension, the accuracy of the balance will be increased. The excess of the weights may be easily determined by the inclination of the beam, pointed out by the tongue or index upon a circular arch fixed to the handle, or more accurately by means of two divided arches fixed near the points of suspension, on a stand independent of the balance. When the value of one of these divisions is determined experimentally, the rest are easily found, being proportional to the tangents of the inclination of the beam.

149.

Theory.

149. Cor. 5. The ſenſibility of the balance will increaſe, the nearer that the centre of gravity approaches to the centre of motion.

150. Cor. 6. If the centre of gravity is above the centre of motion, the balance is uſeleſs.

Scholium.

Kuhne's balance.

151. A balance with all the properties mentioned in the preceding corollaries, has been invented by M. Kuhne, and deſcribed in the work already quoted (Art. 144.). It is ſo contrived that the points of ſuſpenſion may be placed either above the centre of motion or below it, or in the line of its axis: the beam is furniſhed with an index, which points out the proportion of the weights upon a divided ſcale, and the friction of the axis is diminiſhed by the application of friction wheels.

Magellan's balance.

152. In order to get rid of the difficulties which attend the conſtruction of the tongue, the handle, and the arms of the balance, M. Magellan invented a very accurate and moveable one, in which there is no handle, and where one of the arms acts as a tongue. The body to be weighed and the counterpoiſe are placed in the ſame ſcale, ſo that it is of little conſequence whether the arms of the balance are equal or not. In this balance the centre of motion can be moved to the ſmalleſt diſtance from the centre of gravity. See *Journal de Phyſique*, Jan. 1781. tom. xvii. p. 43.

Ludlam's balance. Plate CCCXVIII. Fig. 3.

153. The balance invented by Ludlam, and deſcribed in the Philoſophical Tranſactions for 1765, N° 55. depends upon Æpinus's property of the lever, which we have explained in Art. 65. The angular lever AFB, in which AF=FB, is moveable round *f*, which is equidiſtant from A and B. The weight P is ſuſpended by a thread from A, and the body W, which is to be weighed, is ſuſpended by a thread from B. Hence it is obvious, that with different bodies the lever AFB will have different degrees of inclination, and the index or tongue LF*f*, which is perpendicular to AB, will form different angles ZFL, *b*F*f* with the line of direction ZF*b*. Now, by Art. 57. and by ſubſtituting for *b*B, *b*A the ſines of the angles F*b*B, F*b*A, to which they are proportional, and alſo by taking inſtead of F*b*B the difference of the angles *f*FB, *f*F*b*, and inſtead of AF*b*, the ſum of theſe angles, we ſhall have

$$\text{Tang.}\, fFb = \frac{P-W}{P+W} \times \text{Tang.}\, \frac{AFB}{2},$$

whence, by tranſpoſition, and by Geometry, Theor. VIII. Sect. IV.

$$\overline{P+W} : \overline{P-W} = \text{Tang.}\, \frac{AFB}{2} : \text{Tang.}\, fFb.$$

Hence, when the angle formed by the arms of the balance, and the angle of aberration *f*F*b* or ZFL, are known, the weights may be found, and *vice verſa*.

Chap. IV. *On the Centre of Inertia, or Gravity.*

154. Definition.—The centre of inertia, or the centre of gravity, of any body or ſyſtem of bodies, is that point upon which the body or ſyſtem of bodies, when influenced only by the force of gravity, will be in equilibrio in every poſition. The centre of inertia of plane ſurfaces bounded by right lines, and alſo of ſome ſolids may be eaſily determined by the common geometry. The application of the method of fluxions, however, to this branch of mechanics is ſo ſimple and beautiful, that we ſhall alſo avail ourſelves of its aſſiſtance. The centre of gravity has been called, by ſome writers, the centre of poſition, and by others, the centre of mean diſtances.

Prop. I.

155. To find the centre of inertia of any number of bodies, whatever be their poſition.

Fig. 4.

Let ABCD be any number of bodies influenced by the force of gravity. Suppoſe the bodies A, B connected by the inflexible line AB conſidered as devoid of weight, then find a point F, ſo that the weight of A : the weight of B=BF : FA. The bodies A, B will therefore be in equilibrio about the point F in every poſition (Art. 36.), and the preſſure upon F will be equal to A+B. Join FC, and find the point *f*, ſo that A+B : C=C*f* : *f*F; the bodies A, B, C will conſequently be in equilibrio, upon the point *f*, which will ſuſtain a preſſure equal to A+B+C. Join D*f*, and take the point φ, ſo that A+B+C : D=φD : φf; the bodies A, B, C, D will therefore be in equilibrio about the point φ, which will be their common centre of inertia, and which ſupports a weight equal to A+B+C+D. In the ſame manner we may find the centre of inertia of any ſyſtem of bodies, by merely connecting the laſt fulcrum with the next body by an inflexible right line, and finding a new fulcrum from the magnitude of the oppoſite weights which it is to ſuſtain.

156. Cor. 1. If the weights of the bodies A, B, C, D be increaſed or diminiſhed in a given ratio, the centre of inertia of the ſyſtem will not be changed, for the poſitions of the points F, *f*, φ are determined by the relative and not by the abſolute weights of the bodies.

157. Cor. 2. A motion of rotation cannot be communicated to a body by means of a force acting upon its centre of inertia; for the reſiſtances which the inertia of each particle oppoſes to the communication of motion act in parallel directions, and as they are proportional to the weights of the particles, they will be in equilibrio about the centre of gravity.

Prop. II.

158. To find the centre of inertia of any number of bodies placed in a ſtraight line.

Fig. 5.

Let A, B, C, D, E be any number of bodies whoſe common centre of gravity is φ. In the ſtraight line AE take any point X. Then ſince all the bodies are in equilibrio about their common centre of gravity φ, we have by by the property of the lever (Art. 36.) $A\times A\varphi + B\times B\varphi = C\times C\varphi + D + D\varphi + E\times E\varphi$; but ſince $X\varphi - XA = A\varphi$, and $X\varphi - XB = B\varphi$, and ſo on with the reſt, we have by ſubſtitution $A\times\overline{X\varphi - XA} + B\times\overline{X\varphi - XB} = C\times\overline{X\varphi - XC} + D\times\overline{X\varphi - XD} + E\times\overline{X\varphi - XE}$. Hence by multiplying and tranſpoſing, we obtain $A\times X\varphi + B\times X\varphi + C\times X\varphi + D\times X\varphi + E\times X\varphi = A\times XA + B\times XB + C\times XC + D\times XD + E\times XE$, then dividing by A+B+C+D+E, we have

Xφ.

Theory.

$$X\varphi=\frac{\overline{A\times XA}+\overline{B\times XB}+\overline{C\times XC}+D\times\overline{XD}+\overline{E\times XE}}{A+B+C+D+E}.$$

Now $A\times XA$; $B\times XB$, &c. are evidently the momenta of the bodies A, B, &c. and the divisor $A+B+C+D+E$ is the sum of the weights of all the bodies; therefore the distance of the point X from the centre of gravity φ is equal to the sum of the momenta of all the weights divided by the sum of the weights.

159. Cor. 1. If the point X had been taken between A and E, at x for example, then the quantity $A\times XA$ would have been reckoned negative, as lying on a different side of the point X.

160. Cor. 2. From this proposition we may deduce a general rule for finding the centre of gravity in any body or system of bodies. Let any point be assumed at the extremity of the system, then the product of the momenta of all the bodies, (or the product arising from the continual multiplication of each body by its distance from the point), divided by the sum of the weights of all the bodies, will be a quotient which expresses the distance of the centre of gravity from the point assumed.

Prop. III.

161. If, in a system of bodies, a perpendicular be let fall from each upon a given plane, the sum of the products of each body multiplied by its perpendicular distance from the plane, is equal to the sum of all the bodies multiplied by the perpendicular distance of their common centre of inertia from the given plane.

Fig. 6. Let A, B, C be the bodies which compose the system, and MN the given plane; by Art. 155. find F the centre of inertia of A and B, and G the centre of gravity of the three bodies; and from A, F, B, G, C draw Aa, Ff, Bb, Gg, Cc perpendicular to the plane MN. Through F draw xFy, meeting Aa produced in x, and Bb in y, then in the similar triangles AxF, ByF, we have $Ax:By=AF:BF$, that is, (Art. 155.) as $B:A$, hence $\overline{A\times Ax}=\overline{B\times By}$, that is, $A\times\overline{xa-Aa}=B\times\overline{Bb-yb}$, or on account of the equality of the lines xa, Ff, Bb; $A\times\overline{Ff-Aa}=B\times\overline{Bb-Ff}$, therefore, by multiplying and transposing, we have $\overline{A+B}\times Ff=\overline{A\times Aa}+\overline{B\times Bb}$. In the very same way, by drawing wGz parallel to the plane, it may be shewn that $\overline{A+B+C}\times Gg=A\times Aa+B\times Bb+C\times Cc$. Q. E. D.

116. Cor. By dividing by $A+B+C$ we have

$$G=\frac{\overline{A\times Aa}+\overline{B\times Bb}+\overline{C\times Cc}}{A+B+C}.$$

Prop. IV.

163. To find the centre of inertia of a straight line, composed of material particles.

If we consider the straight line as composed of a number of material particles of the same size and density, it is evident that its centre of inertia will be a point in the line equidistant from its extremities. For if we regard the line as a lever supported upon its middle point as a fulcrum, it will evidently be in equilibrio in every position, as the number of particles or weights on each side of the fulcrum is equal.

Prop. V.

164. To find the centre of inertia of a parallelogram.

Let ABCD be a parallelogram of uniform density, bisect AB in F, and having drawn Ff parallel to AC or BD, bisect it in φ; the point φ will be the centre of inertia of the parallelogram. The parallelogram may be regarded as composed of lines AB, ab parallel to one another, and consisting of material particles of the same size and density. Now, by Art. 155. the centre of inertia of AB is F, and the centre of inertia of ab is c; and in the same way it may be shewn that the centre of inertia, of every line of which the surface is composed, lies in the line Ff. But Ff may be considered as composed of a number of material particles of uniform density, each being equal in weight to the particles in the line AB, therefore, by Art. 165. its centre of inertia will be in φ, its middle point. Fig. 7.

Prop. VI.

165. To find the centre of inertia of a triangle.

Let ABC be a triangle of uniform density, and let AB, BC be bisected in the points E, D. Join CE, AD, and the point of intersection F shall be the centre of inertia of the triangle ABC. The triangle may be considered as composed of a number of parallel lines of material particles BC, bc, $\beta\varkappa$; but in the similar triangles ADC, Aec; $AD:DC=Ae:ec$, and in the triangles ADC, ADB, Aeb; $BD:DA=be:eA$; hence by composition $BD:DC=be:ec$; but BD and DC are equal; therefore, $be=ec$, and the line bc, supposed to consist of material particles, will be in equilibrio about e. In the same way it may be shewn that every other line $\beta\varkappa$ will be in equilibrio about a point situated in the line AD; consequently the centre of gravity is in that line. For the same reason it follows, that the centre of gravity is in the line CE, that is, it will be in F, the point of intersection of these two lines. In order to determine the relation between FA and FD, join ED; then, since BE=EA, and BD=DC, $BE:EA=BD:DC$, and, consequently, (Geometry, Sect. IV. Theor. 18.) ED is parallel to AC, and the triangles BED, BAC similar. We have, therefore, $CA:CB=DE:DB$, and by alternation $CA:DE=CB:DB$, that is, $CA:DE=2:1$. In the similar triangles CFA, DFE, $AF:AC=DF:DE$, and by alternation $AF:DF=AC:DE$, that is, $AF:DF=2:1$, or $AF=\frac{2}{3}AD$. Fig. 8.

166. Cor. 1. By Geometry, Theor. 16. Sect. IV. we have

$$AB^2+AC^2=2BD^2+2\,AB^2(=\tfrac{1}{2}BC^2+\tfrac{9}{2}\overline{AF}^2$$
$$AB^2+BC^2=2\,CC^2+2\,BG^2=\tfrac{1}{2}AC^2+\tfrac{9}{2}\overline{CF}^2$$
$$AC^2+BC^2=2\,AE^2+2\,EC^2=\tfrac{1}{2}AB^2+\tfrac{9}{2}\overline{BF}^2.$$

By

By adding these three equations, and removing the fractions, we have $AB^2+BC^2+AC^2=3\,AF^2+3\,CF^2+3\,BF^2$, or in any plane triangle, the sum of the squares of the three sides is equal to thrice the sum of the squares of the distances of the centre of gravity from each of the angular points.

167. Cor. 2. By resolving the three quadratic equations in the preceding corollary, we obtain $AF=\frac{1}{3}\sqrt{2\,AB^2+2\,AC^2-BC^2}$; $CF=\frac{1}{3}\sqrt{2\,BA^2+2\,BC^2-AC^2}$; and $BF=\frac{1}{3}\sqrt{2\,BC^2+2\,AC^2-AB^2}$, formulæ which express the distances of the centre of gravity from each of the angular points.

Prop. VII.

168. To find the centre of inertia of a trapezium or any rectilineal figure.

Fig. 9. Let ABCDE be the trapezium, and let it be divided into the triangles ABC, ACE, ECD by the lines AC, EC. By the last proposition find m, n, o, the centres of gravity of the triangles, and take the point F in the line $m\,n$, so that $F\,n : F\,m =$ triangle ABC : triangle ACE, then F will be the centre of gravity of these triangles. Join $F\,o$, and find a point f, so that $f\,o : F\,f =$ triangle ABC + triangle ACE : triangle CED, then all the triangles will be in equilibrio about f, that is, f is the centre of gravity of the rectilineal figure ABCDE. The same method may be employed in finding the centre of gravity of a trapezium, whatever be the number of its sides.

Prop. VIII.

169. To find the centre of inertia of a pyramid with a polygonal base.

Fig. 10. Let the pyramid be triangular, as ABCD, fig. 10. Bisect BD in F, and join CF and FA. Make $F\,f=\frac{1}{3}$ of FC, and $F\,\varphi=\frac{1}{3}$ of FA, and draw $f\,\varphi$. It is evident, from Art. 159. that f is the centre of gravity of the triangular base BCD, and that the line AF, which joins the vertex and the point f, will pass through the centre of gravity of all the triangular laminæ or sections of the pyramid parallel to its base ABC; for, by taking any section $b\,c\,d$, and joining $c\,m$, it may be easily shewn, that $b\,m=m\,d$, and $m\,n=\frac{1}{3}m\,c$, so that n is the centre of gravity of the section $b\,c\,d$. It follows, therefore, that $A\,f$ will pass through the centre of gravity of the pyramid. In the same way it may be shewn, by considering ABD as the base, and D the vertex, and making $F\,\varphi=\frac{1}{3}FA$, that the centre of gravity lies in the line $\varphi\,C$. But, as the lines $A\,f$, $\varphi\,C$ lie in the plane of the triangle AFC, they must intersect each other; and therefore the point of intersection H will be the centre of inertia of the triangular pyramid. Now, since $F\,f=\frac{1}{3}FC$, and $F\,\varphi=\frac{1}{3}FA$, we have $F\,\varphi : FA=F\,f : FC$, therefore (Geometry, Theor. 8. Sect. IV.) $\varphi\,f$ is parallel to AC. The triangle $\varphi\,f\,H$ will consequently be similar to AHC, and $H\,\varphi : HC=H\,f : HA=f\,\varphi : AC=1 : 3$; therefore $H\,\varphi=\frac{1}{3}HC=\frac{1}{4}\varphi\,C$, and $f\,H=\frac{1}{3}AH=\frac{1}{4}A\,f$.

170. When the pyramid has a polygonal base, it may be conceived to be formed of a number of triangular pyramids, whose centres of inertia will be in one plane parallel to the base. Their common centre of gravity will therefore be in the same plane, and in the line drawn from the vertex to the centre of gravity of all the triangles which compose the base; the distance of the centre of gravity, therefore, from the vertex, will be equal to three-fourths of the altitude of the pyramid.

171. Cor. 1. Hence it is obvious, that the centre of gravity of a right cone is a point in its axis, whose distance from the vertex is equal to three-fourths of the length of the axis; for as this may be demonstrated of a pyramid whose base is a polygon, with an infinite number of sides, it must hold also of a right cone which may be considered as a pyramid of this description.

172. Cor. 2. By proceeding as in Art. 160. it will be found, that in a triangular pyramid, the distance of any of the vertices from its centre of inertia, is equal to one-fourth of the square root of the difference of thrice the sum of the squares of the three edges which meet at that vertex, and the sum of the squares of the other three edges;—and likewise, that the sum of the squares of the distances of the centre of inertia from the vertices of any triangular pyramid, is equal to one-fourth of the sum of the squares of the six edges of the pyramids. A demonstration of these theorems may be seen in Gregory's Mechanics, vol. i. p. 59, 60.

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173. In order to shew the application of the doctrine of fluxions to the determination of the centre of inertia of curve lines, areas, solids, and the surfaces of solids, let ABC be any curve line whose axis is BR. Fig. 11
Then, since the axis bisects all the ordinates DG, AC, each of the ordinates, considered as composed of material particles, will be in equilibrio about their points of bisection E, R; and therefore the centre of inertia of the body will lie in the axis. But, if we consider the body as composed of a number of small weights $D\,d\,g\,G$, we shall find its centre of inertia by multiplying each weight by its distance from any line $m\,n$ parallel to the ordinates, and dividing the sum of all these products by the sum of all the particles, Art. 158. Thus, let x denote the distance EB, then its fluxion $\dot{x}$ will be the breadth of the element or small weight $D\,d\,g\,G$, and $\dot{x}\times DG$ will represent the weight, and the fluent of this quantity will be the sum of all the weights. Again, if we multiply the weight $\dot{x}\times DG$ by $x=EB$ its distance from the point B, we shall have the momentum of that weight $=x\times\dot{x}\times DG$, and the fluent of this quantity will express the sum of the momenta of all the weights into which the body is divided. But, by Art. 158. the distance of the centre of gravity from a given point B is equal to the sum of all the momenta divided by the sum of all the weights or bodies, that is, if F be the centre of gravity of the body ABC, we have $FB=\dfrac{\text{fluent of } x\times\dot{x}\times DG}{\text{fluent of } \dot{x}\times DG}$, or calling y the ordinate DE, we have $DG=2\,y$, and $FB=\dfrac{\text{fluent of } x\,2\,y\,\dot{x}}{\text{fluent of } 2\,y\,\dot{x}}$, or $FB=\dfrac{\text{fluent of } x\,y\,\dot{x}}{\text{fluent } y\,\dot{x}}$ in the case of areas.

174. In the case of solids generated by rotation, the element or small weight $F\,\dot{x}\times DG$ will be a circular section,

Theory.

section, whose diameter is $2\,DE = 2y$, and since the area of a circle is equal to its circumference multiplied by its diameter, we have (making $\pi = 3.1416$) $2\pi y^2 \dot{x}$, = the circular section whose diameter is DG; and since $x \times 2\pi y^2 \dot{x}$, or $2\pi x y^2 \dot{x}$, will represent the momentum of the weight, we shall have $FB = \frac{\text{fluent of } 2\pi x y^2 \dot{x}}{\text{fluent of } 2\pi y^2 \dot{x}}$, and dividing by $2\pi y$, we have $FB = \frac{\text{fluent of } y x \dot{x}}{\text{fluent of } y \dot{x}}$.

175. In finding the centre of inertia of the surfaces of solids, the elements or small weights are the circumferences of circles, whose radii are the ordinates of the curve by whose revolution the solid is generated. Now, the surface of the solid may be conceived to be generated by the circumference of a circle increasing gradually from B towards A and C; making z therefore equal to BD, its fluxion $\dot{z}$ multiplied into the periphery of the circle whose diameter is DG, that is, $2\pi y \dot{z}$ will express the elementary surface or small weight whose diameter is DG. Then, since $x \times 2\pi y \dot{z}$, or $2\pi x y \dot{z}$ will be the momentum of the elementary weight, we shall have $FB = \frac{\text{fluent of } 2\pi x y \dot{z}}{\text{fluent of } 2\pi y \dot{z}}$, and dividing by 2π we obtain $FB = \frac{\text{fluent of } x y \dot{z}}{\text{fluent of } y \dot{z}}$.

176. If the body, whose centre of inertia is to be found, be a curve line, as GBD, then it is manifest that the small weights will be expressed by the fluxion of

Fig. 11. GBD, that is, by $2\dot{z}$, since $GBD = 2\,BD = 2z$; consequently their momenta will be $2x\dot{z}$, and we shall have $FB = \frac{\text{fluent } 2x\dot{z}}{\text{fluent } 2\dot{z}} = \frac{\text{fluent } x\dot{z}}{\text{fluent } \dot{z}} = \frac{\text{fluent } x\dot{z}}{z}$.

Prop. IX.

177. To find the centre of inertia of a circular segment.

Fig. 12. Let $AE = x$, $FC = y$, and AD the radius of the circle = R, consequently $ME = 2R - EA$. Then, since by the property of the circle (Geometry, Theor. 28. Sect. IV.) $ME \times EA = BE^2$, we have, by substitution, $BE^2 = 2R \times EA - EA \times EA$, or $y^2 = 2Rx - x^2$; hence $y = \sqrt{2Rx - x^2}$. Now, by Art. 174. we have the distance of the centre of gravity from A, that is, $AG = \frac{\text{fluent } x y \dot{x}}{\text{fluent } y \dot{x}}$; but the fluent of $y\dot{x}$ or the sum of all the weights, is equal to the area of half the segment ABEC; therefore $AG = \frac{\text{fluent } x y \dot{x}}{\frac{1}{2}ABEC}$. Then, by substituting instead of y, in this equation, the value of it deduced from the property of the circle, we have $AG = \frac{\text{fluent of } x\dot{x}\sqrt{2Rx - x^2}}{ABEC}$; or, in order to find GD the distance of the centre of gravity from the centre, we must substitute instead of x (without the vinculum) its value $R - x$, and we have $GD = \text{fluent } \frac{(R-x)\dot{x}\overline{(2Rx - x^2)}}{\frac{1}{2}ABEC}$. Now, in order to find the fluxion of the numerator of the preceding fraction, assume $z = 2Rx - x^2$, and $z^{\frac{1}{2}} = \sqrt{2Rx - x^2}$, and by taking the fluxion, we have $\dot{z} = 2R\dot{x} - 2x\dot{x} = \overline{2R - 2x} \times \dot{x}$; but this quantity is double of the first term of the numerator, therefore $\frac{\dot{z}}{2} = \overline{R - x} \times \dot{x}$. By substituting these values in the fractional formula, we obtain GD = fluent $\frac{z^{\frac{1}{2}}}{2} \times \frac{1}{2}\dot{z} = \frac{z^{\frac{3}{2}}}{3} = \frac{\overline{\sqrt{2Rx - xx}}|^{\frac{3}{2}}}{3}$; but since $y = \overline{2Rx - xx}|^{\frac{1}{2}}$ we have, by raising both sides to the third power, $y^3 = \overline{2Rx - xx}|^{\frac{3}{2}}$; therefore $GD = \frac{\frac{1}{3}y^3}{\frac{1}{2}ABEC} = \frac{\frac{1}{24} \times 8y^3}{\frac{1}{2}ABEC} = \frac{\frac{1}{12}(2y)^3}{ABEC}$, that is, the distance of the centre of gravity of a circular segment from the centre of the circle, is equal to the twelfth part of the cube of twice the ordinate, (or the chord of the segment) divided by the area of the segment.

178. Cor. When the segment becomes a semicircle we have $2y = 2r$; and therefore $= GD = \frac{\frac{1}{12}(2r)^3}{ABEC} = \frac{(2r)^3}{12\,ABEC} = \frac{8 \times r^3}{12\,ABEC} = \frac{r^3}{1\frac{1}{2}ABEC}$, that is, the distance of the centre of gravity of a semicircle from the centre of the semicircle, is equal to the cube of the radius, divided by one and a half times the area of the segment.

Prop. X.

179. To find the centre of inertia of the sector of a circle.

Let ABDC be the sector of the circle. By Art. 157. find m the centre of inertia of the triangle BCD, and by the last proposition find G the centre of inertia of the segment; then take a point n so situated between G and m, that $ABEC : ECB = mn : Gn$, then the point n will be the centre of gravity of the sector.— By proceeding in this way, it will be found that Dn, or the distance of the centre of gravity of the sector from the centre of the circle, is a fourth proportional to the semiarc, to the semichord, and to two-thirds of the radius.

Prop. XI.

180. To find the centre of inertia of a plane surface bounded by a parabola whose equation is $y = ax^n$.

Since $y = ax^n$, multiply both terms by $x\dot{x}$, and $\dot{x}$ separately, and we have $yx\dot{x} = ax^{n+1}\dot{x}$, and $y\dot{x} = ax^n\dot{x}$. But, by Art. 174. we have $FB = \frac{\text{fluent of } x y \dot{x}}{\text{fluent } y\dot{x}}$, therefore, by substituting the preceding values of $xy\dot{x}$ and $y\dot{x}$ in the formula, we obtain $FB = \frac{\text{fluent of } ax^{n+1}\dot{x}}{\text{fluent of } ax^n\dot{x}}$, and

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and by taking the fluents it becomes

$$FB=\frac{\frac{a x^{n+2}}{n+2}}{\frac{a x^{n+1}}{n+1}}=\frac{n+1}{n+2}\times x.$$

If n, therefore, be equal to $\frac{1}{2}$, then $y=a x^{\frac{1}{2}}$, and, ſquaring both ſides, $y^2=a^2x$, which is the equation of the common or Apollonian parabola. Hence, $FB=\frac{3}{5}x$, that is, the diſtance of the centre of gravity from the vertex is $\frac{3}{5}$ths of the axis.

When n is equal to 1, then $y=a x$, and the parabola degenerates into a triangle, in which caſe $FB=\frac{2}{3}x$, as in Art. 165.

Prop. XII.

181. To find the centre of inertia of a ſolid, generated by the revolution of the preceding curve round its axis.

Since $y=a x^n$, ſquare both ſides, and we have $y^2=a^2x^{2n}$; then multiply both ſides by $x\dot{x}$, and $\dot{x}$ ſeparately, we obtain $y^2x\dot{x}=a^2x^{2n+1}\dot{x}$, and $y^2\dot{x}=a^2x^{2n}\dot{x}$. But, by Art. 174. we have $FB=\frac{\text{fluent of } y^2x\dot{x}}{\text{fluent of } y^2\dot{x}}$; therefore, by ſubſtituting the preceding values of $y^2x\dot{x}$, and $y^2\dot{x}$ in that formula, we obtain $FB=\frac{\text{fluent of } a^2x^{2n+1}\dot{x}}{\text{fluent of } a^2x^{2n}\dot{x}}$, and by taking the fluents we ſhall have

$$FB=\frac{\frac{a^2x^{2n+2}x}{2n+2}}{\frac{a^2x^{2n+1}}{2n+1}}=\frac{2n+1}{2n+2}\times x.$$

When $n=\frac{1}{2}$, the ſolid becomes a common paraboloid, and we obtain $FB=\frac{2}{3}x$.

When $n=1$, the ſolid becomes a cone, and $FB=\frac{3}{4}x$, as in Art. 171.

Prop. XIII.

182. To find the centre of gravity of a ſpherical ſurface or zone, comprehended between two parallel planes, or of the ſpherical ſurface of any ſpherical ſegment.

Fig. 12. Let BMNC be a ſection of the ſpherical ſurface comprehended between the planes BC, MN, and let $EP=x$, $EC=y$, $DC=R$, and $z=$ the arc CN. Suppoſe the abſciſſa EP to increaſe by the ſmall quantity $E\,o$, draw $o\,r$ parallel to EC, $C\,s$ parallel to $E\,o$, and $C\,r$ perpendicular to DC; then it is evident, that in the ſimilar triangles CDE, $C\,s\,r$, $EC : DC = C\,s : C\,r$, that is, $y : R=C\,s : C\,r$; but $C\,r$ is the fluxion of the arc NC, and $C\,s$ the fluxion of the abſciſſa PE; therefore $y : R = \dot{x} : \dot{z}$, and $\dot{z}y=R\dot{x}$, and $\dot{z}=\frac{R\dot{x}}{y}$. Now, by Art. 175. $FB=\frac{\text{fluent of } x\,y\,\dot{z}}{\text{fluent of } x\,y\,\dot{z}}$, therefore, by ſubſtituting the preceding value of $\dot{z}$ in this formula, we obtain $FB=\frac{\text{fluent of } R\,x\,\dot{x}}{\text{fluent of } R\,\dot{x}}$, for

$$\frac{\frac{R x\dot{x}\dot{z}}{y}}{\frac{R\dot{x}z}{y}}=\frac{R\,y\,x\,\dot{x}\,\dot{z}}{R\,y\,\dot{x}\,\dot{z}}\text{ (and dividing by } y\dot{z})=\frac{Rx\dot{x}}{R\dot{x}}.$$ By taking the fluents we obtain $FB=\frac{1}{2}\frac{R\,x^2}{R\,x}=\frac{1}{2}x$, a fluent which requires no correction, as the other quantities vaniſh at the ſame time with x.

183. When DP is equal to DC, the ſolid becomes a ſpherical ſegment, and EA becomes the altitude of the ſegment, ſo that univerſally the centre of gravity of the ſpherical ſurface of a ſpherical ſegment is in the middle of the line which is the altitude of the ſegment, or in the middle of the line which joins the centres of the two circles that bound the ſpherical ſegment.

184. When the ſpherical ſegment is a hemiſpheroid, the centre of gravity of its hemiſpherical ſurface is obviouſly at the diſtance of one-half the radius from its centre.

Prop. XIV.

185. To find the centre of gravity of a circular arc.

Let BAC be the circular arc, it is required to find its centre of inertia, or the diſtance of the centre of inertia of the half arc AC from the diameter HG; for it is evident, that the line which joins the centres of gravity of each of the ſemiarcs AB, AC muſt be parallel to HG, and therefore the diſtance of their common centre of gravity, which muſt be in that line, from the line HG, will be equal to the diſtance of the centre of gravity of the ſemiarc from the ſame line. Make $PC=DE=x$; $EC=y$; $DC=DA=R$, and $AC=z$, then it may be ſhewn, as in the laſt propoſition, that $y : R=\dot{x} : \dot{z}$; hence $\dot{z}\,y=R\,\dot{x}$. But, by Art. 176. we have $FB=\frac{\text{fluent of } y\,\dot{z}}{z}$, y being in this caſe equal to x in the formula in Art. 176. and ſubſtituting the preceding value of $y\,\dot{z}$, it becomes $FB=\frac{\text{fluent of } R\,\dot{x}}{z}$, and, taking the fluent, we have $FB=\frac{R\,x}{z}$, which requires no correction, as the fluent of $y\,\dot{z}$ vaniſhes at the ſame time with x. Calling d, therefore, the diſtance of the centre of inertia of the arc BAC from the centre D, we have $d=\frac{R\,x}{z}$, and $d\,z = R\,x$; hence $z : x = R : d$, or $2\,Z : 2\,x=R : d$, that is, the diſtance of the centre of inertia of a circular arc from the centre of the circle is a fourth proportional to the arc, the chord of the arc, and radius. Fig. 13.

186. When the arc BAC becomes a ſemicircle, PC or x is equal to DG or radius, ſo that we have $2\,z : 2\,R = R : d$, or $4\,Z : 4\,R = R : d$; but $4\,z$ is equal to the whole circumference of the circle, and $4\,R$

is

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is equal to twice the diameter; therefore, $3.141593 : 2 = R : d$; hence $d = \frac{2R}{3.141593} = .63662 R$.

187. When y is equal to $2R$, or when the arc ABC becomes equal to the whole circumference of the circle, x vaniſhes, and is $= 0$, and therefore $\frac{Rx}{z} = 0$, which ſhews, that the centre of inertia coincides with the centre of the circle.

Scholium I.

188. From the ſpecimens which the preceding propoſitions contain of the application of the formulæ in Articles 173, 174, 175, 176, the reader will find no difficulty in determining the centre of inertia of other ſurfaces and ſolids, when he is acquainted with the equation of the curves by which the ſurfaces are bounded, and by whoſe revolution the ſolids are generated.

A knowledge of the nature of theſe curves, however, is not abſolutely neceſſary for the determination of the centres of inertia of ſurfaces and ſolids. A method of finding the centre of gravity, without employing the equation of the bounding curves, was diſcovered by our countryman, Mr Thomas Simſon *. It was afterwards more fully illuſtrated by Mr Chapman, in his work on the Conſtruction of Ships; by M. Leveque, in his tranſlation of Don George Juan's Treatiſe on the Conſtruction and Management of Veſſels; and by M. Prony, in his *Architecture Hydraulique*, tom. i. p. 93, to which we muſt refer ſuch readers as wiſh to proſecute the ſubject.

* *Mathematical Diſſertations*, p. 109.

Scholium II.

Poſition of the centre of inertia in bodies of various forms.

189. As it is frequently of great uſe to know the poſition of the centre of inertia in bodies of all forms, we ſhall collect all the leading reſults which might have been obtained, by the method given in the preceding propoſitions.

1. The centre of inertia of a ſtraight line is in its middle point.

2. The centre of inertia of a parallelogram is in the interſection of its diagonals.

3. The centre of inertia of a triangle is diſtant from its vertex two-thirds of a line drawn from the vertex to the middle of the oppoſite ſide.

4. The centre of inertia of a circle, and of a regular polygon, coincides with the centres of theſe figures.

5. The centre of inertia of a parallelopiped is in the interſection of the diagonals joining its oppoſite angles.

6. The centre of inertia of a pyramid is diſtant from its vertex three-fourths of the axis.

7. The centre of inertia of a right cone is in a point in its axis whoſe diſtance from the vertex is three-fourths of the axis.

8. In the ſegment of a circle, the centre of inertia is diſtant from the centre of the circle a twelfth part of the cube of the chord of the ſegment divided by the area of the ſegment, or $d = \frac{\frac{1}{12}C^3}{A}$, where $d =$ the diſtance of the centre of inertia from the centre of the circle, $C =$ the chord of the ſegment, and A its axis.

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9. In the ſector of a circle, the centre of inertia is diſtant from the centre of the circle, by a quantity which is a fourth proportional to the ſemiarc, the ſemichord, and two-thirds of the radius.

10. In a ſpherical ſurface or zone, comprehended between two planes, the centre of inertia is in the middle of the line which joins the centres of the two circular planes by which it is bounded. When one of the circular planes vaniſhes, the ſpherical zone becomes the ſpherical ſurface of a ſpherical-ſegment; therefore,

11. In a ſpherical ſurface of a ſpherical ſegment, the centre of inertia is in the middle of its altitude or verſed ſine; conſequently,

12. The centre of inertia of the ſurface of a complete ſphere coincides with the centre of the ſphere.

13. In a ſpherical ſegment, the centre of inertia is diſtant from the vertex by a quantity equal to $\frac{4a-3x}{6a-4x} \times x$, where a is the diameter of the ſphere, and x the altitude or verſed ſine of the ſegment. Hence,

14. The centre of inertia of a hemiſphere is diſtant from its vertex by a quantity equal to five-eighths of the radius, or it is three-eighths of the radius diſtant from the hemiſphere; and,

15. The centre of inertia of a complete ſphere coincides with the centre of the ſphere.

16. In a circular arc the centre of inertia is diſtant from its centre by a quantity equal to $\frac{Rx}{z}$, where R is the radius, x the ſemichord, and z the ſemiarc. Hence,

17. In a ſemicircular arc the centre of inertia is diſtant from its centre .63662 R, and,

18. The centre of inertia of the circumference of a circle coincides with the centre of the circle.

19. In a circular ſector the centre of inertia is diſtant from the centre of the circle $\frac{2cR}{3a}$, where R is the radius, a the arc, and c its chord.

20. In a ſpherical ſector, compoſed of a cone and a ſpherical ſegment, the centre of inertia is diſtant from the vertex of the ſegment by a quantity equal to $\frac{2R+3x}{8}$, where R is radius, and x the altitude or verſed ſine of the ſegment.

21. In an ellipſis the centre of inertia coincides with the centre of the figure.

22. The centre of inertia of an oblate and prolate ſpheroid, ſolids generated by the revolution of an ellipſe round its leſſer and its greater axis reſpectively, coincides with the centres of the figures.

23. In the ſegment of an oblate ſpheroid the centre of inertia is diſtant from its vertex by a quantity equal to $\frac{4m-3x}{6m-4x} \times x$, where m is the leſſer axis, or axis of rotation, and x the altitude of the ſegment. Hence,

24. In a hemiſpheroid the centre of inertia is diſtant from its vertex five-eighths of the radius.

25. The centre of inertia of the ſegment of a prolate ſpheroid

Theory. spheroid is distant from its vertex by a quantity equal to $\frac{4n-3x}{6m-4x} \times x$, where n is the greater axis, or axis of rotation.

26. In the common or Apollonian parabola, the distance of the centre of inertia from its vertex is three-fifths of the axis.

27. In the cubical parabola the distance of the centre of inertia from its vertex is four-sevenths of the axis, in the biquadratic parabola five-ninths of the axis, and in the sursolid parabola six-elevenths of the axis.

28. In the common semiparabola, the distance of its centre of gravity from the centre of gravity of the whole parabola, in the direction of the ordinate passing through that centre, is $\frac{1}{4}$ of the greatest ordinate.

29. In the common paraboloid, the distance of the centre of inertia from its axis, is equal to $\frac{2}{3}$ of the axis.

30. In the common hyperboloid, the distance of the centre of inertia from the vertex is equal $\frac{4a+3x}{6a+4x} \times x$, where a is the transverse axis of the generating hyperbola, and x the altitude of the solid.

31. In the frustum of a paraboloid, the distance of the centre of inertia from the centre of the smallest circular end is $\frac{2R^2+r^2}{R^2+r^2} \times \frac{h}{4}$, where h is the distance between the centres of the circles which contain the paraboloidal frustum, R the radius of the greater circle, and r the radius of the lesser circle.

32. In a conic frustum or truncated cone, the distance of the centre of inertia from the centre of the smallest circular end is $\frac{3R^2+2Rr+r^2}{R^2+Rr++r^2} \times \frac{h}{4}$ which represents the distance between the centres of the circles which contain the frustum, and R, r the radii of the circles.

33. The same formula is applicable to any regular pyramid, R and r representing the sides of the two polygons by which it is contained.

Prop. XIV.

190. If a quantity of motion be communicated to a system of bodies, the centre of gravity of the system will move in the same direction, and with the same velocity, as if all the bodies were collected in that centre, and received the same quantity of motion in the same direction.

Fig. 14. Let A, B, C be the bodies which compose the system, and let F be the centre of gravity of the bodies B, C, and f the centre of gravity of the whole system, as determined by Art. 155. Then if the body A receives such a momentum as to make it move to a in a second, join Fa, and take a point φ so that $F\varphi : \varphi a = Ff : fa$, φ will now be the centre of gravity of the system, $f\varphi$ the the path of that centre will be parallel to A a, and $f\varphi$ will be to A a as B is to A+B+C. Let the same quantity of motion be now communicated to B, so as to make it describe the space B b in a second; and having drawn φ G parallel to B b, take a point G, so that $\varphi G : Bb = B : A+B+C$, and G will be the centre of gravity of the bodies after B has moved to b. In the same it may be found, that H will be the common centre of gravity of the bodies after the same quantity of motion has been communicated to C in the direction C c. Now if the quantity of motion which was communicated to A, B, C separately had been communicated to them at the same instant, they would have been found at the end of a second in the points a, b, c, and their centre of gravity would have been the point H. Let us now suppose the three bodies collected in their common centre of gravity f, the body at F will be equal to A+B+C, and if the same quantity of motion which made A move to a in a second be communicated to the body at f and in the same direction, it will be found somewhere in the line $f\varphi$ at the end of a second. But as the quantity of motion is equal to the product of the velocity of the body multiplied by its quantity of matter, the velocities are inversely as the quantities of matter, and consequently the velocity of the body at f is to A's velocity as A is to A+B+C, that is, as $f\varphi$ is to A a; therefore A a and $f\varphi$ are described by A and by the body at f in equal times, and the body at f will be found at φ at the end of a second. In the same way it may be shewn, that the body at f will be found at G if it receives the same momentum that was given to B, and in the same direction, and that it will be found at H after it has received the momentum that was communicated to C, consequently if it received all these momenta at the same instant, it would have described fH in a second. Q. E. D. Theory.

191. Cor. 1. If the bodies of a system move uniformly in right lines, their common centre of gravity will either be at rest, or move uniformly in a right line. For if the momenta communicated to the bodies A, B, C were communicated to a body at f=A+B+C, it will either remain at rest or move uniformly in a straight line. See *Newton's Principia*, I. Sect. III. Cor. 1.

192. Cor. 2. The centre of gravity of any system is not affected by the mutual action of the bodies which compose it. For let B and C be two bodies whose common centre of gravity is F; and let the points $\beta, \varkappa$, be taken so that $B\beta : C\varkappa = C : B$, the spaces $B\beta$, $C\varkappa$ will represent the mutual action of the bodies B, C, that is $B\beta$ will represent the action of C upon B, or the motion which is the result of that action, and $C\varkappa$ the action of B upon C, or the motion which results from it. Then, since F is the common centre of gravity, of B and C, we have (Art. 155.) $B : C = FC : FB$, but $B : C = C\varkappa : B\beta$, therefore $FC : FB = C\varkappa : B\beta$; but $C\varkappa$ is a magnitude taken from FC, and $B\beta$ is a magnitude taken from FB, consequently (Playfair's Euclid, Book V. Prop. 19.) the remainder $\varkappa F : \beta F = FC : FB$, that is, $\varkappa F : \beta F = B : C$, that is (Art. 155.) the point F continues to be the centre of gravity notwithstanding the action of the bodies B, C. If the system is composed of several bodies, the same thing may be proved of every two of the bodies, and consequently of the whole system. See *D'Alembert's Dynamique*, Art. 76. and *Newton's Principia*, I. Sect. III. Cor. 4. Fig. 14.

Prop. XV.

193. If a body is placed upon a horizontal plane, or suspended by two threads, it cannot be in

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equilibrio unleſs a perpendicular drawn from the centre of gravity to the horizontal plane, or to a horizontal line paſſing through the two threads, fall within the baſe of the body, or upon that part of the horizontal line which lies between the threads.

Fig. 15. 194. 1. Let ABCD be a body placed in the horizontal plane CD, G its centre of gravity, and GE a perpendicular drawn to the horizontal line DE. Then the whole matter of the body ABCD may be conceived as united in its centre of gravity G, and as its tendency downwards is in the vertical line GE, it can deſcend only by turning round the point C as a centre. Here then we have a body G placed at the end of a lever GC whoſe fulcrum is C, and its power to turn round C is repreſented by the quantity of matter in G multiplied by the perpendicular CE, let fall from the fulcrum upon its line of direction; and as there is no force to counterbalance this, the body G, and conſequently the body ABCD, will fall by turning round C. When the vertical line GE coincides with GC, EC vaniſhes, and the weight of the body concentrated at G has no power to turn the lever round C, but is ſupported upon the fulcrum C. When the vertical line GE, (by ſome writers called the *line of direction*), falls within the baſe CD, it is obvious that the weight at G has no influence in producing a motion round C or D, but is employed in preſſing the body upon the horizontal plane ED.

Fig. 16. 195. 2. Let the body ACBD be ſuſpended at the points f, φ by the threads hf, $h'\varphi$, and let G be the centre of gravity of the body. Join Gφ, Gf, draw $f\varphi$ parallel to the horizon, and through G draw no parallel to $f\varphi$. Continue hf, $h'\varphi$ to o and n, and draw Gi perpendicular to $f\varphi$, the body AB cannot be in equilibrio unleſs the point i falls upon the horizontal line $f\varphi$ which paſſes through the threads. It is obvious that the centre of gravity can never change its diſtance from the fixed points of ſuſpenſion f, φ; if therefore the body is not in equilibrio, its centre of gravity muſt deſcend either towards m or n; let it deſcend towards m till it reſts at the point γ, then $\gamma f = f$G; but $\gamma\varphi$ is greater than Gφ (Euclid, Book I. Prop. 7.) which is abſurd, therefore the point G cannot deſcend, that is, the body is in equilibrio. It may be ſhewn in the ſame way, that it will be in equilibrio when G is any where between n and o, that is, when the perpendicular let fall from G cuts the horizontal line $f\varphi$ that lies between the threads. If the body be ſuſpended by the two threads HE, hf, ſo that the perpendicular Gi falls without the line fF, the body is not in equilibrio, for the centre of gravity G acting at the end of the lever GF tends to turn round F with a power equal to G $\times$ Gm, it will therefore deſcend, and as its diſtance from f cannot change, the point f will riſe, and the thread fh will be relaxed. When G arrives at m the perpendicular Gm vaniſhes, and G has no power to turn round F. The body AB therefore cannot be in equilibrio till the perpendicular Gi fails within fF, which it does as ſoon as it arrives at m.

196. Cor. 1. If a body is placed upon an inclined plane, ſuppoſed without friction, it will ſlide down the plane when the line of direction falls within its baſe, and will roll down when this line falls without the baſe. This is the reaſon why a ſphere or cylinder rolls down an inclined plane; for as they touch the plane only in one point or line, the line of direction muſt always fall without the baſe. Theory.

197. Cor. 2. The higher the centre of gravity of a body is, the more eaſily will it be overturned. For if ABCD be the body whoſe centre of gravity is F, and if any force be employed to move it round C as a fulcrum, the power with which it will reſiſt this force is inverſely as FC; then, if the centre of gravity is raiſed to f, fC will be greater than FC, and the power with which it reſiſts being overturned is diminiſhed, that is, the body is the more eaſily overturned the higher that its centre of gravity is placed. Fig. 17.

198. Cor. 3. If a body be ſuſpended by one thread, it will not be at reſt unleſs its centre of gravity is in the direction of the thread produced, for when the two threads hf', $h'\varphi$ approach ſo near each other as to coincide with the ſingle thread HE, the point i muſt in the caſe of an equilibrium fall upon F, and the lines Gi, GF muſt coincide with mF; but HF and mF are both perpendicular to the horizontal line $f\varphi$, therefore the centre of gravity G is in the direction of the thread HF.

199. Cor. 4. If the bodies A, B, C, fig. 18. be ſuſpended by any point F from the hook H, they will not be in equilibrio unleſs their common centre of gravity G is in the vertical line FG paſſing through the point of ſuſpenſion; and in fig. 19. the bodies A, B connected by the bent rod AFB will not be in equilibrio unleſs their common centre of gravity G is in a vertical line paſſing through F, the point in which the ſyſtem reſts upon the plane CD. Fig. 18. Fig. 19.

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200. We have ſeen in the preceding propoſition and corollaries, the poſition which muſt be given to the centre of gravity in order to procure an equilibrium. It is evident, however, that though the bodies are neceſſarily at reſt, yet they have different degrees of ſtability, depending on the poſition of the centre of gravity with regard to the centre of motion. Hence bodies are ſaid to have a ſtable equilibrium when their centre of gravity cannot move without aſcending, or when the path deſcribed by their centre of gravity has its concavity upwards;—a tottering equilibrium when the centre of gravity cannot move without deſcending, or when the path which it deſcribes has its concavity downwards,—and a neutral equilibrium when the body will reſt in any poſition. Thus in fig. 20. if the veſſels A, B have their handles ſo placed that in the one the handle A is fixed above the centre of gravity g, and in the other the handle B is fixed below the centre of gravity g, then the equilibrium of A will be ſtable, and that of B tottering; for if A is held by the handle it will require a conſiderable force to make its centre of gravity deſcribe the path mn, whereas the ſmalleſt force will deſtroy the equilibrium of B. The veſſel A, too, has a conſtant tendency to recover its equilibrium, and always recovers it as ſoon as the diſturbing force is removed, but the veſſel B has no tendency to do this even when its equilibrium is affected in the ſmalleſt degree. For the ſame reaſon the elliptical body A, when reſting on the extremity of its conjugate axis, has a ſtable equilibrium, but when reſting on its tranſverſe axis as at B, its equilibrium

Different kinds of equilibrium.

Fig. 20. Fig. 21.

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um is tottering. The equilibrium of a circle or ſphere is always neutral, for when it is diſturbed, the body has neither a tendency to fall nor to reſume its former ſitua-
Fig. 22. tion.—A flat body A ſupported by a ſphere B will have its equilibrium ſtable when its centre of gravity is nearer the point of contact than the centre of the ſphere is, and the equilibrium of C will be tottering when its centre of gravity is farther diſtant from the ſurface of the ſphere D than the centre of the ſphere is.

Prop. XVI.

1. To find the centre of inertia mechanically.

Mechanical method of finding the centre of gravity.

201. If the body whoſe centre of inertia is to be found can be ſuſpended by a thread, then when the body is in equilibrio, the centre of gravity will be ſomewhere in the line, prolonged if neceſſary, that is formed by the thread upon the ſurface of the body. Let a body be again ſuſpended from another part of its ſurface, ſo that the direction of the thread may be nearly at right angles to its former direction, then as the centre of gravity muſt alſo be in the new direction of the thread prolonged, it will be in the point where theſe two lines interſect each other.

202. 2. If the body is of ſuch a kind that it cannot be conveniently ſuſpended, balance it upon two ſharp points, and its centre of motion will be ſomewhere in the line which joins theſe points. Balance it a ſecond time upon the ſharp points, ſo that the line which joins the points may be nearly at right angles to the former line. The interſection of theſe two lines will be the centre of inertia of the body.

203. 3. If the body is ſo flexible that it can neither be ſuſpended by a thread nor balanced upon points, then let a thin board be balanced upon the points as before, and let the body be ſo placed upon this board when balanced, that the equilibrium may ſtill continue; then, having found the centre of gravity of the board when loaded with the body, the centre of gravity of the body will be a point on its ſurface exactly oppoſite to that centre.

204. The preceding method, however, only gives us the centre of gravity when the body has no ſenſible thickneſs, for when it is of three dimenſions, the centre of gravity muſt be ſomewhere between the two oppoſite ſurfaces.

205. *Definition.*—The centro-baryc method is the method of determining the areas of ſurfaces, and the contents of ſolids, by conſidering them as generated by motion, and by employing the laws of the centre of gravity.

Prop. XVII.

Centro-baryc method of Guldinus.

206. If any ſtraight or curve line, or any plane ſurface bounded by ſtraight or curve lines revolve round an axis ſituated in the ſame plane with the lines or ſurfaces, the ſurface or ſolid thus generated will be reſpectively equal to a ſurface or ſolid whoſe baſe is equal to the given line or ſurface, and whoſe height is equal to the arc deſcribed by the centre of gravity of of the generating line or ſurface.

Fig. 23.

Let ABCD be the plane ſurface by whoſe revolution round the axis MPN is generated the ſolid a D, contained by the parallelograms ABCD, $a\,b\,c\,d$, and by the areas a AC c, b BD d, and a AB b, c CD d; let G be the centre of gravity of ABCD, then the ſolid a D ſhall be equal to a ſolid whoſe baſe is ABCD, and whoſe altitude is a line equal to G g, the ſpace deſcribed by its centre of gravity G. It is evident from Art. 161. that the ſum of the products of all the particles of the ſurface ABCD, multiplied by their reſpective diſtances from any given point P, is equal to the ſum of all the particles multiplied by the diſtance of their common centre of gravity G from the ſame point P. Now every particle of the ſurface ABCD, during its revolution round the point P, will obviouſly deſcribe the arch of a circle proportional to the diſtance of that particle from the point P, which is the centre of all the arches; therefore the ſum of the product of all the particles multiplied by the arch deſcribed by each of them, will be equal to the ſum of the particles multiplied by the arch which their common centre of gravity deſcribes, that is, the ſolid a D will be equal to the area of the ſurface multiplied by the path of its centre of gravity. In order to have a clearer illuſtration of this reaſoning, let P, p, π, &c. be the particles of the ſurface ABCD; D, d, δ their diſtance from the centre of rotation P, and A, a, α, the arches which they deſcribe, while GP is the diſtance of the centre of gravity of the ſurface ABCD from the centre P, and G g the arch deſcribed by it. Then by Art. 161. $\overline{P\times D+p\times d+\pi\times\delta}=\overline{P+p+\pi}\times GP$, but $D:d:\delta:GP=A:a:\alpha:Gg$, therefore $\overline{P\times A+p\times a+\pi\times\alpha}=\overline{P+p+\pi}\times Gg$. But $\overline{P\times A+p\times a+\pi\times\alpha}$ &c. make up the whole ſolid a D, and $\overline{P+p+\pi}$, &c. make up the whole ſurface ABCD; therefore the ſolid a D is equal to the generating ſurface ABCD multiplied by the path of its centre of gravity. Q. E. D.

207. Cor. 1. Let us ſuppoſe the circle BACO to be generated by the revolution of the line DA round the point D; then ſince the centre of gravity of the line DA is in its middle point G, the path of this centre will be a circumference whoſe radius is DG, or a line equal to half the circumference BONAB, therefore, by the theorem, the area of the circle BONB will be equal to the radius DA multiplied by the ſemicircumference, which coincides with the reſult obtained from the principles of geometry. See Playfair's Geometry, Supp. B. I. Prop. 5. In the ſame way, by means of the preceding theorem, we may readily determine the area of any ſurface, or the content of any ſolid that is generated by motion. Fig. 12.

Scholium.

208. The centro-baryc method, which is one of the fineſt inventions of geometry, was firſt noticed by Pappus in the preface to the ſeventh book of his mathematical collections, but it is to Father Guldinus that we are indebted for a more complete diſcuſſion of the ſubject. He publiſhed an account of his diſcovery partly in 1635, and partly in 1640, in his work entitled *De Centro Gravitatis*, lib. ii. cap. 8. prop. 3. and gave an indirect demonſtration of the theorem, by ſhowing the conformity of its reſults with thoſe which were obtained by other means. Leibnitz demonſtrated the theorem in the caſe of ſuperficies generated by the revolution of curves, but concealed his demonſtration (Act. Leipſ. 1695, p. 493.

Theory.

493. The theorem of Leibnitz, however, as well as that of Guldinus, was demonftrated by Varignon in the Memoirs of the Academy for 1714, p. 78. Leibnitz obferves that the method will ftill hold, even if the centre round which the revolution is performed be continually changed during the generating motion. For further information on this fubject, the reader is referred to Dr Wallis's work, *De Calculo Centri Gravitatis*, Hutton's Menfuration, Prony's Architecture Hydraulique, vol. i. p. 88, and Gregory's Mechanics, vol. i. p. 64.

PROP. XVIII.

209. To fhow the ufe of the doctrine of the centre of gravity in the explanation of fome mechanical phenomena.

On the motion of animals.

In the equilibrium and motion of animals, we perceive many phenomena deducible from the properties of the centre of gravity. When we endeavour to rife from a chair, we naturally draw our feet inwards, and reft upon their extremities, in order to bring the centre of gravity directly below our feet, and we put the body into that pofition in which its equilibrium is tottering, a pofition which renders the fmalleft force capable of producing motion, or of overturning the body. In this fituation, in order to prevent ourfelves from falling backwards, we thruft forward the upper part of the body for the purpofe of throwing the centre of gravity beyond our feet; and when the equilibrium is thus deftroyed, we throw out one of our feet, and gradually raife the centre of gravity till the pofition of the body is erect.—When we walk, the body is thrown into the pofition of tottering equilibrium by refting it on one foot; this equilibrium is deftroyed by pufhing forward the centre of gravity, and the body again affumes the pofition of tottering equilibrium by refting it on the other foot. During this alternate procefs of creating and deftroying a tottering equilibrium, the one foot is placed upon the ground, and the other is raifed from it; but in running, which is performed in exactly the fame way, both the feet are never on the ground at the fame time: At every ftep there is a fhort interval, during which the runner does not touch the ground at all.

210. When we afcend an inclined plane the body is thrown farther forward than when we walk on a horizontal one, in order that the line of direction may fall without our feet; and in defcending an inclined plane, the body is thrown backward, in order to prevent the line of direction from falling too fuddenly without the bafe. In carrying a burden, the centre of gravity is brought nearer to the burden, fo that the line of direction would fall without our feet if we did not naturally lean towards the fide oppofite to the burden, in order to keep the line of direction within our feet. When the burden is therefore carried on the back, we lean forward; when it is carried in the right arm, we lean towards the left; when it is carried in the left arm, we lean towards the right; and when it is carried before the body, we throw the head backwards.

211. When a horfe walks, he firft fets out one of his fore feet and one of his hind feet, fuppofe the right foot; then at the fame inftant he throws out his left fore foot and his left hind foot, fo as to be fupported only by the two right feet. His two right feet are then brought up at the fame inftant, and he is fupported only by his two left feet.—When a horfe pulls at a load which he can fcarcely overcome, he raifes both his fore feet, his hind feet become the fulcrum of a lever, and the weight of the horfe collected in his centre of gravity acts as a weight upon this lever, and enables him to furmount the obftacle. (See Appendix to Fergufon's Lectures, vol. ii.)

Theory.

Method in which a rope-dancer keeps his equilibrium.

212. When a rope-dancer balances himfelf upon the fore part of one foot, he preferves his equilibrium in two ways, either by throwing one of his arms or his elevated foot, or his balancing pole, to the fide oppofite to that towards which he is beginning to fall, or by fhifting the point of his foot, on which he refts, to the fame fide towards which he is apt to fall; for it amounts to the fame thing whether he brings the centre of gravity directly above the point of fupport, or brings the point of fupport directly below the centre of gravity. For this purpofe the convex form of the foot is of great ufe, for if it had been perfectly flat, the point of fupport could not have admitted of fmall variations in its pofition *.

* See Dr T. Young's *Natural Philofophy*, vol. i. p. 64.

The conftruction of mail coaches erroneous.

213. We have already feen (Art. 197.) that any body is more eafily overturned in proportion to the height of its centre of gravity. Hence it is a matter of great importance that the centre of gravity of all carriages fhould be placed as low as poffible. This may often be effected by a judicious difpofition of the load, of which the heavieft materials fhould always have the loweft place. The prefent conftruction of our mail and poft coaches is therefore adverfe to every principle of fcience, and the caufe of many of thofe accidents in which the lives of individuals have been loft. The elevated pofition of the guard, the driver, and the outfide paffengers, and the two boots which contain the baggage, raifes the centre of gravity of the loaded vehicle to a very great height, and renders it much more eafily overturned than it would otherwife have been. When any accident of this kind is likely to happen, the paffengers fhould bend as low as poffible, and endeavour to throw themfelves to the elevated fide of the carriage.—In two wheeled carriages where the horfe bears part of the load upon its back, the elevation of the centre of gravity renders the draught more difficult, by throwing a greater proportion of the load upon the horfe's back when he is going down hill, and when he has the leaft occafion for it; and taking the load from the back of the horfe when he is going up hill, and requires to be preffed to the ground.

Fig. 24.

214. A knowledge of the laws of the centre of gravity enables us to explain the experiment reprefented in fig. 24. where the veffel of water CG is fufpended on a rod AB, paffing below its handle, and refting on the end E of the beam DE. The extremity B of the rod AB is fupported by another rod BF, which bears againft the bottom of the veffel; fo that the veffel and the two rods become, as it were, one body, which, by Art. 199. will be in equilibrio when their common centre of gravity C is in the fame vertical line with the point of fupport E.

A loaded cylinder may be made to afcend an inclined plane by its own weight.

215. The cylinder G may be made to afcend the inclined plane ABC by putting a piece of lead or any heavy fubftance on one fide of its axis, fo that the centre of gravity may be moved from G towards g. Hence it

it is obvious, that the centre of gravity g will defcend, and by its defcent the body will rife towards A. The inclination of the plane, however, muft be fuch, that before the motion commences, the angles formed by a vertical line drawn from g with a line drawn from G perpendicularly to AB, muft be lefs than the angle of inclination ABC, or, which is the fame thing, when the vertical line drawn from g does not cut the line which lies between the point of contact and the centre of the cylinder. When the vertical line, let fall from g, meets the perpendicular line drawn from G to the plane in the point of contact, the cylinder will be in equilibrio on the inclined plane.

A double cone may be made to afcend an inclined plane by its own weight.

216. Upon the fame principle, a double fcalene cone may be made to afcend an inclined plane without being loaded with a weight. In fig. 26. let ABC be the fection of a double inclined plane, AB, BC being fections of its furfaces perpendicular to the line in which the double fcalene cone ADEFC moves. Then, fince the centre of gravity of a cone is in the line joining the vertex and the centre of its bafe, and fince the axis of a fcalene cone is not perpendicular to its bafe, the line which joins the centres of both the cones, when in the pofition reprefented in the figure, will be above the line which joins the centres of their bafes. If the circle, therefore, in fig. 27 reprefents the bafe of one of the cones, and C its centre, the line which joins the centres of gravity of the two cones will terminate in fome point G at a diftance from the centre, and therefore the double cone will afcend the plane upon the fame principles, and under the fame conditions, as thofe mentioned in the laft paragraph.

Fig. 26.

Fig. 27.

Chap. V. *On the Motion of Bodies along inclined Planes and Curves, on the Curve of fwifteft defcent, and on the Ofcillations of Pendulums.*

Prop. I.

Plate CCCXXI. fig. 1.

217. When a body moves along an inclined plane, the force which accelerates or retards its motion, is to the whole force of gravity as the height of the plane is to its length, or as the fine of its inclination is to radius.

Let ABC be the inclined plane, A the place of the body, and let AB reprefent the whole force of gravity. The force AB is equivalent to the two forces AD, DB or AE, AD, of which AD is the force that accelerates the motion of the body down the plane, while AE is deftroyed by the refiftance or reaction of the plane. The part of the force of gravity, therefore, which makes the body arrive at C is reprefented by AD, while the whole force of gravity is reprefented by AB; but the triangle ABD is equiangular to ABC, and AD : AB=AB : AC, that is, the accelerating force which makes the body defcend the inclined plane, is to the whole force of gravity as the height of the plane is to its length, or as the fine of the plane's inclination is to radius; for when AC is radius, AB becomes the fine of the angle ACB.

218. Cor. 1. Since the force of gravity, which is uniform, has a given ratio to the accelerating force, the accelerating force is alfo uniform; confequently the laws of accelerated and retarded motions, as exhibited in the article Dynamics, are alfo true when the bodies move along inclined planes. If H, therefore, reprefent the height AB of the plane, L its length AC, g the force of gravity, and A the accelerating force, we fhall have, by the propofition, L : H$=g$: A, hence $A=g\times\frac{H}{L}$, or, fince g : A$=$radius : fin. ACB, and A $=g\times$ fin. ACB. Now, from the principles of Dynamics, $s=\frac{1}{2}gt^2$, $v=gt=\sqrt{2gs}$, and $t=\frac{v}{g}=\sqrt{\frac{2s}{g}}$, where s is the fpace defcribed, g the force of gravity, or $32\frac{1}{4}$ feet, v the velocity, and t the time. Making φ, therefore, equal to ACB, and fubftituting the value of A inftead of g in the preceding equation, we fhall have $s'=\text{fin.}\,\varphi\times\frac{1}{2}t'^2$; $v'=g\,\text{fin.}\,\varphi t=\sqrt{2gs'\,\text{fin.}\,\varphi}$, and $t=\frac{v'}{g.\,\text{fin.}\,\varphi}=\sqrt{\frac{2s'}{g.\,\text{fin.}\,\varphi}}$.

219. Cor. 2. If one body begins to defcend through the vertical AB at the fame time that another body defcends along the plane AC, when the one is at any point m, the pofition of the other will be n, which is determined by drawing $m\,n$ perpendicular to AC. The forces by which the two bodies are actuated, are as AB : to AD, that is, as Am to An; but forces are meafured by the fpaces defcribed in the fame time; therefore, the fpaces defcribed in the fame time, are as Am, An, that is, as the length of the plane is to its height; for Am : An=AC : AB; confequently, when the body that defcends along the vertical line AB is at m, the other body will be at n.—Through the three points A, m, n defcribe the femicircle A$m\,n$; then, fince A$n\,m$ is a right angle, the centre of the femicircle will be in the line Am (Playfair's Euclid, Book iv. Prop. 5.); confequently, *if two bodies defcend from the point* A *at the fame time, the one through the diameter of a circle* A m, *and the other through any chord* A n, *they will arrive at the points* m n, *the extremities of the diameter and of the chord at the fame inftant.* It alfo follows from this corollary, that if from the point A there be drawn any number of lines making different angles with the diameter Am, and if bodies be let fall from A, fo as to move along thefe lines, they will, at the end of any given time, be found in the circumferences of circles which touch one another in the point A. If the lines are not in the fame plane, the bodies will be in the circumferences of fpheres which touch each other in the point A.

220. Cor. 3. If any number of bodies defcend from the fame point A along any number of inclined planes AC, AF. their velocities at the points C, F will be equal. By Cor. 1. the velocity of a body defcending the plane AC, is $v=\sqrt{2gs.\,\text{fin.}\,\varphi}$, and the velocity of a body falling in the vertical line AB is $v'=\sqrt{2gs'}$. But, fince $v=v'$, we have $\sqrt{2gs.\,\text{fin}\,\varphi}=\sqrt{2gs'}$ or $2gs\,\text{fin.}\,\varphi=2gs'$, and dividing by $2g$; $s\,\text{fin.}\,\varphi=s'$, confequently $s:s'=\text{fin}\,\varphi:1$, or AB : AC=fin. DAB : radius. Therefore, when $v=v'$, that is, when the velocities of the two bodies are equal, the fpaces defcribed are as fin. DAB : radius, which can only happen when BC is perpendicular to AB. In the fame way it may be fhewn that the velocity at F is equal to the velocity at C, therefore the velocity at C is equal to the velocity at F.

221. Cor. 4. The time of defcending along AC is to

Theory.

to the time of descending along AB, as AC is to AB. From the values of s, s' in Cor. 1. we obtain $t^2 : t'^2 = \frac{s}{\text{sin. } \varphi} : s' = \frac{AC}{\text{sin. } \varphi} : AB$. But $\frac{AB}{AC} = \text{sin. } \varphi$; therefore, $t^2 : t'^2 = \frac{AC^2}{AB} : AB$, and taking equal multiples of these two last terms, that is, multiplying them by AB, we have $t^2 : t'^2 = AC^2 : AB^2$, or $t : t' = AC : AB$. Hence the time of descending along AF and AC, are as AF and AC.

222. Cor. 5. The velocities acquired by descending any planes AC, AF, are as the square roots of their altitudes AB. The velocity acquired by falling through AB is, by the principles of Dynamics, as the square root of AB; and as the velocities at F, C, are equal to that at B, they will also be as the square root of AB.

Prop. II.

223. If a body descend from any point along a number of inclined planes to a horizontal line, its velocity, when it reaches the horizontal line, will be equal to that which it would have acquired by falling in a vertical direction from the given point to the horizontal line.

Fig. 2.

Let AB, BC, CD be a number of planes differently inclined to a horizontal line DN, and let the body be let fall from the point A so as to move along these planes, without losing any of its velocity at the angular points; it will have the same velocity when it reaches the horizontal plane at D, which it would have acquired by falling freely from A to F. It is manifest, from Art. 220. that the velocity of the body when at B will be the same as that of another body which had fallen freely from A to c in a vertical line. The two bodies set out from B and c with the same velocity, and will therefore continue to have the same velocity when they reach the points C, G, because $c\,G = B\,d$. The two bodies again set off from the points C, G with the same celerity, and since $GF = C\,e$, their respective velocities will be equal when they arrive at the points D, F in the horizontal plane. The velocity, therefore, acquired by the body falling along the planes AB, BC, CD is equal to that which is acquired by the same body falling through the vertical line AF.

224. Cor. 1. As the preceding proposition holds true, whatever be the number of inclined planes which lie between the point A and the horizontal line, it will hold true also of any curve line which may be considered as made up of an infinite number of straight lines. And, since the small planes are diminished without limit, the radius is diminished without limit, and therefore the versed sine, or the velocity lost in passing from one plane to another, is diminished without limit (A), consequently, abstracting from friction, a body will ascend or descend a curve surface without losing any of its velocity from the curvature of the surface.

225. Cor. 2. If a body be made to ascend a curve surface, or a system of inclined planes, the vertical height to which it will rise, is equal to that through which it must fall in order to acquire the velocity with which it ascended, abstracting from the effects of friction, and the velocity which is lost in passing from one plane to another. This is obvious, from Dynamics, § 26, 51; for the body experiences the same decrements of velocity in its ascent, as it received increments in its descent.

226. Cor. 3. The same thing will hold if the body is kept in the curve by a string perpendicular to the curve, for the string sustains that part of the weight which was sustained by the curve, since the reaction of the curve surface is in a line perpendicular to the curve.

Scholium.

227. It is obvious, that the body which moves along the system of inclined planes must lose a part of its velocity in passing from one plane to another. By the resolution of motion it will be found that the velocity acquired by falling through any of the planes, is to the velocity lost in passing to the succeeding one, as radius is to the versed sine of the angle formed by the two planes. Or the velocity with which the body enters upon one plane is as the cosine of the angle made by the contiguous planes, divided by the velocity which the body had when it left the preceding plane.

Prop. III.

228. The times of descending two systems of inclined planes similar and similarly situated, are in the subduplicate ratio of their lengths.

Let AB, BC, CD, and $a\,b$, $b\,c$, $c\,d$ be the similar systems of inclined planes, and let T be the time of descending ABCD, and t the time of descending $a\,b\,c\,d$. Fig. 2.

By Cor. 4. Prop. 1. we have

$$\text{Time along AB} : \text{Time along A}\,c = AB : A\,c,$$
$$\text{Time along } a\,b : \text{Time along } \alpha\,\beta = a\,b : \alpha\,\beta,$$

But, on account of the similar triangles ABc, $a\,b\,\beta$, we have,

$$AB : A\,c = a\,b : \alpha\,\beta.$$

Hence (Euclid, Book v. Prop. 11. 16.)

$$\text{Time along AB} : \text{Time along } a\,b = \text{Time along A}\,c : \text{Time along } \alpha\,\beta.$$

(A) See Wood's Principles of Mechanics, p. 58. note; and also Gregory's Mechanics, vol. i. p. 112. where this corollary is demonstrated by the method of fluxions.

In the same way it may be shewn, that

$$\text{Time along BC : Time along } bc = \text{Time along } c\text{G : Time along } \beta\varkappa,$$
$$\text{Time along CD : Time along } cd = \text{Time along GF : Time along } \varkappa f.$$

Then, by GEOMETRY, Sect. III. Theorem VIII.

Time along AB+BC+CD: Time along $\overline{ab+bc+cd}$=Time along $\overline{\text{A}c+c\text{G}+\text{GF}}$: Time along $\overline{a\beta+\beta\varkappa+\varkappa f}$, that is,

$$\text{Time along } \overline{\text{AB}+\text{BC}+\text{CD}} : \text{Time along } \overline{ab+bc+cd} = \text{Time along AF : Time along } af.$$

But by DYNAMICS §. 37, 2.

$$\text{Time along AF : Time along } af = \sqrt{\text{AF}} : \sqrt{af},$$

Therefore, EUCLID, B. V. Prop. 11.

$$\text{Time along } \overline{\text{AB}+\text{BC}+\text{CD}} : \text{Time along } \overline{ab+bc+cd} = \sqrt{\text{AF}} : \sqrt{af}. \quad \text{Q. E. D.}$$

But by similar triangles, &c.

$$\sqrt{\text{AF}} : \sqrt{af} = \sqrt{\text{AB}+\text{BC}+\text{CD}} : \sqrt{ab+bc+cd}.$$

Therefore,

$$\text{Time along } \overline{\text{AB}+\text{BC}+\text{CD}} : \text{Time along } \overline{ab+bc+cd} = \sqrt{\text{AB}+\text{BC}+\text{CD}} : \overline{ab+bc+cd}. \quad \text{Q. E. D.}$$

229. COR. 1. This proposition holds true of curves, for the reasons mentioned in Prop. 2. Cor. 1.

230. COR. 2. The times of descent along similar arcs of a circle are as their radii; for by the preceding corollary the times are as the arcs, and the arcs are as the radii, therefore the times are as the radii.

PROP. IV.

Fig. 4. 231. An inverted semi-cycloid is the curve of quickest descent, or the curve along which a body must descend in order to move between two points not in a vertical line, in the least time possible.

Let q FZ be a semicycloid, and A′D′, C′F′ two parallel and vertical ordinates at an infinitely small distance. Draw the ordinate B′E′ an arithmetical mean between the ordinates A′D′ and C′F′, and from F′,E′ draw F′v, E′u perpendicular to B′F′, C′E′. Make C′F′=a, B′E′=b, E′v=c, C′B′=m, B′A′=n. Then since F′E′ may be considered as a straight line, and since B′C′=F′v, we have (Euclid, B. I. Prop. 47.) F′E′=$\sqrt{m^2+c^2}$, and since F′v=E′u, E′D′=$\sqrt{n^2+c^2}$. Now the velocities at F′ and E′ vary as $\sqrt{a}$ and $\sqrt{b}$, and F′E′, E′D′ are the elementary spaces described with these velocities; but the times are directly as the square root of the spaces, and inversely as the velocities, therefore the time of describing F′E′ is $\frac{\sqrt{m^2+c^2}}{\sqrt{a}}$, and the time of describing E′D′ is $\frac{\sqrt{n^2+c^2}}{\sqrt{b}}$, consequently, the time of describing F$\dot{\text{D}}$ must be $\frac{\overline{m^2+c^2}|^{\frac{1}{2}}}{a^{\frac{1}{2}}}+\frac{\overline{n^2+c^2}|^{\frac{1}{2}}}{b^{\frac{1}{2}}}$. But the proposition requires that this time should be the least possible or a minimum, therefore taking its fluxion and making it equal to 0, we have

$$\frac{2m\dot{m}}{2\sqrt{a\times mm+c^2}}+\frac{2n\dot{n}}{2\sqrt{b\times nn+c^2}}=0.$$

But since CA is invariable $m+n$ is invariable, and therefore its fluxion $\dot{m}+\dot{n}=0$, or $\dot{m}=-\dot{n}$ and $\dot{n}=-\dot{m}$, therefore by transposing the second member of the preceding equation, and substituting these values of $\dot{m}$ and $\dot{n}$, it becomes $\frac{m}{\sqrt{a\times m^2+c^2}}=\frac{n}{\sqrt{b\times n^2+c^2}}$. Let us now call the variable abscissa q C′=x, the ordinate C′F′=y, and the arc q F′=z, then m and n are fluxions of x, and F′E′ is the increment of q F or z, when y is equal to a, and E′D′ the increment of q F or z, when y is equal to b, therefore by substituting these values in the preceding equation, we obtain $\frac{x'}{\sqrt{yz'}}=\frac{x'}{\sqrt{yz''}}$, which shews that this quantity is constant, and gives us the following analogy, $z':x'=1:\sqrt{y}$. Now in the cycloid $\sqrt{y}$ is always the chord of the generating circle when the diameter is y (for by Euclid, Book. I. Prop. 47, Book. II. Fig. 5.
Prop. 8. and Book III. Prop. 35.) AF=$\sqrt{\text{AD}\times\text{AO}}$, and since AO=1 and AD=$y$, we have AF=$\sqrt{y}$. But since the arc of the cycloid at F is perpendicular to the chord AF, the elementary triangle FEv is similar to FDO, (for BE is parallel to AO) and consequently to AFO (Euclid. B. VI. Prop. 8.), therefore, we have FE : E′z'=AO : AF; but FE=x', Ev=v, AO=1 and AF=$\sqrt{y}$, consequently $z':x'=1:\sqrt{y}$, which coincides with the analogy already obtained, and being the property of the cycloid shews that the curve of quickest descent is an inverted cycloidal arc.

Properties of the Cycloid.

DEFINITION.—If a circle NOP be so placed as to be in contact with the line AD, and be made to roll along that line from D towards A, till the same point D of the circle touches the other extremity A, the point D will describe a curve DBA, called a cycloid. Fig Properties of the cycloid.

The line AD is called the *base of the cycloid*; the line CB, which bisects AD at right angles and meets the curve in B, is called the *axis*, and B the *vertex*.

The circle NOP is called the generating circle.

232. 1. The

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232. 1. The baſe AD is equal to the circumference of the generating circle, and AC is equal to half that circumference.

2. The axis CB is equal to the diameter of the generating circle.

3. If from any point G of the cycloid, there be drawn a ſtraight line GM parallel to AD, and meeting the circle BLC in L, the circular arc BL is equal to the line GL.

4. If the points L, B be joined, and a tangent drawn to the cycloid at the point G, the tangent will be parallel to the chord LB, and the tangent is found by joining G, E, for GE is parallel to LB.

5. The arc BG of the cycloid is double of the chord BL, and the arc BA or BD is equal to twice the axis BC.

6. If the two portions AB, DB of the cycloid in fig. 3. be placed in the inverted poſition AB, DB (fig. 4.), and if a ſtring BP equal in length to BA be made to coincide with BA, and then be evolved from it, its extremity P will deſcribe a ſemicycloid AF, ſimilar and equal to BA. In the ſame way the ſemicycloid DF, produced by the evolution of the ſtring BP from the ſemicycloid BD, is equal and ſimilar to BD and to AF. Therefore, if BP be a pendulum or weight attached to the extremity of a flexible line BP, which vibrates between the cycloidal cheeks BA, BD, its extremity D will deſcribe a cycloid AFD, equal to that which is compoſed of the two halves BA, BD. Fig. 4.

7. The chord CN is parallel to MP, and MP is perpendicular to the cycloid AFD, at the point P.

8. If Pp be an infinitely ſmall arc, the perpendicular to the curve drawn from the points Pp will meet at M, and Pp may be regarded as a circular arc, whoſe radius is MP. An infinitely ſmall cycloidal arc at F may likewiſe be conſidered as a circular arc whoſe radius is BF.

As theſe properties of the cycloid are demonſtrated in almoſt every treatiſe on mechanics, and as their demonſtrations more properly belong to geometry than to mechanics, they are purpoſely omitted to make room for more important matter.

233. Definition.—If a body deſcend from any point of a curve, and aſcend in the ſame curve till its velocity is deſtroyed, the body is ſaid to oſcillate in that curve, and the time in which this deſcent and aſcent are performed is called the time of an oſcillation or vibration.

234. Definition.—A cycloidal pendulum is a pendulum which oſcillates or vibrates in the arch of a cycloid.

235. Definition.—Oſcillations which are performed in equal times are ſaid to be iſochronous.

Prop. V.

Fig. 4. 236. The velocity of a cycloidal pendulum BP at the point F, varies as the arch which it deſcribes.

The velocity of the pendulum at F is that which it would have acquired by falling through EF (Prop. 2. and Cor 3. Prop. 2.), and the velocity of a falling body is as the ſquare root of the ſpace which it deſcribes (Dynamics, §. 37.), therefore the velocity of the pendulum P, when it reaches F, varies as $\sqrt{EF}$. But (Geometry, Sect. IV. Theor. 23. and 8.) FE varies as $\frac{FN^2}{FC}$, and ſince FC is a conſtant quantity, FE will vary as FN^2 varies, or, to adopt the notation uſed in the article Dynamics, $FE \doteqdot FN^2$, or $\sqrt{FE} \doteqdot FN$, but the velocity acquired by falling through EF varies as $\sqrt{FE}$, therefore the velocity of the pendulum at F varies as FN, that is, as FP, for (Art. 232. N° 5.) FN is equal to half FP. Q. E. D. Theory.

Prop. VI.

237. If the pendulum begins its oſcillation from the point P, the velocity of the pendulum at any point R varies as the ſine of a circular arc whoſe radius is FP, and whoſe verſed ſine is PR.

Through F draw p F q parallel to AD, and with a radius equal to the cycloidal arc FP, deſcribe the ſemicircle $p\,o\,q$. Make $p\,r$ equal to the arc PR of the cycloid, and through r draw $r\,m$ perpendicular to p F. Through the points P, R draw PE, RT parallel to AD, and cutting the generating circle CNF in the points N, S.—By Prop. 4. the velocity at R varies as $\sqrt{ET}$, that is, as $\sqrt{EF-TF}$, or ſince CF is conſtant, as $\sqrt{CF\times EF-CF\times TF}$, that is, as $\sqrt{FN^2-FS^2}$, (For, Playfair's Euclid, Book. I. Prop. 47, Book II. Prop. 7. and Book. III. Prop. 35; $FN^2=CF\times EF$, and $FS=CF\times TF$), that is, as $\sqrt{4FN^2-4FS^2}$, that is (Art. 232. N° 5.) as $\sqrt{FP^2-FR^2}$. But Fp or Fm was made equal to FP, and, $p\,r$ being made equal to PR, the remainder Fr muſt be equal to FR, therefore, the velocity at R varies as $\sqrt{Fm^2-Fr^2}$, but (Euclid 47. 1.) $rm=\sqrt{Fm^2-Fr^2}$, and $r\,m$ is by conſtruction equal to the ſine of a circular arc, whoſe radius is FP, and verſed ſine PR, conſequently, the velocity at R varies as the ſine of that arc. Q. E. D. Fig. 4.

238. Corollary. The velocity of the pendulum at F is to the velocity of the pendulum at R, as F$m : r\,m$, for the verſed ſine is in this caſe equal to radius, and therefore the correſponding arc muſt be a quadrant whoſe ſine is alſo equal to radius or Fm.

Prop. VII.

239. The time in which the pendulum performs one complete oſcillation from P to O, is equal to the time in which a body would deſcribe the ſemicircle $p\,o\,q$, uniformly with the velocity which the pendulum acquires at the point F. Fig. 4.

Take any infinitely ſmall arc RV, and making $r\,v$ equal to it, draw $v\,o$ parallel to $r\,m$, and $m\,n$ to $r\,v$. Now, by the laſt propoſition, and by Dynamics, Art. 28.; the velocity with which RV is deſcribed is to the velocity with which $m\,o$ is deſcribed as $r\,m$ is to Fm, that

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that is as $\frac{RV}{rm} : \frac{mo}{Fm}$, or as $\frac{mn}{rm} : \frac{mo}{Fm}$, for $mn = rv = RV$. But in the similar triangles Fmr, mno, $Fm : rm = mo : mn$, consequently $\frac{mn}{rm} = \frac{mo}{Fm}$, therefore the velocity with which RV is described is equal to the velocity with which mo is described, and the times in which these equal spaces are described must likewise be equal. The same thing may be demonstrated of all the other corresponding arcs of the cycloid and circle, and therefore it follows that the time in which the pendulum performs one complete oscillation is equal to the time in which the semicircle poq is uniformly described with the velocity acquired at F.

Prop. VIII.

240. **The time in which a cycloidal pendulum performs a complete oscillation is to the time in which a body would fall freely through the axis of the cycloid, as the circumference of a circle is to its diameter.**

Fig. 4. Since $FP = 2FN$, and since the velocity acquired by falling down NF is equal to the velocity acquired by falling down PF, the body, if it continued to move uniformly with this velocity, would describe a space equal to 2PF (Dynamics, § 37. N° 6.) in the same time that it would descend NF or CF (Art. 219). Calling T therefore the time of an oscillation, and t the time of descent along the axis, we have, by the preceding proposition,

T = time along poq, with the velocity at F,

and by the preceding paragraph,

t = time along Fp, with the same velocity; therefore

$T : t$ = time along poq with velocity at V : time along Fp with the same velocity; that is, $T : t = poq : Fp = 2poq : 2Fp$ = the circumference of a circle : its diameter.

241. Cor. 1. The oscillations in a cycloid are isochronous, that is, they are performed in equal times whatever be the size of the arc which the pendulum describes. For the time of an oscillation has a constant ratio to the time of descent along the axis, and is therefore an invariable quantity.

242. Cor. 2. The oscillations in a small circular arc whose radius is BF, and in an equal arc of the cycloid, being isochronous (Art. 232. N° 8.), the time of an oscillation in a small circular arc will also be to the time of descent along the axis, as the circumference of a circle is to its diameter.

243. Cor 3. Since the length BF of the pendulum is double of the axis CF, the time of an oscillation in a cycloid or small circular arc varies as the time of descending along CF, half the length of the pendulum, the force of gravity being constant. But the time of descent along CF varies as $\sqrt{CF}$, therefore the time of an oscillation in a small circular or cycloidal arc varies as the square root of half the length of the pendulum, or as the square root of its whole length. If T, t therefore be the times of oscillations of two pendulums, and L, l their respective lengths, we have by this corollary $T : t = \sqrt{L} : \sqrt{l}$, and $T \times \sqrt{l} = t \times \sqrt{L}$; hence $T = \frac{t \times \sqrt{L}}{\sqrt{l}}$; $t = \frac{T \times \sqrt{l}}{\sqrt{L}}$; $l = \sqrt{\frac{t \times \sqrt{L}}{T}}$, and $L = \sqrt{\frac{T \times \sqrt{l}}{t}}$, from which we may find the time in which a pendulum of any length will vibrate; a pendulum of 39.2 inches vibrating in one second.

244. Cor. 4. When the force of gravity varies, which it does in going from the poles to the equator, the time of an oscillation is directly as the square root of the length of the pendulum, and inversely as the square root of the force of gravity. The time of an oscillation varies as the time of descent along half the length of the pendulum, and the time of descent through any space varies as $\frac{\sqrt{s}}{\sqrt{g}}$, where s is the space described and g the force of gravity; but in the present case $s = \frac{L}{2}$; therefore, by substitution, the time of descent along half the length of the pendulum, or the time of an oscillation, varies as $\frac{\sqrt{\frac{1}{2}L}}{\sqrt{g}}$, or as $\frac{\sqrt{L}}{\sqrt{g}}$. Hence $T : t = \frac{\sqrt{L}}{\sqrt{g}} : \frac{\sqrt{l}}{\sqrt{g}}$, from which it is easy to deduce equations similar to those given in the preceding corollary.

245. Cor. 5. Since $T \doteq \frac{\sqrt{L}}{\sqrt{g}}$, $\sqrt{g} \times T \doteq \sqrt{L}$; and if the time of oscillation is 1 second, we have $\sqrt{g} \doteq \sqrt{L}$, or $g \doteq L$, that is, the force of gravity in different latitudes varies as the length of a pendulum that vibrates seconds.

246. Cor. 6. The number of oscillations which a pendulum makes in a given time, and in a given latitude, are in the inverse subduplicate ratio of its length. The number of oscillations n made in a given time are evidently in the inverse ratio of t, the time of each oscillation; that is $n \doteq \frac{1}{t}$; but by Corollary 3. $t \doteq \sqrt{l}$, therefore $n \doteq \frac{1}{\sqrt{l}}$, and $l \doteq \frac{1}{n^2}$, from which it is easy to find the length of a pendulum which will vibrate any number of times in a given time, or the number of vibrations which a pendulum of a given length will perform in a given time.

Prop. IX.

247. **To find the space through which a heavy body will fall in one second by the force of gravity.**

Since by Proposition 8. the time of an oscillation : time along half the length of the pendulum as 3.14159 is to 1, and since the spaces are as the squares of the times, the spaces described by a heavy body in the time of an oscillation will be to half the length of the pendulum as $\overline{3.14159}|^2$ is to 1. Now it appears from the experiments of Mr Whitehurst, that the length of a pendulum which vibrates seconds at London at 113 feet above the level of the sea, in a temperature of 60°

Theory. 60° of Fahrenheit, and when the barometer is 30 inches, is 39.1196 inches; hence $1^2 : \overline{3.14159}|^2 = \frac{39.1196}{2} : 19.5598 \times \overline{3.14159}|^2 = 16.087$ feet the ſpace required.

The methods of determining the centre of oſcillation, gyration, and percuſſion, properly belong to this chapter, but they have been already given in the article Rotation, to which we muſt refer the reader who wiſhes to proſecute the ſubject.

Chap. VI. *On the Colliſion or Impulſion of Bodies.*

248. Def. 1. When a body moving with a certain velocity ſtrikes another body, either at reſt or in motion, the one is ſaid to impinge againſt, or to impell the other. This effect has been diſtinguiſhed by the names colliſion, impulſion or impulſe, percuſſion, and impact.

249. Def. 2. The colliſion or impulſion of two bodies is ſaid to be *direct* when the bodies move in the ſame ſtraight line, or when the point in which they ſtrike each other is in the ſtraight line which joins their centres of gravity. When this is not the caſe, the impulſe is ſaid to be oblique.

250. Def. 3. A *hard* body is one which is not ſuſceptible of compreſſion by any finite force. An *elaſtic* body is one ſuſceptible of compreſſion, which recovers its figure with a force equal to that which compreſſes it. A *ſoft* body is one which does not recover its form after compreſſion. There does not exiſt in nature any body which is either perfectly hard, perfectly elaſtic or perfectly ſoft. Every body with which we are acquainted poſſeſſes elaſticity in ſome degree or other. Diamond, cryſtal, agate, &c. though among the hardeſt bodies, are highly elaſtic; and even clay itſelf will in ſome degree recover its figure after compreſſion. It is neceſſary, however, to conſider bodies as hard, ſoft, or elaſtic, in order to obtain the limits between which the required reſults muſt be contained.

251. Def. 4. The maſs of a body is the ſum of the material particles of which it is compoſed; and the *momentum*, or *moving force*, or *quantity of motion* of any body is the product ariſing from multiplying its maſs by its velocity.

Prop. I.

252. Two hard bodies B, B′ with velocities V, V′ ſtriking each other perpendicularly, will be at reſt after impulſe, if their velocities are inverſely as their maſſes.

1. When the two bodies are equal, their velocities muſt be equal in the caſe of an equilibrium after impulſe, and therefore $B : B' = V' : V$, or $BV = B'V'$; for if they are not at reſt after impulſe, the one muſt carry the other along with it: But as their maſſes and velocities are equal, there can be no reaſon why the one ſhould carry the other along with it.

2. If the one body is double of the other, or $B = 2B'$, we ſhould have $V' = 2V'$. Now inſtead of B we may ſubſtitute two bodies equal to B′, and inſtead of V′ we may ſubſtitute two velocities equal to V, with which the bodies B′ may be conceived to move; conſequently we have $2B' \times V = B' \times 2V$, or $B' : 2B' = V : 2V$; but 2V is the velocity of B′, and V is the velocity of 2B′, therefore when one body is double of the other, they will remain at reſt when the maſſes of the bodies are inverſely as their velocities. Theory.

In the ſame way the propoſition may be demonſtrated when the bodies are to one another in any commenſurable proportion.

Prop. II.

253. To find the common velocity v of two hard bodies B, B′ whoſe velocities are V, V′, after ſtriking each other perpendicularly.

If the bodies have not equal quantities of motion they cannot be in equilibrio after impulſe. The one will carry the other along with it, and in conſequence of their hardneſs, they will remain in contact, and move with a common velocity v.

1. In order to find this, let us firſt ſuppoſe B′ to be at reſt and to be ſtruck by B in motion. The quantity of motion which exiſts in B before impulſe is BV, and as this is divided between the two bodies after impulſe, it muſt be equal to the quantity of motion after impulſe. But $v \times \overline{B+B'}$ is the quantity of motion after impulſe, therefore $v \times \overline{B+B'} = BV$, and $v = \frac{BV}{B+B'}$.

2. Let us now ſuppoſe that both the bodies are in motion in the ſame direction that B follows B′. In order that B may impel B′, we muſt have V greater than V′. Now we may conceive both the bodies placed upon a plane moving with the velocity V′. The body B′, therefore, whoſe velocity is V′ equal to that of the plane, will be at reſt upon the plane, while the velocity of B with regard to B′, or the plane, will be $V - V'$; conſequently, the bodies are in the ſame circumſtances as if B′ were at reſt, and B moving with the velocity $V - V'$. Therefore, by the laſt caſe, we have the common velocity of the bodies in the moveable plane $\frac{BV - BV'}{B+B'}$; and by adding to this V′, the velocity of the plane, we ſhall have v, or the abſolute velocity of the bodies after impulſe, $v = \frac{BV + B'V'}{B+B'}$. Hence the quantity of motion, after impact, is equal to the ſum of the quantities of motion before impact.

3. If the impinging bodies mutually approach each other, we may conceive, as before, that the body B′ is at reſt upon a plane which moves with a velocity V′ in an oppoſite direction to V, and that B moves on this plane with the velocity $V + V'$. Then, by Caſe 1. $\frac{BV + BV'}{B+B'}$ will be the common velocity upon the plane after impulſe; and adding to this V′, or the velocity of the plane, we ſhall have v, or the abſolute velocity of the bodies after impact, $v = \frac{BV - B'V'}{B+B'}$. Hence the quantity of motion after impact is equal to the difference of the quantities of motion before impact. It is obvious that v is poſitive or negative, according as BV is greater or leſs than B′V′, ſo that when BV is greater than B′V′, the bodies will move in the direction of B's

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B's motion; and when BV is less than B′V′, the bodies will move in the direction of A's motion.

254. All the three formulæ which we have given, may be comprehended in the following general formula, $v=\frac{BV\pm B'V'}{B+B'}$; for when B′ is at rest, $V'=0$, and the formula assumes the form which it has in Case 1.

255. Cor. 1. If $B=B'$, and the bodies mutually approach each other, the equation in Case 3. becomes $v=\frac{V-V'}{2}$, or the bodies will move in the direction of the quickest body, with a velocity equal to one half of the difference of their velocities.

256. Cor. 2. If $V=V'$, and the bodies move in the same direction, the last formula will become $v=V\times\frac{B+B'}{B+B'}$, or $v=V$; for in this case there can be no impulsion, the one body merely following the other in contact with it. When the bodies mutually approach each other, and when $V=V'$, we have $v=V\times\frac{B-B'}{B+B'}$.

257. Cor. 3. When the bodies move in the same direction, we have, by Case 2. $v=\frac{BV+BV'}{B+B'}$. Now the velocity gained by B′ is evidently $v-V'$, or $\frac{BV+B'V'}{B+B'}-V'=\frac{BV-BV'}{B+B'}$; hence $B+B':B=V-V':\frac{BV-BV'}{B+B'}$; but this last term is the velocity gained by B, and $V-V'$ is the relative velocity of the two bodies. Therefore, *in the impact of two hard bodies moving in the same direction*, $B+B'$: B *as the relative velocity of the two bodies is to the velocity gained by* B′. It is obvious also, that the velocity lost by B is $V-v=V-\frac{BV+B'V'}{B+B'}$ or $\frac{B'V-B'V'}{B+B'}$; hence $B+B':B'=V-V':\frac{B'V-B'V'}{B+B}$; but this last term is the velocity lost by B, and $V-V'$ is the relative velocity of the bodies, therefore *in the impact of two hard bodies* $B+B'$: B′ *as their relative velocity is to the velocity lost by* B. The same thing may be shewn when the bodies move in opposite directions, in which case their relative velocity is $V+V'$.

Prop. III.

258. To determine the velocities of two elastic bodies after impulse.

If an elastic body strikes a hard and immoveable plane, it will, at the instant of collision, be compressed at the place of contact. But as the elastic body instantaneously endeavours to recover its figure, and as this force of restitution is equal and opposite to the force of compression, it will move backwards from the plane in the same direction in which it advanced.—If two elastic bodies, with equal momenta, impinge against each other, the effect of their mutual compression is to destroy their relative velocity, and make them move with a common velocity, as in the case of hard bodies. But by the force of restitution, equal to that of compression, the bodies begin to recover their figure,—the parts in contact serve mutually as points of support, and the bodies recede from each other. Now, before the force of restitution began to exert itself, the bodies had a tendency to move in one direction with a common momentum; therefore, the body whose effort to recover its figure was in the same direction with that of the common momentum, will move on in that direction, with a momentum or moving force equal to the sum of the force of restitution and the common momentum; while the other body, whose effort to recover from compression is in a direction opposite to that of the common momentum, will move with a momentum equal to the difference between its force of restitution and the common momentum, and in the direction of the greatest of these momenta: After impulse, therefore, it either moves in the direction opposite to that of the common momentum, or its motion in the same direction as that of the common momentum is diminished, or it is stopped altogether, according as the force of restitution is greater, less, or equal to the common momentum.

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259. In order to apply these preliminary observations, let us adopt the notation in the two preceding propositions, and let v be the common velocity which the bodies would have received after impulse, if they had been hard, and v', v'' the velocities which the elastic bodies B, B′ receive after impact.

260. 1. If B follows B′, then V is greater than V′, and when B has reached B′, they are both compressed at the point of impact. Hence, since v is the common velocity with which they would advance if the force of restitution were not exerted, we have $V-v=$ the velocity lost by B, and $v-V'=$ the velocity gained by B′ in consequence of compression.—But, when the bodies strive to recover their form by the force of restitution, the body B will move backwards in consequence of this force, while B′ will move onward in its former direction with an accelerated velocity. Hence, from the force of restitution, B will again lose the velocity $V-v$, and B′ will, a second time, gain the velocity $v-V'$; consequently, the whole velocity lost by B is $2V-2v$, and the whole velocity gained by B′ is $2v-2V'$. Now, subtracting this loss from the original velocity of B, we have $V-\overline{2V-2v}$, for the velocity of B after impact, and adding the velocity gained by B to its original velocity, we have $V'+\overline{2v-2V'}$ for the velocity of B′ after impact; hence we have

$$v'=V-\overline{2V-2v}=2v-V$$
$$v''=V'+\overline{2v-2V'}=2v-V.$$

Now, substituting in these equations, the value of v as found in Case 2. Prop. 2. we obtain

$$v'=\frac{BV-B'V+2B'V'}{B+B'}$$
$$v''=\frac{BV'-B'V'+2BV}{B+B'}.$$

261. 2. When the bodies move in opposite directions or mutually approach each other, the body B is in precisely the same circumstances as in the preceding case; but

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but the body B′ loſes a part of its velocity equal to $2v+2V'-V'$. Hence we have, by the ſame reaſoning that was employed in the preceding caſe,

$$v'=2v-V'$$
$$v''=2v+V',$$

and by ſubſtituting inſtead of v its value, as determined in Caſe 3. Prop. 2. or by merely changing the ſign of V′ in the two laſt equations in the preceding corollary, we obtain the two following equations, which will anſwer for both caſes, by uſing the upper ſign when the bodies move in the ſame direction, and the under ſign when they move in oppoſite directions.

$$v'=\frac{BV-B'V\pm 2B'V'}{B'+B'}$$
$$v''=\frac{\pm BV'\pm B'V'+2BV}{B+B'}.$$

From the preceding equation the following corollaries may be deduced.

262. Cor. 1. The velocity gained by the body that is ſtruck, and the velocity loſt by the impinging body, are twice as great in elaſtic as they are in hard bodies; for in hard bodies the velocities gained and loſt were $v-V'$, and $V-v$; whereas in elaſtic bodies the velocities gained and loſt were $2v-2V'$, and $2V-2v$.

263. Cor. *If one of the bodies, ſuppoſe* B′, *is at reſt*, its velocity $V'=0$, and the preceding equation becomes

$$v'=\frac{VB-VB'}{B+B'};\ v''=\frac{2VB}{B+B'}.$$

264. Cor. 3. If one of the bodies B′ is at reſt, and their maſſes equal, we have $B=B'$, and $V'=o$, by ſubſtituting which in the preceding formulæ, we obtain $v'=o$, and $v''=V$; that is, the impinging body B remains at reſt after impact, and the body B′ that is ſtruck when at reſt moves on with the velocity of the body B that ſtruck it, ſo that there is a complete transfer of B's velocity to B′.

265. Cor. 4. If B′ is at reſt and B greater than B′, both the bodies will move forward in the direction of B's motion; for it is obvious from the equations in Cor. 2. that when B is greater than B′, v' and v'' are both poſitive.

266. Cor. 5. If B′ is at reſt, and B leſs than B′, the impinging body B will return backwards, and the body B′ which is ſtruck will move forward in the direction in which B moved before the ſtroke. For it is evident that when B is leſs than B′, v' is negative, and v'' poſitive.

267. Cor. 6. *If both the bodies move in the ſame direction*, the body B′ that is ſtruck will after impact move with greater velocity than it had before it. This is obvious from the formula in Caſe 1. of this propoſition.

268. Cor. 7. *If the bodies move in the ſame direction*, and if $B=B'$, there will at the moment of impact be a mutual transfer of velocities, that is, B will move on with B′'s velocity, and B′ will move on with B's velocity, For in the formulæ in Caſe 1. when $B=B$, we have $v'=V'$ and $v''=V$.

269. Cor. 8. *When the bodies move in oppoſite directions*, or mutually approach other, and when $B=B'$ and $V=V'$, both the bodies will recoil or move backwards after impact with the ſame velocities which they had before impact. For in the formulæ in Caſe 2. with the inferior ſigns, when $B=B'$ and $V=V'$, we have $v'=-V$ and $v''=V'$.

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270. Cor. 9. If the bodies move in oppoſite directions, and $V=V'$, we have $v'=V\times\frac{B-3B'}{B+B'}$, and $v''=V\times\frac{3B-B'}{B+B'}$. Hence it is obvious, that if $B=3B'$, or if one of the impinging bodies is thrice as great as the other, the greateſt will be ſtopped, and the ſmalleſt will recoil with a velocity double of that which it had before impact. For ſince $B=3B'$, by ſubſtituting this value of B in the preceding equations, we obtain $v'=o$, and $v''=2V$.

271. Cor. 10. If the impinging bodies move in oppoſite directions, and if $B=B'$, they will both recoil after a mutual exchange of velocities. For when $B=B'$, we have $v'=-V'$, and $v''=V$.

272. Cor. 11. When the bodies move in oppoſite directions, the body which is ſtruck, and the body which ſtrikes it, will ſtop, continue their motion or return backwards according as $BV-B'V$ is equal to, or greater or leſs than $2B'V'$.

273. Cor. 12. The relative velocity of the bodies after impact, is equal to their relative velocity before impact, or, which is the ſame thing, at equal inſtants before and after impact, the diſtance of the bodies from each other is the ſame. For in the different caſes we have $v'=2v-V$; $v''=2v\mp V'$. But the relative velocity before impact is in the different caſes $V\mp V'$, and the relative velocity after impact is $v'-v.'=V\mp V'$.

274. Cor. 13. By reaſoning ſimilar to that which was employed in Prop. 2. Cor. 3. it may be ſhewn that $B+B':2B$ as their relative velocity before impact is to the velocity gained by B′ in the direction of B's motion; and $B+B':2B'$ as their relative velocity before impact is to the velocity loſt by B in the direction of A's motion.

275. Cor. 14. The *vis viva*, or the ſum of the products of each body multiplied by the ſquare of its velocity, is the ſame before and after impact, that is, $Bv'^2+B'v''^2=BV^2+B'V'^2$. From the formulæ at the end of Caſe 2. we obtain

$$Bv^2=\frac{\overline{B-B'}|^2\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2}\text{ and}$$

$$B'v'^2=\frac{4BB'\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2},\text{ hence their ſum } Bv'^2\times B'v''^2$$

$$=\frac{\overline{B-B'}|^2\times\overline{BV^2+B'V'^2}+4BB'\times\overline{BV^2+B'V'^2}}{\overline{B+B'}|^2}=$$

$$\frac{\overline{BV^2+B'V'^2}\times\overline{B-B'^2+4BB'}}{\overline{B+B'^2}}=BV^2+B'V'^2.$$

276. Cor. 14. If ſeveral equal elaſtic bodies B, B″, B‴, B⁗, &c. are in contact, and placed in the ſame ſtraight line, and if another elaſtic body β of the ſame magnitude impinges againſt B, they will remain at reſt, except the laſt body B⁗, which will move on with the velocity of β. By Art. 264. B will transfer to

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to B″ all its velocity, and therefore B will be at rest, in the same way B″ will transfer to B‴ all its velocity, and B″ will remain at rest, and so on with the rest; but when the last body B⁗ is set in motion, there is no other body to which its velocity can be transferred, and therefore it will move on with the velocity which it received from B‴, that is, with the velocity of β.

277. Cor. 15. If the bodies decrease in size from B to B⁗, they will all move in the direction of the impinging body β, and the velocity communicated to each body will be greater than that which is communicated to the preceding body.

278. Cor. 16. If the bodies increase in magnitude, they will all recoil, or move in a direction opposite to that of β, excepting the last, and the velocity communicated to each body will be less than that which is communicated to the preceding body.

Prop. IV.

279. To determine the velocities of two imperfectly elastic bodies after impulse, the force of compression being in a given ratio to the force of restitution or elasticity.

Let B, B′ be the two bodies, V, V′ their velocities before compact, v', v'' their velocities after impact, and $1 : n$ as the force of compression is to that of restitution. It is evident from Case 1. Prop. 8. that in consequence of the force of compression alone we have,

$$\left.\begin{array}{l} V-v = \text{velocity lost by B} \\ v-V' = \text{velocity gained by B}' \end{array}\right\} \text{from compression.}$$

But the velocity which B loses and B′ gains by the force of compression will be to the velocity which B loses and B′ gains by the force or restitution or elasticity as $1 : n$; hence

$$\left.\begin{array}{l} 1 : n = V-v : nV-nv, \text{ the velocity lost by B} \\ 1 : n = v-V' : nv-nV' \text{ the velocity gained by B} \end{array}\right\} \text{from elasticity.}$$

therefore by adding together the two portions of velocity lost by B, and also those gained by B′, we obtain

$$\overline{1+n}\,V-\overline{1+n}\,v, \text{ the whole velocity lost by B,}$$
$$\overline{1+n}\,v-\overline{1+n}\,V', \text{ the whole velocity gained by B}$$

Hence by subtracting the velocity lost by B in consequence of collision from its velocity before impact, we shall have v' or the velocity of B after impact, and by adding the velocity gained by B′ after collision to its velocity before impact, we shall find v'' or the velocity of B′ after impact, thus

$$v'=V-\overline{1+nV-1+n\,v} \text{ the velocity of B after impact.}$$
$$v''=V'+1+nv-1+nV' \text{ the velocity of B}' \text{ after impact.}$$

Now by substituting in the place of v its value as determined in Case 2. Prop. 2. we obtain

$$v'=V-\frac{\overline{1+n}\times\overline{B'V}-\overline{B'V'}}{B+B'}.$$

$$v''=V'+\frac{\overline{1+n}\times BV-BV'}{B+B'}.$$

280. Cor. 1. Hence by converting the preceding equation into analogies, $B+B. : \overline{1+n}\times B$ as the relative velocity of the bodies before impact is to the velocity gained by B′ in the direction of B's motion; and $B+B' : 1+n\times B'$ as the relative velocity of the bodies before impact is to the velocity lost by B.

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281. Cor. 2. The relative velocity before impact is to the relative velocity after impact as the force of compression is to the force of restitution, or as $1 : n$.

The relative velocity after impact is $v''-v'$, or taking the preceding values of these quantities $v''-v'=V'$

$$+\frac{\overline{1+n\times\overline{BV-BV'}}}{B+B'}-V-\frac{\overline{1+n\times B'V-B'V'}}{B+B'}=V'-V+\frac{1+n\times\overline{B+B'}\times\overline{V-V'}}{B+B'},$$

dividing by $B+B'$ we have $v''-v'=V'-V+V-V'+\overline{n\times V-V'}=n\times\overline{V-V'}$ = the relative velocity after impact. But the relative velocity before impact is $V-V'$, and $V-V' : n\times\overline{V-V'}=1 : n$. Q. E. D. The quantity V′ has evidently the negative sign when the bodies move in opposite directions.

282. Cor. 3. Hence from the velocities before and after impact we may determine the force of restitution or elasticity.

Prop. V.

283. To find the velocity of a body, and the direction in which it moves after impinging upon a hard and immoveable plane.

284. Case 1. *When the impinging body is perfectly hard.* Let AB be the hard and immoveable plane, and let the impinging body move towards AB in the direction CD, and with a velocity represented by CD. Then the velocity CD may be resolved into the two velocities CM, MD, or MD, FD; CMDF being a parallelogram. But the part of the velocity FD, which carries the body in a line perpendicular to the plane, is completely destroyed by impact, while the other part of the velocity MD, which carries the body in a line parallel to the plane, will not be affected by the collision, therefore the body will, after impact, move along the plane with the velocity MD. Now, CD : MD = radius : cos. ∠CDM, therefore since MD = CF the sine of the angle of incidence CDF, the *velocity before impact is to the velocity after impact, as radius is to the sine of the angle of incidence;* and since AM = CD—MD, *the velocity before impact is to the velocity lost by impact, as radius is to the versed sine of the complement of the angle of incidence.*

When the body is perfectly hard. Fig. 6.

285. Case 2. *When the impinging body is perfectly elastic.* Let the body move in the direction CD with a velocity represented by CD, which, as formerly, may be resolved to MD, FD. The part of the velocity MD remains after impact, and tends to carry the body parallel to the plane. The other part of the velocity FD is destroyed by compression; but the force of restitution or elasticity will generate a velocity equal to FD, but in the opposite direction DF. Consequently the impinging body after impact is solicited by two velocities, one of which would carry it uniformly from D to F in the same time that the other would carry it uniformly from M to D, or from D to N; the body will, therefore

When the body is perfectly elastic.

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therefore, move along DE, the diagonal of the parallelogram DFEN, which is equal to the parallelogram DFCM. Hence the angle CDF is equal to the angle EDF, therefore, when *an elastic body impinges obliquely against an immoveable plane, it will be reflected from the plane, so that the angle of reflexion is equal to the angle of incidence.* Since CD, DE are equal spaces described in equal times, the velocity of the body after impact will be equal to its velocity before impact.

When the body is imperfectly elastic.

286. Case 3. *When the impinging body is imperfectly elastic.* In DF take a point m, so that DF is to Dm as the force of compression is to the force of restitution or elasticity, and having drawn $m\,e$ parallel to DB, and meeting NE in e, join De; then, if the impinging body approach the plane in the direction CD, with a velocity represented by CD, De will be the direction in which it will move after impact. Immediately after compression, the velocity DF is destroyed as in the last case, while the velocity MD tends to carry the body parallel to the plane. But, by the force of restitution, the body would be carried uniformly along Dm, perpendicular to the plane, while, by the velocity MD=DN=$m\,e$, it would be carried in the same time along $m\,e$, consequently, by means of these two velocities, the body will describe De, the diagonal of the parallelogram D$m\,e$N. The velocity, therefore, before impact is to the velocity after impact as DC : De, or as DE : De, or as sin. DeE, sin. DEe, or as sin. Dem : sin. DEe, or as sin. FDe : sin. FDE. Now, by producing De so as to meet the line CE produced in G, we have, on account of the parallels FE, $m\,e$, Dm:DF=$m\,e$: FG; but, FD being radius, FE is the tangent of FDE, or FDG the angle of incidence, and FDG is the tangent of the angle of reflexion FDG: Therefore Dm : DF=tang. $\angle$CDF : tang. $\angle$FDG. Consequently, *when an imperfectly elastic body impinges against a plane,* it will be reflected in such a manner *that the tangent of the angle of reflexion is to the tangent of the angle of incidence, as the force of compression is to the force of restitution or elasticity; and the velocity before incidence will be to the velocity after reflexion, as the sine of the angle of reflexion is to the sine of the angle of incidence.*

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287. When the surface against which the body impinges is curved, we must conceive a plane touching the surface at the place of incidence, and then apply the rules in the preceding proposition. The doctrine of the oblique collision of bodies is of great use both in acoustics and optics, where the material particles which suffer reflexion, are regarded as perfectly elastic bodies.

Prop. VI.

288. To find the point of an immoveable plane which an elastic body moving from a given place must strike, in order that it may, after reflexion, either from one or two planes, impinge against another body whose position is given.

Fig. 7.

289. Case 1. *When there is only one reflexion.* Let C be the place from which the impinging body is to move, and let E be the body which is to be struck after reflexion from the plane AB. From C let fall CH perpendicular to AB, continue it towards C till HG=CH, and join G, E by the line GDE; the point D where this line cuts the plane, is the place against which the body at C must impinge in order that, after reflexion, it may strike the body at E. The triangles CDH,HDG are equiangular, because two sides and one angle of each are respectively equal, therefore the angles DCH, DGH are equal. But on account of the parallels FD, CG the angle EDF=DGC=DCH, and DCH=FDC, therefore the angle of incidence FDC=FDE the angle of reflexion; consequently by Prop. 4. a body moving from C and impinging on the plane at D will, after reflexion, move in the line DE, and strike the body at E.

290. Case 2. *When there are two reflexions.* Let AB, BL be the two immoveable planes, C the place from which the impinging body is to move, and F the body which it is to strike after reflexion from the two planes, it is required to find the point of impact D. Draw CHG perpendicular to AB, so that HG=CH. Through G draw GMN parallel to AB, cutting LB produced in M, and make GM=MN. Join N, F, and from the point E, where NF cuts the plane BL, draw EG, joining the points EG: the point D will be the point of the plane, against which the body at C must impinge, in order to strike the body at F. By reasoning as in the preceding case, it may be shewn that the angle CDH=EDB, therefore DE will be the path of the body after the first reflexion. Now, the triangles GEM, EMN are equiangular, because GM=MN, and the angles at M right, therefore DEB=FEL, that is, the body after reflexion at E will strike the body placed at F. Fig. 8.

Prop. VII.

291. To determine the motions of two spherical bodies which impinge obliquely upon each other, when their motion, quantities of matter, and radii, are given.

Let A, B be the two bodies, and let CA, DB be the directions in which they move before impact, and let these lines represent their respective velocities. Join A, B the centres of the bodies, and produce it both ways to K and I. Draw LM perpendicular to IK, and it will touch the bodies at the point of impact. Now, the velocity CA may be resolved into the two velocities CI, IA, and the velocity DB into the velocities DK, KB, but CA and DB are given, and also the angles CAI, DBK, consequently CI and IA, and DK and KB may be found. The velocities CI, DK, which are parallel to the plane, will not be altered by collision, therefore IA, KB are the velocities with which the bodies directly impinge upon each other, consequently their effects or the velocities after impact may be found from Prop. 3.; let these velocities be represented by AN, BP. Take AF=CI and BH=DM, and having completed the parallelograms AFON, BPQH, draw the diagonals AO,BQ. Then, since the body A is carried parallel to the line LM with a velocity CI=AF, and from the line LM by the velocity AN, it will describe AO, the diagonal of the parallelogram Fig. 9.

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rallelogram NF; and for the same reason the body B will describe the diagonal BQ of the parallelogram PH.

292. Corollary. If A=B, and if the body which is struck moves in a given direction and with a given velocity after impact, the direction of the impinging body, and the velocity of its motion, may be easily found. Let the body D impinge against the equal body C, and let CB be the direction in which C moves after impact, it is required to find the direction in which D will move. Draw D*c*, touching the ball C at *c*, the place where the ball D impinges; produce BC to E, and through *c* draw A*c*F perpendicular to EB, and complete the rectangle FE. The force D*c* may be resolved into the forces E*c*, *c*F, of which E*c* is employed to move the ball C in the direction CB and with the velocity E*c*; but the force *c*F has no share in the impulse, and is wholly employed in making the body D move in the direction CA, and with the velocity CF.

Fig. 10.

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The phenomena of impulsion owing to repulsive forces which prevent bodies from coming into mathematical contact.

293. In the preceding proposition, we have endeavoured to give a short and perspicuous view of the common theory of impulsion. The limits of this article will not permit us to enter upon those interesting speculations to which this subject has given rise; but those who are anxious to pursue them will find ample assistance in the article Impulsion, in the Supplement to the last edition of this work, where Dr Robison has treated the subject with his usual ability. It may be proper however to remark, that all the phenomena of impulse as well as pressure, are owing to the existence of forces which prevent the particles of matter from coming into mathematical contact. The body which is struck, in the case of collision, is put in motion by the mutual repulsion of the material particles at the point of impact, while the velocity of the impinging body is diminished by the same cause. Hence we see the absurdity of referring all motion to impulse, or of attempting to account for the phenomena of gravitation, electricity, and magnetism by the intervention of any invisible fluid. Even if the supposition that such a medium exists were not gratuitous, it would be impossible to shew that its particles, by means of which the impulse is conveyed, are in contact with the particles of the body to which that impulse is communicated.

Don Georges Juan's physico mathematical theory of percussion.

294. A physico-mathematical theory of percussion, in which the impinging bodies are considered as imperfectly elastic, has been lately given by Don Georges Juan, in his *Examen Maritimo*, a Spanish work which has been translated with additions by M. L'Eveque, under the title of *Examen maritime, theorique et pratique, ou Traite de mecanique, appliquè a la construction, et a la manœuvre des vaisseaux et autres batimens*. This theory has been embraced by many eminent French philosophers, and may be seen in Prony's *Architecture Hydraulique*, vol. i. p. 208, and in Gregory's Mechanics, vol. i. p. 291. We shall endeavour, under the article Percussion, to give a short account of this interesting theory, which has been found to accord with the most accurate experiments.

295. In some cases of collision the results of experiments are rather at variance with those of theory, in consequence of the communication of motion not being exactly instantaneous. "If an ivory ball (says Mr Leslie) strikes against another of equal weight, there should, according to the common theory, be an exact transfer of motion. But if the velocity of the impinging ball be very considerable, so far from stopping suddenly, it will recoil back again with the same force, while the ball which is struck will remain at rest; the reason is, that the shock is so momentary, as not to permit the communication of impulse to the whole mass of the second ball; a small spot only is affected, and the consequence is therefore the same as if the ball had impinged against an immoveable wall. On a perfect acquaintance with such facts depends, in a great measure, the skill of the billiard player. It is on a similar principle that a bullet fired against a door which hangs freely on its hinges will perforate without agitating it in the least. Nay, a pellet of clay, a bit of tallow, or even a small bag of water, discharged from a pistol will produce the same effect. In all these instances the impression of the stroke is confined to a single spot, and no sufficient time is allowed for diffusing its action over the extent of the door. If a large stone be thrown with equal momentum, and consequently with smaller velocity, the effect will be totally reversed, the door will turn on its hinges, and yet scarcely a dent will be made on its surface. Hence likewise the theory of most of the tools, and their mode of application in the the mechanical arts: the chisel, the saw, the file, the scythe, the hedge bill, &c.—In the process of cutting, the object is to concentrate the force in a very narrow space, and this is effected by giving the instrument a rapid motion. Hence, too, the reason why only a small hammer is used in rivetting, and why a mallet is preferred for driving wedges." *Enquiry into the Nature of Heat*, p. 127,8.

Successive propagation of motion illustrated.

Fig. 11.

296. The successive propagation of motion may be illustrated by a very simple experiment. Take two balls A, B, of which B is very large when compared with A, and connect them by a string S passing over the pulley P. If the ball B is lifted up towards S and allowed to fall by its own weight, instead of bringing the little ball A along with it, as might have been expected, the string will break at P. Here it is evident that the motion is not propagated instantaneously, for the string is broken before the motion is communicated to the portion of the string between P and A.

Apparatus for experiments on collision.

Fig. 12.

297. An apparatus for making experiments on the collision of bodies is represented in fig. 12. The impinging bodies are suspended by threads like pendulums, and as the velocities acquired by descending through the arches of circles are in the ratio of their chords, the velocities of the impinging bodies may be easily ascertained. The apparatus is therefore furnished with a graduated arch MN which is generally divided into equal parts, though it would be more convenient to place the divisions at the extremities of arcs whose chords are expressed by the corresponding numbers. The balls that are not used may be placed behind the arc as at *m* and *n*; and in order to give variety to the experiments, the balls may be of different sizes. Sometimes a dish like G is attached to the extremities of the strings, for the purpose of holding argillaceous balls, and balls of wax softened with a quantity of oil equal to one fourth part of their weight.—See *Smeaton's Experiments on the Collision of Bodies*.

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CHAP. VII. *On the Maximum Effects of Machines.*

298. We have already seen in some of the preceding chapters, that when two bodies act upon each other by the intervention either of a simple or compound machine, there is an equilibrium when the velocity of the power is to the velocity of the weight as the weight is to the power. In this situation of equilibrium, therefore, the velocity of the weight is nothing, and the power has no effect in raising the weight, or in other words, the machine performs no work. When the weight to be raised is infinitely small, the velocity is the greatest possible; but in this case likewise, the machine performs no work. In every other case, however, between these two extremes, some work will be performed.—In order to illustrate this more clearly, let us suppose a man employed in raising a weight by means of a lever with equal arms; and that he exerts a force upon the extremity of the lever, equivalent to 50 pounds. If the weight to be raised is also 50 pounds, there will be an equilibrium between the force of the man and the weight to be raised, the machine will remain at rest, and no work will be performed. If the man exert an additional force of one pound, or if his whole force is 51 pounds, the equilibrium will be destroyed, the weight will rise with a very slow motion, and the machine will therefore perform some work. When the motion of the machine therefore is $=0$ the work performed is also nothing, and when the machine is in such a state that the power preponderates, the work performed increases. Let us now suppose that the weight suspended from the lever is infinitely small, the motion of the machine will then be the greatest possible; but no work will be performed. If the weight however is increased, the motion of the machine will be diminished, and work will be performed. Here then it is evident that the work performed increases from nothing when the velocity is a maximum, and decreases to nothing when the velocity is a minimum. There must therefore be a particular velocity when the work performed is a *maximum*, and this particular velocity it is our present object to determine. Sometimes, indeed, the velocities of the machine are determined by its structure, and therefore it is out of the power of the mechanic to obtain a maximum effect by properly proportioning them. The same object however may be obtained, by making the work to be performed, or the resistance to be overcome, in a certain proportion to the power which is employed to perform the work or overcome the resistance.

299. Def. 1.—In a machine performing work, the powers employed to begin and continue the motion of the machine, are called the *first movers, the movers of powers;* and those powers which oppose the production and continuance of motion are called *resistances.* The friction of the machine, the inertia of its parts, and the work to be performed, all oppose the production and continuance of motion, and are therefore the resistances to be overcome. When various powers act at the same time, and in different directions, the equivalent force which results from their combined action is called the *moving force*, and the force resulting from all the resisting forces, the *resistance.* If the machine, for example, is a lever AB moving round the centre F, by means of which, two men raise water out of two pump barrels by the chains A u, C w attached to the pistons, and passing over the arched heads or circular sectors M, N, for the purpose of giving the pistons and chains a vertical motion. Let the force of the man at B, six feet from F, be equal to 50 pounds, or π, his mechanical energy to turn the lever is $6\times50=300$. Let the force of the other man applied at E, four feet from F, be also equal to 50 pounds, or p. His mechanical energy will be $4\times50=200$, so that the whole moving power is equal to $300+200=500$. But if the two forces of 50 pounds, instead of being applied at two different distances from F, had been applied at the same point G, 5 feet from F, their energy to turn the lever would have been the same, for $5\times50+50=500$. In the present case, therefore, the *moving force* is equivalent to $P\times GF$, or a force of 100 pounds acting at a distance of five feet from the centre of motion. Now let us suppose that each piston A u, C w raises 60 pounds of water equivalent to the weights u, w, and that $CF=2$ feet, and $AF=3$ feet, then the mechanical energy of these weights will be respectively $2\times60=120$, and $3\times60=180$, and the sum of their energies $=300$. But two forces of 60 pounds each, acting at the distances two feet and three feet from F, are equivalent to their sum $=120$ pounds, acting at a distance of two feet and a half from F, for $2\frac{1}{2}\times120=300$; therefore, the resistance arising from the work to be performed, or from the water raised in the pump barrels, is equal to a weight P of 120 pounds acting at the distance $DF=2\frac{1}{2}$ feet. But in addition to the resistance arising from the work to be performed, the two men have to overcome the resistance arising from the friction of the piston in the barrels, which we may suppose equivalent to f, φ, each equal to 10 pounds, acting at the points A, C; but these forces are equivalent to 20 pounds, or $f+\varphi$ acting at D, therefore the resistance arising from the work and from friction is equal to 140 pounds, acting at the distance $DF=2$ feet and a half. While the two men are employed in overcoming these resistances, they have also to contend against the inertia of the beam AF, and that of the chains and pistons, which we may suppose equal to 20 pounds when collected in their centre of gravity g, whose distance from F is 2.2 feet; but a weight of 20 pounds acting at the distance of 2.2 feet is equivalent to a weight of $19\frac{1}{2}$ pounds, acting at the distance of 2.5 feet, or DF, consequently the sum of all the resistances when reduced to the same point D of the lever is equal to $159\frac{1}{2}$ pounds acting at the distance of 2.5 feet from F. The mechanical energy, therefore, of the sum of all the resistances will be $=2.5\times159\frac{1}{2}=398.75$, while the energy of the moving force, or the sum of all the moving powers, is equal to 500.

Plate CCCXXII. Fig. 1.

300. Def. 2.—The *impelled point* of a machine is that point to which the moving power is applied, if there is only one power, or that point to which all the moving powers are reduced, or at which the moving force is supposed to act. The *working point* of a machine is that point at which the resistance acts if it is single, or that point to which all the resistances are reduced, and at which they are supposed to act when combined. Thus in fig. 1. G is the impelled point of the machine, and D the working point. Had a single force π been applied at the point B to raise a single weight u, acting at Fig. 1.

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at the point A, then B would have been the impelled point, and A the working point of the machine. In the wheel and axle, the point of the wheel at which the rope touches its circumference is the impelled point, while the working point is that point in the circumference of the axle where the rope which carries the weight is in contact with it.

301. DEF. 3.—The velocity of the moving power, and the velocity of the resistance, are respectively the same as the velocity of the impelled point, and the velocity of the working point.

302. DEF. 4.—The *effect* of a machine, or the *work performed*, is equal to the resistance multiplied by the velocity of the working point; for when any machine raises a mass of matter to a given height in a certain time, the effect produced is measured by the product of the mass, and the height through which it rises, that is, by the product of the mass by the velocity with which it moves.

303. DEF. 5.—The *momentum of impulse* is equal to the moving force multiplied by the velocity of the impelled point.

Explanation of symbols.

304. In any machine that has a motion of rotation, let x be the velocity of the impelled point, and y the velocity of the working point. When the machine is a lever, x, y will express the perpendiculars let fall from the centre of motion upon the line of direction in which the forces act; and if the machine is a wheel and axle, x, y will represent the diameters of the wheel and the axle respectively. In compound machines, which may be regarded as composed of levers, (Art. 90.) x will represent the sum of all the levers by which the power acts, and y the sum of all the levers by which the resistance acts.

305. Let P be the real pressure which the moving power exerts at the impelled point of the machine, and R the actual pressure which the mere resistance of the work to be performed exerts at the working point, or which it directly opposes to the exertion of the power. Let a be the inertia of the power P, or the mass of matter which the power P must move with the velocity of the impelled point, in order that P may exert its pressure at the impelled point; and let b be the inertia of the resistance R, or the mass of matter which must be moved with the velocity of the working point in the performance of the work.

306. Since the resistance arising from the friction of the communicating parts is an uniformly retarding force, it may be measured by a weight φ acting at the working point of the machine, which will oppose the same resistance to the moving power as the friction of the parts.

307. Let m be the inertia of the machine, or rather that quantity of matter, which acting at the working point of the machine will require the same part of the moving force to give it an angular motion, then since y represents the arm of the lever by which the resistance acts, or the distance of the working point from the centre of motion; and since the momentum of inertia, or the momentum with which any mass revolving round a centre resists being put in motion, is equal to its quantity of matter multiplied by the square of its distance from its centre of motion (see article ROTATION), we have my^2 for the momentum of inertia of the machine. It is obvious that every machine opposes a certain resistance to any force that endeavours to give it an angular motion, and that this resistance will increase with the inertia of its parts. It is easy, therefore, to find a quantity of matter, which, when placed at any part of the machine, will oppose the same resistance to an angular motion, as the combined inertia of the various parts of the machine. This is the quantity of matter which we have called m, and which we have supposed to act at the working point, because to that point all the other resistances have been reduced. Collecting the symbols, therefore, we have

Theory.

x=the velocity of the impelled point or the radius of the wheel, or the length of the lever by which the power acts.

y=the velocity of the working point, or the radius of the axle, or the length of the lever by which the resistance acts against the power.

P=the pressure exerted by the power at the impelled point of the machine.

R=the pressure which the resistance arising from the work to be performed exerts at the working point of the machine.

a=the inertia of the power P, or the quantity of matter to which it must communicate the velocity of the impelled point.

b=the inertia of the resistance R, or the quantity of matter which it must move with the velocity of the working point before any work is performed.

φ=a quantity of matter which, if placed at the working point of the machine, would oppose the same resistance to the moving power as that which arises from the friction of the communicating parts.

m=the quantity of matter which, if placed at the working point of the machine, would oppose the same resistance to the production of an angular motion, that is opposed by the inertia of the various parts of which the machine is composed. Hence, by the principles of rotation, we have

my^2=the momentum of inertia of the machine.

We are now prepared for determining the conditions of construction, which will enable any machine to produce a maximum effect.

PROP. I.

308. To determine the velocities which must be given to the impelled and working points of a machine, or the ratio of the levers by which the power and resistance ought to act, in order to obtain a maximum effect.

Let AB be a lever, whose fulcrum is F, and to whose extremity B is applied the power P to overcome the resistance R, and let FB=x, and FA=y. Then, by Art. 36. we shall have, from the following analogy, the weight which, placed at B, would be in equilibrio with R; $x : y = \text{R} : \frac{\text{R}y}{x}$, the weight which will keep R in equilibrio, or the weight which is equal Fig. 2.

 to

Theory.

to that part of the power P which balances the resistance R. Hence, $P-\frac{Ry}{x}$ will be the effective force exerted by the power P, which, multiplied by x, its distance from the centre of motion, gives $Px-Ry$ for the force which is exerted in giving an angular motion to the power and resistance. But the resistance of friction was supposed equal to the weight φ acting at the working point or at the distance FA or y; consequently φy will be the resistance which friction opposes to the force $Px-Ry$, and therefore $Px-Ry-\varphi y$ is the motive force exerted by P. Now, the momentum of the inertia of the power P, or the force with which it resists being put in motion, is ax^2, and the momentum of inertia of the resistance R is by^2, while the momentum of inertia of the machine is my^2. Therefore, the sum of these momenta, viz. $ax^2+by^2+my^2$ is the mass to be put in motion by the power P. But, by DYNAMICS, § 167. the velocity generated in a given time is directly as the motive force, and inversely as the quantity of matter to which that force is applied. Hence the angular velocity, or the number of turns which the machine will make in a given time, is $\frac{Px-Ry-\varphi y}{ax^2+by^2+my^2}$. But in every rotatory machine the velocities of its different parts are as their distance from the axis; hence, we shall have the velocities of the impelled and working points of the machine, by multiplying the angular velocity by x, y the distances of the impelled and working points of the machine from the centre of motion. Therefore,

$$\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}=\text{the velocity of the impelled point,}$$

and

$$\frac{Pxy-Ry^2-\varphi y^2}{ax^2+by^2+my^2}=\text{the velocity of the working point}$$

of the machine; and multiplying by R, we have from Def. 4. $\frac{PxyR-R^2y^2-\varphi Ry^2}{ax^2+vy^2+my^2}=$ the work performed.

309. But as forces are proportional to the velocities generated by them in equal times (DYNAMICS, § 153. Cor. 4. § 159.), the preceding quantities will represent the accelerating forces. Now, the velocities are as the forces and times jointly (DYNAMICS, § 153.), that is, $v=Ft$, or is $=gtF$; but F, the accelerating force, which generates the velocity of the impelled point, is represented by the formula $\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}$. Therefore, v, or the absolute velocity of the impelled point, is $\frac{Px^2-Rxy-\varphi xy}{ax^2+by^2+my^2}\times gt$, and the absolute velocity of the working point $\frac{Pxy-Ry^2-\varphi y^2}{ax^2+by^2+my^2}\times gt$. Again, by Def. 4. the effect of a machine, or the work performed, is equal to the resistance of the work multiplied by the velocity; consequently, since R is the work, we have, for the performance of the machine,

$$\frac{PxyR-R^2y^2-\varphi Ry^2}{ax^2+by^2+my^2}\times gt.$$

Now, considering y as the variable quantity, and making the fluxion of the preceding formula $=0$, we shall find that the performance of the machine is a maximum, when

$$y=\frac{\overline{\overline{a^2\times\overline{R+\varphi}|^2+P^2a\times\overline{m+b}}}|^{\frac{1}{2}}-aR-a\varphi}{Pm+Pb}\times x.$$

When $R=0$, we have

$$y=\frac{\overline{a^2\varphi^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-a\varphi}{Pm+Pb}\times x.$$

When $\varphi=0$, the first formula becomes

$$y=\frac{\overline{a^2R^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-aR}{Pm+Pb}\times x.$$

When both R and $\varphi=0$, we have, after reduction,

$$y=\frac{\sqrt{a}}{\sqrt{m+b}}\times x.$$

When $b=0$, the first formula becomes

$$y=\frac{\overline{a^2\times\overline{R+\varphi}|^2+P^2am}|^{\frac{1}{2}}-aR-a\varphi}{Pm}\times x,$$

When R, φ and $b=0$, we have

$$y=\frac{\sqrt{a}}{\sqrt{m}}\times x.$$

When $a:b=P:R$, we have, by substituting P and R instead of a and b,

$$y=\frac{\overline{P^2\times\overline{R+\varphi}|^2+P^3\times\overline{m+R}}|^{\frac{1}{2}}-PR-P\varphi}{Pm+PR}\times x.$$

When Pm and $\varphi=0$, the last formula becomes

$$y=\frac{\overline{P^2R^2+P^3R}|^{\frac{1}{2}}-PR}{PR}\times x=\sqrt{\frac{P^2R^2+P^3R}{P^2R^2}}-\frac{PR}{PR}\times x$$

$$=x\sqrt{\overline{\frac{P}{R}+1}|}-1,$$

and when $x=1$, and $R=1$, we have

$$y=\sqrt{\overline{P+1}|}-1,$$

and when $P=1$, and $x=1$, we obtain

$$y=\sqrt{\overline{\frac{1}{R}+1}|}-1.$$

When $x=1$,

$$y=\sqrt{\overline{\frac{}{R}+1}|}-1.$$

These various formulae, the application of which to particular cases shall be shown in the practical part of this article, give us values of y for almost every species of machinery; so that the mechanic may easily determine the velocities which must be given to the impelled and working points of the machine in order to produce a maximum effect.

310. When the machine, however, is already constructed, the velocities of the impelled and working points cannot be changed, without altering the structure of the machine; and therefore we must find the ratio between the power and resistance, which will enable

enable us to obtain a maximum effect. The method of determining this will be ſhewn in the following propoſition.

Prop. II.

311. To determine the ratio between the power and the reſiſtance of a machine when its performance is a maximum.

Since the ſtructure of the machine is given, the values of x, y are known, and therefore we have to determine the relative values of P and R, when the effect of the machine is a maximum. This would be eaſily done, by making R variable in the formula which expreſſes the performance of the machine, and making its fluxion equal to 0, if none of the other quantities varied along with R. It often happens, however, that while R varies, the maſs b ſuffers a conſiderable change, though in other caſes the change induced upon b is too unimportant to merit notice. This propoſition, therefore, admits of two caſes, 1. When the change upon b is ſo ſmall that it may be ſafely omitted in the inveſtigation; and, 2. When the change upon b is ſufficiently great to require attention.

312. Case 1. When R is the only quantity which is variable, the fluxion of the formula

$$\frac{\mathrm{P}\,x\,y\,\mathrm{R} - \mathrm{R}^2 y^2 - \varphi\,\mathrm{R}\,y^2}{a\,x^2 + b\,y^2 + m\,y^2},$$

which repreſents the work performed, is equal to the fluxion of the numerator, becauſe the denominator is conſtant, that is, $\mathrm{P}\,x\,y\,\dot{\mathrm{R}} - 2\mathrm{R}\dot{\mathrm{R}}\,y^2 - \varphi\,\dot{\mathrm{R}}\,y^2 = 0$, and, dividing by $\dot{\mathrm{R}}$; $\mathrm{P}\,x\,y - 2\mathrm{R}\,y^2 - \varphi\,y^2 = 0$, hence $2\mathrm{R}\,y^2 = \mathrm{P}\,x\,y - \varphi\,y^2$, and $\mathrm{R} = \frac{\mathrm{P}\,x\,y - \varphi\,y^2}{2\,y^2}$, which, divided by y, gives $\mathrm{R} = \frac{\mathrm{P}\,x - \varphi\,y}{2\,y}$. Now, according to the experiments of Coulomb, the friction is, in general, proportional to the reſiſting preſſure, or a certain part of that preſſure, for example, $\frac{1}{15}\mathrm{R}$; and calling $Z = \frac{1}{15}$, and, omitting $\varphi\,y$, we have for the reſiſtance $\mathrm{R} + \frac{1}{15}\mathrm{R}$, or $\frac{16}{15}\mathrm{R} = \frac{\mathrm{P}\,x - \varphi}{2\,y}$, or $\mathrm{R} = \left(\frac{\mathrm{P}\,x}{2\,y}\right) \div \frac{16}{15}$, and making $\mathrm{P} = 1$, and $x = 1$, we have $\mathrm{R} = \left(\frac{1}{2y}\right) \div \frac{16}{15}$, ſo that, abſtracting from the quotient $\frac{16}{15}$, which being little greater than 1, will not alter the reſult, the reſiſtance ſhould be one half of the force which would keep the impelling power in equilibrio.

313. Case 2. When b varies at the ſame time with R, it will in moſt caſes vary in the ſame proportions, and therefore may be repreſented by any multiple of R, as $d\,\mathrm{R}$, where d may be either an integer or a fraction. In order to ſimplify the inveſtigation, we may conſider the fraction φ as a reſiſtance diminiſhing the impelling power, inſtead of regarding it as a reſiſtance to be added to the other reſiſting forces. Thus the impelling power P will become $\mathrm{P} - \varphi$. In the ſame way we may conſider the momentum of the machine's inertia applied to the impelled point, that is, inſtead of $m y^2$ it may be made $m x^2$. Now making $\mathrm{P} - \varphi$, or the impelling power $= 1$, and making $x = 1$, we ſhall have by theſe ſubſtitutions in the formula which expreſſes the effect of the machine, $\frac{\mathrm{R}\,y - \mathrm{R}^2 y^2}{a + m + d\,\mathrm{R}\,y^2}$, or, for the ſake of ſimplicity, making $a + m = q$, we have for the performance of the machine $\frac{\mathrm{R}y - \mathrm{R}^2 y^2}{q + d\,r\,y^2}$; then ſince R is the variable quantity, we ſhall find, after making the fluxion of this formula $= 0$, that the performance is a maximum when $\mathrm{R} = \frac{\overline{q^2 + q\,d\,y}\,|^{\frac{1}{2}} - q}{d\,y^2}$.

When $b = \mathrm{R}$ then $d = 1$, and we ſhall have

$$\mathrm{R} = \frac{\overline{q^2 + q\,y}\,|^{\frac{1}{2}} - q}{y^2}.$$

When $a = \mathrm{P}$ and $\mathrm{P} = 1$, and when m, the inertia of the machine, $= 0$, we ſhall have $a + m = 1 = q$, and then the formula becomes

$$\mathrm{R} = \frac{\overline{y + 1}\,|^{\frac{1}{2}} - 1}{y^2}.$$

When $y = x$, then $y = 1$, and

$$\mathrm{R} = \frac{\overline{1 + 1}\,|^{\frac{1}{2}} - 1}{1} = 0.4142$$

Scholium.

314. Thoſe who wiſh to proſecute this intereſting ſubject may conſult the different papers of Euler in the *Comment. Petropol.* vol. x. p. 80, 1743, and in the *Comment. Nov. Petropol.* vol. iii. and viii. In the article Machinery in the Supplement to the laſt edition of this Work, the ſubject has been treated with great ability by Dr Robiſon, though he has omitted the various ſteps in the inveſtigation which conduct to the leading formulæ. The ſubject has been alſo ably diſcuſſed by Profeſſor Leſlie in a paper publiſhed in the Appendix to Ferguſſon's Lectures, vol. ii. p. 353; and as the reſults of his inveſtigations may be of great uſe in practice, we ſhall here preſent the reader with a ſhort abſtract of them.

If the reſiſtance is equal to the power, is double, triple, or quadruple, &c. a maximum effect will be produced when the velocity of the power, or its diſtance from the centre of motion, is $1 + \sqrt{2}$; $2 + \sqrt{6}$; $3 + \sqrt{12}$; $4 - \sqrt{20}$; $5 + \sqrt{30}$; $6 + \sqrt{42}$, that of the weight being 1, &c. If the reſiſtance is very great, compared with the power, the velocity ſhould at leaſt be double of that which would procure an equilibrium, in order that the machine will produce a maximum effect.

315. If the velocity of the power, or its diſtance from the centre of motion, be equal to, double, triple, quadruple, &c. &c. of the velocity of the weight or reſiſtance, a maximum effect will be produced when the power P is equal to $\mathrm{R} \times \overline{1 + \sqrt{2}}$; $\mathrm{R} \times \overline{\tfrac{1}{2} + \sqrt{\tfrac{3}{8}}}$; $\mathrm{R} \times \overline{\tfrac{1}{3} + \sqrt{\tfrac{4}{27}}}$; $\mathrm{R} \times \tfrac{1}{4} + \sqrt{\tfrac{5}{64}}$, $\mathrm{R} \times \tfrac{1}{5} + \sqrt{\tfrac{6}{125}}$, &c. where R is the reſiſtance or weight to be raiſed. If the velocity of the power be very large, a maximum effect will be produced when the power P is, at leaſt, double of that which would procure an equilibrium. It appears alſo from Mr Leſlie's paper, that in whatever way the maximum be procured, the force which impells the

Theory. the weight can never amount to one-fourth part of the direct action of the power; and that in machines where the velocity of the power is great, we may disregard the momenta of the connecting parts, and consider the force which ought to be employed as double of what is barely able to maintain the equilibrium.

Chap. VIII. *On the Equilibrium of Arches, Piers, and Domes.*

Fig. 3. 316. Def. 1. An arch is represented in fig. 3. by the assemblage of stones *a b*, *c d*, *e f*, &c. forming the mass ABMN, whose inferior surface is the portion of a curve. The parts A, B are called the *spring of the arch*, the line AB the *span of the arch*, C *b* its *altitude*, *b* its *crown*, *a b* the *keystone*, the curve or lower surface A *b* B the *intrados*, and the roadway TUV the *extrados*; PQ, RS, the *piers* when they stand between two arches, and the *abutments* when they are at the extremities of the bridge.

Fig. 4. 317. Def. 2. A catenarian curve is the curve formed by any line or cord perfectly flexible, and suspended by its extremities. Thus if the chain ACB be suspended by its extremities A, B, it will by the action of gravity upon all its parts assume the form ACB, which is called the catenary or catenarian curve.

318. There are three modes of determining the construction of arches; the first of which is to consider the arch as an inverted catenary; the second is to establish an equilibrium between the vertical pressures of all the materials between the intrados and extrados; and the third is to regard the different arch-stones as portions of wedges without friction, which, endeavour by their own weight to force their way through the arch. The first of these methods was given by the ingenious Dr Hook, and is contained in the following proposition.

Prop. I.

319. To determine the form of an arch by considering it as an inverted catenary, when its span, its altitude, and the form of the roadway or extrados are given.

Fig. 5. Let *a*, *b*, *c*, *d* be a number of spheres or beads connected by a string, and suspended by their extremities A, B; they will form a catenarian curve A *a b c* B, and be in equilibrio by the action of gravity. Each sphere is acted upon by two forces; at its lower point by the weight of the spheres immediately below it, and at its upper point by the weight of the same spheres added to that of the sphere itself; that is, any sphere *c* is in equilibrio from the result of two forces, one of which is produced by the weights of *c d e* acting at the lower point of *b*, while the other force arises from the weight of *b c d e* acting at its upper point. The equilibrium of this chain of spheres is evidently of the stable kind, as it will immediately recover its position when the equilibrium is disturbed. Let us now suppose this arch inverted, so as to stand in a vertical plane as in fig. 6. It will still preserve its equilibrium. For the Fig. 6. relative positions of the lines which mark the directions remain unchanged by inverting the curve, the force of gravity continues the same, and therefore the result of these forces will be the same, and the arch will be in equilibrio. The equilibrium, however, which the arch now possesses is of the tottering kind, so that the least disturbing force will destroy it, and it will consequently be unable to support any other weight but its own.

320. Let us now suppose that it is required to form an equilibrated arch, whose span is AB, whose altitude is D *k*, and which will support the materials of a roadway, whose form TUV is given. It is obvious, that if the spheres *a*, *b*, *c*, *d* increase in density from *k* towards *a*, the catenarian curve will grow less concave at its vertex *e*, and more concave towards its extremities A, B. Let us then suppose that the densities of the spheres *a*, *b*, *c*, *d*, *e*, &c. are respectively as *a m*, *b n*, *c o*, *d p*, *e q*, &c. the vertical distances of their respective centres from the roadway TUV, the arch will have a form different from that which it would have assumed if the spheres were of equal density, and will be in equilibrio when inverted as in fig. 6. Now, in place of the Fig. 6. spheres *a*, *b*, *c*, *d*, *e*, &c. of different densities, let us substitute spheres of the same density, and having the same position as those of different densities; let us then load the sphere *a* with a weight which, when combined with the weight of *a*, will be equal to the weight of the corresponding sphere *a*, that had a greater density; and let us load the other spheres *b*, *c*, *d*, &c. with weights proportional to *b n*, *c o*, *d p*, &c. Then it is obvious that the pressure of each sphere when thus loaded upon that which is contiguous to it, is precisely equal to the pressure of the spheres of different densities upon each other, because the density of these spheres varied as their distances from the roadway. But the arch composed of spheres of different densities was in equilibrio when inverted, therefore since the loaded spheres of the same density have the same position and exert the same pressures, the arch composed of these spheres and supporting TUVB *k* A composed of homogeneous materials, will be in equilibrio. *Hence a roadway of a given form, and composed of homogeneous materials, will be supported by an arch whose form is that of a catenary, each of whose points varies in density as their distance from the surface of the roadway;* or, which is the same thing, *A roadway of a given form, and composed of homogeneous materials, will be supported by an arch whose form is that of a catenary, each of whose points is acted upon by forces proportional to the distances of these points from the surface of the roadway.*

321. Hence we have the following practical method of ascertaining the form of an equilibrated arch, whose span is AB, and altitude D *k*, and which is to support a roadway of the form T′U′V′. Let a chain Fig. 7. A *a b c k* B, of uniform density, be suspended from the points A, B, so that it forms a catenary whose altitude is D *k*, the required height of the arch. Divide AB into any number of equal parts, suppose eight, and let the vertical lines 1 *m*, 2 *n*, 3 *o*, drawn from these points, intersect the catenary in the points *a*, *b*, *c*. From the points *a*, *b*, *c k*, *r*, *s*, *t*, suspend pieces of chain of uniform density, and form them of such a length, that when the whole is in equilibrio, the extremities of the chains may lie in the line T′U′V′; then the form which the catenary A *k* B now assumes, will be the form of an equilibrated arch, which, when inverted like AKB, will support the roadway TUV, similar to T′U′V′.

This

Theory. This is obvious from the laſt paragraph, for the pieces of chain $a\,m$, $b\,n$, $c\,o$, k U, &c. are forces acting upon the points a, b, c, k of the catenary, and are proportional to $a\,m$, $b\,n$, $c\,o$, &c. the diſtances of the points a, b, c, k, &c. from the roadway.

322. An arch of this conſtruction will evidently anſwer for a bridge, in which the weight of the materials between the roadway and the arch ſtones is to the weight of the arch ſtones, as the weight of all the pieces of chain ſuſpended from a, b, c, &c. is to the weight of the chain A k B. As the ratio, however, of the weight of the arch ſtones to the weight of the ſuperincumbent materials is not known, we may aſſume a convenient thickneſs for the arch ſtones, and if from this aſſumed thickneſs their weight be computed, and be found to have the required ratio to the weight of the incumbent maſs, the curve already found will be a proper form for the arch. But if the ratio is different from that of the weight of the whole chain to the weight of the ſuſpended chains; it may be eaſily computed how much muſt be added to or ſubtracted from the pieces of chain, in order to make the ratios equal. The new curve which the catenary then aſſumes, in conſequence of the change upon the length of the ſuſpended chains, will be the form of an equilibrated arch, the weight of whoſe arch ſtones is equal to that which was aſſumed.

Scholium.

323. In moſt caſes the catenarian curve thus determined will approach very near to a circular arc equal to 120 degrees, which ſprings from the piers ſo as to form an angle of 60 degrees with the horizon. The form of the arch, however, as determined in the preceding propoſition, is ſuited only to thoſe caſes in which the ſuperincumbent materials exert a vertical preſſure. A quantity of looſe earth and gravel exerts a preſſure in almoſt every direction, and therefore tends to deſtroy the equilibrium of a catenarian arch. This tendency, however, may be removed by giving the arch a greater curvature towards the piers. This will make it approach to the form of an ellipſis, and make it ſpring more vertically from the piers or abutments.

324. We ſhall now proceed to deduce the form of an arch and its roadway, by eſtabliſhing an equilibrium among the weights of all the materials between the arch and the roadway. This method was given by Emerſon in his Fluxions, publiſhed in 1742, and afterwards by Dr Hutton in his excellent work on bridges.

Prop. II.

325. To determine the form of the roadway or extrados, when the form of the arch or intrados is given.

Fig. 8. Let the lines AD, DE, EB, BF, FG, GH lie in the ſame plane, and let them be placed perpendicular to the horizon. From the points D, E, B, &c. draw the vertical lines D d, E e, B b, &c. and taking D p of any length, make E r equal to D p, &c. and complete the parallelograms $p\,c$, $q\,r$. Again, make B s = qe, and complete the parallelogram $t\,s$; in like manner make F k = $s\,b$, and complete the parallelogram F f; and ſo on with all the other lines, making the ſide of each parallelogram equal to that ſide of the preceding parallelogram which is parallel to it. Let us now ſuppoſe that the lines CD, DE, EB, &c. can move round the angular points D, E, B, F, &c. the extremities A, C being immoveable; and that forces proportional to Dd, Ee, Bb, &c. are exerted upon the points D, E, B, F, &c. and in the direction D d, E e, &c. Now, by the reſolution of forces, the force D d, may be reſolved into the forces Dc, Dp, the force E e into the forces E q, E r, and the force B b into the forces B s, B t, and ſo on with the reſt. The force D c produces no other effect than to preſs the point A on the plane on which it reſts, and is therefore deſtroyed by the reſiſtance of that plane; but the remaining force D p tends to bring the point D towards E, and to enlarge the angle ADE; this force, however, is deſtroyed by the equal and oppoſite force E q, and in the ſame way the forces E r, B t, F x are deſtroyed by the equal and oppoſite forces, B s, F k, G v, while the remaining force G w is deſtroyed by the reſiſtance of the plane which ſupports the point C. When the lines AD, DE, &c. therefore are acted upon by vertical forces proportional to D d, E e, B b, &c. theſe forces are all deſtroyed by equal and oppoſite ones, and the lines will remain in equilibrio. Theory.

326. Now the force D c : D p or E q = ſin. $c\,d$ D or d D p : ſin. AD d, that is, by taking the reciprocals

$$\mathrm{D}c : \mathrm{E}q = \frac{1}{\text{ſin. AD}d} : \frac{1}{\text{ſin. }d\mathrm{D}p},$$

and for the ſame reaſon

$$\mathrm{E}q : \mathrm{B}s = \frac{1}{\text{ſin. E}eq} : \frac{1}{\text{ſin. }b\mathrm{B}s}.$$

Hence

$$\mathrm{E}q \doteq \frac{1}{\text{ſin. E}eq}.$$

Now, ſince E q : E e = ſin. E $e\,q$: ſin. E $q\,e$, we have $\mathrm{E}e = \frac{\mathrm{E}q \times \text{ſin. E}qe}{\text{ſin. E}eq}$, that is, ſince DE m = E $q\,e$, and e EB = E $e\,q$; $\mathrm{E}e = \frac{\mathrm{E}q \times \text{ſin. DE}m}{\text{ſin. }e\mathrm{EB}}$. But $\mathrm{E}q \doteq \frac{1}{\text{ſin. E}eq}$ therefore, by ſubſtitution, we obtain

$$\mathrm{E}e \doteq \frac{\text{ſin. DE}m}{\text{ſin. E}eq \times \text{ſin. }e\mathrm{EB}}.$$

Now, as the ſame reaſoning may be employed to find D d, B b, &c. we have obtained expreſſions of the forces which, when acting at the angular points D, E, B, &c. keep the whole in equilibrio, and theſe expreſſions are in terms of the angles which the lines DE, EB, &c. form with the direction of the forces. If the lines AD, DE, &c. be increaſed in number ſo that they may form a polygon with an infinite number of ſides, which will not differ from a curve line, then the forces will act at every point of the curve, and the line m E will be a tangent to the curve at the point E, and DE m will be the angle of contact. The line E q being now infinitely ſmall will coincide with E m, and therefore the angles e E q and e EB or E $e\,q$ will be equal to the angle e E m, and conſequently their ſines will be equal. Therefore by making theſe ſubſtitutions in the laſt formula, we have an expreſſion of the force at every point of the curve, thus

$$\mathrm{E}e \doteq \frac{\text{ſin. DE}m}{\text{ſin. }e\mathrm{E}m \times \text{ſin. }e\mathrm{E}m} \doteq \frac{\text{ſin. DE}m}{\overline{\text{ſin. }e\mathrm{E}m}|^2}.$$

But

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But the angle of contact DEm varies with the curvature at the point E, and the curvature varies as the reciprocal of the radius of curvature, therefore the angle of contact varies as the reciprocal of the radius of curvature; hence by ſubſtitution,

$$E\,e \div \frac{1}{\text{radius of curvature} \times \text{ſin. } e\,E\,m^2}.$$

Fig. 9. In order to get rid of the confuſion in fig. 8. where the arch is a polygon, let us ſuppoſe ABC, fig. 9. to be the curve, $m\,n$ a tangent to any point E, and E e a vertical line; *then the preſſure at any point of the arch is reciprocally as the radius of curvature at that point, and the ſquare of the ſine of the angle which the tangent to that point of the curve forms with a vertical line.*

327. COROLLARY. Let us now ſuppoſe that the arch ABC ſupports a maſs of homogeneous materials lying between the roadway TUV and the arch AEBC; and the whole being ſuppoſed in equilibrio, let us determine the weight which preſſes on the point E. The weight of the ſuperincumbent column E $c\,b\,d$ varies as E$c \times g\,d$, but $g\,d$ = E $d \times$ ſin. d E g, E d being radius, and d E g = E n B, on account of the parallels E c, UB, therefore the weight of the column E $c\,b\,d$ varies as E$c \times$ E$d \times$ ſin. E n B, that is, as E$c \times$ ſin. E n B, becauſe E d is a conſtant quantity; but the preſſure at E was proved to vary as $\frac{1}{\text{radius curvature} \times \text{ſin. } e\,E\,m^2}$, therefore the weight of the column E $c\,b\,d$ or E$c \times$ ſin. En B varies alſo as this quantity, that is,

$$E\,c \times \text{ſin. } E\,n\,B \div \frac{1}{\text{radius curvature} \times \text{ſin. } e\,E\,m^2}.$$

But as the angle E n B is equal to the angle e E m, we ſhall have, by ſubſtitution and diviſion,

$$E\,c \div \frac{1}{\text{radius curvature} \times \overline{\text{ſin. } e\,E\,m}|^3}, \text{ that is,}$$

When an arch ſupports a roadway, the preſſure exerted upon any point of it, is reciprocally as the radius of curvature, and the cube of the ſine of the angle which the tangent to that point forms with a vertical line.

328. Having thus obtained an expreſſion for E c, we ſhall proceed to ſhew the application of the formula to the caſe when the arch is a portion of a circle.

Fig. 10. Let EB be the arch of a circle whoſe centre is F. Let the radius = R, BD = verſed ſine, BE = x, DF = coſ. BE = b, BU = m. Draw the tangent GE, and through E the vertical line $c\,e$, which will be parallel to BE. Then ſince GEF is a right angle, and e EF = EFB, the angle GE e is the complement of EFB, therefore, ſin. GE e = coſ. EFB = FD. But, in the preſent caſe, the radius of curvature is the radius of the arch, or R, therefore, E $c \div \frac{1}{R \times \text{ſin. } GE\,e}$, or by ſubſtitution, E $c \div \frac{1}{R\,b^3}$, that is, ſince R is conſtant, E $c \div \frac{1}{b^3}$. But when the point E coincides with B, the coſine b becomes equal to radius; therefore, in that caſe E $c \div \frac{1}{R^3}$, and E c becomes BU = m, hence $\frac{1}{R^3} : \frac{1}{b^3} = m :$ Ec, and by GEOMETRY, Theor. 8. Sect. IV. and Diviſion, we have E $c = \frac{m\,b^3}{b^3}$. Now, by the notation R : b = BF : DF; therefore $R^3 : b^3 = \overline{BF}^3 : DF^3$, hence $\frac{R^3}{b^3} = \frac{\overline{BF}^3}{DF^3}$, and multiplying each ſide by m, we have $\frac{m\,R^3}{b^3} = \frac{m\,\overline{BF}^3}{DF^3}$; but $\frac{m\,R^3}{b^3}$ = E c, therefore the vertical diſtance of the ſurface of the roadway from the point F, or E $c = \frac{m\,\overline{BF}^3}{DF^3} = \frac{BU \times \overline{BF}^3}{DF^3}$.

When the point E coincides with B, BF = DF, and E e = BU. When E coincides with A, the coſine DF vaniſhes, and therefore E c, or the diſtance of the point A from the extrados or roadway, is infinite. The curve VU c T, therefore, will run up to an infinite height, approaching continually to a vertical line, drawn from A, which will be its aſymptote. Such a form of the extrados, however, is inadmiſſible in practice; and therefore a ſemicircular arch is not an arch of equilibration. When the arch is leſs than a ſemicircle, as PBR, the curve terminates in the point p; and as it does not riſe very much above a horizontal line, paſſing through U when the arch is ſmall, we might produce a perfect equilibrium, by making the roadway horizontal as t U v, and making the denſity of the ſuperincumbent columns Pn, Eo, which preſs upon the points P, E reſpectively, in the ratio of Pp, E c, the diſtances of theſe points from the curvilineal roadway.

329. The inconvenience, however, ariſing from the inflexion of the extrados, may be conſiderably removed by throwing the point of contrary flexure to a greater diſtance, which may be done by diminiſhing BU, the thickneſs of the incumbent maſs above the keyſtone. Thus, if BU is diminiſhed to B d, and if points a, b are taken in the lines Pp, Ec, ſo that Pa : Pp = Eb : Ec = Bd : BU, and ſo on with all the points in the arch; and if a new roadway $v\,d\,b\,a\,t$ be drawn through theſe points, the equilibrium of the arch will ſtill continue, for the various preſſures which it ſuſtained, though they are diminiſhed, preſerve the ſame proportion.

330. Let us ſuppoſe it neceſſary to have the extrados a horizontal line, and let it be required to find BU = m when there is an equilibrium. In this caſe the point H coincides with U; or rather, when the curve U c T cuts the horizontal line t U v, the point H coincides with U. By ſubſtituting BF—BD inſtead of DF in the value of E c, formerly determined, and by putting BD = y, we have E $c = \frac{m\,R^3}{\overline{R-y}|^3}$. But when H coincides with U, c coincides with o, and therefore E o = E c = BD + BU = $y + m$, conſequently, $\frac{m\,R^3}{\overline{R-y}|^3} = y + m$, and multiplying by $\overline{R-y}|^3$, we have $m R^3 = y \times \overline{R-y}|^3 + m \times \overline{R-y}|^3$, or $m\,R^3 + m \times \overline{R-y}|^3 = y \times \overline{R-y}|^3$, and, dividing by the coefficients of m, we have

$$m = \frac{y \times \overline{R-y}|^3}{R^3 - \overline{R-y}|^3}, \text{ that is,}$$

The thickneſs of the roadway above the keyſtone, when the extrados is a ſtraight line, is equal to the quotient ariſing

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arising from multiplying the versed sine of half the arch by the cube of its cosine, and dividing this product by the difference between the cube of the radius, and the cube of the cosine; or, to change the expressions, *the thickness of the roadway above the keystone, when the roadway is a straight line, is equal to the quotient arising from multiplying the height of the arch, by the cube of the difference between the radius of the arch and its height, and dividing this product by the difference between the cube of the radius, and the cube of the difference between the radius and the height of the arch.*

331. When the arch is a semicircle R—y vanishes, and m becomes equal 0, so that the semicircular arch is evidently inadmissible. But when the arch is less than a semicircle, the value of m will be finite. Thus, if the arches are respectively

Arch.
60°, we have $m=\frac{1}{4}$ the span,
90°, we have $m=\frac{1}{2}$ of the span, or
110°, we have $m=\frac{1}{17}$ of the span nearly.

The two first arches of 60° and 90°, manifestly give too great a thickness to the part BU or m. In the third arch of 110°, the thickness of BD is nearly what is given to it by good architects, and is therefore the best in practice; for if the arch were made greater than 110°, the thickness of BU or m would be too small. It is obvious, however, that an arch of 110° is not an arch of *perfect* equilibration, for this can be the case only when the roadway has the form U z r. When the roadway, therefore, is horizontal, as Ur, there is an unbalanced pressure on both sides of the keystone, produced by the weight of the materials in the mixtilinear space r z U. It is indeed very small, and might be counteracted, by making the materials below Z lighter than those below U; but the unbalanced pressure is so trifling, that it may be safely neglected. We may, therefore, conclude, *that when the arch is to be circular with a horizontal roadway, an arch of 110 degrees approaches nearest to an arch of equilibration.*

Elliptical arches superior to circular arches when their transverse axis is horizontal.

332. When the arch is elliptical, it will be found, as in the circle, that $m=\frac{y\times\overline{R-y}|^3}{R^3-\overline{R-y}^3}$. An elliptical arch, however, has the advantage of a circular one, when the transverse axis is horizontal; for as it is much flatter, the point of contrary flexure in the extrados is thrown at a greater distance, and therefore it will, with less inconvenience, admit of a horizontal roadway. Elliptical arches have also the advantage of being more elegant, and likewise require less labour and materials.

333. The cycloidal arch is likewise superior to a circular one, but inferior to those which are elliptical. Parabolic, hyperbolic, and catenarian arches, may be employed when the bridge has only one arch, and is to rise high; but in other cases they are inadmissible. The method of determining the roadway for all these forms of arches, will be found in Dr Hutton's excellent work on the Principles of Bridges, p. 3. See also Emerson's Miscellanies, p. 156.; and his work on Fluxions, published in 1742.

On the mechanical curve of equilibration.

334. When the form of the roadway is given, the shape of the intrados for an arch of equilibration may be determined. As the investigation is very difficult, unless when the roadway is a horizontal line, we shall merely give the formula, which will enable any person to construct the curve. In all the other curves the equilibrium of the arch is imperfect; but the curve described by the following formula is an arch of perfect equilibration, and has been called *the mechanical curve of equilibration.*

$$ED=AF\times\frac{\text{Hyperbol. log. }\dfrac{BU+BD+\sqrt{2\,BU\times BD+\overline{BD}^2}}{BU}}{\text{Hyperbol. log. }\dfrac{BU+BF+\sqrt{2\,BU\times BF+\overline{BF}^2}}{BU}}$$

From this formula, which corresponds with figure 11. Dr Hutton has computed the following table, containing the values of c U and c E, for an arch whose span AC is 100, whose height BF is 40, and whose thickness at the crown or BU is 6. The table will answer for any other arch whose span and thickness are as the numbers 100, 40, 6; only the values of c U and c E must be increased or diminished in the same ratio as these numbers.

Table for constructing the Curve of Equilibration, when the span, height, and thickness at the crown, are as the numbers 100, 40, *and* 6.

Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.	Value of cU.	Value of cE.
0	6.000	15	8.120	24	11.911	33	18.627	42	29.919
2	6.035	16	8.430	25	12.489	34	19.617	43	31.56[illegible]
4	6.144	17	8.766	26	13.106	35	20.665	44	33.29[illegible]
6	6.324	18	9.168	27	13.761	36	21.774	45	35.13[illegible]
8	6.580	19	9.517	28	14.457	37	22.948	46	37.07[illegible]
10	6.914	20	9.934	29	15.196	38	24.190	47	39.1[illegible]
12	7.330	21	10.381	30	15.980	39	25.505	48	41.[illegible]
13	7.571	22	10.858	31	16.811	40	26.894	49	43.[illegible]
14	7.834	23	11.368	32	17.693	41	28.364	50	46.[illegible]

The

335. The conftruction of arches has alfo been deduced from confidering the arch-ftones as fruftums of polifhed wedges without friction, which endeavour to force their way through the arch. This principle has been adopted by Belidor, Parent, Boffut, Prony, and other French philofophers, and likewife by our ingenious countryman, the late Mr Atwood. This theory, however, is more plaufible than ufeful. So far from the arch-ftones having liberty to flide between thofe which are contiguous to them, without friction, they are bound together by the ftrongeft cement, and fometimes connected by iron pins or wedges. The theory likewife requires, that the weight of the arch muft regularly increafe as the portion of the vertical tangent cut off by lines drawn from a given point in a direction parallel to that of the joints, and therefore either the denfity or the magnitude of the arch-ftones muft be very great at the fpring of the arch, where the portion of the vertical tangent is a maximum. Thofe who wifh to be acquainted with the mode of inveftigation, by which the equilibrium of arches is eftablifhed in this theory, may confult Prony's *Architecture Hydraulique*, tom. i. p. 152.

On the Conftruction of Piers and Abutments.

336. In the conftruction of piers and abutments, there are two circumftances which claim our attention. 1. The ftrength that muft be given to them, in order to refift the lateral thruft which they fuftain from the adjacent femiarches, and which tend either to overfet them, or make them flide upon their bafe. 2. The form which muft be given to their extremities, fo that the force of the current may be a minimum.—The adhefion of the pier to the place on which it refts is always much greater than one-third of the preffure; and as the lateral thruft of the arch which this adhefion refifts, is oblique to the horizon, and may be refolved into two forces, one of which is horizontal, and the other vertical, we have the vertical portion of the lateral thruft, the weight of the pier, and the friction on its bafe, combined in refifting the horizontal portion of the lateral thruft, which tends to make the pier flide upon its bafe, fo that there is no danger of the pier yielding to fuch a preffure.—We do not here confider, that the lateral thruft which tends to give a horizontal motion to the pier, is completely counteracted by the lateral thruft of the oppofite femiarch, becaufe it is neceffary that the pier fhould have fufficient ftability to refift the lateral thruft of one femiarch, in cafe of the failure of the oppofite one. Let us therefore confider the ftrength of the pier which will prevent it from being overfet.

337. For this purpofe, let ABC be an arch, MHTO the pier, and BUHA the loaded femiarch, whofe preffure tends to overturn the pier. Let G be the centre of gravity of the mafs BUHA: Join GA, and from G draw GK perpendicular to AC. Then, fince the whole preffure of the arch is exerted at its fpring A; and fince this preffure is the fame as if the whole weight of the arch were collected into the point G, GA will be the direction in which the weight of the arch and the fuperincumbent mafs acts upon the point A. Now, by DYNAMICS, the force GA may be refolved into the two forces GK, KA, one of which KA endeavours to give the pier a motion of rotation about the point O, while the other GK denotes the weight of the loaded arch in the direction GK. Putting W, therefore, for the weight or area of the fuperincumbent mafs, we have $GK : KA = W : \frac{W \times KA}{GK}$, the preffure upon A. Now, as this force tends to turn the pier round O by means of the lever OA, and as $ON = AM$ is the perpendicular from the centre of motion upon the line of direction, we have $AM \times \frac{W \times KA}{GK}$ for the force which tends to overturn the pier. Now, the force which is oppofed to this is the weight of the pier MHTO collected in its centre of gravity g, which acts by the vertical lever $Om = \frac{1}{2}OM$, becaufe g is in the centre of the rectangle TM (Art. 164.). But the weight or area of the pier may be reprefented by $OM \times MH$; therefore, the force which refifts the lateral thruft of the loaded arch is $OM \times MH \times \frac{1}{2}OM$, or $\frac{1}{2}MH \times OM$. Now, in the cafe of an equilibrium between thefe oppofing forces, we have $AM \times \frac{W \times KA}{GK} = \frac{1}{2}MH \times OM^2$, which, by reduction, becomes $OM = \sqrt{\frac{2\ AM \times W \times KA}{MH \times GK}}$. This formula gives us the breadth of the pier which is capable of balancing the lateral thruft; and therefore OM muft be taken a little greater than the preceding value. In practice, OM is generally between one-fifth and one-feventh of AC, the fpan of the arch. The method of finding the centre of gravity G of the loaded arch, whether the arch is in perfect equilibrium or not, may be feen in Dr Hutton's work, already quoted, p. 49. A very fimple method of doing this is to form the part BVHA of a piece of card, and to find its centre of gravity G by the rules given in Articles 201, 202, 203. This indeed fuppofes all the materials to be homogeneous; but if they are of various kinds, we can load the arch made of card in a fimilar manner, and determine its centre of gravity as before.

338. The limits of this article will not permit us to apply the method of fluxions to the determination of the form which fhould be given to the ends of the pier, in order that the impulfe of the current may be the leaft poffible. The theory of the refiftance of fluids, indeed, differs fo widely from experiment, that fuch an inveftigation would, in this place, be of little practical utility. It may be fufficient merely to remark, that the pier fhould have an angular form, and that the impulfe of the current will be diminifhed as the angle is more acute. When the ends are femicircular, the impulfe of the ftream is reduced to one half; and though a triangular termination of the piers reduces the impulfe ftill more, yet femicircular ends are more pleafing to the eye, and are particularly advantageous when fmall veffels have occafion to pafs the arch. When thofe veffels happen to impinge againft the piers, the femicircular ends are more able to bear the fhock, and do lefs injury to the veffel, while the additional quantity of mafonry will give greater ftability to the pier.

On the Conſtruction of Domes.

339. Definition. A dome, cupola, or vault, is an arched roof, either of a ſpherical, conoidal, or ſpheroidal form.

The following propoſition, taken from Dr Robiſon's article upon this ſubject, in the Supplement to the laſt edition of the Encyclopædia Britannica, contains a very brief view of the theory of domes.

Proposition.

340. " To determine the thickneſs of a dome vaulting when the curve is given, or the curve when the thickneſs is given.

Plate CCCXXIII. Fig. 1.

" Let BbA, figure 1. be the curve which produces the dome by revolving round the vertical axis AD. We ſhall ſuppoſe this curve to be drawn through the middle of all the arch-ſtones, and that the courſing or horizontal joints are every where perpendicular to the curve. We ſhall ſuppoſe (as is always the caſe) that the thickneſs KL, HI, &c. of the arch-ſtones is very ſmall, in compariſon with the dimenſions of the arch. If we conſider any portion HAh of the dome, it is plain that it preſſes on the courſe, of which HL is an arch-ſtone, in a direction bC perpendicular to the joint HI, or in the direction of the next ſuperior element βb of the curve. As we proceed downwards, courſe after courſe, we ſee plainly that this direction muſt change, becauſe the weight of each courſe is ſuperadded to that of the portion above it, to complete the preſſure on the courſe below. Through B draw the vertical line BCG, meeting βb, produced in C. We may take bc to expreſs the preſſure of all that is above it, propagated in this direction to the joint KL. We may alſo ſuppoſe the weight of the courſe HL united in b, and acting on the vertical. Let it be repreſented by bF. If we form the parallelogram $bFGC$, the diagonal bG will repreſent the direction and intenſity of the whole preſſure on the joint KL. Thus it appears that this preſſure is continually changing its direction, and that the line, which will always coincide with it, muſt be a curve concave downward. If this be preciſely the curve of the dome, it will be an equilibrated vaulting; but ſo far from being the ſtrongeſt form, it is the weakeſt, and it is the limit to an infinity of others, which are all ſtronger than it. This will appear evident, if we ſuppoſe that bG does not coincide with the curve AbB, but paſſes without it. As we ſuppoſe the arch-ſtones to be exceedingly thin from inſide to outſide, it is plain that this dome cannot ſtand, and that the weight of the upper part will preſs it down, and ſpring the vaulting outwards at the joint KL. But let us ſuppoſe, on the other hand, that bG falls within the curvilineal element bB. This evidently tends to puſh the arch-ſtone inward, toward the axis, and would cauſe it to ſlide in, ſince the joints are ſuppoſed perfectly ſmooth and ſlipping. But ſince this takes place equally in every ſtone of this courſe, they muſt all abut on each other in the vertical joints, ſqueezing them firmly together. Therefore, reſolving the thruſt bG into two, one of which is perpendicular to the joint KL, and the other parallel to it, we ſee that this laſt thruſt is withſtood by the vertical joints all around, and there remains only the thruſt in the direction of the curve. Such a dome muſt therefore be firmer than an equilibrated dome, and cannot be ſo eaſily broken by overloading the upper part. When the curve is concave upwards, as in the lower part of the figure, the line bC always falls below bB, and the point C below B. When the curve is concave downwards, as in the upper part of the figure, $'bC'$ paſſes above, or without bB. The curvature may be ſo abrupt, that even $b'G'$ ſhall paſs without $'bB'$, and the point G' is above B'. It is alſo evident that the force which thus binds the ſtones of a horizontal courſe together, by puſhing them towards the axis, will be greater in flat domes than in thoſe that are more convex; that it will be ſtill greater in a cone; and greater ſtill in a curve whoſe convexity is turned inwards: for in this laſt caſe the line bG will deviate moſt remarkably from the curve. Such a dome will ſtand (having poliſhed joints) if the curve ſprings from the baſe with any elevation, however ſmall; nay, ſince the friction of two pieces of ſtone is not leſs than half of their mutual preſſure, ſuch a dome will ſtand, although the tangent to the curve at the bottom ſhould be horizontal, provided that the horizontal thruſt be double the weight of the dome, which may eaſily be the caſe if it do not riſe high.

" Thus we ſee that the ſtability of a dome depends on very different principles from that of a common arch, and is in general much greater. It differs alſo in another very important circumſtance, viz. that it may be open in the middle: for the uppermoſt courſe, by tending equally in every part to ſlide in toward the axis, preſſes all together in the vertical joints, and acts on the next courſe like the key-ſtone of a common arch. Therefore an arch of equilibration, which is the weakeſt of all, may be open in the middle, and carry at top another building, ſuch as a lantern, if its weight do not exceed that of the circular ſegment of the dome that is omitted. A greater load than this would indeed break the dome, by cauſing it to ſpring up in ſome of the lower courſes; but this load may be increaſed if the curve is flatter than the curve of equilibration: and any load whatever, which will not cruſh the ſtones to powder, may be ſet on a truncate cone, or on a dome formed by a curve that is convex toward the axis; provided always that the foundation be effectually prevented from flying out, either by a hoop or by a ſufficient maſs of ſolid pier on which it is ſet."

" We have ſeen that if bG, the thruſt compounded of the thruſt bC, exerted by all the courſes above HILK, and if the force bF, or the weight of that courſe, be everywhere coincident with bB, the element of the curve, we ſhall have an equilibrated dome; if it falls within it, we have a dome which will bear a greater load; and if it falls without it, the dome will break at the joint. We muſt endeavour to get analytical expreſſions of theſe conditions. Therefore draw the ordinates $b\delta b''$, BDB'', CdC''. Let the tangents at b and b'' meet the axis in M, and make MO, MP, each equal to bc, and complete the parallelogram MONP, and draw OQ perpendicular to the axis, and produce bF, cutting the ordinates in E and e. It is plain that MN is is to MO as the weight of the arch HAh to the thruſt bc which it exerts on the joint KL (this thruſt being propagated through the courſe of HILK); and that MQ, or its equal be, or δd, may repreſent the weight of the half AH.

"Let AD be called x, and DB be called y. Then $be = \dot{x}$, and $eC = \dot{y}$ (becauſe bc is in the direction of the element βb). It is alſo plain, that if we make $\dot{y}$ conſtant, BC is the ſecond fluxion of x, or BC $= \ddot{x}$, and be and BE may be conſidered as equal, and taken indiſcriminately for $\dot{x}$. We have alſo $bC = \sqrt{\dot{x}^2+\dot{y}^2}$. Let d be the depth or thickneſs HI of the arch-ſtones. Then $d\sqrt{\dot{x}^2+\dot{y}^2}$ will repreſent the trapezium HL; and ſince the circumference of each courſe increaſes in the proportion of the radius y, $dy\sqrt{\dot{x}^2+\dot{y}^2}$ will expreſs the whole courſe. If $\int$ be taken to repreſent the ſum or aggregate of the quantities annexed to it, the formula will be analogous to the fluent of a fluxion, and $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$ will repreſent the whole maſs, and alſo the weight of the vaulting, down to the joint HI. Therefore we have this proportion, $\int dy\sqrt{\dot{x}^2+\dot{y}^2} : dy\sqrt{\dot{x}^2+\dot{y}^2} = be : bF, = be : \overline{CG}, = \delta d : CG, = \dot{x} : CG$. Therefore $CG = \frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}$.

"If the curvature of the dome be preciſely ſuch as puts it in equilibrium, but without any mutual preſſure in the vertical joints, this value of OG muſt be equal to CB, or to $\ddot{x}$, the point G coinciding with B. This condition will be expreſſed by the equation $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}} = \ddot{x}$, or, more conveniently, by $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}} = \frac{\ddot{x}}{\dot{x}}$. But this form gives only a tottering equilibrium, independent of the friction of the joints and the coheſion of the cement. An equilibrium, accompanied by ſome firm ſtability, produced by the mutual preſſure of the vertical joints, may be expreſſed by the formula $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}} > \frac{\ddot{x}}{\dot{x}}$, or by $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}} = \frac{\ddot{x}}{\dot{x}} + \frac{\dot{t}}{t}$, where t is ſome variable poſitive quantity, which increaſes when x increaſes. This laſt equation will alſo expreſs the equilibrated dome, if t be a conſtant quantity, becauſe in this caſe $\frac{\dot{t}}{t}$ is $=0$.

"Since a firm ſtability requires that $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2=\dot{y}^2}}$ ſhall be greater than $\ddot{x}$, and CG muſt be greater than CB: Hence we learn, that figures of too great curvature, whoſe ſides deſcend too rapidly, are improper. Alſo, ſince ſtability requires that we have $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\ddot{x}}$ greater than $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$, we learn that the upper part of the dome muſt not be made very heavy. This, by diminiſhing the proportion of bF to bC, diminiſhes the angle cbG, and may ſet the point G above B, which will infallibly ſpring the dome in that place. We ſee here alſo, that the algebraic analyſis expreſſes that peculiarity of dome-vaulting, that the weight of the upper part may even be ſuppreſſed.

"The fluent of the equation $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}^2}} = \frac{\ddot{x}}{\dot{x}} + \frac{\dot{t}}{t}$ is moſt eaſily found. It is $L\int dy\sqrt{\dot{x}^2+\dot{y}^2} = L\dot{x} + Lt$, where L is the hyperbolic logarithm of the quantity annexed to it. If we conſider $\dot{y}$ as conſtant, and correct the fluent ſo as to make it nothing at the vertex, it may be expreſſed thus, $L\int dy\sqrt{\dot{x}^2+\dot{y}^2} - La = L\dot{x} - L\dot{y} + Lt$. This gives us $L\frac{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}{a} = L\frac{\dot{x}}{\dot{y}}t$, and therefore $\frac{\int dy\sqrt{\dot{x}^2+\dot{y}^2}}{a} = t\frac{\dot{x}}{\dot{y}}$.

"This laſt equation will eaſily give us the depth of vaulting, or thickneſs d of the arch, when the curve is given. For its fluxion is $\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{a} = \frac{\dot{t}\dot{x}+t\ddot{x}}{\dot{y}}$, and $d = \frac{a\dot{t}\dot{x}+at\ddot{x}}{y\dot{y}\sqrt{\dot{x}^2+\dot{y}^2}}$, which is all expreſſed in known quantities; for we may put in place of t any power or function of x or of y, and thus convert the expreſſion into another, which will ſtill be applicable to all ſorts of curves.

"Inſtead of the ſecond member $\frac{\ddot{x}}{\dot{x}} + \frac{\dot{t}}{t}$ we might employ $\frac{p\ddot{x}}{\dot{x}}$, where p is ſome number greater than unity. This will evidently give a dome having ſtability; becauſe the original formula $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}}}{\int dy\sqrt{\dot{x}^2+\dot{y}}}$ will then be greater than $\ddot{x}$. This will give $d = \frac{pa\dot{x}^{p-1}\ddot{x}}{y\dot{y}^{p}\sqrt{\dot{x}^2+\dot{y}^2}}$. Each of theſe forms has its advantages when applied to particular caſes. Each of them alſo gives $d = \frac{a\ddot{x}}{y\dot{y}\sqrt{\dot{x}^2+\dot{y}^2}}$ when the curvature is ſuch as is in preciſe equilibrium. And, laſtly, if d be conſtant, that is, if the vaulting be of uniform thickneſs, we obtain the form of the curve, becauſe then the relation of $\ddot{x}$ to $\dot{x}$ and to $\dot{y}$ is given.

"The chief uſe of this analyſis is to diſcover what curves are improper for domes, or what portions of given curves may be employed with ſafety. Domes are

Theory. are generally built for ornament; and we see that there is great room for indulging our fancy in the choice. All curves which are concave outwards will give domes of great firmneſs: they are alſo beautiful. The Gothic dome, whoſe outline is an undulated curve, may be made abundantly firm, eſpecially if the upper part be convex and the lower concave outwards.

" The chief difficulty in the caſe of this analyſis ariſes from the neceſſity of expreſſing the weight of the the incumbent part, or $\int \dot{d} y \sqrt{\dot{x}^2 + \dot{y}^2}$. This requires the meaſurement of the conoidal ſurface, which, in moſt caſes, can be had only by approximation by means of infinite ſerieſes.

" The ſurface of any circular portion of a ſphere is very eaſily had, being equal to the circle deſcribed with a radius equal to the chord of half the arch. This radius is evidently $= \sqrt{\dot{x}^2 + \dot{y}^2}$.

" In order to diſcover what portion of a hemiſphere may be employed (for it is evident we cannot employ the whole) when the thickneſs of the vaulting is uniform, we may recur to the equation or formula $\frac{d y \dot{x} \sqrt{\dot{x}^2 - \dot{y}^2}}{\ddot{x}} = \int d y \sqrt{\dot{x}^2 + \dot{y}^2}$. Let a be the radius of the hemiſphere. We have $\dot{x} = \frac{a y y}{\sqrt{a^2 - y^2}}$, and $\ddot{x} = \frac{a^2 \dot{y}^2}{\overline{a^2 - y^2}|^{\frac{3}{2}}}$. Subſtituting theſe values in the formula, we obtain the equation $\dot{y}^2 \sqrt{a^2 - y^2} = \int \frac{a^2 y \ddot{y}}{\sqrt{a^2 - y^2}}$. We eaſily obtain the fluent of the ſecond member $= a^3 - a^2 \sqrt{a^2 - y^2}$, and $y = a \sqrt{-\frac{1}{2} + \sqrt{\frac{5}{4}}}$. Therefore if the radius of the ſphere be 1, the half breadth of the dome muſt not exceed $\sqrt{-\frac{1}{2} \times \sqrt{\frac{5}{4}}}$, or 0.786, and the height will be .618. The arch from the vertex is about 51° 49′. Much more of the hemiſphere cannot ſtand, even though aided by the cement, and by the friction of the courſing joints. This laſt circumſtance, by giving connection to the upper parts, cauſes the whole to preſs more vertically on the courſe below, and thus diminiſhes the outward thruſt; but it at the ſame time diminiſhes the mutual abutment of the vertical joints, which is a great cauſe of firmneſs in the vaulting. A Gothic dome, of which the upper part is a portion of a ſphere not exceeding 45° from the vertex, and the lower part is concave outwards, will be very ſtrong, and not ungraceful.

" 341. Perſuaded that what has been ſaid on the ſubject convinces the reader that a vaulting perfectly equilibrated throughout is by no means the beſt form, provided that the baſe is ſecured from ſeparating, we think it unneceſſary to give the inveſtigation of that form, which has a conſiderable intricacy, and ſhall merely give its dimenſions. The thickneſs is ſuppoſed uniform. The numbers in the firſt column of the table expreſs the portion of the axis counted from the vertex, and thoſe of the ſecond column are the length of the ordinates.

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AD	DB	AD	DB	AD	DB
0.4	100	610.4	1080	2990	1560
3.4	200	744	1140	3442	1600
11.4	300	904	1200	3972	1640
26.6	400	1100	1260	4432	1670
52.4	500	1336	1320	4952	1700
91.4	600	1522	1360	5336	1720
146.8	700	1738	1400	5756	1740
223.4	800	1984	1440	6214	1760
326.6	900	2270	1480	6714	1780
475.4	1000	2602	1520	7260	1800

" The curve formed according to theſe dimenſions will not appear very graceful, becauſe there is an abrupt change in its curvature at a ſmall diſtance from its vertex; if, however, the middle be occupied by a lantern of equal or of ſmaller weight than the part whoſe place it ſupplies, the whole will be elegant, and free from this defect.

" The connexion of the parts ariſing from cement and from friction has a great effect on dome-vaulting. In the ſame way as in common arches and cylindrical vaulting, it enables an overload on one place to break the dome in a diſtant place. But the reſiſtance to this effect is much greater in dome-vaulting, becauſe it operates all round the overloaded part. Hence it happens that domes are much leſs ſhattered by partial violence, ſuch as the falling of a bomb, or the like. Large holes may be broken in them without much affecting the reſt; but, on the other hand, it greatly diminiſhes the ſtrength which ſhould be derived from the mutual preſſure in the vertical joints. Friction prevents the ſliding in of the arch-ſtones which produces this mutual preſſure in the vertical joints, except in the very higheſt courſes, and even there it greatly diminiſhes it. Theſe cauſes make a great change in the form, which gives the greateſt ſtrength; and as their laws of action are but very imperfectly underſtood as yet, it is perhaps impoſſible, in the preſent ſtate of our knowledge, to determine this form with tolerable preciſion. We ſee plainly, however, that it allows a greater deviation from the beſt form than the other kind of vaulting; and domes may be made to riſe perpendicular to the horizon at the baſe, although of no great thickneſs; a thing which muſt not be attempted in a plane arch. The immenſe addition of ſtrength which may be derived from hooping largely compenſates for all defects; and there is hardly any bounds to the extent to which a very thin dome-vaulting may be carried, when it is hooped or framed in the direction of the horizontal courſes. The roof of the Halle du Bled at Paris is but a foot thick, and its diameter is more than 200, yet it appears to have abundant ſtrength."

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342. The ſection of the dome of St Paul's cathedral is part of an ellipſe whoſe conjugate diameter is parallel to the horizon. It is built of wood, and confined by ſtrong iron chains; and is ſupported by carpentry reſting on a cone of brick work.

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CHAP. IX. *On the Force of Torſion.*

Fig. 2. 343. DEFINITION. Let $g\,a$ be a metallic wire firmly fixed in the pincers g by means of the ſcrew s; let the cylindrical weight P, furniſhed with an index $e\,o$, be ſuſpended at the lower extremity of the wire; and let the axis of the cylinder, or the wire $g\,a$ produced, terminate in the centre of the divided circle MNO. Then, if the cylinder P is made to move round its axis ſo that the index $e\,o$ may deſcribe the arch ON, the wire $g\,a$ will be twiſted. If the cylinder be now left to itſelf, the wire will, in conſequence of its elaſticity, endeavour to recover its form; the index $e\,o$ will therefore move backwards from N, and oſcillate round the axis of the cylinder. The force which produces theſe oſcillations is called the *force of torſion*, and the angle meaſured by the arch ON is called the *angle of torſion.*

PROP. I.

344. To deduce formulæ for the oſcillatory motion of the cylinder, on the ſuppoſition that the reaction of the force of torſion is proportional to the angle of torſion, or nearly proportional to it.

Fig. 3. Let PQ be a ſection of the cylinder P in fig. 2. and let all the elements of the cylinder be projected upon this circular ſection in d, d', d''. Let ACB, the primitive angle of torſion, be called A, and let this angle, after the time t, become ACb, ſo that it has been diminiſhed by the angle BCb=M; then ACb=A—M=the angle of torſion after the time t.

Since the force of torſion is ſuppoſed to be proportional to the angle of torſion, the momentum of the force of torſion muſt be ſome multiple of that angle, or $n\times\overline{A-M}$, n being a conſtant coefficient, whoſe value depends on the nature, length, and thickneſs of the metallic wire. If, therefore, we call v the velocity of any point d at the end of the time t, when the angle of torſion becomes ACb, and r=Cd the diſtance of the point d from the axis of rotation C, we ſhall have by the principles of Dynamics,

$$n\times\overline{A-M}\times\dot{t}=\int d\,r\,\dot{v}.$$

But if CD, the radius of the cylinder, be equal a, and if u be the velocity of the point D after the time t, we have evidently $v:u=r:a$, and $v=\frac{r\,u}{a}$. Now by ſubſtituting the fluxion of this value of v in the place of $\dot{v}$ in the preceding formula, we have

$$n\times\overline{A-M}\times\dot{t}=\dot{u}\int\frac{d\,r^2}{a};$$

and ſince $\dot{t}=\frac{a\,\dot{M}}{u}$, we have by ſubſtitution

$$n\times\overline{A-M}\times\frac{a\,\dot{M}}{u}=\dot{u}\int\frac{d\,r^2}{a},$$

whoſe fluent is

$$n\times\overline{2AM-M^2}=u^2\int\frac{d\,r^2}{a^2}.$$

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Taking the ſquare root of both ſides of the equation, we have

$$\sqrt{n}\times\sqrt{2AM-M^2}=u\times\left.\overline{\int\frac{d\,r^2}{a^2}}\right|^{\frac{1}{2}}.$$

Multiplying both ſides by $\frac{a\,\dot{M}}{u}$, and dividing by $\sqrt{n}\times\sqrt{2AM-M^2}$, the equation becomes

$$\frac{a\,\dot{M}}{u}=\frac{\frac{a\,\dot{M}}{u}\times u\times\left.\overline{\int\frac{d\,r^2}{a^2}}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}=\frac{a\,\dot{M}\times\frac{1}{a}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}$$

$$=\frac{\dot{M}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}}.$$

Therefore, ſince $\dot{t}=\frac{a\,\dot{M}}{u}$, we ſhall have

$$\dot{t}=\frac{\dot{M}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2AM-M^2}},\text{ or}$$

$$\dot{t}=\frac{\dot{M}}{\sqrt{2AM-M^2}}\times\left.\overline{\int\frac{d\,r^2}{n}}\right|^{\frac{1}{2}}.$$

But $\frac{\dot{M}}{\sqrt{2AM-M^2}}$ repreſents an arch or angle whoſe radius is A and whoſe verſed ſine is M, which arch vaniſhes when M=0, and which becomes equal to 90° when M=A. Therefore the time of a complete oſcillation will be

$$T=\left.\overline{\int\frac{p\,r^2}{n}}\right|^{\frac{1}{2}}\times 180^\circ.$$

345. In order to compare the force of torſion with the force of gravity in a pendulum, we have for the time of a complete oſcillation of a pendulum whoſe length is l, g being the force of gravity,

$$T=\left.\overline{\frac{l}{g}}\right|^{\frac{1}{2}}180^\circ.$$

Therefore, ſince the time in which the cylinder oſcillates muſt be equal to the time in which the pendulum oſcillates, we have

$$\left.\overline{\int\frac{p\,r^2}{n}}\right|^{\frac{1}{2}}180^\circ=\left.\overline{\frac{l}{g}}\right|^{\frac{1}{2}}\times 180^\circ.$$

Hence dividing by 180°, and ſquaring both ſides, we obtain

$$\left.\overline{\int\frac{p\,r^2}{n}}\right|=\frac{l}{g}.$$

We muſt therefore find for a cylinder the value of $\int p\,r^2$, or the ſum of all the particles multiplied by the ſquares of their diſtances from the axis. Now, if we make π=6.28318 the ratio of the circumference of a circle to its radius, a=radius of the cylinder, λ=its length, d=its denſity; then we ſhall have for the area of its baſe $\frac{a^2\,\pi}{2}$, which multiplied by λ gives the ſolid content of the cylinder $=\frac{a^2\,\pi\,\lambda}{2}$, and this multiplied by

d

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d gives $\frac{a^2\pi\lambda d}{2}$ for the sum of all its particles. But as this is to be multiplied by the sum of the squares of all the distances of the particles from the centre C, we shall have $\int p r^2=\frac{a^4\pi^2\lambda d}{4}$. But the number of particles in the cylinder, or the mass μ of the cylinder, is $\frac{a^2\pi\lambda d}{2}$, therefore substituting μ, instead of this value of it in the preceding equation, we have $\int p r^2=\frac{\mu a^2}{2}$, and, dividing both sides by n, we have $\frac{\int p r^2}{n}=\frac{\mu a^2}{2n}$, and, extracting the square root and mutiplying by 180 it becomes

$$\overline{\frac{\int p r^2}{n}}\Big|^{\frac{1}{2}}\times 180^\circ=\overline{\frac{a^2}{2n}}\Big|^{\frac{1}{2}}\times 180^\circ.$$ Therefore

$$T=\overline{\frac{\mu a^2}{2n}}\Big|^{\frac{1}{2}}\times 180, \text{ and since } \int\frac{p r^2}{r}=\frac{l}{g},$$

$\frac{\mu a^2}{2n}=\frac{l}{g}$, and by reduction $n=\frac{g\,\mu\,a^2}{2l}$. But $g\,\mu$ is the weight W of the cylinder, therefore, by substituting W instead of $g\,\mu$, we obtain $n=\frac{P\,a^2}{2l}$, a very simple formula for determining the value of n from experiments.

If it were required to find a weight Q, which, acting at the extremity of a lever L, would have a momentum equal to the momentum of the force of torsion when the angle of torsion is A—M, we must make $Q\times L=n\times\overline{A-M}$.

346. In the preceding investigation we have supposed, what is conformable to experiment, that the force of torsion is proportional to the angle of torsion, which gives us $n\times\overline{A-M}$ for the momentum of that force. Let us now suppose that this momentum is altered by any quantity S, then the momentum of the force of torsion will become $n\times\overline{A-M}-S'$, and the general equation will assume this form

$$n\times\overline{A-M}-S\times\dot{t}=\dot{u}\int\frac{p r^2}{a};$$

and by multiplying in place of $\dot{t}$ its value $\frac{a\dot{M}}{u}$, and taking the fluent, we have

$$n\times\overline{2AM-M^2}-2\int S\dot{M}=u^2\int\frac{d r^2}{a^2}.$$

Now, in order to find the value of T or a complete oscillation, we must divide the oscillation into two parts, the first from B to A, where the force of torsion accelerates the velocity u, while the retarding force, arising from the resistance of the air and the imperfection of elasticity, diminishes the velocity u; and the second from A to B′, where the force of torsion, as well as the other forces, concur in diminishing u or retarding the motion.

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347. *Ex.* 1. If $S=m\times\overline{A-M}|^{\nu}$, we shall have for the state of motion in the first portion BA

$$n\times\overline{2AM-M^2}+\frac{2m\times\overline{A-M}|^{\nu+1}}{\nu+1}-\frac{2mA^{\nu+1}}{\nu+1}=u^2\int\frac{pr^2}{a^2}.$$

Hence, when the angle of torsion becomes equal to nothing, or A—M=0, we have

$$n\,A^2-\frac{2mA^{\nu+1}}{\nu+1}=UU\int\frac{p r^2}{a^2},$$

which dividing by $\int\frac{p r^2}{a^2}$, becomes

$$U^2=\frac{n\,A^2-\frac{2m\,A^{\nu+1}}{\nu+1}}{\int\frac{p r^2}{a^2}}.$$

Let us now consider the other part of the motion from A to B′, and suppose the angle ACb'=M′, we shall find, by calling U the velocity of the point A,

$$\frac{n\,M'^2}{2}+\frac{m\,M'^{\nu+1}}{\nu+1}=\frac{U^2-u^2}{2}\times\int\frac{p r^2}{a^2}.$$

Then, by substituting instead of U its value as lately found, and taking the fluents, we shall have, when the velocity vanishes, or when the oscillation is finished,

$$A-M'=\frac{2m}{n\times\overline{\nu+2}}\times\frac{A^{\nu+1}+M'^{\nu+1}}{A+M'},$$

and if the retarding forces are such, that at each oscillation, the amplitude is a little diminished, we shall have for the approximate value of A—M′

$$A-M'=\frac{2m\,A^{\nu}}{n\times\overline{\nu+1}},$$

and if the angle A—M′ is so small that it may be treated as a common fluxional quantity, we shall then have for any number N of oscillations

$$N\times\frac{2m}{n\times\overline{\nu+1}}=\frac{1}{\nu-1}\times\frac{1}{M^{\nu-1}}-\frac{1}{A^{\nu-1}},$$

where M represents the angle to which A becomes equal after any number of oscillations N. Hence we obtain

$$M=\frac{1}{\overline{\left(N\times\frac{2m\times\nu-1}{n\times\overline{\nu+1}}+\frac{1}{A^{\nu-1}}\right)}\times\frac{1}{\nu-1}},$$

which determines the value of M after any number of oscillations N.

348. *Ex.* 2. If $S=m\times\overline{A-M}|^{\nu}+m'\times\overline{A-M}|^{\nu'}$, m' and ν' being different values of m and ν, we shall obtain by following the mode of investigation in the last example,

$$n\times A-M=\frac{2m}{\nu+1}\times\frac{A^{\nu+1}+M^{\nu+1}}{A+M}+\frac{2m'}{\nu'+1}\times\frac{A^{\nu'+1}+M^{\nu'+1}}{A+M}:$$

and if the retarding force is much less than the force of torsion, we shall have for an approximate value of $n\times\overline{A-M}$

$$n\times\overline{A-M}=\frac{2\,mA^{\nu}}{\nu+1}+\frac{2\,m'A^{\nu'}}{\nu'+1}.$$

349. *Ex.* 3. In general, if $S=m\times\overline{A-M}|^{\nu}+m'\times\overline{A-M}|^{\nu'}+m''\times\overline{A-M}|^{\nu''}+m'''\times\overline{A-M}|^{\nu'''}$, &c. we ſhall always have for an oſcillation when S is ſmaller than the force of torſion,

$$n\times\overline{A-M}=\frac{2mA^{\nu}}{\nu+1}+\frac{2m'A^{\nu'}}{\nu'+1}+\frac{2m''A^{\nu''}}{\nu''+1}+\frac{2m'''A^{\nu'''}}{\nu'''+1}\text{ \&c.}$$

350. Having thus given after Coulomb, the mode of deducing formulæ for the oſcillatory motion of the cylinder, we ſhall proceed to give an account of the reſults of his experiments.

Torſion balance. Fig. 2.

In theſe experiments M. Coulomb employed the torſion balance repreſented in fig. 2. in which he ſuſpended cylinders of different weights from iron and braſs wires of different lengths and thickneſſes; and by obſerving carefully the duration of a certain number of oſcillations, he was enabled to determine, by means of the preceding formulæ, the laws of the force of torſion relative to the length, the thickneſs, and the nature of the wires employed. If the elaſticity of the metallic wires had been perfect, and if the air oppoſed no reſiſtance to the oſcillating cylinder, it would continue to oſcillate till its motion was ſtopped. The diminution of the amplitudes of the oſcillations, therefore, being produced ſolely by the imperfection of elaſticity, and by the reſiſtance of the air, M. Coulomb was enabled, by obſerving the ſucceſſive diminution of the amplitude of the oſcillation, and by ſubſtracting the part of the change which was due to the reſiſtance of the air, to aſcertain, with the aſſiſtance of the preceding formulæ, according to what laws this elaſtic force of torſion was changed.

351. From a great number of experiments it appeared, that when the angle of torſion was not very great, the oſcillations were ſenſibly iſochronous; and therefore it may be regarded as a fundamental law, *That for all metallic wires, when the angles of torſion are not very great, the force of torſion is ſenſibly proportional to the angle of torſion.* Hence, as the preceding formulæ are founded on this ſuppoſition, they may be ſafely applied to the experiments.

352. In all the experiments, a cylinder of two pounds weight oſcillated in twice the time employed by a cylinder which weighed only half a pound; and therefore *the duration of the oſcillations is as the ſquare root of the weights of the oſcillating cylinders.* Conſequently the tenſion of the wires has no ſenſible influence upon the force of torſion. If the tenſions however be very great relative to the ſtrength of the metal, the force of torſion does ſuffer a change; for when the weight of the cylinder, and conſequently the tenſion of the wire, is increaſed, the wire is lengthened, and as this diminiſhes the diameter of the wire, the duration of the oſcillation muſt evidently be affected.

353. When the lengths of the wires are varied without changing their diameters or the weights of the cylinders, *the times of the ſame number of oſcillations are as the ſquare roots of the lengths of the wires*, a reſult alſo deducible from theory.

354. When the diameters of the wires are varied without changing their lengths, or the weight of the cylinders, the momentum of the force of torſion varied as the fourth power of the diameters of the wires. Now this reſult is perfectly conformable to theory; for if we ſuppoſe two wires of the ſame ſubſtance, and of the ſame length, but having their diameters as one to two, it is obvious that in the wire whoſe diameter is double of the other, there are four times as many parts extended by torſion, as in the ſmaller wire, and that the mean extenſion of all theſe parts will be proportional to the diameter of a wire, the ſame as the mean arm of a lever is, relative to the axis of rotation. Hence it appears that, according to theory, the force of torſion of two wires of the ſame nature and of the ſame length, but of different diameters, is proportional to the fourth power of their diameter.

355. From this it follows in general, that in metallic wires the momentum of torſion is directly in the compound ratio of the angle of torſion and the fourth power of their diameter, and inverſely as the length of the wires. If a therefore be the angle of torſion, λ the length of the thread, δ its diameter, and F the force of torſion, we ſhall have

$$F=\frac{m\,a\,\delta^4}{l},$$

where m is a conſtant coefficient for wires of the ſame metal, depending on the tenacity of the metal, and deducible from experiment.

356. When the angle of torſion is not great, relative to the length of the wire, the index of the cylinder returns to the poſition which it had before the torſion took place, or, in other words, the wire untwiſts itſelf by the ſame quantity by which it had been twiſted. But when the angle of torſion is very great, the wire does not completely untwiſt itſelf, and therefore the centre of torſion will have advanced by a quantity equal to that which it has not untwiſted.—When the angle of torſion was below 45°, the decrements of the amplitudes of the oſcillations were nearly proportional to the amplitudes of the angle of torſion; but when the angle exceeded 45°, the decrements increaſed in a much greater ratio.—The centre of torſion did not begin to advance or be diſplaced till the angle of torſion was nearly a ſemicircle: its diſplacement was very irregular till the angle was one circle and 10 degrees, but beyond this angle the torſion remained nearly the ſame for all angles.

357. The theory of torſion is particularly uſeful in delicate reſearches, where ſmall forces are to be aſcertained with a preciſion which cannot be obtained by ordinary means. It has been ſucceſsfully employed by Coulomb in diſcovering the laws of the forces of electricity and magnetiſm, and in determining the reſiſtance of fluids when the velocities are very ſmall.

PART

PART II. ON THE CONSTRUCTION OF MACHINERY.

358. WE have already seen, when considering the maximum effects of machines, the various causes which affect their performance. It appeared from that investigation, that there must be a certain relation between the velocities of the impelled and working points of a machine, or between the power and the resistance to be overcome, before it can produce a maximum effect, and therefore it must be the first object of the engineer to ascertain that velocity, and to employ it in the construction of this machine. The performance of the machine is also influenced by the friction and inertia of its various parts; and as both these act as resistances, and therefore destroy a considerable portion of the impelling power, it becomes an object of great importance to attend to the simplification of the machinery, and to ascertain the nature of friction so as to diminish its effect, either by the application of unguents or by mechanical contrivances. Since the impelled and working points of a machine are generally connected by means of toothed wheels, the teeth must be formed in such a manner, that the wheels may always act upon each other with the same force, otherwise the velocity of the machine will be variable, and its structure soon injured by the irregularity of its motion. The irregular motion of machines sometimes arises from the nature of the machinery, from an inequality in the resistance to be overcome, and from the nature of the impelling power. In large machines, the momenta of their parts are generally sufficient to equalize these irregularities; but in machines of a small size, and in those where the irregularities are considerable, we must employ fly-wheels for regulating and rendering uniform their variable movements. These various subjects, and others intimately connected with them, we shall now proceed to discuss in their order.

CHAP. I. *On the Proportion between the Velocity of the Impelled and Working points of Machines, and between the Power and Resistance, in order that they may perform the greatest work.*

359. IN the chapter on the maximum effect of machines we have deduced formulæ containing x and y, the velocities of the impelled and working points of the machines, and including every circumstance which can affect their motion. The formula which exhibits the value of y, or the velocity of the working point, assumes various forms, according as we neglect one or more of the elements of which it is composed.—When the work to be performed resists only by its inertia, which is the case in urging round a millstone or heavy fly, the quantity R may be neglected, and the second formula, (Page 92. col. 2.) should be employed. In small machines, and particularly in those where the motion is conveyed by wheels with epicycloidal teeth, the friction is very trifling, and the element φ may be safely omitted. In corn and saw mills, the quantity b or the inertia of the resistance may be left out of the formula, as the motion communicated to the flour or to the saw dust is too small to be subjected to computation. In machines where one heavy body is employed to raise another merely by its weight, the inertia of the power and the resistance, viz. a, b, are proportional to P, R, the powers and resistances themselves, and consequently P, R may be substituted in the formula in the place of a, b.—The engineer therefore must consider, before he construct his machine, what elements should enter into the formula, and what should be omitted, in order that he may adapt it to the circumstances of the case, and obtain from his machine the greatest possible effect.

To find the relation between the velocities of the impelled and working points of a machine.

360. When the inertia of the power and that of the resistance are proportional to the power and resistance themselves; and when the inertia and friction of the machine may be omitted, the formula becomes $y=\sqrt{\frac{P}{R}+1}-1$ from which the following table is computed, which contains the values of y for different values of P; R being supposed $=10$, and $m=1$.

TABLE *containing the best Proportions between the Velocities of the Impelled and Working Points of a Machine, or between the Levers by which the Power and Resistance act.*

Proportional value of the impelling power, or P	Value of the velocities of the working point or y; or of the lever by which the resistance acts, that of x being 1.	Proportional value of the impelling power, or P.	Value of the velocities of the working point, or y; or of the lever by which the resistance acts, that of x being 1.
1	0.048809	20	0.732051
2	0.095445	21	0.760682
3	0.140175	22	0.788854
4	0.183216	23	0.816590
5	0.224745	24	0.843900
6	0.264911	25	0.870800
7	0.303841	26	0.897300
8	0.341641	27	0.923500
9	0.378405	28	0.949400
10	0.414214	29	0.974800
11	0.449138	30	1.000000
12	0.483240	40	1.236200
13	0.516575	50	1.449500
14	0.549193	60	1,645700
15	0.581139	70	1.828400
16	0.612451	80	2.000000
17	0.643168	90	2.162300
18	0 673320	100	2.316600
19	0.702938		

In order to explain the use of this table, let us suppose that it is required to raise one cubic foot of water in a second, by means of a stream which discharges three cubic feet of water in a second; and let it be required to find the construction of a wheel and axle for performing this work; that is, the diameter of the axle, that of the wheel being 6. Here the power is evidently 3 cubic feet, while the resistance is only one cubic foot, therefore $P=3R$; but in the preceding table $R=10$,

$R=10$, consequently $P=3\times 10=30$. But it appears from the table that when $P=30$, y or the diameter of the axle is 1, upon the supposition that the diameter x of the wheel is 1; but as x must be $=6$, we shall have $y=6$.

361. Instead of using the preceding table, we might find the best proportion between x and y by a kind of tentative process, from the formula $\frac{PxRy-R^2y^2}{Px^2+Ry^2}$, which expresses the work performed. This method is indeed tedious; and we mention it only for the sake of showing the conformity of the results, and of proving that there is a certain proportion between x and y which gives a maximum effect. Let $x=6$, as in the preceding paragraph, and let us suppose y to be successively 5, 6, and 7, in order to see which of these values is the best. Since $P=3$, $R=1$, and $x=6$, we have

$$\text{When } y=5\quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times5-1\times5\times5}{3\times6\times6+1\times5\times5}=\frac{65}{133}=0.488$$

$$\text{When } y=6\quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times6-1\times6\times6}{3\times6\times6+1\times6\times6}=\frac{72}{144}=0.500$$

$$\text{When } y=7\quad \frac{PxRy-R^2y^2}{Px^2+Ry^2}=\frac{3\times6\times1\times7-1\times7\times7}{3\times6\times6+1\times7\times7}=\frac{77}{157}=0.49045$$

It appears therefore that when $y=5, 6, 7$, the work performed is 0.488; 0.5000; 0.49045; so that the effect is a maximum when $y=6$, a result similar to what was obtained from the table.

To find the best proportion between the power and the resistance.

362. When the machine is already constructed, x and y cannot be varied so as to obtain a maximum effect. The same object however will be gained by properly adjusting the power to the work when the work cannot be altered, or the work to the power when the power is determinate. The formulæ in Prop. 2. Chap. 7. exhibit the values of R under many circumstances, and it depends on the judgement of the engineer to select such of them as are adapted to all the conditions of the case.

363. The following table is founded on the formula $R=\frac{\sqrt{y+1}-1}{y^2}$, which answers to the case where the inertia of the impelling power is the same with its pressure, and where the inertia and the friction of the machine may be safely neglected. The second column contains the different values of R corresponding to the values of y in the first column. The numbers in the third column shew the ratio of y to R, or they have the same proportion to 1, which R has to the resistance which will balance P. In the table it is supposed that $P=1$ and $x=1$.

Table containing the best proportions between the Power *and the* Resistance, *the inertia of the impelling power being the same with its pressure, and the friction and inertia of the Machine being omitted.*

Values of y, or the velocity of the working point; x being equal to 1.	Values of R, or the resistance to be overcome, P being = 1.	Ratio of R to the resistance which would balance P.	Values of y, or the velocity of the working point; x being equal to 1.	Values of R, or the resistance to be overcome, P being = 1.	Ratio of R to the resistance which would balance P.
$\frac{1}{4}$	1.8885	0.4724 to 1	7	0.03731	0.26117 to 1
$\frac{1}{3}$	1.3928	0.4639 ——	8	0.03125	0.25000 ——
$\frac{1}{2}$	0.8986	0.4493 ——	9	0.02669	0.24021 ——
1	0.4142	0.4142 ——	10	0.02317	0.23170 ——
2	0.1830	0.3660 ——	11	0.02037	0.22407 ——
3	0.1111	0.3333 ——	12	0.01809	0.21708 ——
4	0.0772	0.3088 ——	13	0.01622	0.21086 ——
5	0.0580	0.2900 ——	14	0.01466	0.20524 ——
6	0.0457	0.2742 ——	15	0.01333	0.19995 ——

364. To exemplify the use of the preceding table, let us suppose that we are to raise water by means of a simple pulley and bucket, with a power $=10$, and that it is required to find the resistance R, or the quantity of water which must be put into the bucket, in order that the work performed may be a maximum. In the simple pulley, x, y, the arms of the vertical levers or the velocities of the impelled and working points are equal; and since x is supposed in the table to be $=1$, we have $y=1$, which corresponds in the table with 0.4142, the value of R, P being $=1$ in the table: But in the present case $P=10$. Therefore, $10:1=0.4142:4.142$, the value of R when $P=10$.

365. The same result might be obtained in a more circuitous method by means of the formula $\frac{PxRy-R^2y^2}{Px^2+Ry^2}$, which expresses the performance of the machine. Thus, let $x=1$; $y=1$; $P=10$, and let us suppose R successively equal to 3; 4; 4.142; 5; so that we may determine which of these values gives the greatest performance.

When

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When R=3, the preceding formula becomes $\frac{\overline{10 \times 3} - \overline{3 \times 3}}{10+3} = \frac{21}{13} = 1.6154$.

When R=4, the formula becomes $\frac{\overline{10 \times 4} - \overline{4 \times 4}}{10+4} = \frac{24}{14} = 1.7143$.

When R=4.142, the formula becomes $\frac{\overline{10 \times 4.142} - \overline{4.142}|^2}{10+4.142} = \frac{24.26384}{14.142} = 1.7157$;

When R=5, the formula becomes $\frac{\overline{10 \times 5} - \overline{5 \times 5}}{10+5} = \frac{25}{15} = 1.6666$.

Hence it appears, that when R=3; 4; 4.142; 5; the work performed is reſpectively = 1.6154; 1.7143; 1.7157; 1.6666; ſo that the work performed is a maximum when R is=4.142, the ſame reſult which was obtained from the table.

Chap. II. *On the Simplification of Machinery.*

366. As the inertia of every machine adds greatly to the reſiſtance to be overcome, and as the friction of the communicating parts is proportional to the preſſure, it becomes a matter of great practical importance, that the different parts of a machine ſhould be proportioned to the ſtrains to which they are expoſed. If the beam of a ſteam-engine, for example, is larger than what is neceſſary, an immenſe portion of the impelling power muſt be deſtroyed at every ſtroke of the piſton, by dragging the ſuperfluous maſs from a ſtate of reſt into motion; the preſſure upon the gudgeons will alſo be increaſed, and their friction in their ſockets proportionally enlarged. The engineer, therefore, ſhould be well acquainted with the ſtrength of the materials of which the machine is to be conſtructed, and ſhould frame its different parts in ſuch a manner that they may not be heavier than what is neceſſary for reſiſting the forces with which they are urged.—When the motions of the machine are neceſſarily irregular, and when the machine may be expoſed to accidental ſtrains, the parts muſt be made conſiderably ſtronger than what is neceſſary for reſiſting its ordinary ſtrains; but it is not often that ſuch a precaution ſhould be obſerved. The gudgeons of water-wheels, and of the beams of ſteam-engines, ought to be made as ſhort and ſmall as poſſible, as the friction increaſes with the rubbing ſurfaces. This is very ſeldom attended to in the conſtruction of water-wheels. The diameter of the gudgeons is frequently thrice as large as what is neceſſary for ſupporting the weight of the wheel.

367. In the conſtruction of machinery we muſt not only attend to the ſimplification of the parts, but alſo to the number of theſe parts, and the mode of connecting them. From the nature and quantity of the work to be performed, it is eaſy to aſcertain the velocity of the working point which is moſt proper for performing it. Now this velocity may be procured in a variety of ways, either by a perplexing multiplicity of wheels, or by more ſimple combinations. The choice of theſe combinations muſt be left ſolely to the judgement of the engineer, as no general rules can be laid down to direct him. It may be uſeful, however, to remark, that the power ſhould always be applied as near as poſſible to the working point of the machine, and that when one wheel drives another, the diameter of the one ſhould never be great, when the diameter of the other is very ſmall. The ſize of wheels is often determined from the ſtrains to which they are expoſed. If, for example, we are obliged to give a certain velocity to an axle by means of a wheel with 120 teeth, and if the force with which this wheel is urged, requires the teeth to be at leaſt one inch thick in order to prevent them from breaking, we ſhall be obliged to make its diameter at leaſt ſeven feet; for ſuppoſing the ſpaces between the teeth to be equal to the thickneſs of the teeth, the circumference of the wheel muſt at leaſt be equal to 120+120=240 inches, the ſum of the teeth and their intervals, which gives a diameter of ſix feet eight inches. There are ſome caſes where our choice of combination muſt be directed by the nature of the machinery. If the work to be performed is a load raiſed with a certain velocity by means of a rope winding round a hollow drum, and if the ſimpleſt combination of mechanical powers for producing this velocity ſhould give a ſmall diameter to the drum, then this combination muſt give way to another which correſponds with a larger ſize of the drum, for, on account of the inflexibility of the ropes, a great portion of the impelling power would be waſted in winding them about the circumference of a ſmall drum.

368. The advantages of ſimplifying machinery are well exemplified in the following capſtane, which unites great ſtrength and ſimplicity. It is repreſented in fig. 4. where AD is a compound barrel compoſed of two cylinders of different radii. The rope DEC is fixed at the extremity of the cylinder D; and after paſſing over the pulley E, which is attached to the load by means of the hook F, it is coiled round the other cylinder D, and fixed at its upper end. The capſtane bar AB urges the compound barrel CD about its axis, ſo that while the rope coils round the cylinder D it unwinds itſelf from the cylinder C. Let us ſuppoſe that the diameter of the part D of the barrel is 21 inches, while the diameter of the part C is only 20 inches, and let the pulley E be 20 inches in diameter. When the barrel AD, therefore, has performed one complete revolution by the preſſure exerted at B, 63 inches of rope, equal to the circumference of the cylinder, will be gathered upon the cylinder D, and 60 inches will be unwinded from the cylinder C. The quantity of wound rope, therefore, exceeds the quantity that is unwound by 63—60=3 inches, the difference of their reſpective perimeters; and the half of this quantity, or $1\frac{1}{2}$ inches, will be the ſpace through which the load or pulley E moves by one turn of the bar. If a ſimple capſtane of the ſame dimenſions had been employed, the length of rope coiled round the barrel would have been 60 inches;

Deſcription of a powerful capſtane.

Plate CCCXXIII. Fig. 4.

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inches; and the ſpace deſcribed by the pulley, or load to be overcome, would have been 30 inches. Now, as the power is to the weight as the velocity of the weight is to the velocity of the power, and as the velocity of the power is the ſame in both capſtanes, the weights which they will raiſe will be as $1\frac{1}{2}$ to 30. If it is wiſhed to double the power of the machine, we have only to cover the cylinder C with lathes a quarter of an inch thick, ſo that the difference between the radii of each cylinder may be half as little as before; for it is obvious that the power of the capſtane increaſes as the difference between the radii of the cylinders is diminiſhed. As we increaſe the power, therefore, we increaſe the ſtrength of our machine, while all other engines are proportionably enfeebled by an augmentation of power. Were we for example to increaſe the power of the common capſtane, we muſt diminiſh the barrel in the ſame proportion, ſuppoſing the bar AB not to admit of being lengthened, which will not only diminiſh its ſtrength, but deſtroy much of its power by the additional flexure of the rope.—This capſtane may be eaſily converted into a crane by giving the compound barrel a horizontal poſition, and ſubſtituting a winch inſtead of the bar AB. The ſuperiority of ſuch a crane above the common ones does not require to be pointed out; but it has this additional advantage, that it allows the weight to ſtop at any part of its progreſs, without the aid of a ratchet wheel and catch, becauſe the two parts of the rope pull on the contrary ſides of the barrel. The rope indeed which coils round the larger part of the barrel acts with a larger lever, and conſequently with greater force than the other; but as this exceſs of force is not ſufficient to overcome the friction of the machine, the weight will remain ſtationary in any part of its path. (*Appendix to Ferguſon's Lectures*, vol. ii.).

Compound double machine on the ſame principle.

369. The principle on which the preceding capſtane is conſtructed, might be applied with great advantage when two ſeparate axles AC, BD are driven by means of the winch H and the wheels B and A. It is evident that when the winch is turned round in one direction, the rope R is unwinded from the axle BD; the wheel B drives the wheel A, ſo that the axle AC moves in a direction oppoſite to that of BD, and the rope is coiled round the axle AC. If the wheels A, B are of the ſame diameter and the ſame number of teeth, the weight W will be ſtationary, as the rope winded about one axle will be always equal to what is unwinded from the other. If the wheels have different diameters, or different numbers of teeth, the quantity of rope wound round the one axle will exceed what is unwound from the other, and the weight will be raiſed.

Fig 5.

Chap. III. *On the Nature of Friction and the Method of diminiſhing its effects in Machinery; and on the rigidity of Ropes.*

370. The friction generated in the communicating parts of machinery, oppoſes ſuch a reſiſtance to the impelling power, and is ſo injurious to the machine itſelf, that an acquaintance with the nature and effects of this retarding force, and with the method of diminiſhing its effects on machinery, is of infinite importance to the practical mechanic.

371. The ſubject of friction has been examined at great length by Amontons, Bulſinger, Parent, Euler, and Boſſut, and has lately occupied the attention of our ingenious countryman Mr Vince of Cambridge.

Reſults of Vince's experiments.

He found that the friction of hard bodies in motion is an uniformly retarding force, and that the quantity of friction conſidered as equivalent to a weight drawing the body backwards is equal to $M\frac{\overline{M+W}\times S}{g\,t^2}$, where M is the moving force expreſſed by its weight, W the weight of the body upon the horizontal plane, S the ſpace through which the moving force or weight deſcended in the time t, and $g=16.087$ feet, the force of gravity. Mr Vince alſo found that the quantity of friction increaſes in a leſs ratio than the quantity of matter or weight of the body, and that the friction of a body does not continue the ſame when it has different ſurfaces applied to the plane on which it moves, but that the ſmalleſt ſurfaces will have the leaſt friction.

Experiments of Coulomb.

372. Notwithſtanding the attempts of preceding philoſophers to unfold the nature of friction, it was reſerved for the celebrated Coulomb to ſurmount the difficulties which are inſeparable from ſuch an inveſtigation, and to give an accurate and ſatisfactory view of this difficult branch of mechanical philoſophy. By employing large bodies and conducting his experiments on a large ſcale, he has corrected ſeveral errors which aroſe from the limited experiments of others; he has brought to light many new and ſtriking phenomena, and confirmed others which were hitherto but partially eſtabliſhed. As it would be foreign to the nature of this work to follow this ingenious philoſopher through his numerous and varied experiments, we ſhall only preſent the reader with the intereſting reſults to which they led.

1. The friction of homogeneous bodies, or bodies of the ſame kind, moving upon one another, is generally ſuppoſed to be greater than that of heterogeneous bodies; but Coulomb has ſhewn that there are exceptions to this rule. He found, for example, that the friction of oak upon oak was equal to $\frac{1}{2.34}$ of the force of preſſion; the friction of pine againſt pine $\frac{1}{1.78}$, and that of oak againſt pine $\frac{1}{1.5}$. The friction of oak againſt copper was $\frac{1}{5.5}$, and that of oak againſt iron nearly the ſame.

2. It was generally ſuppoſed, that in the caſe of wood, the friction is greateſt when the bodies are dragged contrary to the courſe of their fibres; but Coulomb has ſhewn that the friction is in this caſe ſometimes the ſmalleſt. When the bodies moved in the direction of their fibres, the friction was $\frac{1}{2.34}$ of the force with which they were preſſed together; but when the motion was contrary to the courſes of the fibres, the friction was only $\frac{1}{3.76}$.

3. *The longer the rubbing ſurfaces remain in contact, the greater is their friction.*—When wood was moved upon

upon wood, according to the direction of the fibres, the friction was increased by keeping the surfaces in contact for a few seconds; and when the time was prolonged to a minute, the friction seemed to have reached its farthest limit. But when the motion was contrary to the course of the fibres, a greater time was necessary before the friction arrived at its maximum. When wood was moved upon metal, the friction did not attain its maximum till the surfaces continued in contact for five or six days; and it is very remarkable, that when wooden surfaces were anointed with tallow, the time requisite for producing the greatest quantity of friction is increased. The increase of friction which is generated by prolonging the time of contact is so great, that a body weighing 1650 pounds was moved with a force of 64 pounds when first laid upon its corresponding surface. After having remained in contact for the space of three seconds, it required 160 pounds to put it in motion; and, when the time was prolonged to six days, it could scarcely be moved with a force of 622 pounds. When the surfaces of metallic bodies were moved upon one another, the time of producing a maximum of friction was not changed by the interposition of olive oil; it was increased, however, by employing swine's grease as an unguent, and was prolonged to five or six days by besmearing the surfaces with tallow.

4. *Friction is in general proportional to the force with which the rubbing surfaces are pressed together; and is, for the most part, equal to between $\frac{1}{2}$ and $\frac{1}{4}$ of that force.*—In order to prove the first part of this proposition. Coulomb employed a large piece of wood, whose surface contained three square feet, and loaded it successively with 74 ponnds, 874 pounds, and 2474 pounds. In these cases the friction was successively $\frac{1}{2.46}$, $\frac{1}{2.16}$, $\frac{1}{2.21}$ of the force of pression; and when a less surface and other weights were used, the friction was $\frac{1}{2.36}$, $\frac{1}{2.42}$, $\frac{1}{2.40}$. Similar results were obtained in all Coulomb's experiments, even when metallic surfaces were employed. The second part of the proposition has also been established by Coulomb. He found that the greatest friction is engendered when oak moves upon pine, and that it amounts to $\frac{1}{1.78}$ of the force of pression; on the contrary, when iron moves upon brass, the least friction is produced, and it amounts to $\frac{1}{4}$ of the force of pression.

5. *Friction is in general not increased by augmenting the rubbing surfaces.*—When a superficies of three feet square was employed, the friction, with different weights, was $\frac{1}{2.28}$ at a medium; but when a small surface was used, the friction instead of being greater, as might have been expected, was only $\frac{1}{2.39}$.

Friction diminished by increasing the velocity.

6. *Friction for the most part is not augmented by an increase of velocity.* In some cases, *it is diminished by an augmentation of celerity.*—M. Coulomb found, that when wood moved upon wood in the direction of the fibres, the friction was a constant quantity, however much the velocity was varied; but that when the surfaces were very small in respect to the force with which they were pressed, *the friction was diminished by augmenting the rapidity*: the friction, on the contrary, was increased when the surfaces were very large when compared with the force of pression. When the wood was moved contrary to the direction of its fibres, the friction in every case remained the same. If wood be moved upon metals, the friction is greatly increased by an increase of velocity; and when metals move upon wood besmeared with tallow, the friction is still augmented by adding to the velocity. When metals move upon metals, the friction is always a constant quantity; but when heterogeneous substances are employed which are not bedaubed with tallow, the friction is so increased with the velocity, as to form an arithmetical progression when the velocities form a geometrical one.

7. *The friction of loaded cylinders rolling upon a horizontal plane, is in the direct ratio of their weights, and the inverse ratio of their diameters.* In Coulomb's experiments, the friction of cylinders of guaiacum wood, which were two inches in diameter, and were loaded with 1000 pounds, was 18 pounds or $\frac{1}{56}$ of the force of pression. In cylinders of elm, the friction was greater by $\frac{2}{5}$, and was scarcely diminished by the interposition of tallow.

373. From a variety of experiments on the friction of the axes of pulleys, Coulomb obtained the following results.—When an iron axle moved in a brass bush the friction was $\frac{1}{6}$ of the pression; but when the bush was besmeared with very clean tallow, the friction was only $\frac{1}{11}$; when swine's grease was interposed, the friction amounted to $\frac{1}{8.5}$; and when olive oil was employed as an unguent, the friction was never less than $\frac{1}{8}$ or $\frac{1}{7.5}$. When the axis was of green oak, and the bush of guaiacum wood, the friction was $\frac{1}{26}$ when tallow was interposed; but when the tallow was removed, so that a small quantity only covered the surface, the friction was increased to $\frac{1}{17}$. When the bush was made of elm, the friction was in similar circumstances $\frac{1}{33}$ and $\frac{1}{20}$ which is the least of all. If the axis be made of box, and the bush of guaiacum wood, the friction will be $\frac{1}{23}$ and $\frac{1}{14}$, circumstances being the same as before. If the axle be of boxwood, and the bush of elm, the friction will be $\frac{1}{29}$ and $\frac{1}{20}$; and if the axle be of iron and the bush of elm, the friction will be $\frac{1}{20}$ of the force of pression.

Method of diminishing the effects of friction.

374. Having thus considered the nature and effects of friction, we shall now attend to the method of lessening the resistance which it opposes to the motion of machines. The most efficacious mode of accomplishing this is to convert that species of friction which arises from one body being dragged over another, into that which is occasioned by one body rolling upon another. As this will always diminish the resistance, it may be easily effected by applying wheels or rollers to the sockets or bushes which sustain the gudgeons of large wheels, and the axles of wheel carriages. Casatus seems to have been the first who recommended this apparatus. It was afterwards mentioned by Sturmius and Wolfius; but was not used in practice till Sully applied it to clocks in the year 1716, and Mondran to cranes in 1725. Notwithstanding these solitary attempts to introduce friction wheels, they seem to have attracted little notice till the celebrated Euler examined and

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and explained, with his usual accuracy, their nature and advantages. The diameter of the gudgeons and pivots should be made as small as the weight of the wheel and the impelling force will permit. The gudgeons should rest upon wheels as large as circumstances will allow, having their axes as near each other as possible, but no thicker than what is absolutely necessary to sustain the superincumbent weight. When these precautions are properly attended to, the resistance which arises from the friction of the gudgeon, &c. will be extremely trifling.

Friction may be diminished by a judicious application of the impelling power.

375. The effects of friction may likewise in some measure be removed by a judicious application of the impelling power, and by proportioning the size of the friction wheels to the pressure which they severally sustain. If we suppose, for example, that the weight of a wheel, whose iron gudgeons move in bushes of brass, is 100 pounds; then the friction arising from both its gudgeons will be equivalent to 25 pounds. If we suppose also that a force equal to 40 pounds is employed to impel the wheel, and acts in the direction of gravity, as in the cases of overshot wheels, the pressure of the gudgeons upon their supports will then be 140 pounds and the friction 35 pounds. But if the force of 40 pounds could be applied in such a manner as to act in direct opposition to the wheel's weight, the pressure of the gudgeons upon their supports would be 100—40, or 60 pounds, and the friction only 15 pounds. It is impossible indeed to make the moving force act in direct opposition to the gravity of the wheel, in the case of water-mills; and it is often impracticable for the engineer to apply the impelling power but in a given way: but there are many cases in which the moving force may be so exerted, as at least not to increase the friction which arises from the wheel's weight.

376. When the moving force is not exerted in a perpendicular direction, but obliquely as in undershot wheels, the gudgeon will press with greater force on one part of the socket than on any other part. This point will evidently be on the side of the bush opposite to that where the power is applied; and its distance from the lowest point of the socket, which is supposed circular and concentric with the gudgeon, being called x, we shall have Tang. $x = \frac{\mathrm{H}}{\mathrm{V}}$, that is, the tangent of the arch contained between the point of greatest pressure and the lowest point of the bush, is equal to the sum of all the horizontal forces, divided by the sum of all the vertical forces and the weight of the wheel, H representing the former, and V the latter quantities. The point of greatest pressure being thus determined, the gudgeon must be supported at that part by the largest friction wheel, in order to equalize the friction upon their axles.

The application of these general principles to particular cases is so simple as not to require any illustration. To aid the conceptions, however, of the practical mechanic, we may mention two cases in which friction wheels have been successfully employed.

Plate CCCXXIII. Fig. 6.

377. Mr Gottlieb, the constructor of a new crane, has received a patent for what he calls an anti-attrition axle-tree, the beneficial effects of which he has ascertained by a variety of trials. It consists of a steel roller R about four or six inches long, which turns within a groove cut in the inferior part of the axle-tree C which runs in the nave AB of the wheel. When the wheel-carriages are at rest, Mr Gottlieb has given the friction wheel its proper position; but it is evident that the point of greatest pressure will change when they are put in motion, and will be nearer the front of the carriage. This point, however, will vary with the weight of the load; but it is sufficiently obvious that the friction roller should be at a little distance from the lowest point of the axle-tree.

378. Mr Gamett of Bristol has applied friction rollers in a different manner, which does not, like the preceding method, weaken the axle-tree. Instead of fixing them in the iron part of the axle, he leaves a space between the nave and the axis to be filled with equal rollers almost touching each other. A section of this apparatus is represented in fig. 7. where ABCD is the metallic ring inserted in the nave of the wheel. The axle-tree is represented at E, placed between the friction rollers I, I, I, made of metal, and having their axes inserted into a circle of brass which passes through their centres. The circles are rivetted together by means of bolts passing between the rollers, in order to keep them separate and parallel. Fig. 7.

379. As it appears from the experiments of Coulomb, that the least friction is generated when polished iron moves upon brass, the gudgeons and pivots of wheels, and the axles of friction rollers, should all be made of polished iron; and the bushes in which these gudgeons move, and the friction wheels, should be formed of polished brass.

Friction diminished by unguents.

380. When every mechanical contrivance has been adopted for diminishing the obstruction which arises from the attrition of the communicating parts, it may be still farther removed by the judicious application of unguents. The most proper for this purpose are swine's grease and tallow when the surfaces are made of wood, and oil when they are of metal. When the force with which the surfaces are pressed together is very great, tallow will diminish the friction more than swine's grease. When the wooden surfaces are very small, unguents will lessen their friction a little, but it will be greatly diminished if wood moves upon metal greased with tallow. If the velocities, however, are increased, or the unguent not often enough renewed, in both these cases, but particularly in the last, the unguent will be more injurious than useful. The best mode of applying it, is to cover the rubbing surfaces with as thin a stratum as possible, for the friction will then be a constant quantity, and will not be increased by an augmentation of velocity.

381. In small works of wood, the interposition of the powder of black lead has been found very useful in relieving the motion. The ropes of pulleys should be rubbed with tallow, and whenever the screw is used, the square threads should be preferred." *Appendix to Ferguson's Lectures*, vol. ii.

On the rigidity of ropes.

382. When ropes pass over cylinders or pulleys, a considerable force is necessary to bend them into the form of the circumference round which they are coiled. The force which is necessary to overcome this resistance is called the *stiffness* or *rigidity* of the ropes. This important subject was first examined by Amontons, * who contrived an ingenious apparatus for ascertaining the rigidity of ropes. His experiments were repeated and confirmed in part by subsequent philosophers, but particularly by M. Coulomb, who has investigated the subject

* *Mem. Acad.* 1699. p. 217.

ject with more care and succefs than any of his predeceffors. His experiments were made both with the apparatus of Amontons, and with one of his own invention; and as there was no great difcrepancy in the refults, he was authorifed to place more confidence in his experiments. The limits of this article will not permit us to give an account of the manner in which the experiments were conducted, or even to give a detailed view of the various conclufions which were obtained. We can only prefent the reader with fome of thofe leading refults which may be ufeful in the conftruction of machinery.

1. The rigidity of ropes increafes, the more that the fibres of which they are compofed are twifted.

2. The rigidity of ropes increafes in the duplicate ratio of their diameters. According to Amontons and Defaguliers, the rigidity increafes in the fimple ratio of the diameters of the ropes; but this probably arofe from the flexibility of the ropes which they employed: for Defaguliers remarks, that when he ufed a rope whofe diameter was half an inch, its rigidity was increafed in a greater proportion; fo that it is probable that if they had employed ropes from two to four inches in diameter, like thofe ufed by Coulomb, they would have obtained fimilar refults. (See N° 9.)

3. The rigidity of ropes is in the fimple and direct ratio of their tenfion.

4. The rigidity of ropes is in the inverfe ratio of the diameters of the cylinders round which they are coiled.

5. In general, the rigidity of ropes is directly as their tenfions and the fquares of their diameters, and inverfely as the diameters of the cylinders round which they are wound.

6. The rigidity of ropes increafes fo little with the velocity of the machine, that it need not be taken into the account when computing the effects of machines.

7. The rigidity of fmall ropes is diminifhed when penetrated with moifture; but when the ropes are thick, their rigidity is increafed.

8. The rigidity of ropes is increafed and their ftrength diminifhed when they are covered with pitch; but when ropes of this kind are alternately immerfed in the fea and expofed to the air, they laft longer than when they are not pitched.—This increafe of rigidity, however, is not fo perceptible in fmall ropes as in thofe which are pretty thick.

9. The rigidity of ropes covered with pitch is a fixth part greater during froft than in the middle of fummer, but this increafe of rigidity does not follow the ratio of their tenfions.

10. The refiftance to be overcome in bending a rope over a pulley or cylinder may be reprefented by a formula compofed of two terms. The firft term $\frac{a\,D^n}{r}$ is a conftant quantity independent of the tenfion, a being a conftant quantity determined by experiment, D^n a power of the diameter D of the rope, and r the radius of the pulley or cylinder round which the rope is coiled. The fecond term of the formula is $T\times\frac{b\,D^n}{r}$, where T is the tenfion of the rope, b a conftant quantity, and D^n and r the fame as before. Hence the complete formula is $\frac{a\,D^n}{r}+T\times\frac{b\,D^n}{r}=\frac{D^n}{r}\times a+Tb$. The exponent n of the quantity D diminifhes with the flexibility of the rope, but is generally equal to 1.7 or 1.8; or, as in N° 2. the rigidity is nearly in the duplicate ratio of the diameter of the rope. When the cord is much ufed, its flexibility is increafed, and n becomes equal to 1.5 or 1.4.

Chap. IV. *On the Nature and Advantages of Fly Wheels.*

383. A FLY, in mechanics, is a heavy wheel or cylinder which moves rapidly upon its axis, and is applied to machines for the purpofe of rendering uniform a defultory or reciprocating motion, arifing either from the nature of the machinery, from an inequality in the refiftance to be overcome, or from an irregular application of the impelling power. When the firft mover is inanimate, as wind, water, and fteam, an inequality of force obvioufly arifes from a variation in the velocity of the wind, from an increafe or decreafe of water occafioned by fudden rains, or from an augmentation or diminution of the fteam in the boiler, produced by a variation in the heat of the furnace; and accordingly various methods have been adopted for regulating the action of thefe variable powers. The fame inequality of force obtains when machines are moved by horfes or men. Every animal exerts its greateft ftrength when firft fet to work. After pulling for fome time, its ftrength will be impaired; and when the refiftance is great, it will take frequent though fhort relaxations, and then commence its labour with renovated vigour. Thefe intervals of reft and vigorous exertion muft always produce a variation in the velocity of the machine, which ought particularly to be avoided, as being detrimental to the communicating parts as well as the performance of the machine, and injurious to the animal which is employed to draw it. But if a fly, confifting either of crofs bars, or a maffy circular rim, be connected with the machinery, all thefe inconveniences will be removed. As every fly wheel muft revolve with great rapidity, the momentum of its circumference muft be very confiderable, and will confequently refift every attempt either to accelerate or retard its motion. When the machine therefore has been put in motion, the fly wheel will be whirling with an uniform celerity, and with a force capable of continuing that celerity when there is any relaxation in the impelling power. After a fhort reft the animal renews his efforts; but the machine is now moving with its former velocity, and thefe frefh efforts will have a tendency to increafe that velocity. The fly, however, now acts as a refifting power, receives the greateft part of the fuperfluous motion, and caufes the machinery to preferve its original celerity. In this way the fly fecures to the engine an uniform motion, whether the animal takes occafional relaxations or exerts his force with redoubled ardour.

384. We have already obferved that a defultory or variable motion frequently arifes from the inequality of the refiftance, or work to be performed. This is particularly manifeft in thrafhing mills, on a fmall fcale, which are driven by water. When the corn is laid unequally

on

on the feeding board, so that too much is taken in by the fluted rollers, this increase of resistance instantly affects the machinery, and communicates a desultory or irregular motion even to the water wheel or first mover. This variation in the velocity of the impelling power may be distinctly perceived by the ear in a calm evening when the machine is at work. The best method of correcting these irregularities is to employ a fly wheel, which will regulate the motion of the machine when the resistance is either augmented or diminished. In machines built upon a large scale there is no necessity for the interposition of a fly, as the *inertia* of the machinery supplies its place, and resists every change of motion that may be generated by an unequal admission of the corn.

385. A variation in the velocity of engines arises also from the nature of the machinery. Let us suppose that a weight of 1000 pounds is to be raised from the bottom of a well 50 feet, by means of a bucket attached to an iron chain which winds round a barrel or cylinder, and that every foot length of this chain weighs two pouuds, It is evident that the resistance to be overcome in the first moment is 1000 pounds added to 50 pounds the weight of this chain, and that this resistance diminishes gradually as the chain coils round the cylinder, till it is only 1000 pounds when the chain is completely wound up. The resistance therefore decreases from 1050 to 1000 pounds; and if the impelling power is inanimate, the velocity of the bucket will gradually increase; but if an animal is employed, it will generally proportion its action to the resisting load, and must therefore pull with a greater or less force according as the bucket is near the bottom or top of the well. In this case, however, the assistance of a fly may be dispensed with, because the resistance diminishes uniformly, and may be rendered constant by making the barrel conical, so that the chain may wind upon the part nearest the vertex at the commencement of the motion, the diameter of the barrel gradually increasing as the weight diminishes. In this way the variable resistance will be equalized much better than by the application of a fly wheel, for the fly having no motion of its own must necessarily waste the impelling power.

386. Having thus pointed out the chief causes of a variation in the velocity of machines, and the method of rendering it uniform by the intervention of fly wheels, the utility, and in some instances the necessity, of this piece of mechanism, may be more obviously illustrated by shewing the propriety of their application in particular cases.

* See Part III. Plate CCCXXIX. Fig. 1.

387. In the description of Vaulone's pile engine *, the reader will observe a striking instance of the utility of fly wheels. The ram Q is raised between the guides *bb* by means of horses acting against the levers S, S; but as soon as the ram is elevated to the top of the guides, and discharged from the follower G, the resistance against which the horses have been exerting their force is suddenly removed, and they would instantaneously tumble down, were it not for the fly O. This fly is connected with the drum B by means of the trundle X, and as it is moving with a very great force, it opposes a sufficient resistance to the action of the horses, till the ram is again taken up by the follower.

388. When machinery is driven by a single-stroke steam engine, there is such an inequality in the impelling power, that for two or three seconds it does not act at all. During this interval of inactivity the machinery would necessarily stop, were it not impelled by a massy fly wheel of a great diameter, revolving with rapidity, till the moving power again resumes its energy.

389. If the moving power is a man acting with a handle or winch, it is subject to great inequalities. The greatest force is exerted when the man pulls the handle upwards from the height of his knee, and he acts with the least force when the handle being in a vertical position is thrust from him in a horizontal direction. The force is again increased when the handle is pushed downwards by the man's weight, and it is diminished when the handle being at its lowest point is pulled towards him horizontally. But when a fly is properly connected with the machinery, these irregular exertions are equalized, the velocity becomes uniform, and the load is raised with an equable and steady motion.

390. In many cases, where the impelling force is alternately augmented and diminished, the performance of the machine may be increased by rendering the resistance unequal, and accommodating it to the inequalities of the moving power. Dr Robison observes that "there are some beautiful specimens of this kind of adjustment in the mechanism of animal bodies."

Besides the utility of fly wheels as regulators of machinery, they have been employed for accumulating or collecting power. If motion is communicated to a fly wheel by means of a small force, and if this force is continued till the wheel has acquired a great velocity, such a quantity of motion will be accumulated in its circumference, as to overcome resistances and produce effects which could never have been accomplished by the original force. So great is this accumulation of power; that a force equivalent to 20 pounds applied for the space of 37 seconds to the circumference of a cylinder 20 feet diameter, which weighs 4713 pounds, would, at the distance of one foot from the centre, give an impulse to a musket ball equal to what it receives from a full charge of gunpowder. In the space of six minutes and 10 seconds, the same effect would be produced if the cylinder was driven by a man who constantly exerted a force of 20 pounds at a winch one footlong (D).

391. This accumulation of power is finely exemplified in the *sling*. When the thong which contains the stone is swung round the head of the slinger, the force of the hand is continually accumulating in the revolving stone, till it is discharged with a degree of rapidity which it could never have received from the force of the hand alone. When a stone is projected from the hand itself, there is even then a certain degree of force accumulated, though the stone only moves through the arch of a circle. If we fix the stone in an opening at the

(D) This has been demonstrated by Mr Atwood. See his Treatise on Rectilineal and Rotatory Motion.

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extremity of a piece of wood two feet long, and difcharge it in the ufual way, there will be more force accumulated than with the hand alone, for the ftone defcribes a larger arch in the fame time, and muft therefore be projected with greater force.

392. When coins or medals are ftruck, a very confiderable accumulation of power is neceffary, and this is effected by means of a fly. The force is firft accumulated in weights fixed in the end of the fly. This force is communicated to two levers, by which it is farther condenfed; and from thefe levers it is tranfmitted to a fcrew, by which it fuffers a fecond condenfation. The ftamp is then impreffed on the coin or medal by means of this force, which was firft accumulated by the fly, and afterwards augmented by the intervention of two mechanical powers.

393. Notwithftanding the great advantage of fly wheels, both as regulators of machines and collectors of power, their utility wholly depends upon the pofition which is affigned them relative to the impelled and working points of the engine. For this purpofe no particular rules can be laid down, as their pofitions depend altogether on the nature of the machinery. We may obferve however, in general, that when fly wheels are employed to regulate machinery, they fhould be near the impelling power; and when ufed to accumulate force in the working point they fhould not be far diftant from it. In hand mills for grinding corn, the fly is for the moft part very injudicioufly fixed on the axis to which the winch is attached; whereas it fhould always be faftened to the upper millftone fo as to revolve with the fame rapidity. In the firft pofition indeed it muft equalize the varying efforts of the power which moves the winch; but when it is attached to the turning millftone, it not only does this, but contributes very effectually to the grinding of the corn.

Defcription of the conical pendulum. Fig. 8.

394. A new kind of fly, called a conical pendulum, has been ingenioufly employed by Mr Watt for procuring a determinate velocity at the working point of his fteam-engine. It is reprefented in fig. 8. where AB is a vertical axis moving upon pivots, and driven by means of a rope paffing from the axis of the large fly over the fheave EF. The large balls M, N are fixed to the rods NG, MH, which have an angular motion round P, and are connected by joints at G and H, with the rods GK, HK attached to the extremity of the lever KL whofe centre of motion is L, and whofe other extremity is connected with the cock which admits the fteam into the cylinder. The frames CD and QR prevent the balls from receding too far from the axis, or from approaching too near it. Now when this conical pendulum is put in motion, the centrifugal force of the balls M, N makes them recede from the axis AB. In confequence of this recefs, the points, C, H, K are depreffed and the other extremity of the lever is raifed; and the cock admits a certain quantity of fteam into the cylinder. When the velocity of the fly is by any means increafed, the balls recede ftill farther from the axis, the extremity of the lever is raifed higher, and the cock clofes a little and diminifhes the fupply of fteam. From this diminution in the impelling power, the velocity of the fly and the conical pendulum decreafes, and the balls refume their former pofition. In this way, when there is any increafe or diminution in the velocity of the fly, the correfponding increafe or diminution in the centrifugal force of the balls raifes or depreffes the arm of the lever, admits a greater or a lefs quantity of fteam into the cylinder, and reftores to the engine its former velocity.

Chap. V. *On the Teeth of Wheels, and the Wipers of Stampers.*

395. In the conftruction of machines, we muft not only attend to the form and number of their parts, but alfo to the mode by which they are to be connected. It would be eafy to fhew, did the limits of this article permit it, that, when one wheel impels another, the impelling power will fometimes act with greater and fometimes with lefs force, unlefs the teeth of one or both of the wheels be parts of a curve generated after the manner of an epicycloid by the revolution of one circle along the convex or concave fide of another. It may be fufficient to fhew, that, when one wheel impels another by the action of epicycloidal teeth, their motion will be uniform. Let the wheel CD drive the wheel AB by means of the epicycloidal teeth mp, nq, or, acting upon the infinitely fmall pins or fpindles a, b, c; and let the epicycloids mp, nq, &c. be generated by the circumference of the wheel AB, rolling upon the convex circumference of the wheel CD. From the formation of the epicycloid it is obvious that the arch ab is equal to mn, and the arch ac to mo; for during the formation of the part nb of the epicycloid nq, every point of the arch ab is applied to every point of the arch mn, and the fame happens during the formation of the part co of the epicycloid or. Let us now fuppofe that the tooth mp begins to act on the pin a, and that b, c are fucceffive pofitions of the pin a after a certain time; then, nq, or will be the pofitions of the tooth mp after the fame time; but $ab = mn$ and $ac = mo$, therefore the wheels AB, CD, when the arch is driven by epicycloidal teeth, move through equal fpaces in equal times, that is, the force of the wheel CD, and the velocity of the wheel AB, are always uniform. Fig. 9.

396. In illuftrating the application of this property of the epicycloid, which was difcovered by Olaus Roemer the celebrated Danifh aftronomer, we fhall call the fmall wheel the *pinion*, and its teeth the *leaves* of the pinion. The line which joins the centre of the wheel and pinion is called the *line of centres*. There are three different ways in which the teeth of one wheel may drive another, and each of thefe modes of action requires a different form for the teeth.

1. When the action is begun and completed after the teeth have paffed the line of centres.

2. When the action is begun and completed before they reach the line of centres.

3. When the action is carried on, on both fides of the line of centres.

First mode of action. Plate CCCXXIV. Fig. 1.

397. 1. The firft of thefe modes of action is reprefented in fig. 1. where B is the centre of the wheel (D), A that of the pinion, and AB the line of centres. It is evident from the figure, that the part b of the tooth ab of the wheel, does not act on the leaf m of the pinion till they arrive at the line of centres AB; and that all the action is carried on after they have paffed this line, and is completed when the leaf m comes into the fituation n. When this mode of action is adopted, the acting faces of

(D) In figs. 1, 2, 3, 4, the letter B is fuppofed to be placed at the centre of the wheels.

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of the leaves of the pinion should be parts of an *interior epicycloid*, generated by a circle of any diameter rolling upon the concave superficies of the pinion, or within the circle *a d h*; and the faces *a b* of the teeth of the wheel should be portions of an *exterior epicycloid* formed by the *same* generating circle rolling upon the convex superficies *o d p* of the wheel.

398. But when one circle rolls within another whose diameter is double that of the rolling circle, the line generated by any point of the latter is a *straight line*, tending to the centre of the larger circle. Therefore, if the generating circle above mentioned should be taken with its diameter equal to the radius of the pinion, and be made to roll upon the concave superficies *a d h* of the pinion, it will generate a straight line tending to the pinion's centre, which will be the form of the faces of its leaves; and the teeth of the wheel will be exterior epicycloids, formed by a generating circle, whose diameter is equal to the radius of the pinion, rolling upon the convex superficies *o d p* of the wheel. This rectilineal form of the teeth is exhibited in fig. 2. and is perhaps the most advantageous, as it requires less trouble, and may be executed with greater accuracy, than if the epicycloidal form had been employed, though the teeth are evidently weaker than those in fig. 1.; it is recommended both by De la Hire and Camus as particularly advantageous in clock and watch work.

Fig. 2.

Fig. 1.

399. The attentive reader will perceive from fig. 1. that in order to prevent the teeth of the wheel from acting upon the leaves of the pinion before they reach the line of centres AB; and that one tooth of the wheel may not quit the leaf of the pinion till the succeeding tooth begins to act upon the succeeding leaf, there must be a certain proportion between the number of leaves in the pinion and the number of teeth in the wheel, or between the radius of the pinion and the radius of the wheel, when the distance of the leaves AB is given. But in machinery the number of leaves and teeth is always known from the velocity which is required at the working point of the machine: It becomes a matter therefore of great importance to determine with accuracy the relative radii of the wheel and pinion.

Relative size of the wheel and pinion.

400. For this purpose, let A, fig. 2. be the pinion having the acting faces of its leaves straight lines tending to the centre, and B the centre of the wheel, AB will be the distance of their centres. Then as the tooth C is supposed not to act upon the leaf A*m* till it arrives at the line AB, it ought not to quit A*m* till the following tooth F has reached the line AB. But since the tooth always acts in the direction of a line drawn perpendicular to the face of the leaf A*m* from the point of contact, the line CH, drawn at right angles to the face of the leaf A*m*, will determine the extremity of the tooth CD, or the last part of it which should act upon the leaf A*m*, and will also mark out CD for the depth of the tooth. Now, in order to find AH, HB, and CD, put a for the number of teeth in the wheel, b for the number of leaves in the pinion, c for the distance of the pivots A and B, and let x be the radius of the wheel, and y that of the pinion. Then, since the circumference of the wheel is to the circumference of the pinion, as the number of teeth in the one to the number of leaves in the other, and as the circumferences of circles are proportional to their radii, we shall have $a : b = x : y$, then by composition (Eucl. v. 18.) $a+b : b = c : y$ (c being equal to $x+y$), and consequently the radius of the pinion, viz. $y = \frac{c\,b}{a+b}$; then by inverting the first analogy, we have $b : a = y : x$, and consequently the radius of the wheel, viz. $x = \frac{a\,y}{b}$; y being now a known number.

Now, in the triangle AHC, right angled at C, the side AH is known, and likewise all the angles (HAC being equal to $\frac{360}{b}$); the side AC, therefore, may be found by plain trigonometry. Then, in the triangle ACB, the $\angle$CAB, equal to HAC, is known, and also the sides AB, AC, which contain it; the third side, therefore, viz. CB, may be determined; from which DB, equal to HB, already found, being subtracted, there will remain CD for the depth of the teeth. When the action is carried on after the line of centres, it often happens that the teeth will not work in the hollows of the leaves. In order to prevent this, the $\angle$ CBH must always be greater than half the $\angle$ HBP. The $\angle$ HBP is equal to 360 degrees, divided by the number of teeth in the wheel, and CBH is easily found by plain trigonometry.

401. If the teeth of wheels and the leaves of pinions be formed according to the directions already given, they will act upon each other, not only with uniform force, but nearly without friction. The one tooth rolls upon the other, and neither slides nor rubs to such a degree as to retard the wheels, or wear their teeth. But as it is impossible in practice to give that perfect curvature to the faces of the teeth which theory requires, a quantity of friction will remain after every precaution has been taken in the formation of the communicating parts.

Second mode of action.

402. 2. The second mode of action is not so advantageous as that which we have been considering, and should, if possible, always be avoided. It is represented in fig. 3. where A is the centre of the pinion, B that of the wheel, and AB the line of centres. It is evident from the figure that the tooth C of the wheel acts upon the leaf D of the pinion before they arrive at the line BA; that it quits the leaf when they reach this line, and have assumed the position of E and F; and that the tooth *c* works deeper and deeper between the leaves of the pinion, the nearer it comes to the line of centres. From this last circumstance a considerable quantity of friction arises, because the tooth C does not, as before, roll upon the leaf D, but slides upon it; and from the same cause the pinion soon becomes foul, as the dust which lies upon the acting faces of the leaves is pushed into the interjacent hollows. One advantage, however, attends this mode of action: It allows us to make the teeth of the large wheel rectilineal, and thus renders the labour of the mechanic less, and the accuracy of his work greater, than if they had been of a curvilineal form. If the teeth C, E, therefore of the wheel BC are made rectilineal, having their surfaces directed to the wheel's centre, the acting faces of the leaves D, F, &c. must be epicycloids formed by a generating circle, whose diameter is equal to the radius B *o* of the circle *o p*, rolling upon the circumference *m n* of the pinion A. But if the teeth of the wheel and the leaves of the pinion are made curvilineal as in the figure, the faces of the teeth of the wheel must be portions of an interior epicycloid formed by any generating

Fig. 3.

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rating circle rolling within the concave superficies of the circle $o\,p$, and the faces of the pinion's leaves must be portions of an exterior epicycloid produced by rolling the same generating circle upon the convex circumference $m\,n$ of the pinion.

Third mode of action. Fig. 4.

403. 3. The third mode of action, which is represented in fig. 4. is a combination of the two first modes, and consequently partakes of the advantages and disadvantages of each. It is evident from the figure that the portion $e\,b$ of the tooth acts upon the part $b\,c$ of the leaf till they reach the line of centres AB, and that the part $e\,d$ of the tooth acts upon the portion $b\,a$ of the leaf after they have passed this line. Hence the acting parts $e\,h$ and $b\,c$ must be formed according to the directions given for the first mode of action, and the remaining parts $e\,d$, $b\,a$, must have that curvature which the second mode of action requires; consequently $e\,h$ should be part of an interior epicycloid formed by any generating circle rolling on the concave circumference $m\,n$ of the wheel, and the corresponding part $b\,c$ of the leaf should be part of an exterior epicycloid formed by the same generating circle rolling upon b EO, the convex circumference of the pinion: the remaining part $c\,d$ of the tooth should be a portion of an exterior epicycloid, engendered by any generating circle rolling upon e L, the concave superficies of the wheel: and the corresponding part $b\,a$ of the leaf should be part of an interior epicycloid described by the same generating circle, rolling along the concave side b EO of the pinion. As it would be extremely troublesome, however, to give this double curvature to the acting faces of the teeth, it will be proper to use a generating circle, whose diameter is equal to the radius of the wheel BC, for describing the interior epicycloid $e\,h$ and the exterior one $b\,c$, and a generating circle, whose diameter is equal to AC, the radius of the pinion, for describing the interior epicycloid $b\,a$, and the exterior one $e\,d$. In this case the two interior epicycloids $e\,h$, $b\,a$, will be straight lines tending to the centres B and A, and the labour of the mechanic will by this means be greatly abridged.

Relative diameters of the wheel and pinion.

404. In order to find the relative diameters of the wheel and pinion, when the number of teeth in the one and the number of leaves in the other are given, and when the distance of their centres is also given, and the ratio of ES to CS, let a be the number of teeth in the wheel, b the number of leaves in the pinion, c the distance of the pivots A, B, and let m be to n as ES to CS, then the arch ES, or $\angle$ SAE, will be equal to $\frac{360^\circ}{b}$, and LD, or $\angle$ LBD, will be equal to $\frac{360^\circ}{a}$. But ES : CS $= m : n$; consequently LD : LC $= m : n$, therefore (Eucl. vi. 16.) LC $\times m =$ LD $\times n$, and LC $= \frac{\text{LD} \times n}{m}$; but LD is equal to $\frac{360}{a}$, therefore by substitution LC $= \frac{360 \times n}{a\,m}$.

Now, in the triangle APB, AB is known, and also PB, which is the cosine of the angle ABD, PC being perpendicular to DB; AP or the radius of the pinion therefore may be found by plane trigonometry. The reader will observe, that the point P marks out the parts of the tooth D and the leaf SP where they commence their action; and the point I marks out the parts where their mutual action ceases (E); AP therefore is the proper radius of the pinion, and BI the proper radius of the wheel, the parts of the tooth L without the point I, and of the leaf SP without the point P, being superfluous. Now, to find BI, we have ES : CS $= m : n$, and CS $= \frac{\text{ES} \times n}{m}$; but ES was shewn to be $= \frac{360}{b}$, therefore, by substitution, CS $= \frac{360 \times n}{b\,m}$. Now the arch ES, or $\angle$ EAS, being equal to $\frac{360}{b}$, and CS, or $\angle$ CAS, being equal to $\frac{360 \times n}{b\,m}$, their difference EC, or the angle EAC, will be equal to $\frac{360}{b} - \frac{360 \times n}{b\,m}$, or $\frac{360^\circ \times \overline{m-n}}{b\,m}$. The $\angle$ EAC being thus found, the triangle EAB, or IAB, which is almost equal to it, is known, because AB is given, and likewise AI, which is equal to the cosine of the angle IAB, AC being radius, and AIC being a right angle, consequently IB the radius of the wheel may be found by trigonometry. It was formerly shewn that AC, the radius of what is called the primitive pinion, was equal to $\frac{c\,b}{a+b}$, and that BC the radius of the primitive wheel was equal to $\frac{\text{AC} \times a}{b}$. If then we subtract AC or AS from AP, we shall have the quantity SP which must be added to the radius of the primitive pinion, and if we take the difference of BC (or BL) and DE, the quantity LE will be found, which must be added to the radius of the primitive wheel. We have all along supposed that the wheel drives the pinion, and have given the proper form of the teeth upon this supposition. But when the pinion drives the wheel, the form which was given to the teeth of the wheel in the first case, must in this be given to the leaves of the pinion; and the shape which was formerly given to the leaves of the pinion must now be transferred to the teeth of the wheel.

Form of the teeth according to Dr Robison.

405. Another form for the teeth of wheels, different from any which we have mentioned, has been recommended by Dr Robison. He shews that a perfect uniformity of action may be secured, by making the acting faces of the teeth involutes of the wheel's circumference, which are nothing more than epicycloids, the centres of whose generating circles are infinitely distant. Thus, in fig. 1. let AB be a portion of the wheel on which

(E) The letter L marks the intersection of the line BL with the arch $e\,m$, and the letter E the intersection of the arch b O with the upper surface of the leaf m. The letters D and S correspond with L and E respectively, and P with I.

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Fig. 5.

which the tooth is to be fixed, and let A*p a* be a thread lapped round its circumference, having a loop hole at its extremity *a*. In this loop hole fix the pin *a*, and with it defcribe the curve or *involute a b c d e h*, by unlapping the thread gradually from the circumference A*p m*. This curve will be the proper fhape for the teeth of a wheel whofe diameter is AB. Dr Robifon obferves, that as this form admits of feveral teeth to be acting at the fame time (twice the number that can be admitted in M. de la Hire's method), the preffure is divided among feveral teeth, and the quantity upon any one of them is fo diminifhed, that thofe dents and impreffions which they unavoidably make upon each other are partly prevented. He candidly allows, however that the teeth thus formed are not completely free from fliding and friction, though this flide is only $\frac{1}{50}$th of an inch, when a tooth three inches long fixed on a wheel ten feet in diameter drivesanother wheel whofe diameter is two feet. *Append. to Ferguſon's Lectures.*

406. *On the Formation of Exterior and Interior Epicycloids, and on the Difpofition of the Teeth on the Wheel's Circumference.*

Mechanical method of forming epicycloids.

Nothing can be of greater importance to the practical mechanic, than to have a method of drawing epicycloids with facility and accuracy; the following, we truft, is the moft fimple mechanical method that can be employed.—Take a piece of plain wood GH, fig. 6. and fix upon it another piece of wood E, having its circumference *m b* of the fame curvature as the circular bafe upon which the generating circle AB is to roll. When the generating circle is large, the fegment B will be fufficient: in any part of the circumference of this fegment, fix a fharp pointed nail *a*, floping in fuch a manner that the diftance of its point from the centre of the circle may be exactly equal to its radius; and faften to the board GH a piece of thin brafs, or copper, or tinplate, *a b*, diftinguifhed by the dotted lines. Place the fegment B in fuch a pofition that the point of the nail *a* may be upon the point *b*, and roll the fegment towards G, fo that the nail *a* may rife gradually, and the point of contact between the two circular fegments may advance towards *m*; the curve *a b* defcribed upon the brafs plate will be an accurate exterior epicycloid. In order to prevent the fegments from fliding, their peripheries fhould be rubbed with rofin or chalk, or a number of fmall iron points may be fixed on the circumference of the generating fegment. Remove, with a file, the part of the brafs on the left hand of the epicycloid, and the remaining concave arch or gage *a b* will be a pattern tooth, by means of which all the reft may be eafily formed. When an *interior epicycloid* is wanted, the concave fide of its circular bafe muft be ufed. The method of defcribing it is reprefented in fig. 7. where CD is the generating circle, F the concave circular bafe, MN the piece of wood on which this bafe is fixed, and *c d* the interior epicycloid formed upon the plate of brafs, by rolling the generating circle C, or the generating fegment D, towards the right hand. The *cycloid*, which is ufeful in forming the teeth of *rack work*, is generated precifely in the fame manner, with this difference only, that the bafe on which the generating circle rolls muft be a ftraight line.

Fig. 6.

Fig. 7.

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Difpofition of the teeth.

In order that the teeth may not embarrafs one another before their action commences, and that one tooth may begin to act upon its correfponding leaf of the pinion, before the preceding tooth has ceafed to act upon the preceding leaf, the height, breadth, and diftance of the teeth muft be properly proportioned. For this purpofe the pitch-line or circumference of the wheel, which is reprefented in fig. 2. and 3. by the dotted arches, muft be divided into as many equal fpaces as the number of teeth which the wheel is to carry. Divide each of thefe fpaces into 16 equal parts; allow 7 of thefe for the greateft breadth of the teeth, and 9 for the diftance between each; or the diftance of the teeth may be made equal to their breadth. If the wheel drive a trundle, each fpace fhould be divided into 7 equal parts, and 3 of thefe allotted for the thicknefs of the tooth, and $3\frac{2}{3}$ for the diameter of the cylindrical ftave of the trundle. If each of the fpaces already mentioned, or if the diftance between the centres of each tooth, be divided into three equal parts, the height of the teeth muft be equal to two of thefe. Thefe diftances and heights, however, vary according to the mode of action which is employed. The teeth fhould be rounded off at the extremities, and the radius of the wheel made a little larger than that which is deduced from the rules in Art. 400, 404. But when the pinion drives the wheel, a fmall addition fhould be made to the radius of the pinion.

On the Nature of Bevelled Wheels, and the method of giving an epicycloidal form to their Teeth.

Bevelled wheels.

407. The principle of bevelled wheels was pointed out by De la Hire, fo long ago as the end of the 17th century. It confifts in one fluted or toothed cone acting upon another, as is reprefented in fig. 8. where the cone OD drives the cone OC, conveying its motion in the direction OC. If thefe cones be cut parallel to their bafes as at A and B, and if the two fmall cones between AB and O be removed, the remaining parts AC and BD may be confidered as two bevelled wheels, and BD will act upon AC in the very fame manner, and with the fame effect, that the whole cone OD acted upon the whole cone OC. If the fection be made nearer the bafes of the cones, the fame effect will be produced: this is the cafe in fig. 9. where CD and DE are but very fmall portions of the imaginary cones ACD and ADE.

Fig. 8.

Fig. 9.

408. In order to convey motion in any given direction, and determine the relative fize and fituation of the wheels for this purpofe, let AB, fig. 10. be the axis of a wheel, and CD the given direction in which it is required to convey the motion by means of a wheel fixed upon the axis AB, and acting upon another wheel fixed on the axis CD, and let us fuppofe that the axis CD muft have four times the velocity of AB, or muft perform four revolutions while AB performs one. Then the number of teeth in the wheel fixed upon AB muft be four times greater than the number of teeth in the wheel fixed upon CD, and their radii muft have the fame proportion. Draw *c d* parallel to CD at any convenient diftance, and draw *a b* parallel to AB at four times that diftance, then the lines *i m* and *i n* drawn perpendicular to AB and CD refpectively, will mark the fituation and fize of the wheels required. In this

Fig. 10.

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this case the cones are O n i and O m i, and s r n i, r p m i, are the portions of them that are employed.

On the formation of their teeth.

The formation of the teeth of bevelled wheels is more difficult than one would at first imagine. The teeth of such wheels, indeed, must be formed by the same rules which been have given for other wheels; but since different parts of the same tooth are at different distances from the axis, these parts must have the curvature of their acting surfaces proportioned to that distance. Thus, in fig. 10. the part of the tooth at r must be more incurvated than the part at i, as is evident from the inspection of fig. 9.; and the epicycloid for the part i must be formed by means of circles whose diameters are i m and F f, while the epicycloid for the part r must be generated by circles whose diameters are C n and D d.

409. Let us suppose a plane to pass through the points O, A, D; the lines AB, AO, will evidently be in this plane, which may be called the *plane of centres*. Now, when the teeth of the wheel DE, which is supposed to drive CD the smallest of the two, commence their action on the teeth of CD, when they arrive at the plane of centres, and continue their action after they have passed this plane, the curve given to the teeth of CD at C, should be a portion of an interior epicycloid formed by any generating circle rolling on the concave superficies of a circle whose diameter is twice C n perpendicular to CA, and the curvature of the teeth at i should be part of a similar epicycloid, formed upon a circle, whose diameter is twice i m. The curvature of the teeth of the wheel DE at D, should be part of an exterior epicycloid formed by the same generating circle rolling upon the concave circumference of a circle whose diameter is twice D d perpendicular to DA; and the epicycloid for the teeth at F is formed in the same way, only instead of twice D d, the diameter of the circle must be twice F f. When any other mode of action is adopted, the teeth are to be formed in the same manner that we have pointed out for common wheels, with this difference only, that different epicycloids are necessary for the parts F and D. It may be sufficient, however, to find the form of the teeth at F, as the remaining part of the tooth may be shaped by directing a straight rule from different points of the epicycloid at F to the centre A, and filing the tooth till every part of its acting surface coincide with the side of the ruler. The reason of this operation will be obvious by attending to the shape of the tooth in fig. 8. When the small wheel CD impels the large one DE, the epicycloids which were formerly given to CD must be given to DE, and those which were given to DE must be transferred to CD.

Fig. 8.

On crown wheels.

410. The wheel represented in fig. 11. is sometimes called a crown wheel, though it is evident from the figure that it belongs to that species of wheels which we have just been considering; for the acting surfaces of the teeth both of the wheel MB and of the pinion EDG are directed to C the common vertex of the two cones CMB, CEG. In this case the rules for bevelled wheels must be adopted, in which AS is to be considered as the radius of the wheel for the profile of the tooth at A, and MN as its radius for the profile of the tooth at M; and the epicycloids thus formed will be the sections or profiles of the teeth in the direction MP, at right angles to MC the surfaces of the cone. When the vertex C of the cone MCG approaches to N till it be in the same plane with the points M, G, some of the curves will be cycloids and others involutes, as in the case of rackwork, for then the cone CEG will revolve upon a plane surface. *Appendix to Ferguson's Lectures.*

Fig. 11.

Sect. II. *On the Wipers of Stampers, &c. the Teeth of Rackwork, &c. &c.*

Fig. 12.

411. In fig. 12. let AB be the wheel which is employed to elevate the rack C, and let their mutual action not commence till the acting teeth have reached the line of centres AC. In this case C becomes as it were the pinion or wheel driven, and the acting faces of its teeth must be *interior epicycloids* formed by any generating circle rolling within the circumference p q; but as p q is a straight line, these interior epicycloids will be *cycloids*, or curves generated by a point in the circumference of a circle, rolling upon a straight line or plane surface. The acting face o p, therefore, will be part of a *cycloid* formed by any generating circle, and m n, the acting face of the teeth of the wheel, must be an *exterior* epicycloid produced by the same generating circle rolling on m r the convex surface of the wheel. If it is required to make o p a straight line, as in the figure, then m n must be an *involute* of the circle m r formed in the manner represented in fig. 5.

412. Fig. 12. likewise represents a wheel depressing the rack c when the third mode of action is used. In this case also c becomes the pinion, and DE the wheel; e h therefore must be part of an interior epicycloid formed by any generating circle rolling on the concave side e x of the wheel, and b c must be an exterior epicycloid produced by the same generating circle rolling upon the circumference of the rack. The remaining part c d of the teeth of the wheel, must be an exterior epicycloid described by any generating circle moving upon the convex side e x, and b a must be an interior epicycloid engendered by the same generating circle rolling within the circumference of the rack. But as the circumference of the rack is in this case a straight line, the exterior epicycloid b c and the interior one b a will be cycloids formed by the same generating circles which are employed in describing the other epicycloids. Since it would be difficult, however, as has already been remarked, to give this compound curvature to the teeth of the wheel and rack, we may use a generating circle whose diameter is equal to D x the radius of the wheel, for describing the interior epicycloid e h, and the exterior one b c; and a generating circle whose diameter is equal to the radius of the rack, for describing the interior epicycloid a b, and the exterior one d e; a b and e h, therefore, will be straight lines and b c will be a cycloid, and d e an involute of the circle e x, the radius of the rack being infinitely great.

413. In the same manner may the form of the teeth of rack-work be determined, when the second mode of action is employed, and when the teeth of the wheel or rack are circular or rectilineal. But if the rack be part of a circle, it must have the same form for its teeth as that of a wheel of the same diameter with the circle of which it is a part.

In

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Proper form of wipers.

In machinery, where large weights are to be raised, such as fulling-mills, mills for pounding ore, &c. or where large pistons are to be elevated by the arms of levers, it is of the greatest consequence that the power should raise the weight with an uniform force and velocity; and this can be effected only by giving a proper form to the wiper.

Now there are two cases in which this uniformity of motion may be required, and each of these demands a different form for the communicating parts. 1. When the weight is to be raised vertically, as the piston of a pump, &c. 2. When the weight to be raised or depressed moves upon a centre, and rises or falls in the arch of a circle, such as the sledge hammer in a forge, &c.

Fig. 13.

414. 1. Let AH be a wheel moved by any power which is sufficient to raise the weight MN by its extremity O, from O to *e*, in the same time that the wheel moves round one-fourth of its circumference, it is required to fix upon its rim a wing OBCDEH which shall produce this effect with an uniform effort. Divide the quadrant OH into any number of equal parts O *m*, *m n*, &c. the more the better, and *o e* into the same number *o b*, *b c*, *c d*, &c. and through the points *m*, *n*, *p*, H draw the indefinite lines AB, AC, AD, AE, and make AB equal to A *b*, AC to A *c*, AD to A *d*, and AE to A *e*; then through the points O, B, C, D, E, draw the curve OBCDE, which is a portion of the spiral of Archimedes, and will be the proper form for the wiper or wing OHE. It is evident that when the point *m* has arrived at O, the extremity of the weight will have arrived at *b*; because AB is equal to A *b*, and for the same reason, when the points *n*, *p*, H have successively arrived at O, the extremity of the weight will have arrived at the corresponding points *c*, *d*, *e*. The motion therefore will be uniform, because the space described by the weight is proportional to the space described by the moving power, O *b* being to O *c* as O *m* to O *n*. If it be required to raise the weight MN with an accelerated or retarded motion, we have only to divide the line O *e* according to the law of acceleration or retardation, and divide the curve OBCDE as before.

When the weight rises in the arch of a circle. Fig. 14.

415. 2. When the lever moves upon a centre, the weight will rise in the arch of a circle, and consequently a new form must be given to the wipers or wings. Let AB, fig. 14. be a lever lying horizontally, which it is required to raise uniformly through the arch BC into the position AC, by means of the wheel BFH furnished with the wing BNOP, which acts upon the extremity C of the lever; and let it be required to raise it through BC in the same time that the wheel BFH moves through one-half of its circumference; that is, while the point M moves to B in the direction MFB. Divide the chord CB into any number of equal parts, the more the better, in the points 1, 2, 3, and draw the lines 1 *a* 2 *b* 3 *c* parallel to AB, or a horizontal line passing through the point B, and meeting the arch CB in the points *a*, *b*, *c*. Draw the lines CD, *a* D, *b* D, *c* D, and BD cutting the circle BFH in the points *m*, *n*, *o*, *p*.

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Having drawn the diameter BM, divide the semicircle BFM into as many equal parts as the chord CB, in the points *q*, *s*, *u*. Take B *m*, and set it from *q* to *r*: Take B *n* and set it from *s* to *t*: Take B *o* and set it from *u* to *v*, and lastly set B *p* from M to E. Through the points *r*, *t*, *v*, E, draw the indefinite lines DN, DO, DP, DQ, and make DN equal to D *c*; DO equal to D *b*; DP equal to D *a*; and DQ equal to DC. Then through the points Q, P, O, N, B, draw the spiral B, N, O, P, Q, which will be the proper form for the wing of the wheel when it moves in the direction EMB.

That the spiral BNO will raise the lever AC, with an uniform motion, by acting upon its extremity *c*, will appear from the slightest attention to the construction of the figure. It is evident, that when the point *q* arrives at B, the point *r* will be in *m*, because B *m* is equal to *q r*, and the point N will be at *c*, because DN is equal to D *c*; the extremity of the lever, therefore, will be found in the point *c*, having moved through B *c*. In like manner, when the point *s* has arrived at B, the point *t* will be at *n*, and the point O, in *b*, where the extremity of the lever will now be found; and so on with the rest, till the point M has arrived at B. The point E will then be in *p*, and the point Q in C; so that the lever will now have the position AC, having moved through the equal heights B *c*, *c b*, *b a*, *a c*, (F) in the same time that the power has moved through the equal spaces *q* B, *s q*, *u s*, M *u*. The lever, therefore, has been raised uniformly, the ratio between the velocity of the power, and that of the weight, remaining always the same.

416. If the wheel D turn in a contrary direction, according to the letters MHB, we must divide the semicircle BH EM, into as many equal parts as the chord *c* B, viz. in the points *e*, *g*, *h*. Then, having set the arch B *m* from *e* to *d*, the arch B *n* from *g* to *f*, and the rest in a similar manner, draw through the points *d*, *f*, *h*, E, the indefinite lines DR, DS. DT, DQ: make DR equal to D *c*; DS equal to D *b*; DT equal to D *a*, and DQ equal to DC; and though the points B, R, S, T, Q, describe the spiral BRSTQ, which will be the proper form for the wing, when the wheel turns in the direction MEB. For, when the point *e* arrives at B, the point *d* will be in *m*, and R in *c*, where the extremity of the lever will now be found, having moved through B *c* in the same time that the power, or wheel, has moved through the division *e* B. In the same manner it may be shewn, that the lever will rise through the equal heights *c b*, *b a*, *a* C, in the same time that the power moves through the corresponding spaces *e g*, *g i*, *i* M. The motion of the lever, therefore, and also that of the power, are always uniform. Of all the positions that can be given to the point B, the most disadvantageous are those which are nearest the points F, H; and the most advantageous position is when the chord B *c* is vertical, and passes, when prolonged, through D, the centre

(F) The arches B *c*, *c b*, &c. are not equal; but the perpendiculars let fall from the points *c*, *a*, *b*, &c. upon the horizontal lines, passing through *a b*, &c. are equal, being proportional to the equal lines *c* 1, 1, 2. Eucl. VI. 2.

centre of the circle (G). In this particular case the two curves have equal bases, though they differ a little in point of curvature. The farther that the centre A is distant, the nearer do these curves resemble each other; and if it were infinitely distant, they would be exactly similar, and would be the spirals of Archimedes, as the extremity c would in this case rise perpendicularly.

It will be easily perceived that 4, 6, or 8 wings may be placed upon the circumference of the circle, and may be formed by dividing into the same number of equal parts as the chord BC, $\frac{1}{4}$, $\frac{1}{6}$, or $\frac{1}{8}$ of the circumference, instead of the semicircle BFM.

That the wing BNO may not act upon any part of the lever between A and C, the arm AC should be bent; and that the friction may be diminished as much as possible, a roller should be fixed upon its extremity C. When a roller is used, however, a curve must always be drawn parallel to the spiral described according to the preceding method, the distance between it and the spiral being everywhere equal to the radius of the roller.

If it should be required to raise the lever with an accelerated or retarded motion, we have only to divide the chord BC, according to the degree of retardation or acceleration required, and the circle into the same number of equal parts as before.

417. As it is frequently more convenient to raise or depress weights by the extremity of a constant radius, furnished with a roller, instead of wings fixed upon the periphery of a wheel; we shall now proceed to determine the curve which must be given to the arm of the lever, which is to be raised or depressed, in order that this elevation or depression may be effected with an uniform motion.

Let AB be a lever, which it is required to raise uniformly through the arch BC, into the position AC, by means of the arm or constant radius DE, moving upon D as a centre, in the same time that the extremity E describes the arch E e F. From the point C draw CH at right angles to AB, and divide it into any number of equal parts, suppose three, in the points 1 2; and through the points 1, 2, draw 1 a 2 b, parallel to the horizontal line AB, cutting the arch CB in the points a, b, through which draw a A, b A. Upon D as a centre, with the distance DE, describe the arch E i e F, and upon A as a centre, with the distance AD, describe the arch e OD, cutting the arch E i e F in the point e. Divide the arches E i e, and F s e, each into the same number of equal parts as the perpendicular c H, in the points k, i, s, m, and through these points, about the centre A, describe the arches k z, i g, q r, m n. Take z x and set it from k to l, and take g f, and set it from i to h. Take r q also, and set it from s to t, and set n m from o to p, and d c from e to O. Then through the points E, l, h, O, and O, t, p, F draw the two curves E l h O, and O t p F, which will be the proper form that must be given to the arm of the lever. If the handle DE moves from E towards F, the curve EO must be used, but if in the contrary direction, we must employ the curve OF.

It is evident, that when the extremity E of the handle DE, has run through the arch E k, or rather E l, the point l will be in k, and the point z in x, because x z is equal to k l, and the lever will have the position A b. For the same reason, when the extremity E of the handle has arrived at i, the point h will be in i, and the point g in f, and the lever will be raised to the position A a. Thus it appears, that the motion of the power and the weight are always proportional. When a roller is fixed at E, a curve parallel to EO, or OF, must be drawn as formerly. See *Appendix to Ferguson's Lectures*.

Chap. VI. *On the First Movers of Machinery.*

418. The powers which are generally employed as the first movers of machines are water, wind, steam, and animal exertion. The mode of employing water as an impelling power has already been given at great length in the article Hydrodynamics. The application of wind to turn machinery will be discussed in the chapter on Windmills; and what regards steam will be more properly introduced into the article *Steam-Engine*. At present, therefore, we shall only make a few general remarks on the strength of men and horses; and conclude with a general view of the relative powers of the first movers of machinery. The following table contains the weight which a man is able to raise through a certain height in a certain time, according to different authors.

Table *of the Strength of Men, according to different authors.*

Number of pounds raised.	Height to which the weight is raised.	Time in which it is raised	Duration of the Work.	Names of the authors.
1000	180	60 minutes		Euler
60 } French.	1 } French.	1 second	8 hours	Bernouilli
25 } French.	220 } French.	145 seconds		Amontons
170 } French.	1 } French.	1 second	half an hour	Coulomb
1000	330	60 minutes		Desaguliers
1000	225	60 minutes		Smeaton
30	$3\frac{1}{2}$	1 second	10 hours	Emerson
29 or 30	2.45 feet	1 second		Schulze.

(G) In the figure we have taken the point B in a disadvantageous position, because the intersections are in this case more distinct.

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Force of men according to Amontons.

419. According to Amontons, a man weighing 133 pounds French, ascended 62 feet French by steps in 34 seconds, but was completely exhausted. The same author informs us that a sawyer made 200 strokes of 18 inches French each, with a force of 25 pounds, in 145 seconds; but that he could not have continued the exertion above three minutes.

According to Desaguliers.

420. It appears from the observations of Desaguliers, that an ordinary man can, for the space of ten hours, turn a winch with a force of 30 pounds, and with a velocity of two feet and a half per second; and that two men working at a windlass with handles at right angles to each other can raise 70 pounds more easily than one man can raise 30. The reason of this is, that when there is only one man, he exerts variable efforts at different positions of the handle, and therefore the motion of the windlass is irregular; whereas in the case of two men, with handles at right angles, the effect of the one man is greatest when the effect of the other is least, and therefore the motion of the machine is more uniform, and will perform more work. Desaguliers also found, that a man may exert a force of 80 pounds with a fly when the motion is pretty quick, and that by means of a good common pump, he may raise a hogshead of water 10 feet high in a minute, and continue the exertion during a whole day.

Results of Coulomb's experiments.

421. A variety of interesting experiments upon the force of men were made by the learned M. Coulomb. He found that the quantity of action of a man who ascended stairs with nothing but his own weight, was double that of a man loaded with 223 pounds avoirdupois, both of them continuing the exertion for a day. In this case the total or *absolute effect* of the unloaded man is the greatest possible; but the *useful effect* which he produces is nothing. In the same way, if he were loaded to such a degree that he was almost incapable of moving, the useful effect would be nothing. Hence there is a certain load with which the man will produce the greatest useful effect. This load M. Coulomb found to be 173.8 pounds avoirdupois, upon the supposition that the man is to ascend stairs, and continue the exertion during a whole day. When thus loaded, the quantity of action exerted by the labourer is equivalent to 183.66 pounds avoirdupois raised through 3282 feet. This method of working is however attended with a loss of three fourths of the total action of the workman.—It appears also from Coulomb's experiments, that a man going up stairs for a day raises 205 chiliogrammes (a chiliogramme is equal to three ounces five drams avoirdupois) to the height of a chiliometre (a chiliometre is equal to 39571 English inches);—that a man carrying wood up stairs raises, together with his own weight, 109 chiliogrammes to one chiliometre;—that a man weighing 150 pounds French, can ascend by stairs three feet French in a second, for the space of 15 or 20 seconds;—that a man cultivating the ground performs $\frac{1}{2}\frac{0}{0}$ as much labour as a man ascending stairs, and that his quantity of action is equal to 328 pounds avoirdupois raised through the space of 3282 feet;—that a man with a winch does $\frac{6}{5}$ as much as by ascending stairs;—and that in a pile-engine, a man by means of a rope drawn horizontally, raised for the space of five hours $55\frac{1}{3}$ pounds French through one foot French in a second.—When men walk on a horizontal road, Coulomb found that the quantity of action was a maximum when they were loaded, and that this maximum quantity of action is to that which is exerted by a man loaded with 190.25 pounds avoirdupois as 7 to 4.—The weight which a man ought to carry in order that the *useful effect* may be a maximum, is 165.3 pounds avoirdupois. When the workman, however, returns unloaded for a new burden, he must carry 200.7 pounds avoirdupois.

422. According to Dr Robison a feeble old man raised seven cubic feet of water $=437.5$ pounds avoirdupois, $11\frac{1}{2}$ feet high, in one minute, for eight or ten hours a day, by walking backwards and forwards on a lever;—and a young man weighing 135 pounds, and carrying 30 pounds, raised $9\frac{1}{4}$ cubic feet of water $=578.1$ pounds avoirdupois, $11\frac{1}{2}$ feet high, for 10 hours a day, without being fatigued.

423. From the experiments of Mr Buchanan, it appears that the forces exerted by a man pumping, acting at a winch, ringing and rowing, are as the numbers 1742, 2856, 3883, 4095.

On the strength of horses.

424. According to Desaguliers and Smeaton, the power of one horse is equal to the power of five men. Several French authors suppose a horse equal to seven men, while M. Schulze considers one horse as equivalent to 14 men.—Two horses, according to the experiment of Amontons, exerted a force of 150 pounds French, when yoked in a plough. According to Desaguliers, a horse is capable of drawing, with a force of 200 pounds, two miles and a half an hour, and of continuing this action eight hours in the day. When the force is 240 pounds he can work only six hours. It appears from Smeaton's reports, that by means of pumps a horse can raise 250 hogsheads of water, 10 feet high, in an hour.—The most disadvantageous way of employing the power of a horse is to make him carry a load up an inclined plane, for it was observed by De la Hire, that *three* men, with 100 pounds each, will go faster up the inclined plane than a horse with 300 pounds. When the horse walks on a good road, and is loaded with about two hundred weight, he may easily travel 25 miles in the space of seven or eight hours.

425. When a horse is employed in raising coals by means of a wheel and axle, and moves at the rate of about two miles an hour, Mr Fenwick found that he could continue at work 12 hours each day, two and a half of which were spent in short intervals of rest, when he raised a load of 1000 pounds avoirdupois, with a velocity of 13 feet per minute;—and that he will exert a force of 75 pounds for nine hours and a half, when moving with the same velocity. Mr Fenwick also found that 230 ale gallons of water delivered every minute on an overshot water wheel, 10 feet in diameter; that a common steam-engine, with a cylinder eight inches in diameter, and an improved engine with a cylinder 6.12 inches in diameter, will do the work of one horse, that is, will raise a weight of 1000 pounds avoirdupois, through the height of 13 feet in a minute. It appears from Mr Smeaton's experiments, that Dutch sails in their common position with a radius of nine feet and a half,—that Dutch sails in their best position with a radius of eight feet, and that his enlarged sails with a radius of seven feet, perform the same work as one man; or perform one-

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one-fifth part of the work of a horſe. Upon theſe facts we have conſtructed the following table, the four firſt columns of which are taken from Mr Fenwick's Eſſays on Practical Mechanics.

TABLE *ſhewing the relative ſtrength of Overſhot Wheels, Steam Engines, Horſes, Men, and Wind-mills of different kinds.*

Number of ale gallons delivered on an overſhot wheel, 10 feet in diameter, every minute.	Diameter of the cylinder in the common ſteam-engine, in inches.	Diameter of the cylinder of the improved ſteam-engine, in inches.	Number of horſes working 12 hours per day, and moving at the rate of two miles per hour.	Number of men working 12 hours a-day.	Radius of Dutch ſails in their common poſition, in feet.	Radius of Dutch ſails in their beſt poſition, in feet.	Radius of Mr Smeaton's enlarged ſails, in feet.	Height to which theſe different powers will raiſe 1000 pounds avoirdupois in a minute.
230	8.	6.12	1	5	21.24	17.89	15.65	13
390	9.5	7.8	2	10	30.04	25.30	22.13	26
528	10.5	8.2	3	15	36.80	30.98	27.11	39
660	11.5	8.8	4	20	42.48	35.78	31.30	52
790	12.5	9.35	5	25	47.50	40.00	35.00	65
970	14.	10.55	6	30	52.03	43.82	38 34	78
1170	15.4	11.75	7	35	56.90	47.33	41.41	90
1350	16.8	12.8	8	40	60.09	50.60	44.27	104
1445	17.3	13.6	9	45	63.73	53.66	46.96	117
1584	18.5	14.2	10	50	67.17	56.57	49.50	130
1740	19.4	14.8	11	55	70.46	59.33	51.91	143
1900	20.2	15.2	12	60	73.59	61.97	54.22	156
2100	21.	16.2	13	65	76.59	64.5	56.43	169
2300	22.	17.	14	70	79.49	66.94	58.57	182
2500	23.1	17.8	15	75	82.27	69.28	60.62	195
2686	23.9	18.3	16	80	84.97	71.55	62.61	208
2870	24.7	19.	17	85	87.07	73.32	64.16	221
3055	25.5	19.6	18	90	90.13	75.90	67.41	234
3240	26.25	20.1	19	95	92.60	77.98	68.23	247
3420	27.	20.7	20	100	95.00	80.00	70.00	260
3750	28.5	22.2	22	110	99.64	83.90	73.42	286
4000	29.8	23.	24	120	104.06	87.63	76.68	312
4460	31.1	23.9	26	130	108.32	91.22	79.81	338
4850	32.4	24.7	28	140	112.20	94.66	82.82	364
5250	33.6	25.5	30	150	116.35	97.98	85.73	390

426. Dutch ſails are always conſtructed ſo that the angle of weather may diminiſh from the centre to the extremity of the ſail. They are concave to the wind, and are in their *common poſition* when their extremities are parallel to the plane in which they move, or perpendicular to the direction of the wind. Dutch ſails are in their *beſt poſition* when their extremities make an angle of ſeven degrees with the plane of their motion. Mr Smeaton's enlarged ſails are Dutch ſails in their beſt poſition, but enlarged at their extremities.

427. It appears from M. Coulomb's experiments on Dutch wind-mills, with rectangular ſails, that when the diſtance between the extremities of two oppoſite ſails is 66 feet French, and the breadth of each ſail ſix feet, a wind moving at the rate of 20 feet per ſecond will produce an effect equivalent to 1000 pounds raiſed through the ſpace of 218 feet in a minute.

According to Watt and Boulton, one of their ſteam-engines, with a cylinder 31 inches in diameter, and which makes 17 double ſtrokes per minute, is equivalent to 40 horſes working day and night; that is, to 101 horſes working nine hours and a half, the time of conſtant exertion in the preceding table. When the cylinder is 19 inches in diameter, and the engine makes 25 ſtrokes of four feet each per minute, its power is equivalent to twelve horſes working conſtantly, or thirty horſes working nine hours and a half;—and when the cylinder is 24 inches in diameter, and the engine makes 22 ſtrokes, of five feet each, in a minute, its power is equal to that of 20 horſes working conſtantly, or 50 horſes working nine hours and a half.

CHAP. VII. *On the Conſtruction of Wind-mills.*

428. A WIND-MILL is repreſented in fig. 1. where MN is the circular building that contains the machinery, E the extremity of the windſhaft, or principal axis, which is generally inclined from 8 to 15 degrees to the horizon; and EA, EB, EC, ED four rectangular frames upon which ſails of cloth of the ſame form are ſtretched. At the lower extremity G of the ſails their ſurface is inclined to the axis 72°; and at their fartheſt extremities A, D, &c. the inclination of the ſail is about 83°. Now, when the ſails are adjuſted to the wind, which happens when the wind blows in the direction of the windſhaft E, the impulſe of the wind upon

Plate CCCXXV. Fig. 1.

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upon the oblique sails may be resolved into two forces, one of which acts at right angles to the windshaft, and is therefore employed solely in giving a motion of rotation to the sails and the axis upon which they are fixed. When the mill is used for grinding corn, a crown wheel, fixed to the principal axis E, gives motion to a lantern or trundle, whose axis carries the moveable millstone.

Methods of turning the sails to the wind.

429. That the wind may act with the greatest efficacy upon the sails, the windshaft must have the same direction as the wind. But as this direction is perpetually changing, some apparatus is necessary for bringing the windshaft and sails into their proper position. This is sometimes effected by supporting the machinery on a strong vertical axis, whose pivot moves in a brass socket firmly fixed into the ground, so that the whole machine, by means of a lever, may be made to revolve upon this axis, and be properly adjusted to the direction of the wind. Most wind-mills, however, are furnished with a moveable roof which revolves upon friction rollers inserted in the fixed kerb of the mill; and the adjustment is effected by the assistance of a simple lever. As both these methods of adjustment require the assistance of men, it would be very desirable that the same effect should be produced solely by the action of the wind. This may be done by fixing a large wooden vane or weather-cock at the extremity of a long horizontal arm which lies in the same vertical plane with the windshaft. By this means, when the surface of the vane, and its distance from the centre of motion, are sufficiently great, a very gentle breeze will exert a sufficient force upon the vane to turn the machinery, and will always bring the sails and windshaft to their proper position. This weather-cock, it is evident, may be applied either to machines which have a moveable roof, or which revolve upon a vertical arbor.

On the Form and Position of Wind-mill Sails.

430. It appears from the investigations of Parent, that a maximum effect will be produced when the sails are inclined $54\frac{2}{3}$ degrees to the axis of rotation, or when the angle of weather is $35\frac{1}{3}$ (G) degrees. In obtaining this conclusion, however, M. Parent has assumed data which are inadmissible, and has neglected several circumstances which must materially affect the result of his investigations. The angle of inclination assigned by Parent is certainly the most efficacious for giving motion to the sails from a state of rest, and for preventing them from stopping when in motion; but he has not considered that the action of the wind upon a sail at rest is different from its action upon a sail in motion: for since the extremities of the sails move with greater rapidity than the parts nearer the centre, the angle of weather should be greater towards the centre than at the extremity, and should vary with the velocity of each part of the sail. The reason of this is very obvious. It has been demonstrated by Bossut, and established by experience, that when any fluid acts upon a plain surface, the force of impulsion is always exerted most advantageously when the impelled surface is in a state of rest, and that this force diminishes as the velocity of the surface increases. Now, let us suppose with Parent that the most advantageous angle of weather for the sails of wind-mills is $35\frac{1}{3}$ degrees for that part of the sail which is nearest the centre of rotation, and that the sail has every where this angle of weather; then, since the extremity of the sail moves with the greatest velocity, it will, in a manner, withdraw itself from the action of the wind, or, to speak more properly, it will not receive the impulse of the wind so advantageously as those parts of the sail which have a less degree of velocity. In order therefore to counteract this diminution of force, we must make the wind act more perpendicularly upon the sail, by diminishing its obliquity or its angle of weather. But since the velocity of every part of the sail is proportional to its distance from the centre of motion, every elementary portion of it must have a different angle of weather diminishing from the centre to the extremity of the sail. The law or rate of diminution, however, is still to be discovered, and we are fortunately in possession of a theorem of Euler's, afterwards given by Maclaurin, which determines this law of variation. Let a represent the velocity of the wind, and c the velocity of any given part of the sail; then the effort of the wind upon that part of the sail will be greatest when the tangent of the angle of the wind's incidence, or of the sail's inclination to the axis, is to radius, as $\sqrt{2+\frac{9cc}{4aa}}+\frac{3c}{2a}$ to 1.

The inclination assigned by Parent, erroneous.

Euler's theorem.

Fig. 2.
Explanation and application of this theorem.

431. In order to apply this theorem, let us suppose that the radius or whip ED of the sail $\alpha\beta\delta\gamma$, is divided into six equal parts; that the point n is equidistant from E and D, and is the point of the sail which has the same velocity as the wind; then, in the preceding theorem, we shall have $c=a$, when the sail is loaded to a maximum; and therefore the tangent of the angle, which the surface of the sail at n makes with the axis, when $a=1$, will be $\sqrt{2+\frac{9}{4}}+\frac{3}{2}=3.561=$ tangent of 74° 19′, which gives 15° 41′ for the angle of weather at the point n. Since, at $\frac{1}{2}$ of the radius $c=a$, and since c is proportional to the distance of the corresponding part of the sail from the centre, we will have, at $\frac{1}{6}$ of the radius $s\,m$, $c=\frac{a}{3}$, at $\frac{2}{6}$ of the radius, $c=\frac{2a}{3}$; at $\frac{4}{6}$, $c=\frac{4a}{3}$, at $\frac{5}{6}$, $c=\frac{5a}{3}$; and at the extremity of the radius, $c=2a$. By substituting these different values of c, instead of c in the theorem, and by making $a=1$, the following table will be obtained, which exhibits the angles of inclination and weather which must be given to different parts of the sails.

Parts

(G) The *weather* of the sails is the angle which the surface forms with the plane in which they move, and is equal to the complement of the angle which that surface forms with the axis.

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Parts of the radius from the centre of motion at E.	Velocity of the sail at these distances—or values of c.	Angle made with the axis.		Angle of weather.	
		Deg.	Min.	Deg.	Min.
$\frac{1}{6}$	$\frac{a}{3}$	63	26	26	34
$\frac{2}{6}$	$\frac{2a}{3}$	69	54	20	6
$\frac{3}{6}$ or $\frac{1}{2}$	a	74	19	15	4
$\frac{4}{6}$ or $\frac{2}{3}$	$\frac{4a}{3}$	77	20	12	40
$\frac{5}{6}$	$\frac{5a}{3}$	79	27	10	33
1	$2a$	81	0	9	0

Results of Smeaton's experiments.

432. Mr Smeaton found, from a variety of experiments, that the common practice of inclining plane sails from 72° to 75° to the axis, was much more efficacious than the angle assigned by Parent, the effect being as 45 to 31. When the sails were weathered in the Dutch manner, that is, when their surfaces were concave to the wind, and when the angle of inclination increased towards their extremities, they produced a greater effect than when they were weathered either in the common way, or according to Euler's theorem. But when the sails were enlarged at their extremities, as represented at $\alpha\beta$, in fig. 2. so that $\alpha\beta$ was one-third of the radius ED, and αD to Dβ as 5 to 3, their power was greatest of all, though the surface acted upon by the wind remained the same. If the sails be farther enlarged, the effect is not increased in proportion to the surface; and besides, when the quantity of cloth is great, the machine is much exposed to injury by sudden squalls of wind. In Mr Smeaton's experiments, the angle of weather varied with the distance from the axis; and it appeared from several trials, that the most efficacious angles were those in the following table.

Fig. 2.

Parts of the radius EA, which is divided into 6 parts.	Angle with the axis.	Angle of weather
1	72	18
2	71	19
3	72	18 middle
4	74	16
5	$77\frac{1}{2}$	$12\frac{1}{2}$
6	83	7

If the radius ED of the sail be 30 feet, then the sail will commence at $\frac{1}{6}$ ED, or 5 feet from the axis, where the angle of inclination will be 72°. At $\frac{2}{6}$ ED, or 10 feet from the axis, the angle will be 71°, and so on.

On the Effect of Wind-mill Sails.

433. The following maxims deduced by Mr Smeaton from his experiments, contain the most accurate information upon this subject.

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Effects of wind-mill sails, according to Smeaton.

Maxim 1. The velocity of wind-mill sails, whether unloaded or loaded, so as to produce a maximum effect, is nearly as the velocity of the wind, their shape and position being the same.

Maxim 2. The load at the maximum is nearly, but somewhat less than, as the square of the velocity of the wind, the shape and position of the sails being the same.

Maxim 3. The effects of the same sails at a maximum, are nearly, but somewhat less than, as the cubes of the velocity of the wind.

Maxim 4. The load of the same sails at the maximum is nearly as the squares, and their effects as the cubes of their number of turns in a given time.

Maxim 5. When sails are loaded, so as to produce a maximum at a given velocity, and the velocity of the wind increases, the load continuing the same: 1st, The increase of effect, when the increase of the velocity of the wind is small, will be nearly as the squares of those velocities: 2dly, When the velocity of the wind is double, the effects will be nearly as 10 : $27\frac{1}{2}$: But, 3dly, When the velocities compared are more than double of that where the given load produces a maximum, the effects increase nearly in the simple ratio of the velocity of the wind.

Maxim 6. In sails where the figure and positions are similar, and the velocity of the wind the same, the number of turns in a given time will be reciprocally as the radius or length of the sail.

Maxim 7. The load at a maximum that sails of a similar figure and position will overcome at a given distance from the centre of motion, will be as the cube of the radius.

Maxim 8. The effects of sails of similar figure and position are as the square of the radius.

Maxim 9. The velocity of the extremities of Dutch sails, as well as of the enlarged sails, in all their usual positions when unloaded, or even loaded to a maximum, are considerably quicker than the velocity of the wind.

434. A new mode of constructing the sails of wind-mills has been recently given by Mr Sutton, and fully described by Mr Hesleden of Barton, in a work exclusively devoted to the subject.

The limits of this article will not permit us to enter into any discussion respecting the principles upon which Mr Sutton's gravitated sails are constructed; but the subject shall be resumed under the article WINDMILL. If may be proper however to remark that Mr Sutton gives his sails the form represented in fig. 4. and makes the angle of weather at the point M, equidistant from A and B, equal to 22° 30′. The inclination of the sail at any other point N of the sail, is an angle whose sine is the distance of that point from the centre of motion A, the radius being the breadth of the sail at that point. Fig. 3. shews the angles at the different points of the sail; and the apparent and absolute breadths of the sail at these points. Mr Sutton's mode of regulating the velocity of the sails, and of bringing them to a state of rest is particularly ingenious. Fig. 3.

On

On Horizontal Wind-mills.

Horizontal wind-mills.

435. Various opinions have been entertained respecting the relative advantages of horizontal and vertical wind mills. Mr Smeaton, with great justice, gives a decided preference to the latter; but when he asserts that horizontal wind-mills have only $\frac{1}{8}$ or $\frac{1}{10}$ of the power of vertical ones, he certainly forms too low an estimate of their power. Mr Beatson, on the contrary, who has received a patent for the construction of a new horizontal wind-mill, seems to be prejudiced in their favour, and greatly exaggerates their comparative value. From an impartial investigation, it will probably appear, that the truth lies between these two opposite opinions; but before entering on this discussion, we must first consider the nature and form of horizontal wind-mills.

Fig. 4.

436. In fig. 4. CK is the windshaft, which moves upon pivots. Four cross bars, CA, CD, IB, FG, are fixed to this arbor, which carry the frames APIB, DEFG. The sails AI, EG, are stretched upon these frames, and are carried round the axis CK, by the perpendicular impulse of the wind. Upon the axis CK, a toothed wheel is fixed, which gives motion to the particular machinery that is employed. In the figure, only two sails are represented; but there are always other two placed at right angles to these. Now, let the sails be exposed to the wind, and it will be evident that no motion will ensue; for the force of the wind upon the sail AI, is counteracted by an equal and opposite force upon the sail EG. In order then, that the wind may communicate motion to the machine, the force upon the returning sail EG must either be removed by screening it from the wind, or diminished by making it present a less surface when returning against the wind. The first of these methods is adopted in Tartary, and in some provinces of Spain; but is objected to by Mr Beatson, from the inconvenience and expence of the machinery and attendance requisite for turning the screens into their proper positions. Notwithstanding this objection, however, I am disposed to think that this is the best method of diminishing the action of the wind upon the returning sails, for the moveable screen may easily be made to follow the direction of the wind, and assume its proper position, by means of a large wooden weathercock, without the aid either of men or machinery. It is true, indeed, that the resistance of the air in the returning sails is not completely removed; but it is at least as much diminished as it can be by any method hitherto proposed. Besides, when this plan is resorted to, there is no occasion for any moveable flaps and hinges, which must add greatly to the expence of every other method.

Common method of bringing back the sails against the wind.

Beatson's method.

437. The mode of bringing the sails back against the wind, which Mr Beatson invented, is, perhaps, the simplest and best of the kind. He makes each sail AI to consist of six or eight flaps or vanes, AP b 1, b 1 c 2, &c. moving upon hinges represented by the dark lines, AP, b 1, c 2, &c. so that the lower side b 1, of the first flap overlaps the hinge or higher side of the second flap, and so on. When the wind, therefore, acts upon the sail AI, each flap will press upon the hinge of the one immediately below it, and the whole surface of the sail will be exposed to its action. But when the sail AI returns against the wind, the flaps will revolve round upon their hinges, and present only their edges to the wind, as is represented at EG, so that the resistance occasioned by the return of the sail must be greatly diminished, and the motion will be continued by the great superiority of force exerted upon the sails in the position AI. In computing the force of the wind upon the sail AI, and the resistance opposed to it by the edges of the flaps in EG, Mr Beatson finds, that when the pressure upon the former is 1872 pounds, the resistance opposed by the latter is only about 36 pounds, or $\frac{1}{52}$ part of the whole force; but he neglects the action of the wind upon the arms CA, &c. and the frames which carry the sails, because they expose the same surface in the position AI, as in the position EG. This omission, however, has a tendency to mislead us in the present case, as we shall now see, for we ought to compare the whole force exerted upon the arms, as well as the sail, with the whole resistance which these arms and the edges of the flaps oppose to the motion of the windmill. By inspecting fig. 4. it will appear, that if the force upon the edges of the flaps, which Mr Beatson supposed to be 12 in number, amounts to 36 pounds, the force spent upon the bars CD, DG, GF, FE, &c. cannot be less than 60 pounds. Now, since these bars are acted upon with an equal force, when the sails have the position AI, $1872+60=1932$ will be the force exerted upon the sail AI, and its appendages, while the opposite force upon the bars and edges of the flaps when returning against the wind will be $36+60=96$ pounds, which is nearly $\frac{1}{20}$ of 1932, instead of $\frac{1}{52}$ as computed by Mr Beatson. Hence we may see the probable advantages of a screen over moveable flaps, as it will preserve not only the sails, but the arms and the frame which support it, from the action of the wind.

Comparisons between vertical and horizontal wind-mills.

438. We shall now conclude this chapter with a comparison of the power of horizontal and vertical wind-mills. It was already stated, that Mr Smeaton rather underrated the former, while he maintained that they have only $\frac{1}{8}$ or $\frac{1}{10}$ the power of the latter. He observes, that when the vanes of a horizontal and a vertical mill are of the same dimensions, the power of the latter is four times that of the former, because, in the first case, only one sail is acted upon at once, while, in the second case, all the four receive the impulse of the wind. This, however, is not strictly true, since the vertical sails are all oblique to the direction of the wind. Let us suppose that the area of each sail is 100 square feet; then the power of the horizontal sail will be 100, and the power of a vertical sail may be called $100 \times \text{sine } 70^{\circ 2}$ (70° being the common angle of inclination) $= 88$ nearly; but since there are four vertical sails, the power of them all will be $4 \times 88 = 352$; so that the power of the horizontal sail is to that of the four vertical ones as 1 to 3.52, and not as 1 to 4, according to Mr Smeaton. But Mr Smeaton also observes, that if we consider the farther disadvantage which arises from the difficulty of getting the sails back against the wind, we need not wonder if horizontal wind-mills have only about $\frac{1}{8}$ or $\frac{1}{10}$ the power of the common sort. We have already seen, that the resistance occasioned by the return of the sails, amounts to $\frac{1}{20}$ of the whole force which they receive; by subtracting $\frac{1}{20}$, therefore, from $\frac{1}{3.52}$, we shall find that the

Practical Mechanics. the power of horizontal wind-mills is only $\frac{1.03}{4.40}$, or little more than $\frac{1}{4}$ that of vertical ones. This calculation proceeds upon a supposition, that the whole force exerted upon vertical sails is employed in turning them round the axis of motion; whereas a considerable part of this force is lost in pressing the pivot of the axis or windshaft against its gudgeon. Mr Smeaton has overlooked this circumstance, otherwise he could never have maintained that the power of four vertical sails was quadruple the power of one horizontal sail, the dimensions of each being the same. Taking this circumstance into the account, we cannot be far wrong in saying, that in theory at least, if not in practice, the power of a horizontal wind-mill is about $\frac{1}{5}$ or $\frac{1}{4}$ of the power of a vertical one, when the quantity of surface and the form of the sails is the same, and when every part of the horizontal sails has the same distance from the axis of motion as the corresponding parts of the vertical sails. But if the horizontal sails have the position AI, EG, in fig. 4. instead of the position CA dm, CD on, their power will be greatly increased, though the quantity of surface is the same, because the part CP 3 m being transferred to BI 3 d, has much more power to turn the sails.

Chap. VIII. *On the Construction of Wheel Carriages.*

On the size of carriage wheels. Plate CCCXXV. Fig. 6.

439. It is evident from Art. 60, that when a wheel surmounts an obstacle, it acts as a lever of the first kind, and that its power to overcome such resistances increases with its diameter. The power of the force P, for example, to raise the wheel NB over the eminence C, is proportional to the vertical lever FC, which increases with the diameter of the wheel, while the lever of resistance FA, by which the weight of the wheel acts, remains unchanged; hence we see the advantages of large wheels for overcoming such obstacles as generally resist the motion of wheel-carriages. There are some circumstances, however, which, independent of the additional weight and expence of large wheels, prescribe limits to their size. If the radius AC of the wheel exceeds the height of that part of the horse to which the traces are attached, the line of traction DA will be oblique to the horizon, and part of the power P will be employed in pressing the wheel upon the ground. A wheel exceeding four and a half feet radius, which is the general distance from the ground of that part of the horse to which the traces are attached, has still the advantage of a smaller wheel; but when we consider that the traces or poles of the cart will, in this case, rub against the flanks of the horses, so that the power of the wheel is diminished by the increase of its weight, we shall be convinced that no power is gained by making the radius of the wheels greater than four and a half feet. Even this size is too great, as shall be afterwards shown, when we treat of the line of traction, so that we may safely assert, that the diameter of wheels should never be greater than six feet. The fore wheels of our carriages are still unaccountably small, and it is not uncommon to see carts moving upon wheels scarcely 14 inches in diameter. The convenience of turning is urged as the reason for diminishing the fore wheels of carriages, and the facility of loading the cart is considered as a sufficient reason for using wheels so small as 14 inches. The first of these advantages, however, may be obtained by going to the end of a street, or to a proper place for turning the carriage; and a few additional turns of a windlass will be sufficient to convey the heaviest loads into carts mounted on high wheels.

440. The next thing to be determined is the shape of the wheels. Now it is certainly a matter of surprise how the unnatural shape which is at present given to them could ever have been brought into use. A cylindrical wheel, with the spokes perpendicular to the naves, is undoubtedly the form which every mechanic would give to his wheels, before he had heard of the pretended advantages of concave or dishing wheels, or those which have inclined spokes and conical rims. It has been alleged, indeed, that the form represented in fig. 5. when A r, B s is the conical rim, and o A, p B the inclined spokes, renders the wheel stronger than it would otherwise be; that by extending the base of the carriage it prevents it from being overturned; that it hinders the fellies from rubbing against the load or the sides of the cart; and that when one wheel falls into a rut, and therefore supports more than one half of the load, the spokes are brought into a vertical position, which renders them more capable of sustaining the additional weight. Now it is evident that the second of these advantages is very trifling, and may be obtained, when required, by interposing a piece of board between the wheel and the load. Plate CCCXXV. Fig. 5.

441. The other two advantages exist only in very bad roads; and if they are necessary, which we much question, in a country like this, where the roads are so excellently made and so regularly repaired, they can easily be procured, by making the axle-tree a few inches longer, and increasing the strength of the spokes. But it is allowed on all hands that perpendicular spokes are preferable on level ground. The inclination of the spokes therefore, which renders concave wheels advantageous in rugged and unequal roads, renders them disadvantageous when the roads are in good order; and where the good roads are more numerous than the bad ones, as they certainly are in this country, the disadvantages of concave wheels must overbalance their advantages. It is true indeed that in concave wheels, the spokes are in their strongest position, when they are exposed to the severest strains, that is, when one wheel is in a deep rut, and sustains more than one half of the load: but it is equally true that on level ground, where the spokes are in their weakest position, a less severe strain, by continuing for a much longer time, may be equally if not more detrimental to the wheel.

Upon these observations, we might rest the opinion which we have been maintaining, and appeal for its truth to the judgement of every intelligent and unbiassed mind; but we shall go a step farther, and endeavour to show that concave dishing wheels are more expensive, more injurious to the roads, more liable to be broken by accidents, and less durable in general, than those wheels in which the spokes are perpendicular to the naves. By inspecting fig. 5. it will appear that the whole of the pressure which the wheel AB sustains is exerted along the inclined spoke ps, and therefore acts obliquely upon the level ground nD, whether the rims are conical or cylindrical. This oblique action must necessarily

necessarily injure the roads, by loosening the stones more between B and D than between B and *n*, and if the load were sufficiently great, the stones would start up between *s* and D. The texture of the roads, indeed, is sufficiently firm to prevent this from taking place; but in consequence of the oblique pressure, the stones between *s* and D will at least be loosened, and by admitting the rain the whole of the road will be materially damaged. But when the spokes are perpendicular to the nave as *pn*, and when the rims *m*A, *n*B are cylindrical, or parallel to the ground, the weight sustained by the wheel will act perpendicularly upon the road; and however much that weight is increased, its action can have no tendency to derange the materials of which it is composed, but is rather calculated to consolidate them, and render the road more firm and durable.

442. It was observed that concave wheels are more expensive than plane ones. This additional expence arises from the greater quantity of wood and workmanship which the former require; for in order that dishing wheels may be of the same perpendicular height as plane ones, the spokes of the former must exceed in length those of the latter, as much as the hypothenuse *o*A of the triangle *o*A*n* exceeds the side *om*; and therefore the weight and the resistance of such wheels must be proportionably great. The inclined spokes, too, cannot be formed nor inserted with such facility as perpendicular ones. The extremity of the spoke which is fixed into the nave is inserted at right angles to it, in the direction *op*, and if the rims are cylindrical, the other spoke should be inserted in a similar manner; while the intermediate portion has an inclined position. There are therefore two flexures or bendings in the spokes of concave wheels, which requires them to be formed out of a larger piece of wood, than if they had no such flexures, and render them liable to be broken by any sudden strain at the points of flexure.

443. We shall now dismiss the subject of concave wheels with one observation more, and we beg the reader's attention to it, because it appears to be decisive of the question. The obstacles which carriages have to encounter, are almost never spherical protuberances that permit the elevated wheel to resume by degrees its horizontal position. They are generally of such a nature, that the wheel is instantaneously precipitated from their top to the level ground. Now the momentum with which the wheel strikes the ground is very great, arising from a successive accumulation of force. The velocity of the elevated wheel is considerable when it reaches the top of the eminence, and while it is tumbling into the level ground, it is receiving gradually that proportion of the load which was transferred to the other wheel, till having recovered the whole, it impinges against the ground with great velocity and force. But in concave wheels the spoke which then strikes the ground is in its weakest position, and therefore much more liable to be broken by the impetus of the fall, than the spokes of the lowest wheel by the mere transference of additional weight. Whereas, if the spokes be perpendicular to the nave, they receive this sudden shock in their strongest posititition, and are in no danger of giving way to the strain.

444. In the preceding observations we have supposed the rims of the wheels to be cylindrical. In concave wheels, however, the rims are uniformly made of a conical form, as A*r*, B*s*, fig. 5. which not only increases the disadvantages which we have ascribed to them, but adds many more to the number. Mr Cumming, in a late Treatise on Wheel Carriages, solely devoted to the consideration of this single point, has shewn with great ability the disadvantages of conical rims, and the propriety of making them cylindrical; but we are of opinion that he has ascribed to conical rims several disadvantages which arise chiefly from an inclination of the spokes. He insists much upon the injury done to the roads by the use of conical rims; yet though we are convinced that they are more injurious to pavements and highways than cylindrical rims, we are equally convinced, that this injury is occasioned chiefly by the oblique pressure of the inclined spokes. The defects of conical rims are so numerous and palpable, that it is wonderful how they should have been so long overlooked. Every cone that is put in motion upon a plane surface will revolve round its vertex, and if force is employed to confine it to a straight line, the smaller parts of the cone will be dragged along the ground and the friction greatly increased. Now when a carriage moves upon conical wheels, one part of the cone rolls while the other is dragged along, and though confined to a rectilineal direction by external force, their natural tendency to revolve round their vertex occasions a great and continued friction upon the linch pin, the shoulder of the axle-tree, and the sides of deep ruts.

445. The shape of the wheels being thus determined, we must now attend to some particular parts of their construction. The iron plates of which the rims are composed should never be less than three inches in breadth, as narrow rims sink deep into the ground, and therefore injure the roads and fatigue the horses. Mr Walker, indeed, attempts to throw ridicule upon the act of parliament which enjoined the use of broad wheels; but he does not assign any sufficient reason for his opinion, and ought to have known that several excellent and well devised experiments were lately instituted by Boulard and Margueron, which evince in the most satisfactory manner the great utility of broad wheels. Upon this subject an observation occurs to us, which has not been generally attended to, and which appears to remove all the objections which can be urged against broad rims. When any load is supported upon two points, each point supports one half of the weight; if the points are increased to four, each will sustain one fourth of the load, and so on; the pressure upon each point of support diminishing as the number of points increases. If a weight therefore is supported by a broad surface, the points of support are infinite in number, and each of them will bear an infinitely small portion of the load; and, in the same way, every finite portion of this surface will sustain a part of the weight inversely proportional to the number of similar portions which the surface contains. Let us now suppose that a cart carrying a load of sixteen hundred weight is supported upon wheels whose rims are four inches in breadth, and that one of the wheels passes over four stones, each of them an inch broad and equally high, and capable of being pulverized only by a pressure of four hundred pounds weight. Then as each wheel sustains one half of the load, and as the wheel which passes over

over the ſtones has four points of ſupport, each ſtone will bear a weight of two hundred weight, and therefore will not be broken. But if the ſame cart, with rims only two inches in breadth, ſhould paſs the ſame way, it will cover only two of the ſtones; and the wheel having now only two points of ſupport, each ſtone will be preſſed with a weight of four hundred weight, and will therefore be reduced to powder. Hence we may infer that narrow wheels are in another point of view injurious to the roads, by pulverizing the materials of which they are compoſed.

446. As the rims of wheels wear ſooneſt at their edges, they ſhould be made thinner in the middle, and ought to be faſtened to the fellies with nails of ſuch a kind that their heads may not riſe above the ſurface of the rims. In ſome military waggons we have ſeen the heads of theſe nails riſing an inch above the rims, which not only deſtroys the pavements of ſtreets, but oppoſes a continual reſiſtance to the motion of the wheel. If theſe nails were eight in number, the wheel would experience the ſame reſiſtance, as if it had to ſurmount eight obſtacles, one inch high, during every revolution. The fellies on which the rims are fixed ſhould in carriages be three inches and a fourth deep, and in waggons four inches. The naves ſhould be thickeſt at the place where the ſpokes are inſerted; and the holes in which the ſpokes are placed ſhould not be bored quite through, as the greaſe upon the axle-tree would inſinuate itſelf between the ſpoke and the naves, and prevent that cloſe adheſion which is neceſſary to the ſtrength of the wheel.

On the Poſition of the Wheels.

447. It muſt naturally occur to every perſon reflecting upon this ſubject, that the axle-trees ſhould be ſtraight and the wheels perfectly parallel, ſo that they may not be wider at their higheſt than at their loweſt point, whether they are of a conical or a cylindrical form. In this country, however, the wheels are always made concave, and the ends of the axle-trees are univerſally bent downwards, in order to make them ſpread at the top and approach nearer below. In ſome carriages which we have examined, where the wheels were only four feet ſix inches in diameter, the diſtance of the wheels at top was fully ſix feet, and their diſtance below only four feet eight inches. By this fooliſh practice the very advantages which may be derived from the concavity of the wheels are completely taken away, while many of the diſadvantages remain; more room is taken np in the coach-houſe, and the carriage is more liable to be overturned by the contraction of its baſe.

448. With ſome mechanics it is a practice to bend the ends of the axle-trees forwards, and thus make the wheels wider behind than before. This blunder has been ſtrenuouſly defended by Mr Henry Beighton, who maintains that wheels in this poſition are more favourable for turning, ſince, when the wheels are parallel, the outermoſt when turning would preſs againſt the linch pin, and the innermoſt would reſt againſt the ſhoulder of the axle-tree. In rectilineal motions, however, theſe converging wheels engender a great deal of friction both on the axle and the ground, and muſt therefore be more diſadvantageous than parallel ones.

On the Line of Traction, and the Method by which Horſes exert their ſtrength.

449. M. Camus attempted to ſhew that the line of traction ſhould always be parallel to the ground on which the carriage is moving, both becauſe the horſe can exert his greateſt ſtrength in this direction, and becauſe the line of draught being perpendicular to the vertical ſpoke of the wheel, acts with the largeſt poſſible lever. M. Couplet, however, conſidering that the roads are never perfectly level, and that the wheels are conſtantly ſurmounting ſmall eminences even in the beſt of roads, recommends the line of traction to be oblique to the horizon. By this means the line of draught HA, (which is by far too much inclined in the figure) will in general be perpendicular to the lever AC which mounts the eminence, and will therefore act with the longeſt lever when there is the greateſt neceſſity for it. We ought to conſider alſo, that when a horſe pulls hard againſt any load, he always brings his breaſt nearer the ground, and therefore it follows, that if a horizontal line of traction is preferable to all others, the direction of the traces ſhould be inclined to the horizon when the horſe is at reſt, in order that it may be horizontal when he lowers his breaſt and exerts his utmoſt force. The particular manner, however, in which living agents exert their ſtrength againſt great loads, ſeems to have been unknown both to Camus and Couplet, and to many ſucceeding writers upon this ſubject. It is to M. Deparcieux, an excellent philoſopher and ingenious mechanic, that we are indebted for the only accurate information with which we are furniſhed; and we are ſorry to ſee that philoſophers who flouriſhed after him have overlooked his important inſtructions. In his memoir on the draught of horſes he has ſhewn in the moſt ſatisfactory manner, that animals draw by their weight, and not by the force of their muſcles. In four-footed animals, the hinder feet is the fulcrum of the lever by which their weight acts againſt the load, and when the animal pulls hard, it depreſſes its cheſt and thus increaſes the lever of its weight, and diminiſhes the lever by which the load reſiſts its efforts. Thus, in fig. 6. let P be the load, AD the line of traction, and let us ſuppoſe FC to be the hinder leg of the horſe, and AE part of its body, A its cheſt or centre of gravity, and CE the level road. Then AFC will repreſent the crooked lever by which the horſe acts, which is equivalent to the ſtraight one AC. But when the horſe's weight acts downwards at A, ſo as to drag forward the rope AD and raiſe the load P, CE will repreſent the power of the lever in this poſition, or the lever of the horſe's weight, and CF the lever by which it is reſiſted by the load, or the lever of reſiſtance. Now if the horſe lowers its centre of gravity A, which it always does when it pulls hard, it is evident that CE, the lever of its weight, will be increaſed, while CF the lever of its reſiſtance will be diminiſhed, for the line of traction AD will approach nearer to CE. Hence we ſee the great benefit which may be derived from large horſes; for the lever AC neceſſarily increaſes with their ſize, and their power is always proportioned to the length of this lever, their weight remaining the ſame. Large horſes, therefore, and other animals, will draw more than ſmall ones, even though they have leſs muſcular force,

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force, and are unable to carry ſuch a heavy burden. The force of the muſcles tends only to make the horſe carry continually forward his centre of gravity, or, in other words, the weight of the animal produces the draught, and the play and force of its muſcles ſerve to continue it.

450. From theſe remarks, then, we may deduce the proper poſition of the line of traction. When the line of traction is horizontal, as AD, the lever of reſiſtance is CF; but if this line is oblique to the horizon, as A*d*, the lever of reſiſtance is diminiſhed to C*f*, while the lever of the horſe's weight always remains the ſame. Hence it appears, that inclined traces are much more advantageous than horizontal ones, as they uniformly diminiſh the reſiſtance to be overcome. Deparcieux, however, has inveſtigated experimentally the moſt favourable angle of inclination, and found, that when the angle DAF made by the trace A*d* and a horizontal line is fourteen or fifteen degrees, the horſes pulled with the greateſt facility and force. This value of the angle of draught will require the weight of the ſpring-tree bar, to which the traces are attached in four-wheeled carriages, to be *one-half* of the height of that part of the horſe's breaſt to which the fore end of the traces is connected.

Fig. 7.

451. When ſeveral horſes are yoked in the ſame carriage as repreſented in fig. 7. and when the declivity changes, the length of the traces has a conſiderable influence upon the draught. From the point E where the traces are faſtened to the horſe next the load, draw ER to the ſame point in the ſecond horſe R, and let R′ be another poſition of the ſecond horſe; it is required to find the difference of effect that will be produced by placing the ſecond horſe at R or at R′, or the comparative advantages of ſhort and long traces. From R′, the point where the traces are fixed, draw R′F′E; and from E draw E*mn* parallel to the declivity DA. Take EF=EF′ to repreſent the power of the horſe in the direction of the traces, which will be the ſame whether he is yoked at R or at R′; draw EA perpendicular to DA, F*n*, F′*m* parallel to EA, and Fφ, F′*f* parallel to E*n*. Then ſince the ſecond horſe when at R pulls with a force repreſented by FE, in the direction FE, we may reſolve this force into the two forces E*n*, Eφ, one of which E*n* is ſolely employed in dragging the cart up the inclined plane DA, while the other Eφ is ſolely employed in preſſing the firſt horſe E to the ground. Let the horſe be now removed from R to R′, the direction of the traces becomes RF′E, and F′E=FE is the power exerted by the horſe at R′ and the direction in which it is exerted. But this force is equivalent to the forces E*m*, E*f*, the firſt of which acts directly againſt the load, while the other preſſes the horſe againſt the ground. Hence we ſee the diſadvantages of long traces, for the force which draws the load when the horſe is at R′ is to the force when the horſe is at R, as E*m* to E*n*, and the forces which preſs the horſe upon the ground as E*f* to Eφ, or as F′*m* to F*n*. Now $E\varphi = Fn = FE \times \text{ſin.}\ nEF$; hence $E\varphi = FE \times \text{ſin.}\ \overline{(nEg' - FEg')}$ ($g'E$ being parallel to AB′), and $En = EF \times \text{coſ.}\ (nEg' - FEg')$. In like manner we have $Ef = FE \times \text{ſin.}\ (nEg' - F'Eg')$, and $Em = EF \times \text{coſ.}\ (nEg' - F'Eg')$. Now $\text{ſin.}\ FEg' = \text{ſin.}\ FEg = \frac{Rg}{ER}$, and $\text{ſin.}\ FEg' = \frac{R'g'}{ER'} = \frac{Rg}{ER'}$; but $Rg = R'g' = BR - EQ = BR - BR \times \text{coſ.}\ nEg' = BR \times (1 - \text{coſ.}\ nEg)$. By ſubſtituting this value in the equations which contain the values of Eφ, E*n*, E*f*, E*m*, and conſidering that the angles FE*g*′, F′E*g*′ are always ſo ſmall that their arcs differ very little from their ſines, we have $FEg = \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER}$, and

$$F'Eg' = \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER'}.$$

By ſubſtituting theſe values in the preceding equations, we have

$$E\varphi = EF \times \text{ſin.}\ \left(nEg - \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER}\right),$$

$$Efn = EF \times \text{ſin.}\ \left(nEg - \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER'}\right),$$

$$En = EF \times \text{coſ.}\ \left(nEg - \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER}\right),$$

$$Em = EF \times \text{coſ.}\ \left(nEg - \frac{BR \times \overline{1 - \text{coſ.}\ nEg}}{ER'}\right).$$

If AB is horizontal, and the declivity $AD = \frac{1}{6}$, we ſhall have $nEg = 9^\circ\ 28'$, or in parts of the radius=0.16522, and coſ. $nEg = 0.98638$. Then, if EF=200 pounds, BR=3½ feet, ER=8 feet, ER′=12 feet, then we ſhall have from the preceding formulæ, Eφ=31.716 pounds, E*f*=32.350 pounds, E*n*=197.470 pounds, and E*m*=197.404. Hence an additional length of four feet to traces eight feet long, preſſes the horſe E to the ground with an additional force of 32.250—31.716 =0.534 pounds, and diminiſhes the effect of the other horſe by 0.066 pounds.

On the Poſition of the Centre of Gravity, and the manner of diſpoſing the load.

452. If the axle tree of a two-wheeled carriage paſs through the centre of gravity of the load, the carriage will be in equilibrio in every poſition in which it can be placed with reſpect to the axle-tree; and in going up and down hill the whole load will be ſuſtained by the wheels, and will have no tendency either to preſs the horſe to the ground or to raiſe him from it. But if the centre of gravity is above the axle-tree, as it muſt neceſſarily be, according to the preſent conſtruction of wheel-carriages, a great part of the load will be thrown on the back of the horſes from the wheels when going down a ſteep road, and thus tend to accelerate the motion of the carriage which the animal is ſtriving to prevent; while, in aſcending ſteep roads, a part of the load will be thrown behind the wheels, and tend to raiſe the horſe from the ground, when there is the greateſt neceſſity for ſome weight on his back to enable him to fix his feet in the earth, and overcome the great reſiſtance which is occaſioned by the ſteepneſs of the road. On the contrary, if the centre of gravity is below the axle, the horſe will be preſſed to the ground in going up hill, and lifted from it when going down. In all theſe caſes, therefore, where the centre of gravity is either on the axle-tree or directly above it or below, the

Practical Mechanics. the horse will bear no part of the load in level ground. In some situations the animal will be lifted from the ground when there is the greatest necessity for his being pressed to it, and he will sometimes bear a great proportion of the load when he should rather be relieved of it.

453. The only way of remedying these evils, is to assign such a position to the centre of gravity, that the horse may bear some portion of the weight when he must exert great force against the load, that is, in level ground, and when he is ascending steep roads; for no animal can pull with its greatest effort unless it is pressed to the ground.—Now this may be in some measure effected in the following manner. Let BCN be the wheel of a cart, AD one of the shafts, D that part of it where the cart is suspended on the back of the horse, and A the axle-tree; then, if the centre of gravity of the load is placed at *m*, a point equidistant from the two wheels, but below the line DA, and before the axle-tree,—the horse will bear a certain weight on level ground,—a greater weight when he is going up hill and has more occasion for it, and less weight when he is going down hill, and does not require to be pressed to the ground: All this will be evident from the figure.—When we recollect that the shaft DA is horizontal, the centre of gravity will press more upon the point of suspension D the nearer it comes to it, or the pressure upon D, or the horse's back, will be proportional to the distance of the centre of gravity from A. If *m*, therefore, be the centre of gravity, *b* A will represent its pressure upon D, when the shaft DA is horizontal. When the cart is ascending a steep road, AH will be the position of the shaft, the centre of gravity will be raised to *a*, and *a* A will be the pressure upon D. But if the cart is going down hill, AC will be the position of the shaft, the centre of gravity will be depressed to *n*, and *c* A will represent the pressure upon the horse's back. The weight sustained by the horse, therefore, is properly regulated by placing the centre of gravity at *m*. We have still, however, to determine the proper length of *b a* and *b m*, the distance of the centre of gravity from the axle, and from the horizontal line DA; but as these depend upon the nature and inclination of the roads, upon the length of the shaft DA, which depends on the size of the horse, on the magnitude of the load, and on other variable circumstances, it would be impossible to fix their value.—If the load, along with the cart, weighs 400 pounds; if the distance DA be eight feet, and if the horse should bear 50 pounds of the weight, then *b* A should be one foot, which, being one-eighth of DA, will make the pressure upon D exactly 50 pounds. If the road slopes four inches in a foot, *b m* must be four inches, or the angle *b* A *m* should be equal to the inclination of the road; for then the point *m* will rise to *a* when ascending such a road, and will press with its greatest force on the back of the horse.

Plate CCCXXV. Fig. 5.

454. When carts are not made in this manner, we may, in some degree, obtain the same end by judiciously disposing the load. Let us suppose that the centre of gravity is at O when the cart is loaded with homogeneous materials, such as sand, lime, &c. then if the load is to consist of heterogeneous substances, or bodies of different weights, we should place the heaviest at the bottom and nearest the front, which will not only lower the point *o*, but will bring it forward, and nearer the proper position *m*. Part of the load, too, might be suspended below the fore part of the carriage in dry weather, and the centre of gravity would approach still nearer the point *m*. When the point *m* is thus depressed, the weight on the horse is not only judiciously regulated, but the cart would be prevented from overturning; and in rugged roads the weight sustained by each wheel would be in a great degree equalised.

Description of different Carriages.

455. In figure 8. is represented a carriage invented by Mr Richard, a physician in Rochelle, which moves without horses, merely by the exertion of the passengers. The machinery by which this is effected is placed in a box behind the carriage, and is shewn in figure 9. where AA is a small axis fixed into the box, and B a pulley over which a rope passes whose two extremities are tied to the ends of the levers or treddles C, D: the other ends of the levers are fixed by joints to the cross beam MN. The cranks FF are fixed to the axle KL, and move upon it as a centre. Each of them has a detent tooth at F which catches in the teeth of the wheels H, H, so that they can move from F to H without moving the wheel, but the detent tooth catches in the teeth of the wheels when the cranks are brought backward, and therefore bring the wheel along with them. When the foot of the passenger, therefore, is placed upon the treddle D, it brings down the crank F and along with it the wheel H, so that the large wheels fixed on the same axis perform part of a revolution; but when D is depressed, the rope DA descends, the extremity C of the other treddle rises, and the crank F rising along with it, takes into the teeth of the wheel H, so that when the elevated treddle C is depressed, the wheels H, H, and consequently the wheels I, I perform another part of a revolution. In this way, by continuing to work at the treddles, the machine advances with a regular pace.

Carriages that move without horses. Fig. 8.

Fig. 9.

456. A carriage of this kind, where the mechanism is much more simple and beautiful than that which we have described, has been lately invented and constructed by Mr Nasmyth of Edinburgh, a gentleman whose mechanical genius is scarcely inferior to his talents as a painter. The pulley B and axle AA, are rendered unnecessary; leather straps are substituted in place of the cranks F, F, and the whole mechanism is contained in two small cylindrical boxes about six inches in diameter, and one and a half broad.

457. A carriage driven by the action of the wind is exhibited in fig. 10. It is fixed on four wheels, and moved by the impulse of the wind upon the sails C, D, being guided by the rudder E. Carriages of this kind will answer very well in a level country where the roads are good and the wind fair; and are said to be much used in China. In Holland they sometimes use similar vehicles for travelling upon the ice; but they have a sledge instead of wheels, so that if the ice should happen to break, there will be no danger of sinking. Stephinus, a Dutchman is said to have constructed one of these carriages with wheels, which travelled at the rate of 21 miles an hour with a very strong wind. Fig. 10.

458. The carriage represented in fig. 11. is made so as to sail against the wind by means of the spiral sails Fig. 11.

Description of Machines.

E, F, G, H, one of which F is expanded by the wind. The impulse of the wind upon the sails gives a rotatory motion to the axle M, furnished with a cog-wheel K, whose trundles act upon teeth placed on the inside of the fore-wheels.

Fig. 12.

459. A carriage which cannot be overturned is represented in figure 12. where AB is the body of the carriage, consisting of a hollow globe, made of leather or wood, at the bottom of which is placed an immoveable weight proportioned to the load which the carriage is to bear. Two horizontal circles of iron D, E connected with bars HI, and two vertical circles F, G, surround the globe; and the wheels are fastened by a handle K to the perpendicular bars HI. Then since the body of the carriage moves freely in every direction within the iron circles, the centre of gravity will always be near C, and the carriage will preserve an upright position even if the wheels and frame were overturned.

PART III. DESCRIPTION OF MACHINES.

Chap. I. *Machines which illustrate the doctrines of Mechanics, or are connected with them.*

1. *Atwood's Machine.*

Atwood's machine, Plate CCCXXVI. Fig. 1. 2. 3. &c.

460. THE ingenious machine invented by Mr Atwood for illustrating the doctrines of accelerated and retarded motion, is represented in figs. 1, 2, 3, 4, 5, 6, and enables us to discover, 1. The quantity of matter moved. 2. The moving force. 3. The space described. 4. The time of description; and 5. The velocity acquired at the end of that time.

461. 1. *Of the quantity of matter moved.*—In order to observe the effects of the moving force, which is the object of any experiment, the interference of all other forces should be prevented: the quantity of matter moved, therefore, considering it before any impelling force has been applied, should be without weight; for though it be impossible to abstract weight from any substance whatever, yet it may be so counteracted as to produce no sensible effect. Thus in the machine fig. 1. A, B represent two equal weights affixed to the extremities of a very fine silk thread: this thread is stretched over a wheel or fixed pulley *a b c d*, moveable round a horizontal axis: the two weights A, B being equal and acting against each other, remain in equilibrio; and when the least weight is superadded to either (setting aside the effects of friction), it will preponderate. When A, B are set in motion by the action of any weight *m*, the sum $A+B+m$, would constitute the whole mass moved, but for the inertia of the materials which must necessarily be used in the communication of motion. These materials consist of, 1. The wheel *a b c d*, over which the thread sustaining A and B passes. 2. The four friction wheels on which the axle of the wheel *a b c d* rests. 3. The thread by which the bodies A and B are connected, so as when set in motion to move with equal velocities. The weight and inertia of the thread are too small to have any sensible effect on the experiments; but the inertia of the other materials constitute a considerable proportion of the mass moved, and must therefore be taken into account. Since when A and B are put in motion, they must move with a velocity equal to that of the circumference of the wheel *a b c d* to which the thread is applied; it follows, that if the whole mass of the wheels were accumulated in this circumference, its inertia would be truly estimated by the quantity of matter moved; but since the parts of the wheels move with different velocities, their effects in resisting the communication of motion to A and B by their inertia will be different; those parts which are furthest from the axis resisting more than those which revolve nearer in a duplicate proportion of those distances, (see ROTATION). If the figures of the wheels were regular, the distances of their centres of gyration from their axes of motion would be given, and consequently an equivalent weight, which being accumulated uniformly in the circumference *a b c d*, would exert an inertia equal to that of the wheels in their constructed form, would also be given. But as the figures are irregular, recourse must be had to experiment, to assign that quantity of matter, which being accumulated uniformly in the circumference of the wheel *a b c d*, would resist the communication of motion to A in the same manner as the wheels.

In order to ascertain the inertia of the wheel *a b c d*, with that of the friction wheels, the weights AB being removed, the following experiment was made:

A weight of 30 grains was affixed to a silk thread of inconsiderable weight; this thread being wound round the wheel *a b c d*, the weight 30 grains by descending from rest communicated motion to the wheel, and by many trials was observed to describe a space of about $38\frac{1}{2}$ inches in 3 seconds. From these data the equivalent mass or inertia of the wheels will be known from this rule.

Let a weight P, fig. 2. be applied to communicate motion to a system of bodies by means of a very slender and flexible thread going round the wheel SLDIM, through the centre of which the axis passes (G being the common centre of gravity, R the centre of gravity of the matter contained in this line, and O the centre of oscillation). Let this weight descend from rest through any convenient space *s* inches, and let the observed time of its descent be *t* seconds; then if *l* be the space through which bodies descend freely by gravity in one second, the equivalent weight sought $= \frac{W \times SR \times SO}{SD^2} = \frac{P \times t^2 l}{s} - P$. Fig. 2.

Here we have $p=30$ grains, $t=3$ seconds, $l=193$ inches, $s=38.5$ inches; and $\frac{P \times t^2 l}{s} - P = \frac{30 \times 9 \times 193}{385}$ $30 = 1323$ grains, or $2\frac{3}{4}$ ounces.

This is the inertia equivalent to that of the wheel *a b c d*, and the friction wheels together: for the rule extends to the estimation of the inertia of the mass contained in all the wheels.

The resistance to motion therefore arising from the wheel's inertia, will be the same as if they were absolutely Fig. 1.

lutely removed, and a mafs of $2\frac{3}{4}$ ounces uniformly accumulated in the circumference of the wheel *a b c d*. This being premifed, let the boxes A and B be replaced, being fufpended by the filk thread over the wheel or pulley *a b c d*, and balancing each other: fuppofe that any weight *m* be added to A fo that it fhall defcend, the exact quantity of matter moved, during the defcent of the weight A, will be afcertained, for the whole mafs will be $A+B+m+2\frac{3}{4}$ oz.

In order to avoid troublefome computations in adjufting the quantities of matter moved and the moving forces, fome determinate weight of convenient magnitude may be affumed as a ftandard, to which all the others are referred. This ftandard weight in the fubfequent experiments is $\frac{1}{4}$ of an ounce, and is reprefented by the letter *m*. The inertia of the wheels being therefore $=2\frac{3}{4}$ ounces, will be denoted by $11\,m$. A and B are two boxes conftructed fo as to contain different quantities of matter, according as the experiment may require them to be varied: the weight of each box, including the hook to which it is fufpended, $=1\frac{1}{2}$ oz. or according to the preceding eftimation, the weight of each box will be denoted by $6\,m$; thefe boxes contain fuch weights as are reprefented by fig. 3. each of which weighs an ounce, fo as to be equivalent to $4\,m$; other weights of $\frac{1}{2}$oz.$=2\,m$, $\frac{1}{4}=m$, and aliquot parts of *m*, fuch as $\frac{1}{2}m$, $\frac{1}{4}m$, may be alfo included in the boxes, according to the conditions of the different experiments hereafter defcribed. Fig. 3.

If $4\frac{3}{4}$ oz. or $19\,m$, be included in either box, this with the weight of the box itfelf will be $25\,m$; fo that when the weights A and B, each being $25\,m$, are balanced in the manner above reprefented, their whole mafs will be $50\,m$, which being added to the inertia of the wheels $11\,m$, the fum will be $61\,m$. Moreover, three circular weights, fuch as that which is reprefented at fig. 4. are conftructed; each of which $=\frac{1}{4}$ oz. or *m*: if one of thefe be added to A and one to B, the whole mafs will now become $63\,m$, perfectly in equilibrio, and moveable by the leaft weight added to either (fetting afide the effects of friction), in the fame manner precifely as if the fame weight or force were applied to communicate motion to the mafs $63\,m$, exifting in free fpace and without gravity.

462. 2. *The moving force.* Since the weight of any fubftance is conftant, and the exact quantity of it eafily eftimated, it will be convenient here to apply a weight to the mafs A as a moving force: thus, when the fyftem confifts of a mafs $=63\,m$, according to the preceding defcription, the whole being perfectly balanced, let a weight $\frac{1}{4}$ oz. or *m*, fuch as is reprefented in fig. 5. be applied on the mafs A; this will communicate motion to the whole fyftem; by adding a quantity of matter *m* to the former mafs $63\,m$, the whole quantity of matter moved will now become $64\,m$; and the moving force being $=m$, this will give the force which accelerates the defcent of $A=\frac{m}{64\,m}$, or $\frac{1}{64}$ part of the accelerating force of gravity. Fig. 5.

By the preceding conftruction, the moving force may be altered without altering the mafs moved; for fuppofe the three weights *m*, two of which are placed on A and one on B, to be removed, then will A balance B. If the weights $3\,m$ be all placed on A, the moving force will become $3\,m$, and the mafs moved $64\,m$ as before, and the force which accelerates the defcent of $A=\frac{3\,m}{64\,m}=\frac{3}{64}$ parts of the force by which gravity accelerates falling bodies.

Suppofe it were required to make the moving force $2\,m$, the mafs moved continuing the fame. Let the three weights, each of which $=m$, be removed; A and B will balance each other; and the whole mafs will be $61\,m$: let $\frac{1}{2}m$, fig. 5. be added to A, and $\frac{1}{2}m$ to B, the equilibrium will be preferved, and the mafs moved will be $62\,m$; now let $2\,m$ be added to A, the moving force will be $2\,m$, and the mafs moved $64\,m$ as before; wherefore the force of acceleration $=\frac{1}{32}$ part of the acceleration of gravity. Thefe alterations in the moving force may be eafily made in the more elementary experiments, there being no neceffity for altering the contents of the boxes A and B: but the proportion and abfolute quantities of the moving force and mafs moved, may be of any affigned magnitude, according to the conditions of the propofition to be illuftrated. Fig. 5.

463. 3. *Of the fpace defcribed.* The body A, fig. 1. defcends in a vertical line; and a fcale about 64 inches in length divided into inches and tenths of an inch is adjufted vertical, and fo placed that the defcending weight A may fall in the middle of a fquare ftage, fixed to receive it at the end of the defcent: the beginning of the defcent is eftimated from o on the fcale, when the bottom of the box A is on a level with o. The defcent of A is terminated when the bottom of the box ftrikes the ftage, which may be fixed at different diftances from the point o; fo that by altering the pofition of the ftage, the fpace defcribed from reft may be of any given magnitude lefs than 64 inches. Fig. 1.

464. 4. *The time of defcription* is obferved by a pendulum, vibrating feconds; and the experiments intended to illuftrate the elementary propofitions, may eafily be fo conftructed that the time of motion fhall be a whole number of feconds. The eftimation of the time, therefore, admits of confiderable exactnefs, provided the obferver takes care to let the bottom of the box A begin its defcent precifely at any beat of the pendulum; then the coincidence of the ftroke of the box againft the ftage, and the beat of the pendulum at the end of the time of motion, will fhow how nearly the experiment and the theory agree. There might be various devices for letting the weight A begin its defcent at the inftant of a beat of the pendulum W; for inftance, let the bottom of the box A, when at o on the fcale, reft on a flat rod, held in the hand horizontally; its extremity being coincident with o, by attending to the beats of the pendulum; and with a little practice, the rod which fupports the box A may be removed at the moment the pendulum beats, fo that the defcent of A fhall commence at the fame inftant.

465. 5. *Of the velocity acquired.* It remains only to defcribe in what manner the velocity acquired by the defcending weight A, at any given point of its path is made evident to the fenfes. The velocity of A's defcent being continually accelerated will be the fame in two points of the fpace defcribed. This is occafioned by the conftant action of the moving force; and fince the velocity of A at any inftant is meafured by the fpace

Description of Machines. which would be described by it moving uniformly for a given time with the velocity it had acquired at that instant, this measure cannot be experimentally obtained, except by removing the force by which the descending body's acceleration was caused.

In order to show in what manner this is effected particularly, let us again suppose the boxes A and B$=25\,m$ each, so as together to be $=50\,m$; this with the wheel's inertia $11\,m$ will make $61\,m$; now let m be added to A, and an equal weight m to B, these bodies will balance each other, and the whole mass will be $63\,m$. If a weight m be added to A, motion will be communicated, the moving force being m, and the mass moved $64\,m$. In estimating the moving force, the circular weight $=m$ was made use of as a moving force: but for the present purpose of showing the velocity acquired, it will be convenient to use a flat rod, the weight of which is also $=m$. Let the bottom of the box A be placed on a level with 0 on the scale, the whole mass being as described above $=63\,m$, perfectly balanced. Now let the rod, the weight of which $=m$, be placed on the upper surface of A; this body will descend along the scale in the same manner as when the moving force was applied in the form of a circular weight. Suppose Fig. 6. the mass A, fig. 6. to have descended by constant acceleration of the force of m, for any given time, or through a given space: let a circular frame be so affixed to the scale, contiguous to which the weight descends, that A may pass centrally through it, and that this circular frame may intercept the rod m by which the body A has been accelerated from rest. After the moving force m has been intercepted at the end of the given space or time, there will be no force operating on any part of the system which can accelerate or retard its motion: this being the case, the weight A, the instant after m has been removed, must proceed uniformly with the velocity which it had acquired that instant: in the subsequent part of its descent, the velocity being uniform will be measured by space described in any convenient number of seconds.

466. Mr Atwood's machine is also useful for estimating experimentally the velocities communicated by the impact of bodies elastic and nonelastic; the quantity of resistance opposed by fluids, as well as for various other purposes. These uses we shall not insist on; but the properties of retarded motion being a part of the present subject, it may be necessary to show in what manner the motion of bodies resisted by constant forces are reduced to experiment by means of the instrument above described, with as great ease and precision as the properties of bodies uniformly accelerated. A single instance will be sufficient: Thus, suppose the mass contained in the weights A and B, fig. 6. and the wheels to be $61\,m$, when perfectly in equilibrio; let a circular weight m be applied to B, and let two long weights or rods, each $=m$, be applied to A, then will A descend by the action of the moving force m, the mass moved being $64\,m$: suppose that when it has described any given space by constant acceleration, the two rods m are intercepted by the circular frame above described, while A is descending through it, the velocity acquired by that descent is known; and when the two rods are intercepted, the weight A will begin to move on with the velocity acquired, being now retarded by the constant force m; and since the mass moved is $62\,m$, the force of retardation will be $\frac{1}{62}$ part of that force whereby gravity retards bodies thrown perpendicularly upwards. The weight A will therefore proceed along the graduated scale in its descent, with an uniformly retarded motion, and the spaces described, times of motion, and velocities destroyed by the resisting force, will be subject to the same measures as in the examples of accelerated motion already described.

In the preceding descriptions, two suppositions have been assumed, neither of which is mathematically true: but it might be easily shown that they are so in a physical sense; the errors occasioned by them being insensible in practice.

2. *Machine for illustrating the Theory of the Wedge.*

467. This machine is represented in fig. 7. where KILM and LMNO are two flat pieces of wood joined Plate CCCXXVI. Fig. 7. together by a hinge at LM; P is a graduated arch on which these pieces of wood can be moved so as to subtend any angle not greater than 60°, and a, b two screws for fixing them at the required angle. The back of the wedge will therefore be represented by IKNO, its sharp edge by LM, and its two sides by KILM, LMNO. The weight p suspended to the wedge by the hook M, and the weight of the wedge itself, may be considered as the force employed to drive the wedge. The wooden cylinders AB, CD, have their extremities made like two flat circular plates to prevent the wedge from slipping off at one side. To the pivots of these cylinders, two of which are represented at e and f, are fastened the cords eW, fU, CV, AX, which passing over the pulleys U, V, X, W are fastened to the two bars uv, xw, on which any equal weights Y, Z may be hung at pleasure. The tendency of these weights is evidently to draw the cylinders towards each other, and they may therefore be regarded as the resistance of the wood acting against the sides of the wedge. The cylinders themselves are suspended by their pivots to the threads E, F, G, H, which may be fixed to the ceiling of the room, or to the horizontal beam of a frame made on purpose.—By placing various equal weights at Y and Z, it may be easy to determine the proportion between the power and the resistance when the wedge is in equilibrio.—In this machine the impelling power is the pressure of the weight p, whereas, in the real wedge, the impelling power is always an impulsive force which is infinitely more powerful.

3. *Machine for illustrating the effects of the centrifugal force in flattening the poles of the Earth.*

468. Fig. 8. represents this machine, which consists of two flexible circular hoops, AB and CD, crossing one another at right angles, and fixed to the vertical axis EF at its lower extremity, but left loose at the pole or intersection e. If this axis be made to revolve rapidly by means of the winch m, and the wheel and pinion n, o, the middle parts A, B, C, D will, by their centrifugal force, swell out and strike against the frame at F and G; if the pole e, when sinking, is not stopped by means of a pin E fixed in the vertical axis. The hoops, therefore, will have a spheroidal form; the equatoreal being larger than the polar diameter. Fig. 8. Machine for trying the strength of materials.

4. *Machine for trying the Strength of Materials.*

469. The piece of wood, whose strength is to be tried,

Description of Machines. Plate CCCXXVII. Fig. 1. tried, is represented by EF, and the force is applied to it by means of the winch A, which winds up the rope BC, passing over the pulley *n*, and below the pulley *m*, and attached to the point D of the beam EF. The pulleys slide on two parallel bars fixed in a frame, held down by a projecting point, at G, of the lever GR, which is graduated like a steelyard, and measures the force employed. The beam EF is held by a double vice IK with four screws, two of which are invisible. When a wire is to be torn it is fixed to the cross bar LM; and when any body is to be crushed, it must be placed beneath the lever NO, the rope BC being fixed to the hook N, and the end O being held down by the click which acts on the double ratchet OP.—The lever is double from O to Q, and acts on the body by a loop fixed to it by a pin. See *Young's Nat. Philos.* vol. i. p. 768. from which this drawing and description are taken.

5. *Machine in which all the Mechanical powers are combined.*

Combination of all the mechanical powers. Fig. 2. 470. The lever AB, whose centre of motion is C, is fixed to the endless screw DE, which drives the wheel and axle FHG. Round the axle G is coiled a rope GHI, which passes round the four pulleys K, L, *m*, *n*, and is fixed to a hook at *m* on the lower block, which carries the weight W. When equal weights are suspended on the lever at equal distances from the fulcrum C, the lever becomes a balance, and the wedge and inclined plane are evidently included in the endless screw DE. If the wheel F has 30 teeth, if the lever AB is equal to twice the diameter of the wheel FH, and if the diameter of the axle G is one-tenth of the diameter of the wheel, a power of 1 exerted at P will raise a weight of 2400 suspended at the lower block of the four pulleys.

6. *Fidler's Balance.*

Fidler's balance. Fig. 3. 471. The balance represented in fig. 3. was made by Fidler for the Royal Institution, and does not differ much from those which have been constructed by Ramsden and Troughton. The middle column A can be raised at pleasure by the nut B, and supports the round ends of the axis in the forks at its upper extremity, in order to remove the pressure on the sharp edges of the axis within the forks. C and D are pillars which occasionally support the scales, and may be elevated or depressed by turning the nut E. The screw F raises or depresses a weight within the conical beam, for the purpose of regulating the position of the centre of gravity. The graduated arc G measures the extent of the vibrations. See *Young's Nat. Phil.* vol. i. p. 765.

7. *Improvement on the Balance.*

Improvement on the balance. Fig. 5. 472. An improvement on the balance is represented in fig. 4. where DC is a micrometer screw fixed to the arm FA, so that when it is turned round by the nut D, it neither approaches to, nor recedes from, the centre of motion F. The screw DC works in a female screw in the small weight *n*, and by revolving in one direction, carries this weight from S to R, and thus gives the preponderance to the scale G. The recession of the weight *n* from the centre F is measured as in the common micrometer, and a weight x placed in the scale suspended at A, will be in equilibrio with *n* placed at any distance S *n*, when $x=\frac{Sn\times n}{FA}$.—*Append. to Ferguson's Lectures.*

8. *Machine for shewing the Composition of Forces.*

Machine for the composition of forces. Fig. 4. 473. The part BEFC is made to draw other parts into the wooden square ABCD. The pulley H is joined to BEFC so as to turn on an axis which will be at H when the square BEFC is pushed in, and at *p* when it is drawn out. A ball G is made to slide on the wire *k* which is fixed to BEFC, and the thread *m* attached to the ball goes over the pulley to I, where it is fixed. Now, when the piece BEFC is pulled out, the pulley, wire, and ball, move along with it, in the direction DCF, and it is evident that the ball G will slide gradually up the wire *k*. It is therefore acted upon by two forces; one in the direction GH, and the other in the direction GC, and will be found at the end of the motion at *g*, having moved in the direction G *g*, the diagonal of a parallelogram whose sides are GH, GC.

8. *Smeaton's Machine for experiments on Windmill Sails.*

Apparatus for windmills. Fig. 6. 474. In the experiments with this machine, the sails were carried round in the circumference of a circle, so that the same effect was produced as if the wind had struck the sails at rest with the velocity which was then given them. In the pyramidal frame ABC is fixed to the axis DE, which carries the arm FG with the sails GI. By pulling the rope Z, which coils round the barrel H, a motion of rotation is given to the sails, so that they revolve in the circumference of a circle, whose radius is DI. At L is fixed a cord which passes round the pulleys M, N, O, and coils round a small cylinder on the axis of the sails and raises the scale C, in which different weights are placed for trying the power of the sails, and which, being in the direction of the axis DE, is not affected by the circular motion of the arm DG. The scale C is kept steady by the pillars Q, R, and prevented from swinging by the chains S, T, which hang loosely round the pillars. VX is a pendulum composed of two leaden balls moveable upon a wooden rod, so that they can be adjusted to vibrate in any given time. The pendulum hangs upon a cylindrical wire, on which it vibrates as on a rolling axis.

9. *Smeaton's Machine for experiments on Rotatory Motion.*

Apparatus for rotatory motion. Plate CCCXXVIII. Fig. 1. 475. This machine is exhibited in fig. 1. where the vertical axis NB is turned by the rope M passing over the pulley R, and carrying the scale S. The axis NB carries two equal leaden weights K, D, moveable at pleasure on the horizontal bar HI. The upper part N of the axis is one half the diameter of the part M, so that when the rope is made to wind round N, it acts at half the distance from the axis, at which it acts when coiled round M.—When the rope is wound round N, the same force will produce in the same time but half the velocity which is produced when the rope coils round M, the situation of the leaden weights being the same: But when the weights K, L are removed to a double distance from the axis, a quadruple force will be required in order to produce an equal angular velocity in a given time.

CHAP.

Deſcription of Machines.

CHAP. II. *Machines for various purpoſes.*

1. *Prony's Condenſer of Forces.*

Prony's condenſer of forces. Plate CCCXXVIII. Fig. 2, 3.

476. The object of this machine is to obtain a maximum effect from an impelling power which is ſubject to variation in its intenſity. Let us ſuppoſe that wind is the firſt mover, and that O, O is the vertical axis of a windmill; *e, e, e, e,* are ſeveral radii iſſuing from this axis, and carrying a wiper *b d*, which acts upon the correſponding wipers *a f*, and give a motion of rotation to the axis *a, a, a, a* to which they are attached. The wipers *b d, a f* muſt be ſo conſtructed that when *b d* ceaſes to preſs on one wiper *a f*, it ſhall at the ſame moment begin to act upon the next wiper. Each of the axes *a, a, a, a,* carries a drum *t t r r*, round which is coiled a cord *t p* F, paſſing over the pulley *p*, and ſupporting a weight Q which can be placed at different diſtances from G on the lever FG. The axes *a, a, a, a* alſo paſs through the pinions *q q*, to which they are not fixed; but theſe pinions carry ratchet wheels that bear againſt the teeth *r r*, ſo that when the weight Q riſes, the rope merely coils round the drum without moving the pinion *q q*. But when the wiper *b d* ceaſes to act upon *a f*, the weight Q deſcends, and then the toothed wheel *r r* acts againſt the ratchet, ſo that Q cannot deſcend without turning the pinion *q q* along with the drum. The pinion *q q* drives the wheel *a b*, which again drives the wheel CE by means of the bevelled teeth CD, and elevates the load at P. Hence, when the axis OO is put in motion by the wind acting on the ſails, it will firſt raiſe a number of weights Q ſufficient to put the machine in motion, and will continue to raiſe new weights while thoſe before raiſed are fallen, ſo that the motion once impreſſed will be continued.

2. *Portable Stone Crane, for loading and unloading Carts.*

Portable ſtone crane. Fig. 4.

477. This crane is mounted on a wooden ſtage, and is ſo conſtructed that it may be taken to pieces. The frame A, A, A, A is about ten feet high, nine feet long and nine feet wide. The wheels B, B are of iron, and about three feet in diameter. The pinion D that is fixed to the axis of the firſt wheel B is eight inches diameter, and the other pinion C is about the ſame diameter. When the ſtones are ſuſpended to the rope that coils round the barrel, the workman turns a winch on the axis of the wheel C, and raiſes or lowers the weight according to the direction in which he turns it.

3. *Portable Cellar Crane.*

Portable cellar crane. Fig. 5.

478. This crane is repreſented in fig. 5. where A, A are two wooden ſupports about ſix feet high, which are jointed at E, and connected by the iron cylinder C and the wooden bar D. The ſupports A, A are faſtened to the edge of the cellar by the iron prongs E, E, and the two ropes which ſupport the barrel and paſs round it are fixed to the iron clamp G, G. Theſe ropes coil round the cylindrical bar F, which is put in motion by the winch K, driving the pinion I about four inches diameter, which gives motion to the wheel H, about three feet in diameter. The barrel, therefore, will riſe or fall according to the direction in which the winch is moved.

4. *Weighing Crane.*

Deſcription of Machines.

Plate CCCXXX. Fig. 6. Andrews's weighing crane.

479. This crane repreſented in fig. 6. was invented by Mr Andrews, and weighs the body at the time that it is raiſing it. The weight W is elevated by means of the levers M, N, O, P which coil the rope HR round the barrel H. The jib ED ſtands on a horizontal beam moveable in a vertical plane round the centre FA, and the diſtance of the upright beam E from the centre of motion A is $\frac{1}{10}$ of BF. The weight of the body W is then aſcertained by the weight at B, which keeps it in equilibrio. The piece of wood C projects from the vertical beam CT, in order to prevent the beam from riſing too high.

5. *Gilpin's Crane.*

Gilpin's crane. Plate CCCXXIX. Fig. 1, 2, 3, 4, 5.

480. In fig. 1. where this machine is repreſented, AB is the perpendicular ſtand, formed of two oaken planks let into caſt iron mortiſes C, D: Between theſe planks is fixed the barrel E with ſpiral grooves on its ſurface, on which the chain RL winds. When the winch N is put in motion it drives the pinion O, which again drives the wheel P, on whoſe axis is fixed the barrel F, ſo that the chain is coiled round the barrel and the weight raiſed. A ſection of this part of the machinery is ſhewn in fig. 2. Figure 3. ſhews an enlarged view of part of the barrel, and part of the chain lying in its proper poſition in the ſpiral grooves or channels. In order to prevent the chain from twiſting when it is wound upon the barrel, the lower edge of one link lies in the groove, and the next link upon the ſurface of the barrel. This will be better underſtood from fig. 4. which is a ſection of the barrel F, and ſhews the manner in which one link lies within it, and the other link on its outſide. The old method of working chains is exhibited in fig. 5. For a full account of this uſeful invention, ſee Nicholſon's Journal, vol. xv. p. 126.

6. *Bramah's Jib for Cranes.*

Bramah's jib. Fig. 6.

481. The nature of this invention, for which we are indebted to the ingenious Mr Bramah, may be eaſily underſtood from a bare inſpection of fig. 6. which repreſents a jib attached to the wall of a warehouſe. The jib turns on a perforated axis or pillar. The rope by which the weight is raiſed after paſſing over two pulleys, goes through the perforated axis, and is conducted over another pulley to the barrel of the crane, which is not repreſented in the figure. In jibs of the common conſtruction which turn in two ſolid gudgeons, the rope paſſes over the upper gudgeon, and is confined between two vertical rollers; but the bending of the rope occaſions a great deal of friction, and produces a conſtant effort to bring the arm of the jib into a poſition parallel to the inner part of the rope.

7. *Gottlieb's Carriage Crane.*

Plate CCCXXIX. Fig. 7. Carriage crane.

482. This machine, which is uſeful for carrying large ſtones where carts and horſes cannot be eaſily obtained, conſiſts of two ſorts of crane wheels applied to the two ſets of wheels belonging to the carriage, ſo that two men, one acting at each winch A, A give motion to the loaded carriage. The pinion B, ſix inches in diameter turns the wheel C, three feet in diameter. The wheel C gives motion to the pinion D one foot in diameter,

meter, which works into two wheels E, E three feet ſix inches diameter, and are fixed on the wheels of the carriage.

8. *Common Jack.*

Common jack. Fig. 8.

483. The common worm jack is repreſented in fig. 8, and is impelled by the weight W, which is ſuſpended to a rope paſſing through the pulleys V, R, and rolling round the barrel Q. When the barrel is put in motion by the action of the weight, it drives the wheel KL of 60 teeth, by means of a catch fixed to AB, which lays hold of the croſs bars in KL. The wheel KL drives the pinion M of 15 teeth, fixed on the axis of the wheel N of 30 teeth, which gives motion to the endleſs ſcrew O, and the fly-wheel P. On the axis of the wheel KL is fixed the pulley DG, which by means of a rope gives motion to the ſpit. The axis ET is fixed in the barrel AC; and as this axis is hollow, both it and the barrel turn round upon the axis FD, ſo that the rope may be coiled round the barrel by the winch H without moving the wheel K.

9. *Loading and Unloading Machine.*

Loading and unloading machine. Fig. 9.

484. This portable machine, invented by Mr Davis of Windſor, is put in motion by the winch A, which drives the two endleſs ſcrews C, C. Theſe ſcrews move the wheels E, E, and conſequently the barrels connected with them, ſo that the ropes F, F paſſing over the pulleys G, G are coiled round the barrels, and the load H which theſe ropes ſupport is raiſed into the frame R, R, which ſhews a part of the cart. The barrels and wheels are contained in an iron box L, the ſides of which are removed in the figure.

10. *Vauloue's Pile Engine.*

Vauloue's pile engine. Plate cccxxx. Fig. 1.

485. The horſes which work this engine are yoked at S, S, and by moving the wheel B and drum C, which are locked together, raiſe the follower GH, (carrying the ram Q by the handle R,) by means of the rope HH which coils round the drum. When the follower G reaches the top of the frame, the upper legs of the tongs H are cloſed by preſſing againſt the adjacent beams; and their lower legs are opened, ſo that they drop the ram Q, which falls and ſtrikes the pile. When G is at the top of the frame, the crooked handle 6, of the follower G, preſſes againſt the cords *a*, *a*, which raiſe the end of the lever L (ſee fig. 2.) round *m* as a centre, and by depreſſing the extremity N, and conſequently the bar S, S, unlock the drum C and the wheel B, ſo that the follower G falls by its weight and ſeizes the ram R. As ſoon as the follower drops, the horſes would tumble down, having no reſiſtance to overcome, were not this prevented by the fly O, which is moved by the wheel B and trundle X, and oppoſes a ſufficient reſiſtance to the horſes till the follower again ſeizes the ram. When the follower falls, the weight L (fig. 2.) puſhes up the bolt Y into the drum C, and locks the wheel and the drum;—and the ſame operation is afterwards repeated. See *Ferguſon's Lect.* vol. i. p. 118.

Fig. 2.

11. *Bunce's Pile Engine.*

Bunce's pile engine. Fig. 3. 4.

486. A ſide view of this engine is ſhewn in fig. 3, 4. It conſiſts of two endleſs ropes or chains A, connected by croſs pieces of iron B, B, &c. (fig. 4.) which paſs round the wheel C, the croſs pieces falling into correſponding croſs grooves, cut in the periphery of the wheel. When the man at S, therefore, drives the wheel *m* by means of the pinion *p*, he moves alſo the wheel C fixed on the axis of *m*, and makes the double ropes revolve upon the wheels C, D. The wheel D is fixed at the end of a lever DHK, whoſe centre of motion is H, a fixed point in the beam FT. Now, when the ram L (fig. 3, 5.) is fixed to one of the croſs pieces B by the hook M, the weight of the ram, acting by the rope, moves the lever DK round H, and brings the wheel D to G, ſo that, by turning the winch, the ram L (fig. 3.) is raiſed in the vertical line LRG. But when it reaches R, the projecting piece R diſengages the ram from the croſs piece B, by ſtriking the bar Q; and as the weight is removed from the extremity D of the lever, the counterpoiſe I brings it back from G to its old poſition at F, and the ram falls without interfering with the chain. When the hook is deſcending, it is prevented from catching the rope by means of the piece of wood N ſuſpended from the hook M at O; for being ſpecifically lighter than the iron weight L, and moving with leſs velocity, it does not come in contact with L till the ram is ſtopped at the end of its path. When N, therefore falls upon L, it depreſſes the extremity M of the hook, and therefore brings the hook over one of the croſs pieces B, by which the ram is again raiſed.

487. For the deſcription of a great variety of uſeful machines, the reader is referred to the ſecond volume of Mr Gregory's Mechanics, and to Dr Young's Natural Philoſophy, a work of great merit, which would have been more particularly noticed if it had reached us before the hiſtorical part of this article was printed off.—See alſo HYDRODYNAMICS, MARLY, *Machine at*, MILL, RAMSDEN, and *WATER-Works*.

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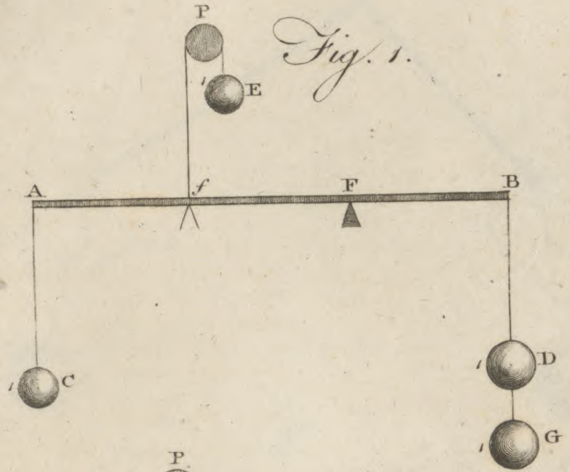
Fig. 1.



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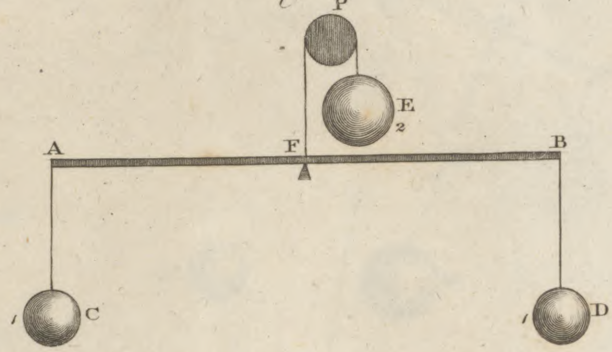

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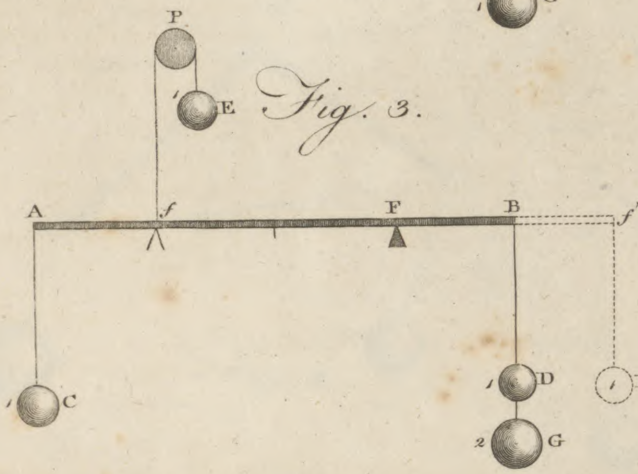

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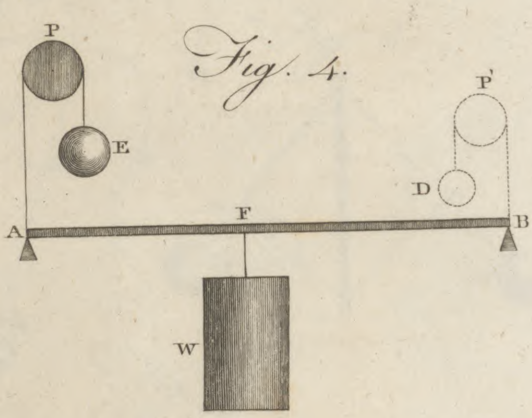

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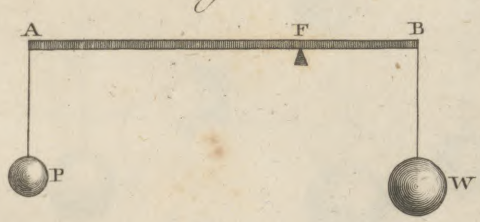

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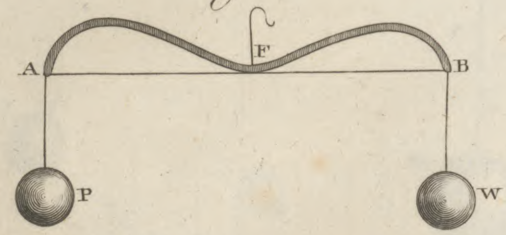

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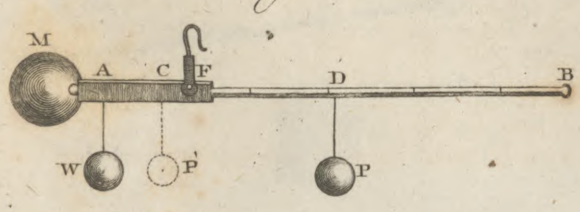

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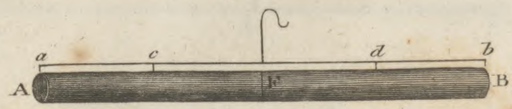

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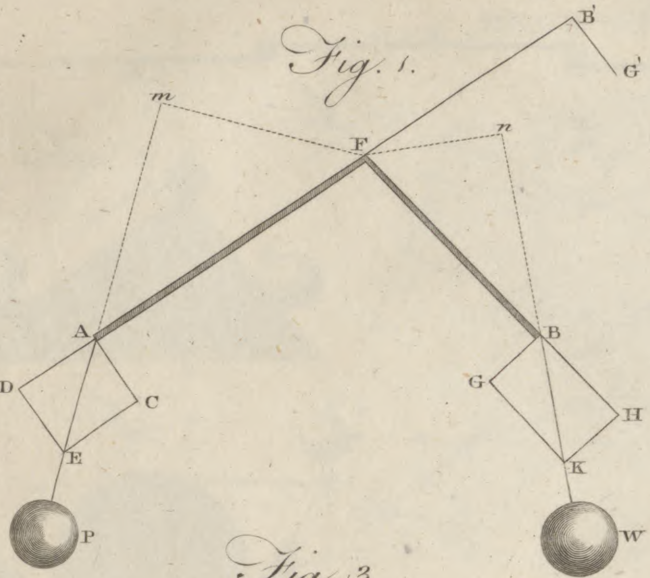

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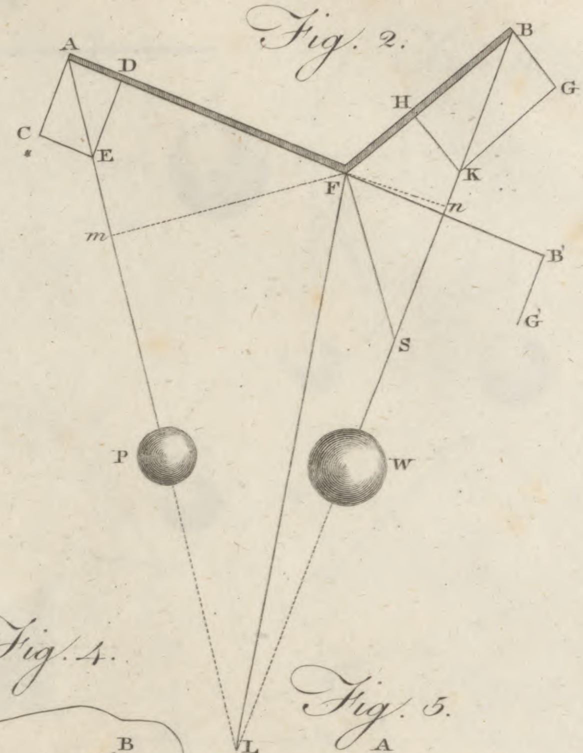

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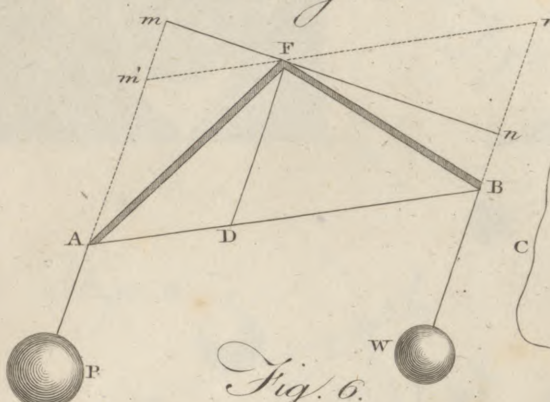

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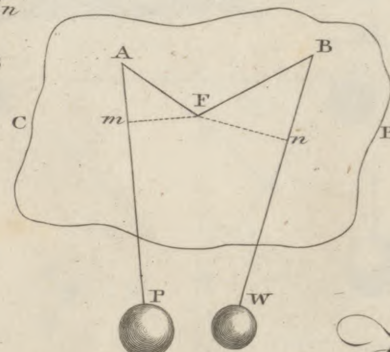

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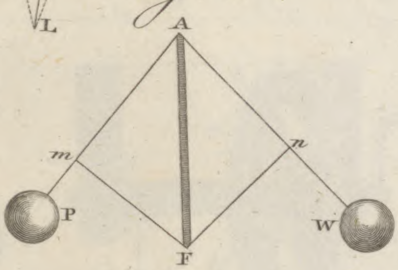

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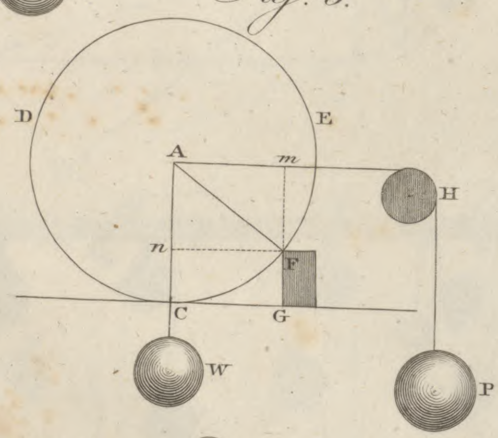

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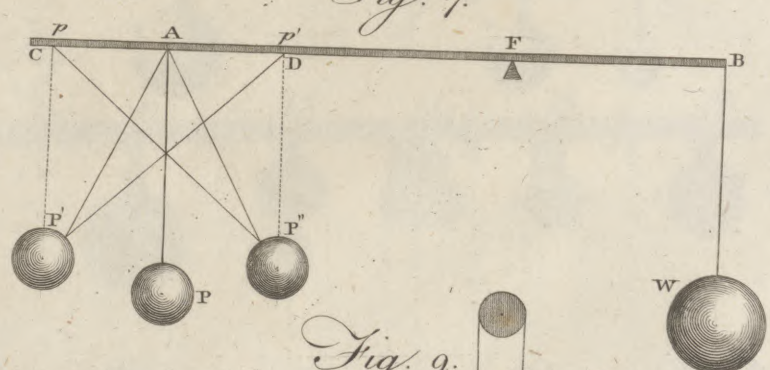

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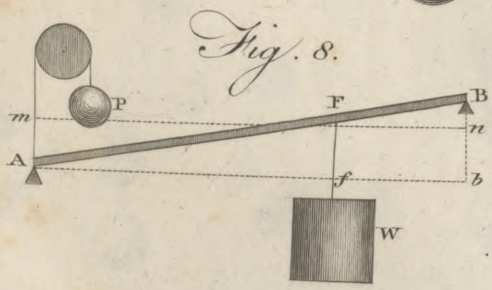

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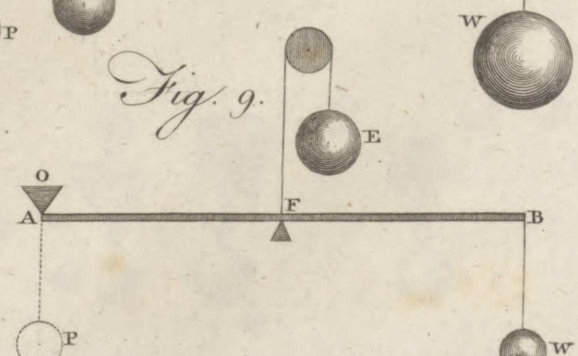

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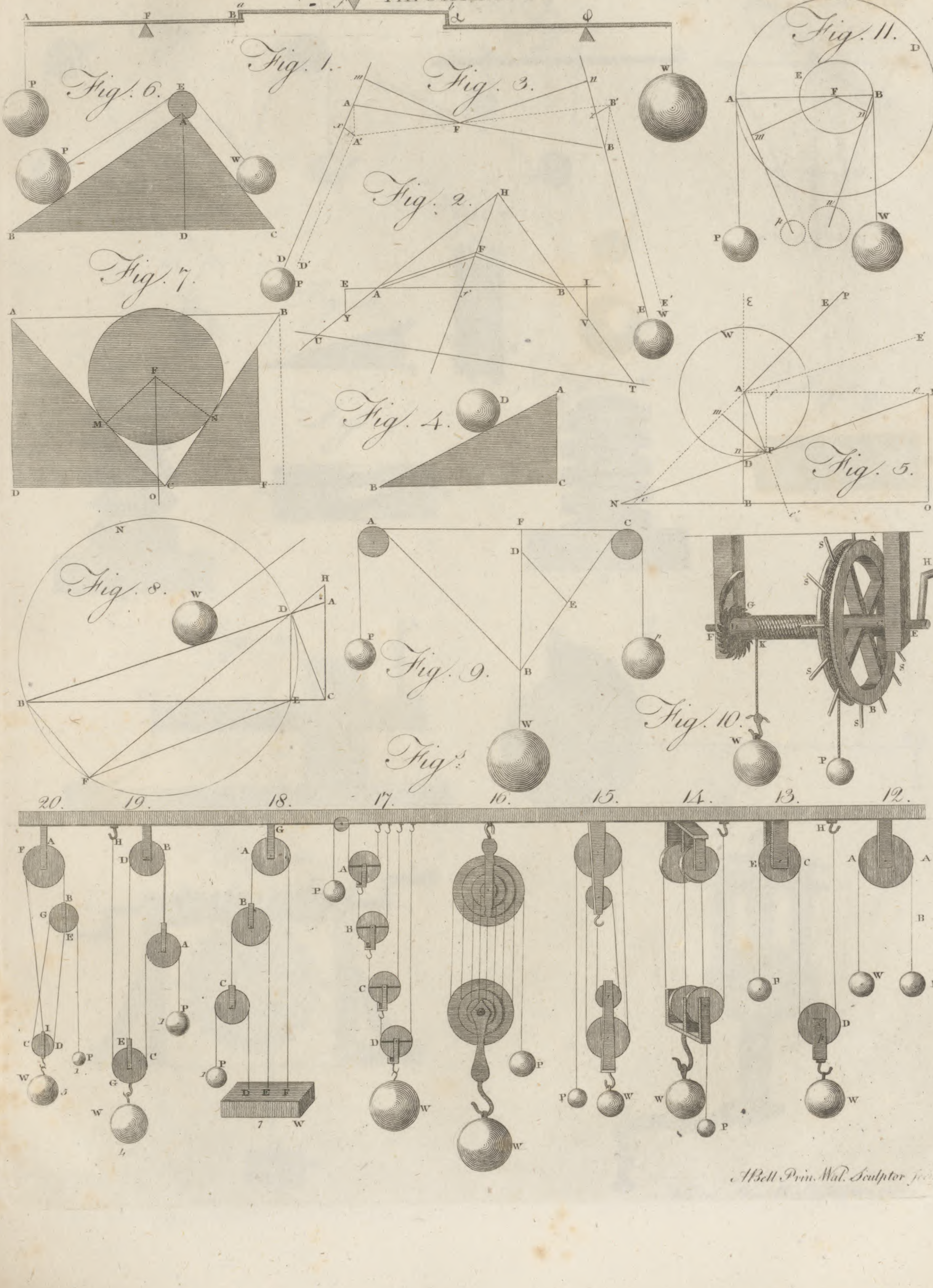

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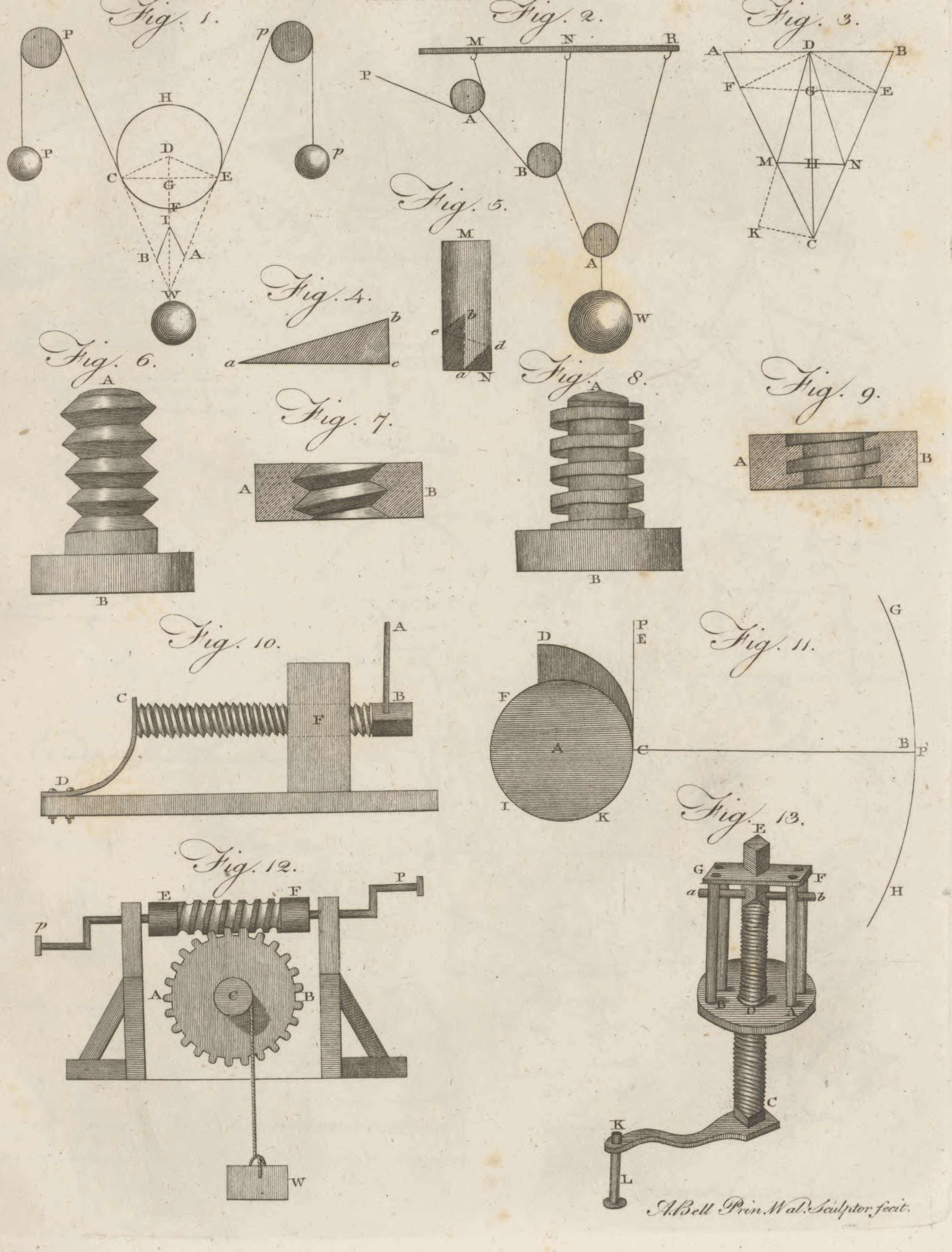

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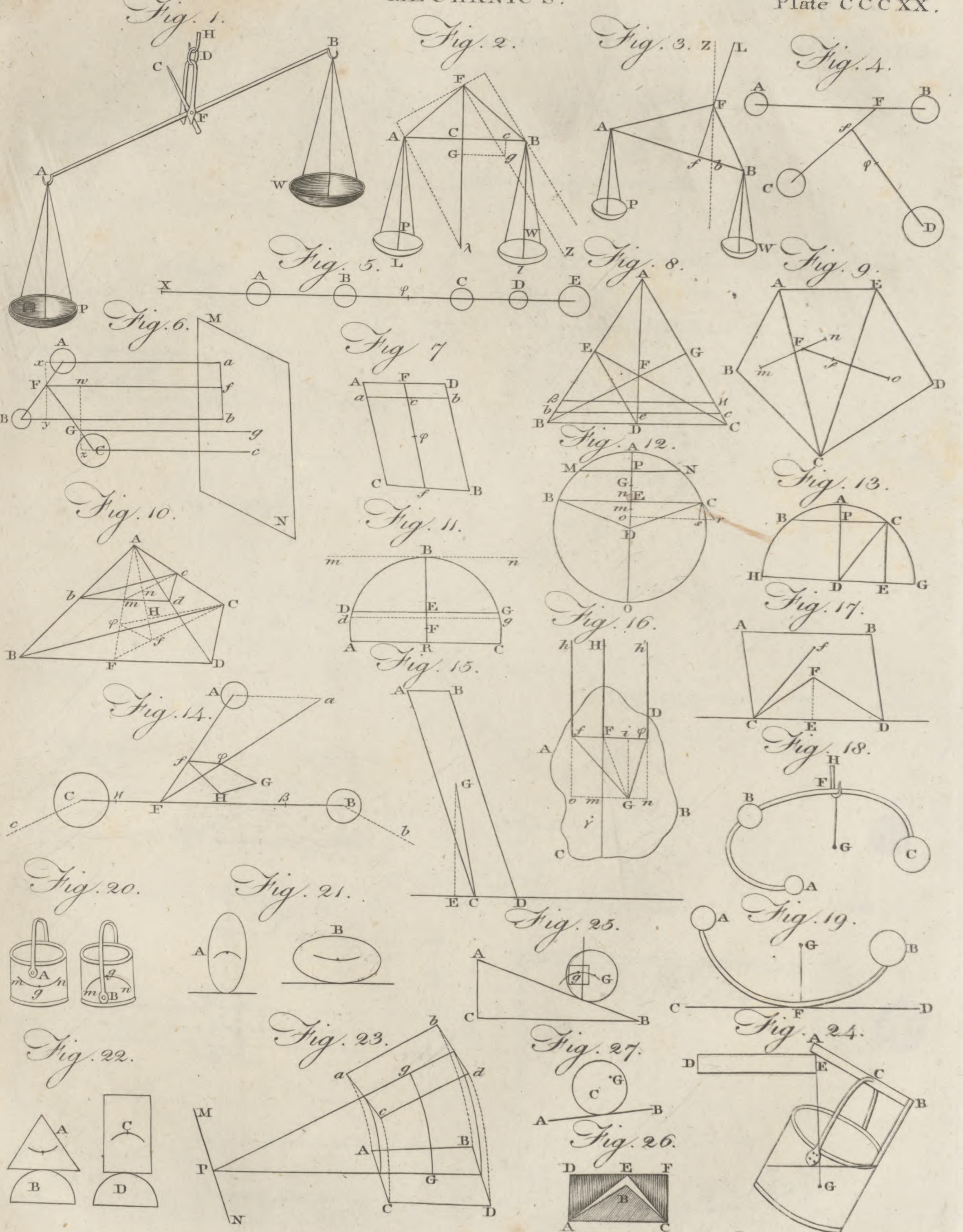

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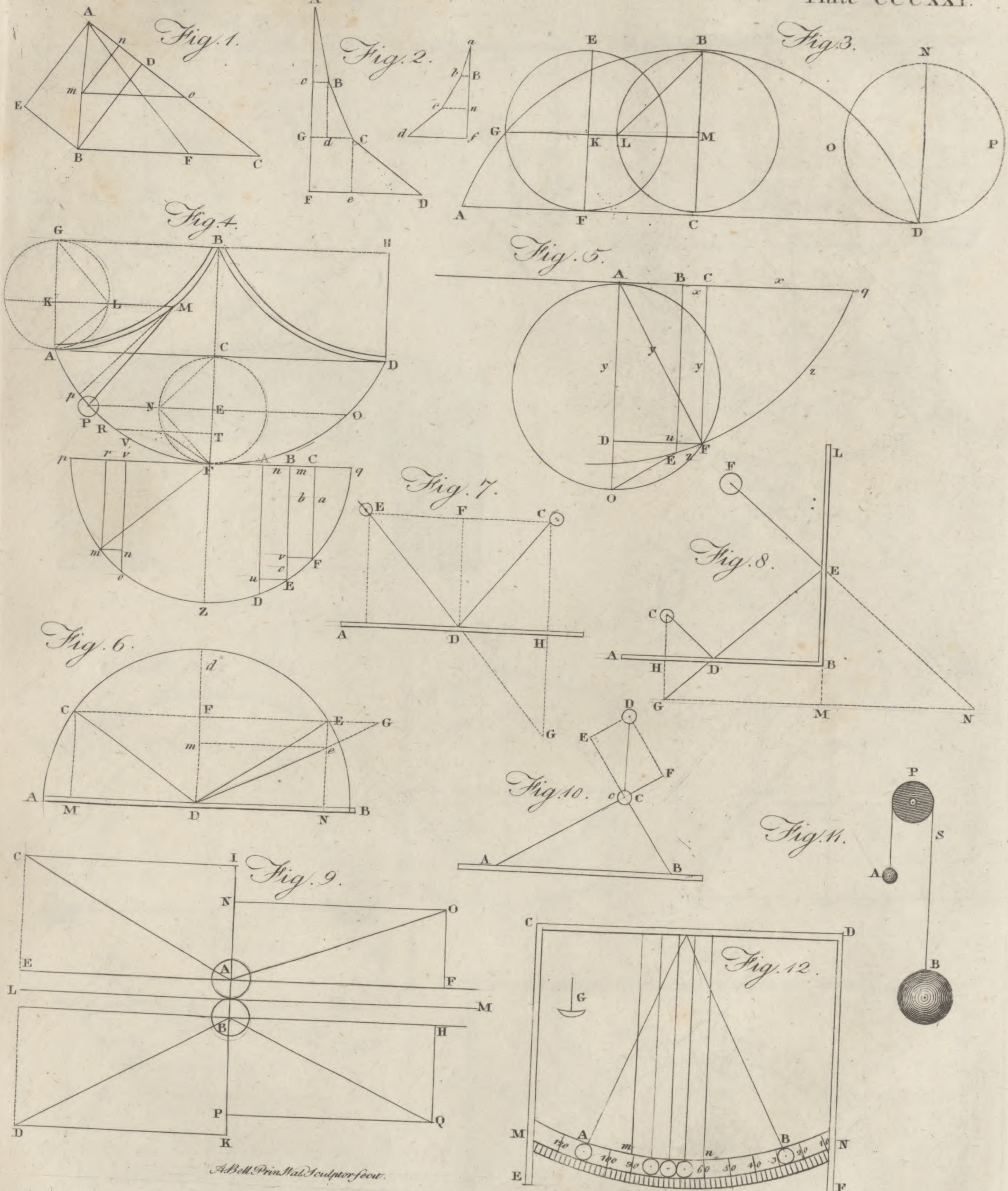

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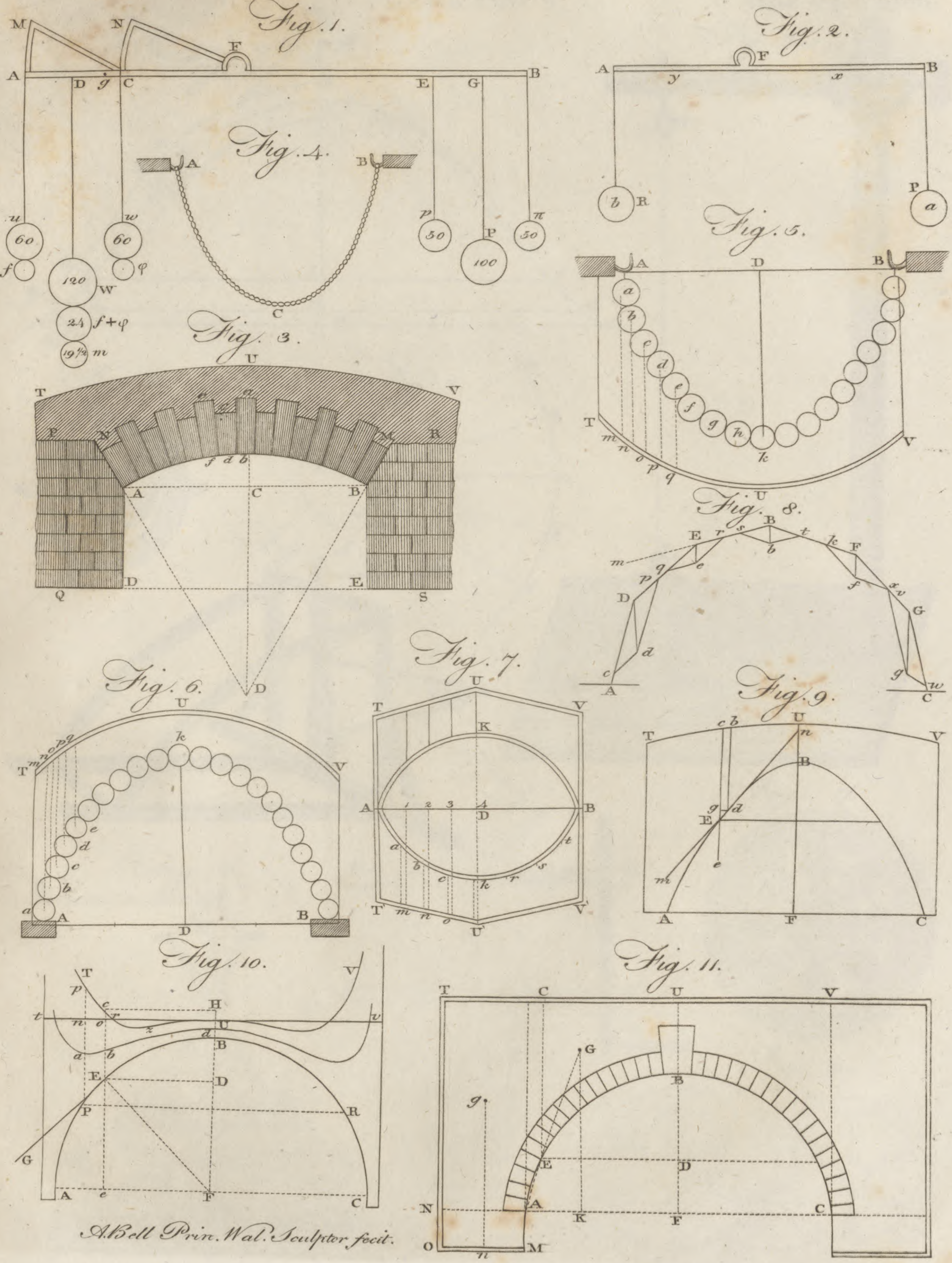


A.Bell Prin. Wal. Sculptor fecit.

Fig. 1.

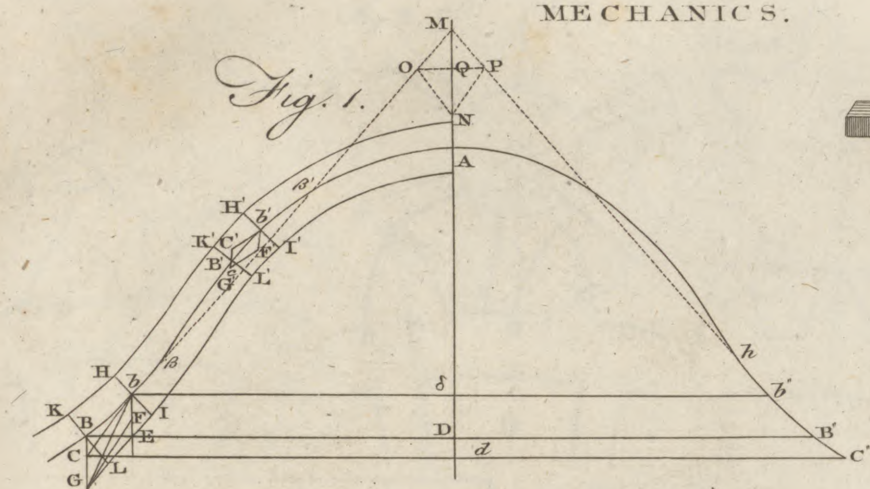
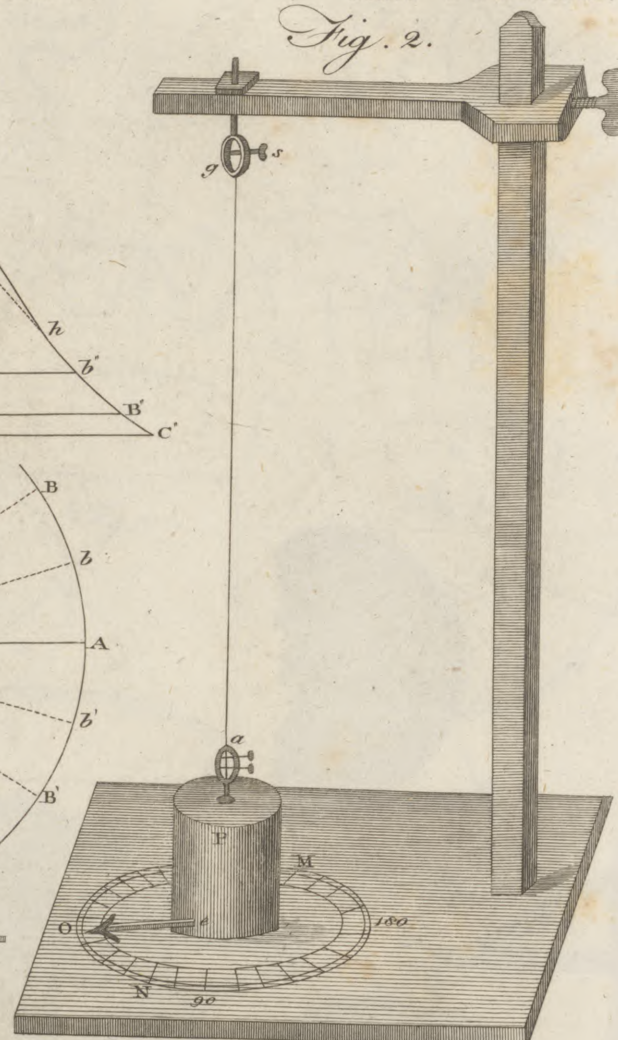


Fig. 2.



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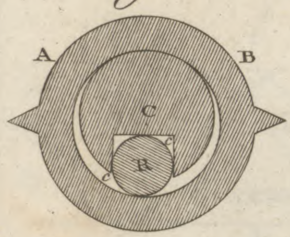

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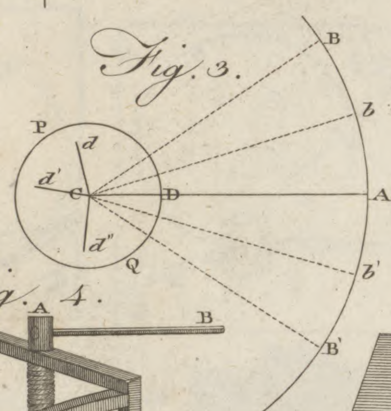
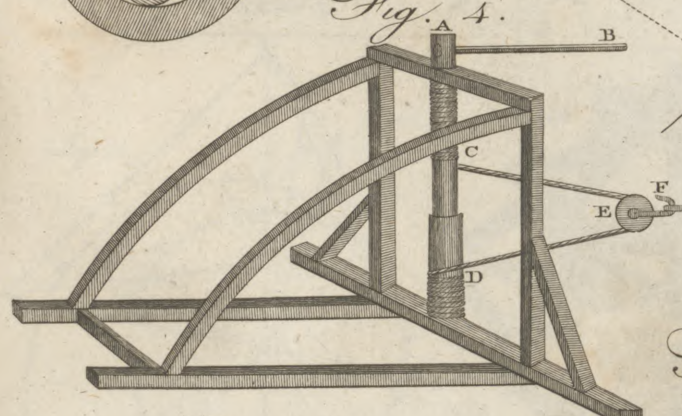


Fig. 4.



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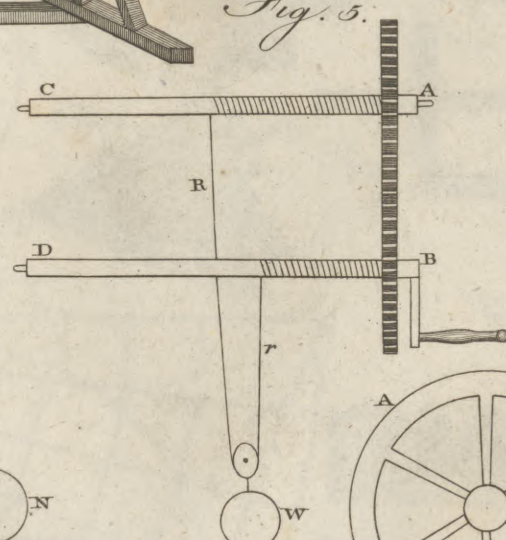

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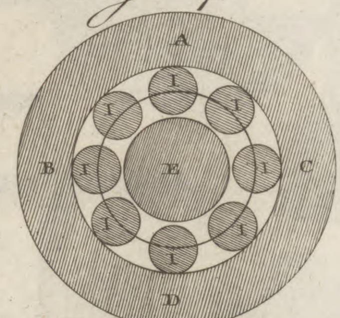


Fig. 8.

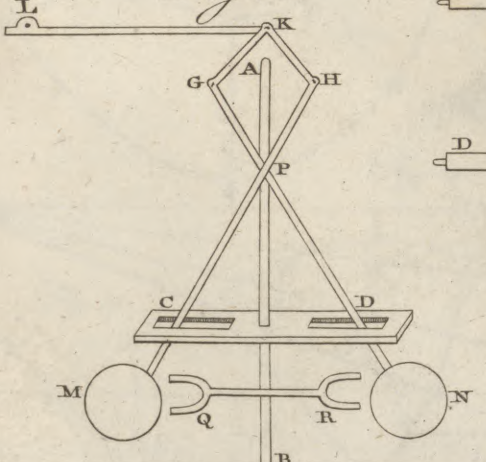
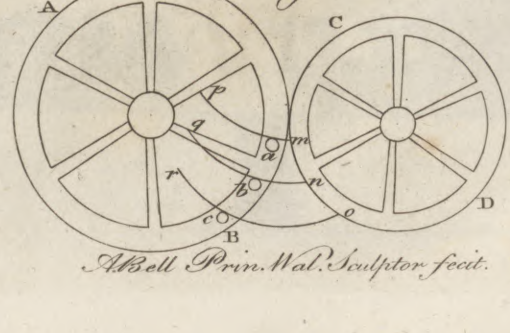
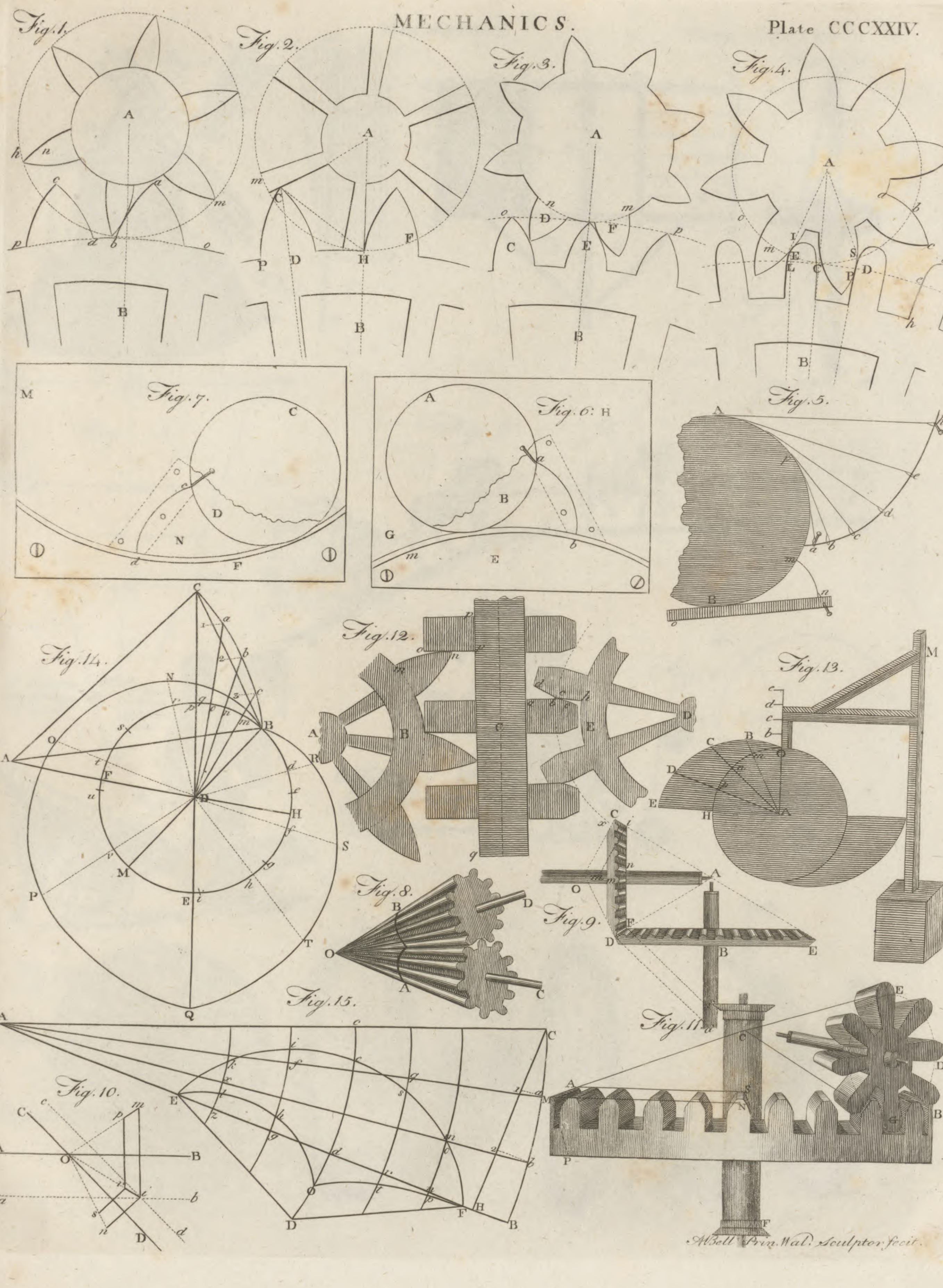


Fig. 9.



A. Bell Prin. Wal. Sculptor fecit.



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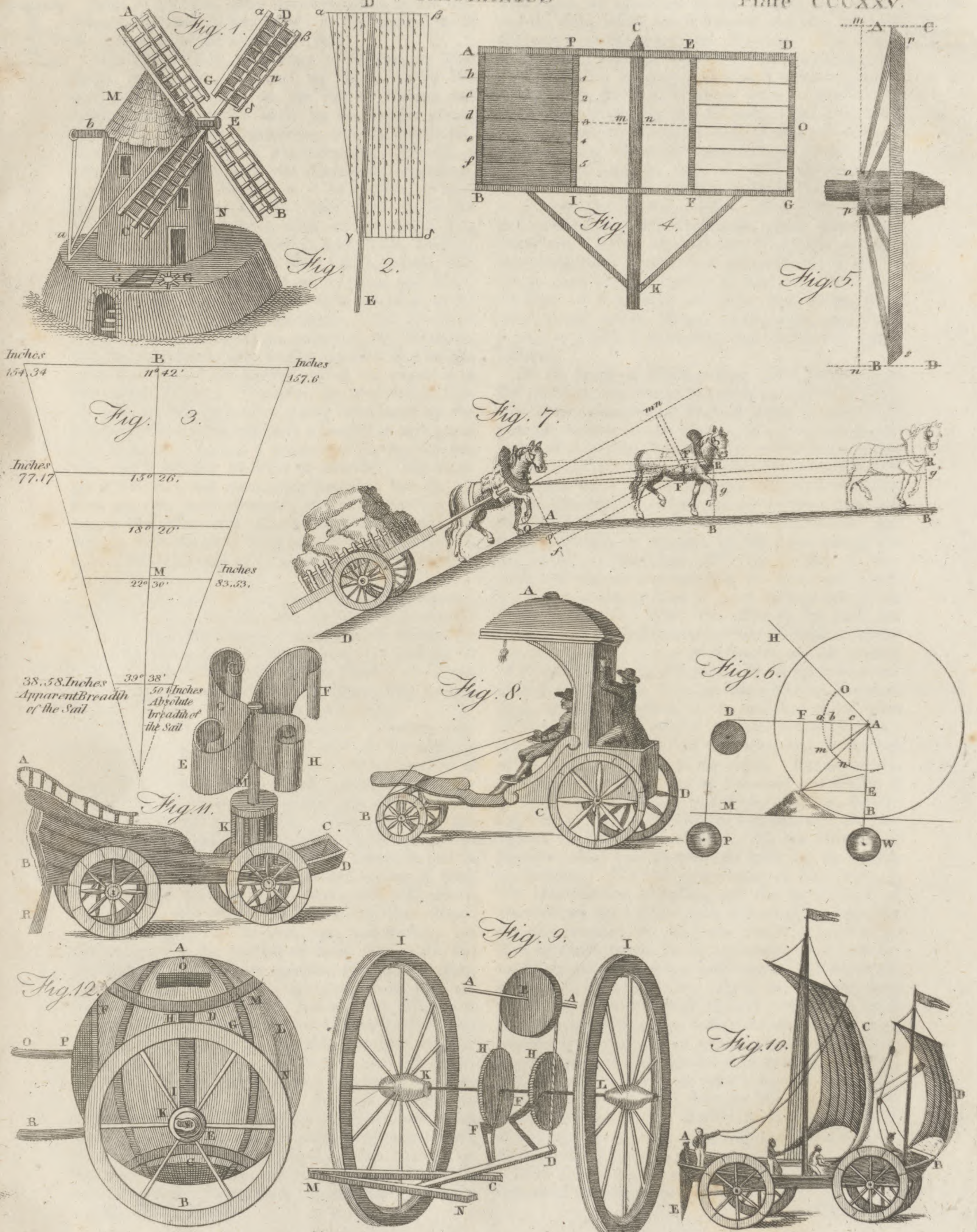

A Bell Prin Wall Sculptor fecit

Mechanism ‖ Mecklenburg.

MECHANISM, either the conſtruction or the machinery employed in any thing; as the mechaniſm of the barometer, of the microſcope, &c.

MECHOACAN, a province of Mexico, or New Spain, in America, bounded on the north by Panuco and Guadalajara, on the eaſt by Panuco and Mexico Proper, on the ſouth by the Pacific ocean, and on the weſt by Guadalajara and the South ſea. It is about 200 miles in circumference. The ſoil is exceedingly fertile; and the climate ſo wholeſome, that the Spaniards imagine it to be poſſeſſed of ſome peculiarly reſtorative quality; for which reaſon the ſick and infirm flock to it from all quarters. The commodities are ſulphur, indigo, ſarſaparilla, ſaſſafras, cacao, vanelloes, ambergris, hides, wool, cotton, ſilk, ſugar, the root mechoacan or white jalap, and ſilver. This province formed an independent kingdom at the time Mexico was reduced by Cortez. The ſovereign had long been the inveterate enemy of the Mexicans, and was conſidered, next to the republic of Tlaſcala, as the moſt formidable barrier againſt the extenſion of the imperial frontier. However, he ſubmitted to Cortez without ſtriking a blow, being intimidated by the wonders he had performed with a handful of men; and thus Mechoacan became a province of the Spaniſh empire, and a valuable addition to Mexico. The country at that time was exceedingly populous, but the natives are now much thinned; and that rather by the luxury and effeminacy introduced by the Spaniards, than by their tyranny. The capital of the province is alſo called *Mechoacan* by the natives, but *Valladolid* by the Spaniards.

MECHOACAN, or *White Jalap*, in the materia medica, the root of an American ſpecies of convolvulus brought from Mechoacan, a province of Mexico, in thin ſlices like jalap, but larger, and of a whitiſh colour. It was firſt introduced into Europe about the year 1524 as a purgative: but ſince jalap became known, mechoacan has been little employed.

MECKLENBURG, a duchy of Germany, containing thoſe of Schwerin and Guſtro, is bounded by Pomerania on the eaſt, by part of the marquiſate of Brandenburg and the duchy of Lunenburg on the ſouth, the Baltic on the north, and Holſtein and Saxe Lawenburg on the weſt. Their greateſt length is about 135 miles, and greateſt breadth upwards of 90. With reſpect to the ſoil, much cannot be ſaid in favour of it, as it conſiſts in general, either of ſand, or large and deſolate heaths interſperſed with moors, woods, fens, and lakes. It yields very little wheat, and not a great deal of oats, rye, and barley; but breeds a conſiderable number of ſheep and cattle, has plenty of fiſh, with ſtone quarries, ſalt ſprings, alum, iron, and ſome copper. The principal rivers here are the Elde and Stor, which fall into the Elbe as it glides along the borders of this country to the ſouth-weſt; the Reckenitz, which diſcharges itſelf into the Baltic; as do the Peene, the Warno, and the Stopenitz. This country has only one harbour on the Baltic, namely that of Roſtock. In both duchies, excluſive of Roſtock, are 45 great and ſmall cities, with three convents, and a great number of manors and farms, belonging either to the duke, the nobility, or convents. The peaſants are in a ſtate of villenage; but the nobility enjoy very conſiderable privileges.

Mecklenburg, Meconium.

The ſtates are compoſed of the nobility and towns; and the diets, which are ſummoned annually, are held alternately at Sternberg and Malchin. The duchy of Schwerin appoints four provincial counſellors, and that of Guſtro as many; who rank according to ſeniority, with the duke's actual privy counſellors, as their marſhals do with the colonels. The leſſer committee repreſents the whole body of the nobility and commons, by whom the members are choſen freely and without controul, and no edict relative to the whole country can be publiſhed without their conſent, or in prejudice of their rights. The inhabitants of this country are moſtly Lutherans, under their ſuperintendants. There are alſo ſome Calviniſts and Roman Catholics. Beſides the grammar ſchools in the towns, there is an univerſity at Roſtock. The commodities of the duchy are corn, flax, hemp, hops, wax, honey, cattle, butter, cheeſe, wool, and wood, a part of which is exported; but hardly any manufactures.

Of the houſe of Mecklenburg, there are two lines ſtill ſubſiſting, viz. that of Schwerin and that of Strelitz. The latter commenced in Duke Adolphus Frederick II. younger brother of the duke of Schwerin, and grandfather of Adolphus Frederick IV. who entered on the government in 1752, and whoſe family received a great additional luſtre by his Britannic majeſty's taking his ſecond ſiſter for his conſort, and by her own great merit and noble deportment in that high ſtation. Beſides the duchy of Strelitz, to this duke belong the principality of Ratzeburg, with the lordſhip of Stargard, the ancient commanderies of Miro and Nemero, and a yearly penſion of 9000 dollars out of the Boitzenburg toll. The title aſſumed by both the dukes is *duke of Mecklenburg; prince of Wenden, Schwerin, and Ratzburg; count of Schwerin and the country of Roſtock, and lord of Stargard.* By the agreement concluded at Wittſtock in 1442, the elector of Brandenburg, on the extinction of the male line of the dukes of Mecklenburg, is entitled to their whole ſucceſſion. The duke of Schwerin has two votes both in the diet of the empire and that of the circle. The matricular aſſeſſment for the duchies of Schwerin and Guſtro is 40 horſe and 67 foot, or 748 florins monthly, including what is paid by Sweden for Wiſmar, and the bailiwicks of Poll and Neukloſter. To the chamber of Wetzlar, theſe two duchies pay each 243 rix dollars, 43 kruitzers. For the government of Mecklenburg, the adminiſtration of juſtice, and the management of the revenue, there is the privy council of regency, the demeſne chamber, the high and provincial court of juſtice, to which appeals lie in moſt cauſes, both from the conſiſtory and the inferior civil courts, and which are common to both the dukes. As to the revenues, thoſe of the Schwerin line muſt be very conſiderable, thoſe ariſing from the demeſne bailiwicks and regalia alone amounting to 300,000 rix dollars per annum. There is a tax on land that produces no contemptible ſum, and that called the *princeſs's tax* is fixed at 20,000 rix dollars: beſides all theſe, there are alſo free gifts. The whole revenues of the Strelitz branch are eſtimated at 120,000 rix dollars. Each of theſe princes maintains a body of troops.

MECONIUM, the excrement contained in the inteſtines of an infant at its birth.

MEDALS.

Utility of them in History, &c.

MEDAL, denotes a piece of metal in the form of coin, such as was either current money among the ancients, or struck on any particular occasion, in order to preserve to posterity the portrait of some great person, or the memory of some illustrious action. Scaliger derives the word *medal* from the Arabic *methalia;* a sort of coin with a human head upon it. But the opinion of Vossius is generally received; viz. that it comes from *metallum*, "metal;" of which substance medals are commonly made.

SECT. I. *Utility of Medals in History, and various other Sciences.*

THERE are few studies of more importance to history than that of medals; the sole evidence we can have of the veracity of a historian being only such collateral documents as are evident to every body, and cannot be falsified. In modern times, these are found in public memoirs, instructions to ambassadors, and state papers of various kinds. Such memorials, however, are subject to various accidents, and besides commonly remain in the countries where they are first published, and cannot therefore give to the world at large that perfect and entire satisfaction which ought to be derived from genuine history; so that more durable and widely diffused monuments are still to be wished for. Such are public buildings, inscriptions, and statues; but these, excepting a few instances of the two last, are always confined to particular countries; so that medals alone remain as infallible documents of truth, capable of being diffused over all countries in the world, and of remaining though the latest ages.

1 Various writers on medals.

The first who showed the importance of medals in ascertaining the dates, and arranging the order of events, in ancient history, by means of medals, was Vaillant, in his History of the Kings of Syria, printed at Paris in 1681. By medals alone, he has been enabled to fix the chronology and important events of history, in the three most ancient kingdoms of the world, viz. Egypt, Syria, and Parthia. Many coins have been discovered since his time, which confirm the accounts he has given. He was followed in this method by Father Hardouin, though with less success. Hardouin's best work is his *Herodiades*, or Series of Successors to Herod king of Judæa. The same plan was pursued by Noris, in his learned Treatise on the Syro-Macedonian princes, and by Bayer in his History of Osrhoene, as well as by Froelich, in the work entitled *Annales Regum et Rerum Syriæ*, Vien. 1754, and another named Kevenhullers *Regum veterum Numismata Anecdota, auct. Perrara*, Vien. 1752, 4to, of which Froelich was properly the author. Corsini and Cary likewise published works of a similar nature; the former in 1744, *De Minnisari, aliorumque Armeniæ Regum, Nummis*, &c.; the latter in 1752, *Histoire des Rois de Thrace, et du Bosphore Cimmerien, eclaircie par les Medailles.*

Utility of them in History, &c.

2 Of the Greek coins.

The study of the Greek coins does not show the dates of events, though it illustrates the chronology of reigns. This defect, however, is abundantly supplied by those of Rome, which commonly mark the date of the prince's consulship, the year of his tribunician power; giving also, upon the reverse, the representation or poetical symbol of some grand event. The year of the tribunician power is sometimes imagined by antiquaries to be synonymous with that of the emperor's reign: but this is not the case; and Mr Pinkerton is at some pains to set them right in this respect. He finds fault with Julius Cæsar, when he assumed the sovereign authority, for taking upon him the title of Perpetual Dictator, as being synonymous with that of king or absolute governor, which the Romans abhorred. "He ought (says our author), under the disguise of some supreme magistrate of annual election, to have lulled the people with a dream, that they might terminate his power when they pleased; or that he himself would resign it, when the necessities of state which had required his temporary elevation had subsided." To this error Mr Pinkerton ascribes the assassination of the dictator, and commends the policy of Augustus, who, with far inferior abilities, continued in possession of the most absolute authority as long as he lived. The tribuneship was an office of annual election; and if put into the hands of any others than plebeians, must have been the supreme power of the state, as it belonged to that office to put a negative upon every public measure whatever. Augustus, being of senatorial rank, could not assume this office: but he invested himself with the tribunician power, which had the advantages of appearing to be only a temporary supremacy, though in truth it was continued during his whole lifetime. Towards the end of his reign, he frequently assumed his destined successor, Tiberius, for his colleague, though in the beginning he had enjoyed it alone. This, with his artifice of resigning his power every ten years, and reassuming it at the desire, as was pretended, of the senate, secured his sovereignty as long as he lived.—His example was followed by his successors; so that most of them have the inscription *Tribunicia Potestate* upon their medals, with the date affixed to it thus, *Tr. Pot.* VII. Yet though this date generally implies the year of the emperor's reign, it sometimes happens that the emperor, by special favour from a former prince, had been endowed with this title before he came to the throne, as being the successor to that prince, of which we have already given an instance in Tiberius. Besides the tribunician power, the emperors very frequently enjoyed that of the consuls; and the date of their consulship is frequently expressed in their coins.

3 Method used by Augustus to secure his power.

The office of Pontifex Maximus was likewise assumed by the Roman emperors, in order to secure themselves in their authority; which, Mr Pinkerton observes, was one of the most efficacious artifices they could have fallen upon. "In the Greek heroic times (says

Utility of them in Hiſtory, &c.

(ſays he), king and prieſt were carefully united in one perſon; and when ſovereigns aroſe in Denmark and Sweden, the ſame plan was followed, as appears from Snorro, and other writers. Nothing could lend more ſecurity to the perſon of the monarch than an office of ſupreme ſanctity, which alſo confirmed his power by all the terrors of ſuperſtition. Even the Chriſtian ſyſtem was afterwards debaſed by a mock alliance with government; though it be clear from the whole New Teſtament, that ſuch an alliance is ſubverſive of its genuine inſtitution, and the greateſt of all its corruptions. But the Roman Catholic clergy, in the dark ages, were the authors of 'no church no king,' for their own intereſt; while the Roman emperors only ſought to ſtrengthen their power by the dark awe of ſuperſtition. The title of Pontifex Maximus was ſo important, that it was retained even by the Chriſtian emperors till the time of Gratian. Its influence in the ſtate was, indeed, prodigious. Cicero obſerves, that to this office were ſubject, temples, altars, penates, gods, houſes, wealth, and fortune of the people.—That of augur is alſo borne by many emperors; and its authority was ſuch, that by the law of the twelve tables no public buſineſs could be tranſacted without a declaration from the augur concerning its event.—The proconſular power was alſo given to Auguſtus and the other emperors. It conferred a direct authority over all the provinces, and implied the emperor to be chief proconſul, or governor of each, and of all. Another ſpecial power aſſigned to the emperors, but not occurring on coins, was the *Jus Relationis Tertiæ, Quartæ*, &c. or the right of making three or four motions in the ſenate on the ſame day, while the ſenators could only propoſe one.

Hence our author infers, that medals afford the moſt authentic documents of the Roman hiſtory, in particular, that could have been invented by man.—The hiſtories of Nerva and Trajan are much better elucidated by medals than by authors; for the hiſtory of Suetonius ends with Domitian, and the *Hiſtoriæ Auguſtæ Scriptores* begin with Adrian: ſo that the reigns of the two emperors juſt mentioned are almoſt unknown; and Mr Pinkerton is ſurpriſed that none of the learned have attempted to ſupply the defect.—"Capitolinus (ſays he), in his life of Maximinus Junior, is quite puzzled to know if Maximus and Pupienus were two emperors, or two names for the ſame. Had he happened on any of thoſe coins which bear M. Cl. Pupienus Maximus Aug. he would have ſeen at once that Maximus was only another name for Pupienus."

4
Uſe of medals in geography.

Medals are uſeful in other ſciences beſides hiſtory. In geography, we find the ſituation of towns determined by their vicinity to ſome noted river, mountain, &c. Thus, ΜΑΓΝΗΤΩΝ ΣΙΠΥΛΟΥ ſhows that Magneſia was ſituated under Mount Sipylus. In like manner, it is ſhown from a medal, that Epheſus ſtood on the river Cayſter; and there is extant a medal, bearin an inſcription, which ſignifies Alexandria on the Scamander; a name given to Troy by Alexander the Great. The reverſe has upon it the famous Apollo

5
In natural hiſtory.

Smintheus of Homer. In natural hiſtory alſo, medals are uſeful chiefly from the coins ſtruck on the celebration of the ſecular games, in which the figures of various animals are preſerved; and thus it may very often be determined whether any animal be known to the ancients or not. On many of the Greek medals are ſeveral uncommon plants and animals. Thus, on moſt of the medals of Cyrene is the figure of the celebrated *Sylphium*; and on thoſe of Tyre, the ſhell-fiſh from which the famous Tyrian purple was procured.

6
In architecture.

By means of medals, alſo, the exact delineations of many noble edifices are preſerved, though not even a veſtige of their ruins be now exiſting; ſo that the uſes of them to the architect are very conſiderable.

7
In the fine arts.

To the connoiſſeur they are abſolutely neceſſary; becauſe by them alone he is enabled to aſcribe ancient buſts and ſtatues to their proper perſons, with multitudes of other points of knowledge which cannot be otherwiſe determined. The elucidations of obſcure paſſages in ancient authors by means of medals are ſo numerous and well known, that it is needleſs to inſiſt upon them.

Mr Addiſon has treated the connexion betwixt medals and poetry at conſiderable length; but Mr Pinkerton finds fault with him for preferring the Latin to the Greek poets. He obſerves alſo, that the knowledge of Greek medals is moſt neceſſary for a ſculptor, and perhaps an architect; but an acquaintance with Latin ones is preferable for a poet, or perhaps a painter.

8
Latin medals of uſe to a poet.

The reaſon of this difference is, that the former generally have on the obverſe the head of ſome king, god, or goddeſs, of exquiſite relief and workmanſhip; but the reverſe ſeldom affords much fancy of ſymbol in the early Greek coins; and in the imperial Greek coins, is chiefly impreſſed with the temples of their deities. To a perſon of poetical imagination, however, the Roman coins afford the greateſt entertainment, from the fine perſonifications and ſymbols to be found on their reverſes; of which our author gives the following inſtances:

9
Perſonifications on Roman medals.

"Happiness has ſometimes the caduceus, or wand of Mercury, which Cicero, 1. *Offic.* tells us was thought to procure every wiſh. She has, in a gold coin of Severus, heads of poppy, to expreſs that our prime bliſs lies in oblivion of misfortune.

"Hope is repreſented as a ſprightly girl, walking quickly, and looking ſtraight forward. With her left hand ſhe holds up her garments, that they may not impede the rapidity of her pace; while in her right hand ſhe holds forth the bud of a flower; an emblem infinitely more fine than the trite one of an anchor, which is the ſymbol of Patience, and not of Hope. This perſonification, with ſome others, muſt have been very familiar to the ancients; for often in this, and in a few more inſtances, no name, as Spes Aug. or the like, is inſerted in the legend.

"Abundance is imagined as a ſedate matron, with a cornucopiæ in her hands, of which ſhe ſcatters the fruits, and does not hold up her cornucopiæ and keep the contents to herſelf, as many modern poets and painters make her do.

"The emperor Titus, having cauſe to import a great ſupply of corn during a ſcarcity at Rome, that ſupply, or the Annona, is finely repreſented as a ſedate lady, with a filled cornucopiæ in her left hand, which ſhe holds upright, to indicate that ſhe does not, however, mean to ſcatter it, as Abundance has a title to do, but to give it to Equity to deal out. This laſt particular is ſhown by her holding a little image of

Equity,

Utility of them in History, &c.

Equity, known by her ſcales, and *haſta pura*, or pointleſs ſpear, in her right hand, over a baſket filled with wheat. Behind the ANNONA is the prow of a ſhip decked with flowers, to imply that the corn was brought by ſea (from Africa), and that the ſhips had had a proſperous voyage. The beſt poet in the world would not have given us a finer train of imagery; the beſt painter would have been puzzled to expreſs ſo much matter in ſo ſmall a compaſs.

" SECURITY ſtands leaning upon a pillar, indicative of her being free from all deſigns and purſuits; and the poſture itſelf correſponds to her name. Horace, in deſcribing the wiſe man, mentions his being *teres atque rotundus*; round and poliſhed, againſt all the rules of chance: an idea ſeemingly derived from the column upon which this ideal lady reclines.

" The emblems of PIETY, MODESTY, and the like, are equally appoſite and poetical.

" The happineſs of the ſtate is pictured by a ſhip failing before a proſperous breeze: an image than which the ſuperlative genius of Gray could find none more exquiſite; and he has accordingly uſed it in his moſt capital production " The Bard," with due ſucceſs.

" The different countries of the then known world are alſo delineated with great poetical imagery. It affords patriotic ſatisfaction in particular to a Briton, to ſee his native iſland often repreſented upon the earlieſt imperial coins ſitting on a globe, with a ſymbol of military power, the *labarum*, in her hand, and the ocean rolling under her feet. An emblem almoſt prophetic of the vaſt power which her dominion over the ſea will always give her, provided ſhe exerts her element of empire with due vigour and perſeverance.

" Coins alſo preſent us with Achaia, Africa, Alamannia, Alexandria, Arabia, Armenia, Aſia, Bithynia, Cappadocia, Dacia, Dardania, Egypt, Gallia, Hiſpania, Italia, Judæa, Macedon, Mauritania, Pannonia, Parthia, Phrygia, Sarmatia, Sicily, Scythia, Syria, and the rivers Danube, Nile, Rhine, Tyber. This perſonification of provinces ſeems to have ariſen from the figures of provinces carried in triumphs; as the perſonification of our old poets ſprung from the ideal perſons actually repreſented in the myſterial plays.

" There is one colonial medal of rude execution of Auguſtus and Agrippa, which has a high claim to merit in diſplaying the ancient poetical imagery. It is inſcribed IMP. and DIVI. F. and on the reverſe, the conqueſt of Egypt is repreſented by the metaphor of a crocodile, an animal almoſt peculiar to that country, and at that period eſteemed altogether ſo; which is chained to a palm tree, at once a native of the country, and ſymbolic of victory.

10
Medals uſeful to a painter.

" As the reverſes are ſo uſeful for knowledge of perſonification, ſymbols of countries and actions, and the like; ſo the portraits to be ſeen on old coins are no leſs important to a painter; the high merit of a great number of them, in every character, juſtly entitling them to be regarded as the beſt ſtudies in the world. Not to mention, that, to an hiſtoric painter, the ſcience of ancient medals is abſolutely neceſſary, that he may delineate his perſonages with the features they really bore while in exiſtence. This can only be attained in this way, or from ſtatues and buſts; any one of which will coſt as much as hundreds of medals; and indeed a collection of ſuch is only attainable by princes.

11
To a ſculptor.

The ſame things which render the ſtudy of medals important to a painter, do ſtill more ſo to a ſculptor; and in this particular, the ſtudy of the Greek coins is remarkably uſeful. The ſkill of the Greeks in the art of ſculpture has always been admired throughout the world; and on their coins the heads of ſeveral deities are repreſented in the moſt exquiſite *alto relievo*. Our author therefore thinks it ſtrange, that the Grecian coins ſhould have hitherto been ſo little attended to by men of learning and taſte. They may have been looked upon, he ſuppoſes, as belonging only to the province of the antiquary; but he aſſures us, that the Greek medals will afford ſatisfaction to the perſons who value them only as pieces of workmanſhip. In moſt reſpects, they greatly excel thoſe of Rome even in its beſt times: which our author ſuppoſes to have been from the days of Auguſtus to Adrian. " In the days of Adrian, in particular (ſays he), the Roman mint ſeems to have been the very ſeat of art and genius; witneſs the vaſt number of exquiſite perſonifications, engraven with equal workmanſhip, which ſwarm on the medals of that prince. Yet from his time down to Poſthumus, coins of admirable workmanſhip are to be found. Thoſe of the Fauſtinas and Lucilla deſerve particular mention. There is one, and not an uncommon one, of the latter in great braſs, which yields to nothing of the kind. The reverſe is a Venus with the name around her. The portrait of the obverſe ſeems to ſpring from the field of the coin; it looks and breathes, nay talks, if you truſt your eyes. The coins of Tarſus are extremely remarkable for a kind of perſpective in the figures, as Froelich obſerves. On others are found triumphal arches, temples, fountains, aqueducts, amphitheatres, circi, hippodromes, palaces, baſilicas, columns and obeliſks, baths, ſea-ports, pharoſes, and the like. Theſe furniſh much pleaſure and inſtruction to the architect, and ſerve to form his taſte to the ancient manner; that manner which unites perfect ſimplicity with ſublimity and grace; that manner which every age admires, in proportion as it has genius to imitate."

Entertainment from ſtudying them.

SECT. II. *Entertainment ariſing from the Study of Medals.*

BESIDES the purpoſes which the ſtudy of medals anſwers in the uſeful arts, a great variety of ſources of entertainment are to be found in it. Mr Pinkerton obſerves, that the moſt barbarous nations are more pleaſed with the rudeſt efforts of art, than with the moſt admirable works of nature; and that in proportion as the powers of the mind are large and various, ſuch are alſo the pleaſures which it receives from thoſe ſuperlative productions of art, which can only be the offspring of vaſt genius. Hence works of art are agreeable both to the enlightened and to the ignorant. The chief amuſement, therefore, which attends the ſtudy of medals, originates from the ſtrength and ſpirit, the finiſh and beauty, which the engraver has diſplayed in the execution of them. It beſides gives a kind of perſonal acquaintance with the perſons of whom they are the repreſentations. Portraits have always been

Entertainment from ſtudying them.

been highly entertaining to mankind; and our author is of opinion, that the love of them gave riſe both to painting and ſculpture. They are nowhere to be found ſo ancient, ſo numerous, and ſo well preſerved as in medals. Amuſement is alſo derived even from the repreſentations of ideal heads and perſons; nay, even from the minuteſt ſymbols. Thus the Greek coins of cities preſent us with heads of deities of exquiſite workmanſhip, apparently copied from ſtatues or paintings; ſo that we may even gueſs at the works of Apelles and Praxiteles from ſome of the Greek medals. Their reverſes afford ſtill greater variety; there being ſcarce an object either in art or nature which is not repreſented upon ſome of them: and to the ſatisfaction ariſing from a view of theſe, we may likewiſe add that of beholding, in a lively manner, the dreſſes, manners and cuſtoms, religious and civil ceremonies, of the ancients: ſo that from medals we may obtain an intereſting hiſtory of manners; which, though very lately cultivated, may perhaps afford the moſt uſeful and entertaining of all the provinces of hiſtory.

12 Difference betwixt a medalliſt and antiquary.

There is a very conſiderable difference betwixt the ſtudy of medals and that of a mere antiquary. The latter frequently ſeems to take delight in coins merely in proportion to their ruſt and deformity; ſo that it is often a recommendation of ſome of their pieces, that neither portrait, reverſe, nor legend, can be diſcovered; at leaſt in ſuch manner as can be intelligibly explained. "The delight of the antiquariſt (ſays Mr Pinkerton), may be called a depraved appetite of the mind, which feeds on traſh, and fills itſelf with emptineſs. It is perhaps a mere childiſh curioſity mingled with caprice and hypochondriciſm. Againſt this character the ridicule of Severus is particularly ſhot, but with little effect; for our antiquiſts exceed in viſions and nonſenſe. I ſay *antiquiſts*; for the name of antiquary is ſacred. By *antiquary*, in foreign countries, is implied a man who illuſtrates their ancient laws, manners, poetry; but eſpecially their ancient hiſtory. There, men of the moſt elevated minds are antiquaries; as Muratori, Leibnitz, Monteſquieu, Du Bos. Here men of talents will not ſtoop, forſooth, to ſtudies the moſt important to their country, but leave its antiquities to chance. Every thing is important but our hiſtory; and we are profound in every ancient matter that is ſuperficial; and ſuperficial in what is profound. Even England cannot boaſt of one general hiſtorian, but truſts to the inaccuracy of Rapin, and the ignorant neatneſs of Hume. It is therefore no wonder that the ſtudy of antiquity is here ridiculous, though moſt important in other countries; none requiring greater talents, learning, or induſtry. But the hiſtoric antiquary has the pleaſure of benefiting ſociety, and enlightening whole nations, while the medallic has only an innocent amuſement. This amuſement, conſidered merely as riſing from antiquarian objects, has not been explained, though felt by moſt people, and more by the learned. It ſeems analogical with that which we derive from an extenſive proſpect: for as the mind delights to expand itſelf into diſtant places, ſo alſo into diſtant times. We connect ourſelves with theſe times, and feel as it were a double exiſtence. The paſſions are ſingularly affected by minute circumſtances, though mute to generalities; and the relicks of antiquity impreſs us more than its general hiſtory."

Sect. III. *Hiſtory of Medals.*

The ſtudy of medals is not of very ancient date: None of the claſſic writers give any account of collections of them; though indeed many little particulars are paſſed without notice by them. In the times of the Greeks, a collection of ſuch coins as then exiſted muſt have been but little regarded, as conſiſting only of thoſe ſtruck by the numerous little ſtates which at that time uſed the Greek characters and language. Hence they would have had an air of domeſtic coinage, and no attention would have been paid to them, however exquiſite their workmanſhip might have been. The little intercourſe at that time carried on betwixt the different provinces alſo, greatly impeded any communication of knowledge to thoſe who wrote hiſtories; ſo that it is no wonder to find any ſmall collections that might then have exiſted altogether unnoticed by them.

13 Greek coins imitated by the Romans.

Almoſt as ſoon as any communication was opened between the Greeks and Romans, the latter treated the arts of the Greeks with all due reſpect and applauſe. Their coins were imitated by the Romans, and preſerved in cabinets by the ſenators among their choiceſt treaſures. Suetonius informs us, that on ſolemn occaſions Auguſtus was accuſtomed to preſent his friends with medals of foreign ſtates and princes, along with other valuable teſtimonies of his friendſhip. In a more advanced period of the Roman empire, however, individuals would undoubtedly form collections of coins peculiar to their own ſtate; for Dr Stukeley, in his Medallic Hiſtory of Carauſius, informs us, that a complete ſeries of ſilver coins was lately found in Britain, containing all the emperors down to Carauſius incluſively. From Banduri we alſo know, that certain Greek coins were ſpecially preſerved by the Romans; and it appears from their code, that ancient gold and ſilver coins were made uſe of inſtead of gems; to which diſtinction thoſe of Sicily were particularly entitled. From the decline of the Roman empire till towards the end of the fifth century, almoſt all branches of literature were involved in darkneſs, and the medallic ſcience among the reſt. While the Chriſtian dominion of Conſtantinople laſted, indeed, almoſt all the arts and ſciences may be ſaid to have been kept within its own boundaries; though the Arabs and eaſtern nations had ſome arts and ſciences of their own: but after the deſtruction of the imperial city by the Turks, the Greeks were once more compelled to become fathers to the European ſcience. Even before this time, indeed, ſome veſtiges of a revival of literature had appeared in Italy; "and ſo intimate and neceſſary a connexion (ſays Mr Pinkerton), has now the ſtudy of medals with that of ancient erudition, that on the earlieſt appearance of a revival of the latter, the former was alſo diſcloſed."

14 Collectors of medals.

The firſt among the moderns who began to ſtudy the metallic ſcience was Petrarch. Being deſired by the emperor Charles IV. to compoſe a book containing the lives of eminent men, and to place him in the liſt, he replied, that he would do ſo whenever the emperor's life and conduct deſerved it. In conſequence of this converſation, he afterwards ſent the emperor a collection of gold and ſilver coins bearing the repre-

ſentations

ſentations of eminent men, with an addreſs ſuitable to his former declaration. A collection of coins was made in the next age by Alphonſo king of Arragon; but though this monarch collected all that could be found throughout Italy, we know that there could not have been very many, as the whole were contained in an ivory cabinet, and carried always about with him. A very conſiderable collection was made by Anthony Cardinal St Mark, nephew to Eugene IV. who aſcended the pontifical chair in 1431; and ſoon after the grand muſeum at Florence was begun by Coſmo de Medici, where a collection of ancient coins and medals had a place among other curioſities. Corvinus king of Hungary about the ſame time formed a noble collection of coins along with ancient manuſcripts and other valuable relicks of antiquity.

Mr Pinkerton conſiders Agnolo Poliziano, more commonly known by the name of *Angelus Politianus*, as the firſt writer who adduced medals as vouchers of ancient orthography and cuſtoms. He cites different coins of the Medicean collection in his Miſcellanea written about the year 1490. By means of a cabinet of medals collected by Maximilian I. emperor of Germany, Joannes Huttichius was enabled to publiſh a book of the lives of the emperors, enriched with their portraits, delineated from ancient coins. It is generally ſuppoſed that this book, which appeared in 1525, was the firſt work of the kind; but Labbé, in his *Bibliotheca Nummaria*, mentions another named *Illuſtrium Imagines*, by one Andreas Fulvius, printed in 1517, in which moſt of the portraits ſeem to be from medals. About the year 1512 alſo, Guillaume Bude, a French author, had written his treatiſe *De Aſſe*, though it was not printed till many years afterwards. M. Grollier, treaſurer of the French armies in Italy, during part of the 16th century, had a great collection of coins of different kinds of metals. After his death, his braſs medals were ſent to Provence, and were about to be ſent into Italy; when the king of France, having got information of the tranſaction, gave orders to ſtop them, and purchaſe the whole at a very high price for his own cabinet of antiquities. M. Grollier had an aſſortment of gold and ſilver as well as of braſs medals; the cabinet in which they were contained fell two centuries afterwards into the hands of M. l'Abbe de Bothelin; and was known to have been that of Grollier from ſome ſlips of paper, on which was his uſual inſcription for his books, *Joannis Grollierii, et amicorum.*

15 Number of cabinets

Cotemporary with Grollier was Guillaume de Choul, who was likewiſe a man of rank and fortune. He had a good collection of medals, and publiſhed many in his Treatiſe on the Religion of the ancient Romans in 1557. In the Low Countries we know, from the letters of Eraſmus, that the ſtudy of medals was begun about the beginning of the 16th century. About the middle of that century, Hubertzus Goltzius, a printer and engraver, travelled over moſt countries in Europe ſearching for coins and medals, in order to publiſh books concerning them. From one of theſe works it appears, that there were then in the Low Countries 200 cabinets of medals; 175 in Germany, upwards of 380 in Italy, and 200 in France. It is probable, however, that there are now four times as many in theſe countries, beſides 500 in Britain; but we are not to imagine that all theſe were grand collections, for of ſuch there are not above a dozen even in Italy: moſt of thoſe juſt mentioned were of the claſs named *caſkets* of medals, containing from 100 to 1000 or 2000.

16 Number of coins found in Britain.

There are few countries, Italy excepted, in which a greater number of coins have been found than in Britain; though we are by no means well acquainted with the time when the ſtudy of them commenced. Mr Pinkerton ſuſpects that Camden was one of the firſt, if not the very firſt Britiſh author, who produced medals in his works, and who muſt have had a ſmall collection. Speed's Chronicle, publiſhed in the 17th century, was illuſtrated with coins from Sir Robert Cotton's cabinet. Gorlæus's collection was purchaſed by Henry prince of Wales, brother to Charles I. to whom he left it at his death. According to Joſeph Scaliger, it conſiſted of 30,000 coins and medals. A collection of 5500 coins was purchaſed by Archbiſhop Laud for 600l. and given to the Bodleian library. Thomas earl of Arundel, earl-marſhal of England, well known from the Arundelian tables and other antiquities which he imported from Greece and Italy into Britain, had a rich cabinet of medals collected by Daniel Niſum. The dukes of Buckingham and Hamilton, Sir William Paſton, Sir Thomas Fanſhaw of Ware-Park, Sir Thomas Hanmer, Ralph Sheldon, Eſq; Mr Selden, &c. are enumerated by Evelyn as collectors of medals. Charles I. as well as his hiſtorian the earl of Clarendon, were alſo collectors. The king had a very fine cabinet; which, however, was diſſipated and loſt during the civil commotions. Oliver Cromwell had a ſmall collection; and the cabinet of Charles II. is mentioned by Vaillant in the preface to his treatiſe entitled *Nummi in Coloniis*," &c. This branch of magnificence has not been much attended to by ſucceeding Britiſh monarchs; though his preſent majeſty has a very good collection of ancient gold coins.

17 Britiſh cabinets.

A great number of fine cabinets have been formed in Britain ſince the time of Evelyn. About the year 1720 Haym makes mention of thoſe of the duke of Devonſhire, the earls of Pembroke and Winchelſea, Sir Hans Sloane, Sir Andrew Fontaine, Mr Sadler, Mr Abdy, Mr Wren, Mr Chicheley, and Mr Kemp. At preſent there are many remarkable collections; but that of the late Dr William Hunter is deſervedly eſteemed the moſt remarkable in Europe, excepting that of the late French king. It was not only formed at a great expence, but with much care and ability; many foreign medals offered to it having been rejected (A). The other remarkable collections are thoſe of the duke of Devonſhire, the earl of Pembroke, Earl Fitzwilliam, formerly the marquis of Rockingham's, the honourable Horace Walpole, the reverend Mr Crachrode, the reverend Mr Southgate, Mr Townley, Mr R. P.

(A) This collection, as well as the reſt of Dr Hunter's Muſeum, is now in the poſſeſſion of the univerſity of Glaſgow, to which it was bequeathed by the doctor's will.

Of what constructed.

R. P. Knight, Mr Edward Knight, Mr Tyson, Mr Barker, Mr Brown, and several others. The British museum and universities in England have also collections; as well as the Advocates library, the Antiquarian Society, and the universities in Scotland.

SECT. IV. *Materials of which Medals are constructed.*

18 Ancient gold coins.

MEDALS are formed of gold, silver, and the various modifications of copper. The gold usually made use of in coinage is about the fineness of 22 carats; and as the art of purifying this metal was very much unknown in former times, the most ancient medals are for this reason much more impure than the modern coins. Gold is never found in its native state above 22 carats fine; and the very ancient medals are much under that standard. Many of them are composed of a mixture of gold and silver, called by the ancients *electrum*. The gold medals were made of much finer metal after Philip of Macedon became possessed of the gold mines of Philippi in Thrace, and the medals of his son Alexander the Great are equally fine; as well as those of some other princes of that age. Those of the Egyptian Ptolemies are of the fineness of 23 carats three grains, with only one grain of alloy. The Roman coins are very pure even from the earliest times; the art of refining gold being well known before any was coined at Rome. Some authors are of opinion, that the Roman coins begin to fall short of their purity after the time of Titus; but Mr Pinkerton denies that any thing of this kind takes place till the time of the emperor Severus; and even then only in a very few instances. Most of the Roman gold was brought from Dalmatia and Dacia, where that metal is still to be met with. A very remarkable circumstance is observed in the eastern part of Hungary, which belonged to the ancient Dacia. It germinates in the vines of Tokay, and is found in their stems; as it is elsewhere in the straw of corn.

19 Metal called *electrum*.

Pliny informs us, and indeed it is generally known, that gold and silver are found mixed together in the earth. Where the silver amounted to one-fifth part of the gold, the metal was called *electrum*; but sometimes the quantity of silver was added artificially. The gold was in those days as well as at present refined by means of mercury: and the ancient artists had certainly attained to great perfection in this branch of metallurgy; as Bodin tells us, that the goldsmiths of Paris upon melting one of Vespasian's gold coins found only $\frac{1}{788}$ part of alloy.

20 Ancient silver.

Most of the ancient silver, particularly that of Greece, is less pure than that of succeeding times; even the Roman silver is rather inferior to the present standard, and that from the very beginning; but in the time of Severus, the silver appears very bad, and continues so until the time of Dioclesian. Many writers upon this subject have mistaken the *denarii ærei*, "coins of brass washed with silver," for silver currency. Silver coins are extremely scarce from the time of Claudius Gothicus to that of Dioclesian, or from the year 270 to 284: in which short space no fewer than eight emperors reigned. Silver at that time was found mostly in Spain; and the commerce with that country was disturbed by the usurpers who arose in Gaul; and such were the troubles of the times, that not only the silver but also the gold coins of those eight emperors, are extremely scarce. There is still, however, some silver extant of these eight emperors; and it is certain, that copper washed was never used as silver currency, but was entirely a distinct coinage. Occasional depravations of silver had taken place long before; as Pliny tells us, that Mark Antony mixed iron with his silver denarii; and Mr Pinkerton informs us, that he had seen a denarius of Antony, which was attracted by a magnet.

21 Ancient brass.

The ancient brass coins consist of two kinds: the red or Cyprian, which indeed is no other than copper; and the common yellow brass. Our author observes, that in the Roman coinage brass was of double the value of copper, and he is of opinion, that it was the same among the Greeks; and the latter is the metal most commonly made use of in the Greek coinage. The Roman sestertii are always of brass: the middling-sized kind are partly copper and partly brass; the former being double the value of the latter, which are the *ases*.

22 Mixed metals.

Mr Pinkerton next proceeds to give an account of the mixed metals used among the Romans. In Britain all kinds of coins made of mixed metal are without hesitation alleged to be forgeries; although it is certain that the variety of mixed metals used in coinage was very considerable. The most valuable mixture was that of gold or silver, already mentioned, named *electrum*; the silver commonly amounting to one-fifth part of the gold made use of, or perhaps more. Of this mixture are many of the early coins of Lydia, and some other Asiatic states; also those of the kings of the Bosphorus Cimmerius, during the imperial ages of Rome. Next to the electrum were the coins of Corinthian brass: but Mr Pinkerton informs us, that not a single coin was ever struck of this metal by the ancients; it having been constantly employed only in the fabrication of vases or toys. It was in use at any rate only for a very short time; being altogether unknown in the days of Pliny the Elder. Our author therefore ridicules those who pretend not only to find out imperial coins of this metal, but to discover three kinds of it; viz. one in which the gold predominates, another in which the silver prevails, and a third where the brass is most conspicuous. He gives Æneas Vico, one of the most ancient writers on medals, as the author of this idea; but whose opinions were confuted by one Savot, a writer in the 17th century. Vico mentions a coin of this kind struck under Augustus, another of Livia, and a third of Claudius. The mistake, he is of opinion, arose from the circumstance of the first propagator not being able to account for the various mixtures and modifications of brass observable in ancient coins of the large size; and which in so common a metal appear very odd to the moderns. Besides the authority of Pliny and other antiquaries of more modern a date, who all declare that they never saw a single medal of Corinthian brass, or of that metal mixed with silver and gold, our author adduces another evidence which he looks upon to be superior to either; viz. that those who have given into this supposition, imagine, that the large pieces called *sestertii*, and others called *dupondiarii*, worth about twopence or a penny, are said to have been composed of this precious metal. It is unreasonable to think, that any proportion of gold

23 Corinthian brass.

gold or ſilver could have been made uſe of in theſe. The coins ſaid to have been ſtruck upon Corinthian braſs are only done upon a modification of common braſs; of which we know, that in proportion to the quantity of zinc made uſe of in conjunction with the copper, the metal aſſumes a variety of hues. On the authority of Pliny he informs us, that the coins miſtaken for Corinthian braſs were no other than prince's metal.

24 Egyptian ſilver coins.

The Egyptian ſilver coins ſtruck under the Roman emperors are at firſt of tolerably pure ſilver; but afterwards degenerate into a mixture of copper and tin with a little ſilver. They are very thick, but many of them are elegantly ſtruck, with uncommon reverſes. There are likewiſe three ſets of braſs coins belonging to this country from the earlieſt times of the Roman emperors there. Some of theſe are of bell-metal or pot-metal; and, after the time of Gallienus and Valerian, the coinage of braſs with a ſmall addition of ſilver becomes authorized by the ſtate; the coins ſtruck upon it being called *denarii ærei*. Thoſe of lead or copper plated with ſilver have been fabricated by Roman forgers. Some coins of lead, however, have been met with of undoubted antiquity: and an ancient writer informs us, that tin money was coined by Dionyſius; but none has been found. The lead coins of Tigranes king of Armenia, mentioned as genuine by Jobert, are accounted forgeries by Mr Pinkerton and other modern medaliſts. Plautus, however, makes mention of leaden coins, and ſeveral of them have been found; but our author looks upon them to have been chiefly eſſay pieces, ſtruck in order to let the artiſt judge of the progreſs of the die. Others are the plated kind already mentioned, fabricated by ancient forgers, but having the plating worn off. A great number of leaden coins are mentioned by Ficorini in a work entitled *Piombi Antichi*, in which he ſuppoſes them to have ſerved as tickets for gueſts; and coins of the ſame kind are alſo mentioned by Paſſeri. In the work entitled *Notitia Imperii Romani*, there is mention of coins made of leather, but none of them have ever been found.

SECT. V. *Of Ancient Money.*

IN conſidering the different ſizes, values, &c. of the Greek and Roman coins, our author treats of the medals as money; a knowledge of which, he ſays, is eſſentially neceſſary to every reader of the claſſics; inſomuch that it may almoſt diſpute the preference with the ſtudies of ancient geography and chronology. Notwithſtanding all that has been written upon the ſubject, however, our author is of opinion, that the ſcience is ſtill in its infancy, in as far as it relates to the real money of the ancients. "The ideal (ſays he), which is indeed the moſt important province of diſcuſſion, has been pretty clearly aſcertained; and we are almoſt as well acquainted with the Attic *mna* or *mina*, and the perplexing progreſs of the Roman *ſeſtertia*, as with our own *pounds*. But with the actual coin of the ancients the caſe is different; and the ignorance even of the learned in this point is wonderful."

25 Knowledge of ancient money imperfect.

Our author now goes on, with great aſperity of language, to particularize the ignorant manner in which modern authors have treated the ſubject of medals. "Arbuthnot and Clarke (ſays he), are, if poſſible, more ignorant of medals than Budæus the very firſt. The latter profeſſes his love of medals, but quotes a conſular coin with the head of Cicero; and looks upon one of the 30 pieces of ſilver, the reward of the treachery of Judas, and which was ſaid to be preſerved among ſome relicks at Paris, to be worthy of reference and commemoration. Arbuthnot, if we may judge from his book, had never ſeen any ancient coins; and Clarke, it is well known, was quite ignorant of them. The latter, with all his labour, ſeems even to have known nothing of the theoretic part of the real ancient money. Indeed Dr Mead's catalogue ſeems to have been almoſt the only *book* on medals which had undergone his peruſal. On the other hand, the ignorance of medalliſts on this ſcore is no leſs profound. To this day they look upon the *didrachms* of Ægina, ſo celebrated in antiquity, as *tridrachms* of Ægium; and upon the early obolus as a braſs coin. In the Roman claſs the large braſs is eſteemed the *as*, while it ſhall be proved that it is the *ſeſtertius*, and worth four *aſes*. The *denarius* is reckoned at ten aſes even in the imperial times; whereas it only went at that rate for the firſt 90 years after the coinage of ſilver at Rome. The denarius æreus is taken for ſilver currency; with other miſtakes, which evince that medalliſts are as ignorant of the theory, as the others are of the practice."

26 Money firſt coined in the eaſt.

In his account of the ancient Greek money, Mr Pinkerton obſerves, that the light of ſcience, like that of the ſun, has proceeded from eaſt to weſt. "It is moſt probable (ſays he), that the firſt invention of money aroſe like the other arts and ſciences; and ſpread from thence into the weſtern parts of the world. In its firſt ſhape it appeared as mere pieces of metal without any ſtated form or impreſſion; in lieu of which, it was regulated by weight. Even down to the Saxon government in England, large ſums were regulated by weight; and in our own times every ſingle piece is weighed in gold; though with regard to ſilver this nicety is not minded, nor indeed does it ſeem practicable. Among the ancients, whoſe commercial tranſactions were leſs important and extenſive than thoſe of the moderns, ſilver was weighed as well as gold; nay even braſs, in ſome caſes.

27 Its firſt rude ſtate.

28 Greek money.

In Greece, large ſums were determined by *mnæ* or *minæ*; and the moſt capital ſums by *talents*. In every country the mina is ſuppoſed to have contained 100 drachmæ, or ſmall ſilver coins, of that country, and the talent 60 minæ. The mina is ſuppoſed to be a pound weight of the country to which it belonged. The Attic pound, according to Dr Arbuthnot, contained 16 ounces, equal to our avoirdupois pound: but Mr Pinkerton looks upon this as a very abſurd opinion, and accuſes the doctor of having adopted it merely that he may explain a paſſage in Livy. He is of opinion, that the Attic pound is very nearly the ſame with the pound Troy. The mina of Athens had at firſt 73 drachms; but by Solon it was fixed at 100. The ancient drachm weighed the ſame which it does at preſent in medical weight, viz. the eighth part of an ounce. The mina or pound of 12 ounces had conſequently 96 of theſe drachms; but four of them were given to the round ſum to ſupply defects in the alloy; "and indeed (ſays our author), in conſequence of a common

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common practice in all ages and in all countries, of giving some addition to a large weight. Thus the pound in weight had but 96 drachmæ in fact, while the pound in tale had 100; as the Roman libra in weight had but 84 denarii, in tale 108; and as our pound in tale, by an inverse progress, is not a third of our pound in common weight.

29 Of the ancient *talents*.

Notwithstanding the very severe criticism on Dr Arbuthnot just mentioned, however, we find our author adopting his account of the *talents* used in coinage in several countries. Thus, according to the doctor,

The Syrian talent had	15 Attic minæ
Ptolemaic -	20
Antiochian -	60
Eubœan - -	60
Babylonian -	70
Larger Attic -	80
Tyrian - -	80
Egyptian -	80
Æginean -	100
Rhodian -	100

Notwithstanding the concession made here by Mr Pinkerton to the doctor, he tells us, that he very much questions this list of talents, and that many ancient writers are little to be relied upon. "Writers on this subject confess, that the numbers in all ancient manuscripts are the parts most subject to error, as being almost always contracted. They ought to allow that the authors themselves must often be liable to wrong information.

"Herodotus mentions, that King Darius ordered gold to be paid into his treasury by the Euboic talent, and silver by the Babylonian. The Euboic is esteemed the same with that called afterwards the Attic; and as we estimate gold by carats, so it is natural to suppose, that the most precious metal would be regulated by the most minute weight. But I confess, I take the Babylonic talent to be the same with that of Ægina. Mr Raper has proved the first coins of Macedon to be upon the standard of Ægina. Now the early Persian coins are upon that very scale, the largest tetradrachms weighing from 430 to 440 grains. Hence it follows, that the Persian silver coins were of the Æginean standard; and the payment was certainly to be made according to the standard of the money. The larger Attic talent was of 80 lesser minæ; because the larger Attic mina was of 16 ounces. The Alexandrian talent, according to Festus, consisted of 12,000 denarii, being the same with that used by the Egyptian kings in their coins; and is shown by Mr Raper to have been the same with the talent of Ægina. Perhaps the whole of the ancient coins of Asia, Africa, Greece, Magna Græcia, and Sicily, are reducible to three talents or standards. 1. That of Ægina, used in most of the more ancient silver coinages; as would seem in even the later of Egypt, Carthage, Cyrene, &c. 2. The Attic (being the Asiatic gold standard, afterwards used by Phidon king of Argos in estimating gold, and called Euboic from Eubœa, one of the quarters of the city of Argos), used in Athens and the greater part of the world as the standard both of gold and silver. 3. The Doric or Sicilian talent of 24 nummi, each worth an obolus and an half; whence the talent is estimated at six Attic drachms or three darics. These weights continued to be the standard of money after it began to be distinguished by impression; nay, to the fall of Greece and prevalence of the Roman empire."

30 Coinage originates in Lydia.

Coinage, according to Herodotus, was first invented by the Lydians, from whom the Greeks quickly received it. The former could not have received it from the Persians, whose empire did not begin till 570 B. C. though our author supposes that it might have proceeded from the Syrians, who carried on commerce in very ancient times. The most ancient Greek coins of silver have an indented mark upon one side, and a tortoise upon the other; and those of greatest antiquity have no letters upon them. Those of later date have ΑΙΓΙ marked upon them, which medallists interpret of Ægium in Achaia; being led into that supposition by the tortoise, which they look upon as the sure mark of the Peloponnesus. But though our author agrees that the tortoise was so, he thinks that they are otherwise very far wrong in their conclusions. Ægium in Achaia was a place of no consequence till the times of Aratus and the Achæan leauge; but there are 11 of these coins in Dr Hunter's cabinet, which show that they must have been struck in times of the most remote antiquity, and that the place where they were struck was rich and flourishing at the time. The coins we speak of are not common; but those which have the name ΑΙΓΕΙΩΝ at full length, and which may perhaps belong to Ægium in Achaia, are extremely scarce; insomuch that in all Dr Hunter's vast collection there are not above one or two. They are likewise constructed upon a scale quite different from all other Grecian money; being of 8, 13, 15$\frac{1}{7}$, 90, and about 186 grains. The Grecian drachma at an average is 66 grains; and Mr Pinkerton thinks it would have been strange if pieces had been struck of eight-tenths of an obolus, of an obolus and an half, or of a drachma and an half. Ægium being originally an obscure village, could not be the first which coined money: so that Mr Pinkerton supposes the name ΑΙΓΙ to have stood for Ægialus, the ancient name of Sicyon, a wealthy and powerful city; or rather Ægina, the mint of which was much celebrated, and perhaps the most ancient in Greece.

31 Most ancient Greek coins described.

Other arguments in favour of these coins being derived from Ægina, are drawn from their weight as well as their workmanship, which are quite different from those bearing the name of Ægium at full length. The coinage of Ægina is known to have been different from that of the rest of Greece; insomuch that its drachma was worth 10 Attic oboli, while the Attic drachma was valued only at six. Hence the drachmas of Ægina were named by the Greeks παχειαν, or *thick*; a name very applicable to the coins in question. From these observations, our author is of opinion, that we may even distinguish the precise weight of the ancient coins of Ægina. According to the exact proportion, the drachma of this place should weigh exactly 110 grains; and one of them very much rubbed weighed above 90. The others of larger size, which seem to be didrachms of Ægina, weigh from 181 to 194 grains; but the latter being the only one he could meet with in good preservation, it was impossible to form any just medium. Even in those best preserved,

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he thinks that 10 grains may be allowed for a waſte of the metal in ſo long a time as 2400 years, which would bring the drachma of Ægina near its proper ſtandard. The obolus of Ægina was in proportion to its drachma of ſix oboli. It is the piece of $15\frac{1}{2}$ grains, and 13 when very much rubbed. The hemiobolon is that of eight, but when rubbed it falls ſhort of this weight.

32
The drachma the moſt general denomination.

The general denomination of the Greek money is the drachma, or eighth part of an ounce; which to this day is retained in the medical weights, the Grecian coins receiving their names from the weights they bore; though in ſome inſtances the weights received their appellations from the coins. The ſilver drachma, according to Mr Pinkerton, was about ninepence ſterling; and he finds fault with thoſe who make the drachma and denarius both equal to one another, the latter being no more than eightpence. The didrachm of ſilver, according to the ſame calculation, was worth 18d.; but the *tridrachm* occurs very rarely: and Mr Pinkerton is even of opinion, that medalliſts give this name to the didrachm of Ægina. The largeſt of all the Grecian coins is the tetradrachm, which on the Æginean ſtandard is worth five ſhillings; but in thoſe of the other ſtates only four. There are, however, many ſubdiviſions in the ſilver drachma; the higheſt being the tetraobolion or coin of four oboli; being in proportion to the drachma as our groat to a ſixpence, weighing about 44 grains, and being in value about ſixpence. The hemidrachm or triobolion comes next in value, weighing about 33 grains, and worth fourpence halfpenny. The ſilver diobolion, or third of the drachma, weighs about 22 grains, and is worth threepence. The obolus of ſilver weighs about 11 grains, and is worth only three halfpence. There is likewiſe a hemiobolion in ſilver, or half the obolus, of five grains and a half, value three farthings: and another called *tetraobolion dichalcos* or quarter obolus, which is the moſt minute coin yet met with; and by reaſon of its extreme ſmallneſs, weighing only two grains and a quarter, is now very ſcarce: but there is one in the cabinet of Dr Hunter, and ſome more have been lately brought from Athens by Mr Stuart. Some of them are likewiſe met with at Tarentum. It would appear, however, that there were ſome ſtill ſmaller, and of value only three-fourths of a farthing. None of theſe have been met with; and the ſmallneſs of the ſize renders it improbable that any will ever be met with; as the peaſants, who commonly diſcover coins, would probably either not obſerve them at all, or if they did, would neglect them as things of no value.

33
Different names of Greek coins.

Many different names have been impoſed on the coins belonging to the different ſtates of Greece: thus Κορη, *the maiden*, was a name often applied to the tetradrachm, and which would ſeem to apply to thoſe of Athens; though there are coins of other cities with the head of Proſerpine, and the word Κορη, to which it would appear more applicable in our author's opinion. Χελωνε, *the ſhell*, was the name of another coin, from its type. A Sicilian coin was named Δεμαρετιον, from Gelon's wife. A tetradrachm was named Κρατατυγους, and had eight ευθειας or hemidrachms. The τροισηνιον, ſo called from its country Troizene, had Pallas on one ſide and a trident on the reverſe. The hemiobolion was the πελανος of Lacedemon; and the κολλυβος is ſuppoſed to have been equal to the Roman ſeſtertius or quarter drachma. The *cyſtophori* were coins with the myſtic cheſt or hamper of Bacchus upon them, out of which a ſerpent riſes; and are much celebrated in antiquity. We are told by Livy, that Marcus Acilius, in his triumph over Antiochus and the Ætolians, carried off 248,000 of them; Cneius Manlius Vulſo in that over Gallo-Græcia had 250,000; and Lucius Emilius Regillus, in his naval triumph over the fleets of Antiochus, had 131,300. Cicero likewiſe mentions his being poſſeſſed of a vaſt ſum in them. The moſt probable opinion concerning them ſeems to be, that they are all ſilver tetradrachms; ſuch as belong to the cities of Apamea and Laodicea in Phrygia; Pergamus in Myſia; Sardis and Tralles in Lydia; and Epheſus: but it is a miſtake to aſcribe any to Crete. Mr Pinkerton thinks it abſurd to imagine that Crete, a ſmall iſland, ſhould ſtrike ſuch vaſt numbers of coins; though Cicero mentions his being in poſſeſſion of an immenſe treaſure in them at the time he was governor of Aſia Minor. "It is moſt likely (ſays Mr Pinkerton), that his wealth ſhould be in the coin of the country to which he belonged. But what had theſe triumphs or Cicero's government to do with Cretan money? But indeed the coins themſelves, as above noticed, eſtabliſh the fact."

Another ſet of coins famous in antiquity were thoſe of Cyzicus in Myſia, which were of gold; but they are now almoſt entirely vaniſhed by being recoined in other forms. The Αριανδικον νομισμα, or *money of Aryandes*, who was made governor of Egypt by Cambyſes, is made mention of by Heſychius; but none of them, as far as is known, have reached our times. They muſt have been marked with Perſian characters, if with any. The coin of Queen *Philiſtis* is mentioned by the ſame writer, and many of theſe pieces are ſtill extant; but we know not where this queen reigned, nor does there ſeem to be any method of finding it out. Mr Pinkerton inclines to believe, that ſhe preſided over Sicily; and as a confirmation of that ſuppoſition, mentions ſome inſcriptions of ΒΑΣΙΛΙΣΣΑΣ ΦΙΛΙΣΤΙΔΟΣ or the *Gradini* of the theatre at Syracuſe; but which appear not older than the Roman times. Some authors are of opinion, that ſhe reigned in Coſſara or Malta; which our author thinks much more improbable.

34
Coins of Cyzicus.

35
Athenian coins.

The moſt particular attention with regard to the names and ſtandard of coins is due to thoſe of Athens; and it is remarkable, that moſt of them which have reached us are of a very late period, with the names of magiſtrates inſcribed upon them. Some of theſe bear the name of Mithridates; and few are older than the era of that prince; who, it is well known, took the city of Athens in his war with the Romans. I ſuſpect (ſays Mr Pinkerton), that no Athenian coins of ſilver are poſterior to Sylla's infamous deſtruction of that city; an event the more remarkable, as Salluſt tells us, that Sylla was learned in Greek. Indeed Caligula, Nero, and moſt of the peſts of ſociety, have been learned men, in ſpite of a noted axiom of Ovid,

Sed ingenuas didiciſſe feliciter artes
Emollit mores, nec ſinit eſſe feros.

It is ſtill more remarkable, that the fabric of Athenian

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nian coins is almoſt univerſally very rude: a ſingular circumſtance, if we reflect how much the arts flouriſhed there. It can only be accounted for from the excellence of their artiſts being ſuch as to occaſion all the good ones to be called into other countries, and none but the bad left at home. In like manner, the coins ſtruck at Rome in the imperial times are excellent, as being done by the beſt Greek artiſts; while thoſe of Greece, though famous at that time for producing miraculous artiſts, are during that period commonly of very mean execution. The opulence of Athens in her days of glory was very great; owing in an eminent degree to her rich commerce with the kingdoms on the Euxine ſea, carried on chiefly from Delos, which belonged to Athens, and was the grand centre of that trade." Hence it has become matter of ſurpriſe to Neumann, that when there are ſo many coins of Mycene, an iſland even proverbially poor, there ſhould be none of Delos. But Mr Pinkerton accounts for this from Mycene's being a free ſtate, and Delos ſubject to Athens. "It may be well ſuppoſed (ſays he), that Athens had a mint at Delos; and ſuch Athenian coins as have ſymbols of Apollo, Diana, or Latona, were ſtruck in this iſland."

36 Greek copper money.

The copper money of the Greeks is next in antiquity to the ſilver. Mr Pinkerton is of opinion, that it was not uſed at Athens till the 26th year of the Peloponneſian war; about 404 years before Chriſt, and 300 after ſilver was firſt coined there. The firſt copper coins were thoſe of Gelo of Syracuſe, about 490 B. C.

37 Of the chalcos.

The chalcos of braſs, of which eight went to the ſilver obolus, ſeems to have been the firſt kind of Greek coin. At firſt it was looked upon as of ſo little conſequence, that it became proverbial; and to ſay that a thing was not worth a *chalcos*, was equivalent to ſaying that it was worth nothing. As the Greeks became poor, however, even this diminutive coin was ſubdivided into two, four, nay eight λεπτα or ſmall coins; but our author cenſures very ſeverely thoſe who have given an account of thoſe diviſions. "Pollux, and Suidas copying from him (ſays he), tell us, that there were ſeven lepta to one chalcos; a number the moſt unlikely that can be, from its indiviſibility and incapacity of proportion.

"Pollux lived in the time of Commodus, ſo was too late to be of the ſmalleſt authority: Suidas is four or five centuries later, and out of the queſtion. Pliny tells us, that there were ten chalci to the obolus; Diodorus and Cleopatra that there were ſix; Iſidorus ſays there were four: and if ſuch writers differ about the larger denomination, we may well imagine that the ſmaller equally varied in different ſtates; an idea ſupported by theſe undeniable witneſſes, the coins which remain. Moſt of the Greek copper coin which has reached our times conſiſts of chalci; the lepta being ſo ſmall as to be much more liable to be loſt." In Dr Hunter's cabinet, however, there are ſeveral of the dilepta of Athens: and from being ſtamped with the repreſentation of two owls, ſeem to be the ſame with the ſilver diobolus: "a circumſtance (ſays Mr Pinkerton), of itſelf ſufficient to confute Pollux; for a dilepton can form no part of ſeven; a number indeed which never appeared in any coinage of the ſame metals, and is contradictory to common ſenſe. It may be obſerved, that the whole braſs coins of Athens publiſhed by Dr Combe are reducible to four ſizes, which may be the *lepton*, *dilepton*, *tetralepton* or *hemichalcos*, and *chalcos*. The firſt is not above the ſize of one of King James I.'s farthing tokens; the laſt about that of our common farthing." The *lepta* was alſo called κερμα, as being change for the poor. The κιδαβος, perhaps ſo called from the figure of a wolf upon it, was the coin of a particular ſtate, and if of braſs muſt have weighed three chalci. The other names of the copper coins of Greece are but little known. Lycurgus ordered iron money to be coined at Sparta; but ſo periſhable is this metal, that none of that kind of money has reached our times.

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38 Lepton, dilepton, &c.

After the conqueſt of Greece by the Romans, moſt of the coins of that country diminiſhed very much in their value, the gold coinage being totally diſcontinued: though ſome of the barbarous kings who uſed the Greek character were permitted to coin gold, but they uſed the Roman model; and the ſtandard uſed by the few cities in Aſia who ſpoke the Greek language in the times of the emperors is entirely unknown. Copper ſeems to have been the only metal coined at that time by the Greeks themſelves; and that upon the Roman ſtandard, then univerſal through the empire, that there might be no impediment to the circulation of currency. They retained, however, ſome of their own terms, uſing them along with thoſe of the Romans. The *aſſarion* or *aſſarium* of Rome, the name of the diminiſhed *as*, being 16 to the drachma or denarius, the obolus was ſo much diminiſhed in value as to be ſtruck in braſs not much larger than the old chalcus, and valued at between two and three aſſaria; which was indeed its ancient rate as to the drachma. This appears from the copper coins of Chios, which have their names marked upon them. The braſs obolus, at firſt equal in ſize to the Roman ſeſtertius or large braſs, leſſens by degrees to about the ſize of a ſilver drachma. From the badneſs of the imperial coinage in Greece alſo, it appears that braſs was very ſcarce in that country, as well as in all the cities uſing the Greek characters; being found moſtly in the weſtern countries of the Roman empire. The time of this declenſion in ſize of the Greek coins is by Mr Pinkerton ſuppoſed to have been from Auguſtus down to Gallienus. He is of opinion, however, that the copper obolus, at firſt above the ſize of large braſs, was uſed in Greece about the time of its firſt ſubjection to Rome; and that the lepta ceaſing, the chalci came in their room, with the dichalcus and the hemiobolion of braſs.

39 Era of the declenſion of the Greek coinage.

40 Gold coins of Greece.

With reſpect to the gold coins of the Greeks, Mr Pinkerton is of opinion that none of that metal was coined before the time of Philip of Macedon, as none have reached our times prior to the reign of that monarch. From a paſſage in Thucydides our author concludes, that in the beginning of the Peloponneſian war the Athenians had no gold coin. Mentioning the treaſure in the Acropolis or citadel of Athens, at the commencement of that war, the hiſtorian mentions ſilver coin, and gold and ſilver in bullion; and had any of the gold been in coin, he would certainly have mentioned it. Philip began his reign about 68 years after the beginning of the Peloponneſian war; and we can ſcarce ſuppoſe that any city would have preceded

ceded the elegant and wealthy Athens in the coining of gold.

41 Gold coined early in Sicily.

Notwithſtanding, however, this deficiency of gold coin among the Greeks, it is certain that the coinage of gold had taken place in Sicily long before; as we have gold coins of Gelo about 491 B. C. of Hiero I. 478, and of Dionyſius I. in 404, all uſing the Greek characters; though not to be ranked among the gold coins of Greece, as Philip cauſed his to be. Gold coins of Syracuſe even appear of the third claſs of antiquity, or with an indented ſquare, and a ſmall figure in one of its ſegments. Gold coins are uſed in the cities of Brettium, Tarentum, and throughout Magna Græcia; alſo in Panticapæa in Thrace, and likewiſe Coſa in that country; but not in Tuſcany, as is commonly believed, though Neumann proves that they were ſtruck by Brutus, and are unqueſtionably as ancient as the Greek coins. The Thebans and Athenians probably coined the firſt gold after Philip had ſet them the example, and when they were attempting to reſiſt the projects of that enterpriſing monarch. The Ætolians probably coined their gold during the time of their greateſt power, about a century after Philip, and when they were combating the power of Aratus and the Achæan league. "There is (ſays Mr Pinkerton) but one ἡμιχρυσος of Thebes, much worn, in Dr Hunter's cabinet, and weighing but 59 grains; and perhaps not above two or three χρυσοι or gold didrachms of Athens in the world; one of which is alſo in the collection of Dr Hunter, and weighs 132½ grains. It appears to be more modern than the reign of Philip. That monarch having got poſſeſſion of the mines of Philippi in Thrace, improved them ſo much, that they produced him annually above a thouſand talents of gold, or 2,880,000l. of our money. From this gold the firſt coins named from the monarch, *Philippi*, were ſtruck. They were marked with his portrait; and for many ages after were ſo numerous, that they were common in the Roman empire; whence the name *Philippi* became at length common to gold, ſilver, and at laſt even braſs coins of their ſize. Even in the time of Philip gold was very ſcarce in Greece; but after the Phocians had plundered the temple of Delphos, this precious metal which had been valued as gems, and conſecrated only to the decoration of the temples of the gods, began to be known among the Greeks. The comparative value of gold and ſilver, however, ſeem to have been at that time very different from what they are now. Herodotus values gold at 13 times its weight in ſilver; Plato in his Hipparchus at 12; and even the low value of 10 to 1 ſeems to have been the ſtated value in Greece, though in Rome the plenty of ſilver from the Spaniſh mines made the value of gold to be much higher; and there is no reaſon to think that it was ever valued in that city at leſs than 12 times its weight in ſilver. The *Philippus* χρυσος, gold piece, or *ſtater*, is a didrachm, and is the moſt common of all the ancient coins. Mr Pinkerton is of opinion that it went for 20 ſilver drachms on its firſt appearance; but in latter times for 25 Greek drachmæ or Roman denarii. There are proofs of the Philippi being didrachms, both from the writings of ancient authors and from numbers of the coins themſelves, which remain to this day; and that the χρυσος, or principal gold coin of Greece, was of the ſame weight, is alſo evident from ancient writings. It was anciently worth about 15s. but valuing gold now at the medium price of 4l. per ounce, it is worth about 20s. The ἡμιχρυσος, or half the former coin, ſcarcely occurs of the coinage of Philip and Alexander, though it does of Hiero I. of Syracuſe and of King Pyrrhus. It paſſed for ten ſilver drachmas, and was valued only at 7s. 6d. though now worth 10s. There was another diviſion of this kind worth about 5s. There were beſides ſome leſſer diviſions of gold coins, which could not be worth above two drachmas. Theſe were coined in Cyrene; and there were beſides ſeveral old gold coins of Aſia Minor, the value of which is now unknown. Our author ſuppoſes that they were coined not with relation to their weight as parts of the drachma, but merely to make them correſpond with ſo many ſilver pieces as was neceſſary. There are alſo larger coins than the χρυσος, the διχρυσος of Alexander and Lyſimachus being double its value. Some others are met with of Lyſimachus, Antiochus III. and ſome of the Egyptian monarchs, weighing four times the χρυσος, and now worth about 4l. ſterling. Some weigh even more; but this our author ſuppoſes owing to a difference in the purity of the gold."

In Rome, as well as in Greece, the money was at 42 Roman money.
firſt eſtimated by weight; and the firſt metal coined by that people was copper, ſilver being long unknown in Rome; nor is it certainly known that any ſilver has ever been found in the Italian mines. In Rome the firſt valuation of money was by the *libra gravis æris*, or pound of heavy braſs: and in the progreſs of their conqueſts, the little ſilver and gold that came in their way was regulated by the ſame ſtandard, as appears from the ſtory of Brennus. The weights made 43 Of the Roman pound.
uſe of were the ſame with thoſe which continue to this day. The pound conſiſted of 12 ounces of 458 grains each; but the pound by which the money was weighed appears to have conſiſted only of 420 grains to the ounce, or to have contained in all 5040 grains. This became the ſtandard of copper; and when ſilver came to be coined, ſeven denarii went to the ounce as eight drachms did in Greece. Gold was regulated by the *ſcriptulum* or *ſcrupulum*, the third part of a denarius, and by the larger weights juſt mentioned. The number 10 was at firſt uſed by the Romans in counting their money; but finding afterwards that a ſmaller number was more convenient, they divided it into quarters; and as the quarter of 10 is 2½, they for this 44 Seſtertius, as, &c.
reaſon beſtowed upon it the name of *ſeſtertius* or "half the third;" to expreſs that it was two of any weights, meaſures, &c. and half a third; whence the ſeſtertius came at laſt to be the grand eſtimate of Roman money. The *as* being at firſt the largeſt, and indeed the only Roman coin, the word *ſeſtertius* means *ſeſtertius as*, or "two aſes and an half." On the firſt coining of ſilver, the denarius of ten aſes was ſtruck in the moſt common and convenient denary diviſion of money, or that by tens; the ſeſtertius being of courſe two aſes and an half. But the denarius being afterwards eſtimated at 16 aſes, the name ſeſtertius was ſtill applied to a quarter of the denarius, though it now contained four aſes. The term *ſeſtertius* was applied to all ſums not exceeding 1000 ſeſtertii, or 8l. 6s. 8d.; but for greater ſums the mode of the ſeſtertius was likewiſe altered, though not to exclude the former. Very large

ſums of money were eſtimated by the hundred weight of braſs; for the Romans were at firſt unacquainted with the talent. The hundred weight, by way of eminence, was diſtinguiſhed by the name of *pondus*, and *ſeſtertium pondus* became a phraſe for two hundred weight and an half. Mr Pinkerton is of opinion, that we may value the *as libralis* of ancient Rome at about eightpence Engliſh. Eſtimating the *as* therefore at a pound weight, the *ſeſtertium pondus* was equal to 1000 *ſeſtertii*, or 8l. 6s. 8d.; and by coincidence which our author ſuppoſes to have been the effect of deſign, as ſoon as the ſilver coinage appeared, the *ſeſtertium centum denariorum* was always equal to 8l. 6s. 8d. alſo. The word *ſeſtertium* itſelf, however, ſeems to have been unknown prior to the coinage of ſilver money at Rome: the *pondera gravis æris* being ſufficient before that time for all the purpoſes of a ſtate in which money was ſo ſcarce. But however this may be, the *pondus* or hundred weight of braſs was preciſely worth 100 denarii, or a pound of ſilver. * As the great ſeſtertium was always valued at 1000 of the ſmaller, or 8l. 6s. 8d. we never find one ſeſtertium mentioned in authors, but two, three, or more; ten thouſand of them being equal to 83,333l. 6s. 8d.

45 Whence the Romans derived their coinage.

The ſtates from which the Romans may be ſuppoſed firſt to have derived their coinage, were the Etruſcans and the Greek colonies in Magna Græcia and Sicily. Joſeph Scaliger, Gronovius, &c. contend that it was from the Sicilians that the Romans firſt derived their knowledge of money; but Mr Pinkerton argues that it was from the Etruſcans. In confirmation of his opinion, he appeals to the ſtate of the Roman territories in the time of Servius Tullius, who is looked upon to have been the firſt who coined money at Rome. At that time the whole Roman dominion did not extend beyond ten miles round the city; and was entirely ſurrounded by the Etruſcan and Latin ſtates; Cumæ being the next Greek colony to it that was of any conſequence, and which was in the neighbourhood of Naples, at about the diſtance of 150 miles. Our author aſks, Is it reaſonable to think that the Romans received the uſe of money from the Etruſcans and Latins who were their neighbours, or from the Greeks, who were at a diſtance, and at that time, as far as appears from their hiſtory, abſolutely unknown to them? "If this argument (adds he), is ſtrong with regard to the neareſt Grecian colonies, what muſt it be with reſpect to Sicily, an iſland 300 miles diſtant from Rome, where it was not known, at that time, if a boat went by land or water?" Arguments, however, for this opinion have been derived from the ſimilarity betwixt the Sicilian and Roman coins; which Mr Pinkerton now proceeds to examine. The Greek pound in Sicily was called λιτρα, and conſiſted, like the Roman, of 12 ουγκιαι, or ounces; and Mr Pinkerton grants that the Roman *libra* was derived from the Greek λιτρα, but denies that the *as*, or libra, a coin, was from Sicilian model. The Sicilians had indeed a coin named λιτρα; but it was of ſilver, and of equal value to the Æginean ſtandard, ten of which went to the Sicilian δεκαλιτρον. He differs from Gronovius, that the ſtandard of Ægina was uſed at Corinth, and of courſe at Syracuſe; and it appears from Ariſtotle, that the Sicilians had a talent or ſtandard of their own. The Sicilian obolus or λιτρα contained alſo 12 ounces or *chalci*, ſo named at firſt becauſe they weighed an ounce weight; but the ουγκιαι of Hiero weigh more than a troy ounce; and the braſs coins of Agrigentum are marked with cyphers as far as ſix: the largeſt weighing only 186 grains, or about one-third of the primitive ounce. Our author denies that even the Roman denarius took its riſe from the Sicilian δεκαλιτρον, as many authors aſſert. Were this the caſe, it would have weighed 180 grains; whereas the Roman denarii are not above the third part of the quantity.

From all theſe conſiderations, our author is of opinion that the Sicilians borrowed the diviſion of their λιτρα from the Etruſcans, or poſſibly from the Romans themſelves; which our author thinks is more probable than that the Romans had it from Sicily. The ſtrongeſt argument, however, againſt the Roman coinage being borrowed from the Sicilian is, that though great numbers of Sicilian coins are to be found in the cabinets of medalliſts, yet none of them reſemble the *as libralis* of the Romans in any degree. In moſt cabinets alſo there are Etruſcan coins upon the exact ſcale of the *as libralis*, and ſeveral of its diviſions; from whence Mr Pinkerton concludes, that "theſe, and theſe alone, muſt have afforded a pattern to the primitive Roman coinage." The Etruſcans were a colony from Lydia, to which country Herodotus aſcribes the firſt invention of coinage. "Thoſe coloniſts (ſays Mr Pinkerton), upon looking round their ſettlements, and finding that *no* ſilver was to be had, and *much leſs* gold," ſupplied the mercantile medium with copper; to which the caſe of Sweden is very ſimilar, which, as late as the laſt century, had copper coins of ſuch magnitude, that wheelbarrows were uſed to carry off a ſum not very conſiderable. 46 Origin of the Sicilian coins.

Some coins are found which exceed the *as libralis* in weight; and theſe are ſuppoſed to be prior to the time of Servius Tullius. Some of them are met with of 34 and of 53 Roman ounces; having upon one ſide the figure of a bull rudely impreſſed, and upon the other the bones of a fiſh. They are moſt commonly found at Tudder, or Tudertum, in Umbria; but they appear always broken at one end: ſo that Mr Pinkerton is of opinion that perhaps ſome might be ſtruck of the decuſſis form, or weighing ten pounds. Theſe pieces, in our author's opinion, make it evident, that the Romans derived their large braſs coins from the Etruſcans and the neighbouring ſtates: they are all caſt in moulds; and the greater part of them appear much more ancient than the Roman aſes, even ſuch as are of the greateſt antiquity. 47 Of the moſt ancient Roman coins.

Mr Pinkerton agrees with Sir Iſaac Newton as to the time that Servius Tullius reigned in Rome, which he ſuppoſes to be about 460 B. C. His coinage ſeems to have been confined to the as, or piece of braſs having the impreſſion of Janus on the one ſide, and the prow of a ſhip on the other; becauſe Janus arrived in Italy by ſea. Varro, however, informs us, that the very firſt coins of Tullius had the figure of a bull or other cattle upon them, like the Etruſcan coins, of which they were imitations. Thoſe with the figure of Janus and the prow of a ſhip upon them may be ſuppoſed firſt to have appeared about 400 B. C. but in a ſhort time, various ſubdiviſions of the as were coined. The *ſemis*, or half, is commonly ſtamped with the head of 48 Subdiviſions of the as.

Jupiter

Jupiter laureated; the *triens* or third, having four cyphers, as being originally of four ounces weight, has the head of Minerva; the *quadrans* or quarter, marked with three cyphers, has the head of Hercules wrapt in the lion's ſkin; the *ſextans* or ſixth, having only two cyphers, is marked with the head of Mercury with a cap and wings; while the *uncia* having only one cypher, is marked with the head of Rome. All theſe coins appear to have been caſt in moulds, by a conſiderable number at a time; and in the Britiſh muſeum there are four of them all united together as taken out of the mould in which perhaps dozens were caſt together. In proceſs of time, however, the ſmaller diviſions were ſtruck inſtead of being caſt; but the larger ſtill continued to be caſt until the as fell to two ounces. Even after this time it was ſtill called *libra*, and accounted a pound of copper; though there

49 Larger denominations of it ſtruck.

were now larger denominations of it coined, ſuch as the *biſſas* or double as; *treſſis* and *quadruſſis* of three and four aſes; nay, as far as *decuſſis* or ten aſes, marked X. Olivieri mentions one in his own cabinet weighing upwards of 25 ounces, and caſt when the as was about three ounces weight. There is likewiſe in the Muſæum Etruſcum a decuſſis of 40 Roman ounces, caſt when the as was at four ounces. There was likewiſe a curious decuſſis in the Jeſuits library at Rome, for which an Engliſh medalliſt offered 20l.; but it was ſeized by the pope along with every other thing belonging to the ſociety.

50 Decreaſe of the as in weight.

Mr Pinkerton conteſts the opinion of Pliny that the as continued of a pound weight till the end of the firſt Punic war. His opinion (he ſays), is confuted by the coins which ſtill remain; and it appears probable to him that the as decreaſed gradually in weight; and, from one or two of the pieces which ſtill exiſt, he ſeems to think that the decreaſe was ſlow, as from a pound to eleven ounces, then to ten, nine, &c.; but neither the as nor its parts were ever correctly ſized. During the time of the ſecond Punic war, when the Romans were ſore preſſed by Hannibal; the as was reduced to a ſingle ounce. It is ſaid to have taken place in the 215th year before our era, being about 36 years after the former change. This as libralis, with the face of Janus upon it, is the form moſt commonly met with previous to its being reduced to two ounces. Our author ſuppoſes that the as libralis continued for at leaſt a century and an half after this coinage of Tullius, down to 300 B. C. about the year of Rome 452, between which and the 502d year of Rome a gradual diminution of the as to two ounces muſt have taken place. The following table of the dates of the Roman coinage is given by Mr Pinkerton.

The libralis, coined by Tullius with the figures of oxen, &c. about 167 years after the building of Rome, according to Sir Iſaac Newton, or about the year before Chriſt	460
As libralis with Janus and the prow of a ſhip	400
As of ten ounces - -	300
Eight - - -	290
Six - - -	280
Four - - -	270
Three - - -	260
Two, according to Pliny - -	250
One, according to the ſame author -	214

About 175 B. C. alſo, we are informed by Pliny, that the as was reduced to half an ounce by the Papyrian law, at which it continued till the time of Pliny himſelf, and long after.

After the Romans began to have an intercourſe with Greece, a variety of elegant figures appear upon the parts of the as, though not on the as itſelf till after the time of Sylla. Towards the latter end of the republic alſo, *dupondii*, or double aſes, were coined, together with the ſeſtertii ærei, which came in place of the *quadruſſes*, when the denarius began to be reckoned at 16 aſſes; probably at the time the latter was reduced to half an ounce. In ſome inſtances it is to be obſerved, that the Romans accommodated their coins to the country where their army was ſtationed; whence we have many coins marked as Roman, which have been coined in Magna Græcia and Sicily, and are evidently upon the Greek and not the Roman ſcale. In the latter part of the republican times, alſo, the types begin to vary; ſo that we have a braſs coin ſuppoſed to be ſtruck by Sextus Pompeius in Sicily, having upon it a double head of that warrior, repreſenting a Janus. Mr Pinkerton ſuppoſes it to have been a dupondius; which indeed appears to be the caſe from the double head. This coin is of copper, and ſtill weighs an ounce, notwithſtanding its antiquity.

51 Coins on the Greek ſcale marked as Roman.

The largeſt imperial copper coin was the ſeſtertius, a piece worth about twopence of our mony. Mr Pinkerton cenſures ſeverely the opinion of other medalliſts, all of whom ſay that the ſeſtertius was of ſilver. "In fact (ſays he), it would be as rational in any antiquary, a thouſand years hence, to contend that the halfpenny and farthing are of ſilver, becauſe they were ſo in the reign of Henry VIII." In confirmation of his own opinion, he quotes the following paſſage from Pliny: "The greateſt glory of braſs is now due to the Marian, called alſo that of Cordova. This, after the Livian, moſt abſorbs the lapis calaminaris, and imitates the goodneſs of native orichalcum in our ſeſtertii and dupondiarii, the aſes being contented with their own copper." Gronovius confeſſes that he does not know what to make of this paſſage, and that it cauſes him heſitate in his opinion. The *Livian* mine mentioned here by Pliny, is ſuppoſed to have got its name from *Livia* the wife of Auguſtus; and it is probable that the pieces marked with her portrait, entitled JUSTITIA, SALUS, VIRTUS, &c. were dupondii from this very mine, the metal being exceedingly fine, and of the kind named *Corinthian braſs* by the ancient medalliſts. "Perhaps (ſays Mr Pinkerton), the mine received its name from this very circumſtance of her coins being ſtruck in the metal taken from it."

53 Of the ſeſtertius.

53 Coinage of yellow braſs.

No change took place in the Roman coinage from the time that the as fell to half an ounce to the days of Pliny: but Mr Pinkerton obſerves, that before the time of Julius Cæſar yellow braſs began to be uſed, and was always looked upon to be double the value of Cyprian or red copper. There are but few coins in large braſs immediately before Julius Cæſar, or even belonging to that emperor; but from the time of Auguſtus downward, the large coins are all found of braſs, and not one of them copper. The largeſt of what are called the middle ſize are all of yellow braſs; and the next ſize, which is the as, and weighs half an ounce, is univerſally copper. What the ancients named

Ancient Money.

med *orichalcum*, or what we call *braſs*, was always looked upon to be greatly ſuperior in value to the æs Cyprium. Procopius, ſpeaking of a ſtatue of Juſtinian, tells us, that braſs inferior in colour to gold is almoſt equal in value to ſilver. The mines of native braſs were very few in number, and were owing entirely to the ſingular combination of copper and lapis calaminaris in the bowels of the earth, which very ſeldom occurs; and the ancients were far from being well acquainted with the method of combining theſe two bodies artificially; ſo that yellow braſs was always eſteemed at double the value of copper; and hence, in the ancient coinages, the braſs and copper pieces were kept as diſtinct as thoſe of gold and ſilver.

Mr Pinkerton challenges to himſelf the diſcovery that the imperial ſeſtertius was of braſs; and is at conſiderable pains to bring proofs of it. Beſides the teſtimony of Pliny, which of itſelf would be deciſive, this is ſupported by the ſtrongeſt collateral evidence of other authors. From a paſſage in Julius Africanus, who wrote the Ιατρικα, or *Treatiſe on Medicine*, it appears that the nummus, or ſeſtertius, weighed an ounce, and of conſequence that it could not be ſilver but braſs; and all the large imperial Roman coins weigh an ounce. We know not the age in which Julius Africanus lived; and as he makes the denarius to contain 16 aſes, he muſt have been before the age of Gallienus, when it had 60. Gronovius ſuppoſes him to have been the ſame mentioned by Euſebius. This author ſpeaks of a Julius Africanus who lived in the time of Heliogabalus, and whom Mr Pinkerton ſuppoſes to have been the ſame with him above-mentioned.

54 Diminution of the ſeſtertius.

The ſeſtertius underwent no change till the time of Alexander Severus, when it was diminiſhed by one-third of its weight. Trajanus Decius was the firſt who coined double ſeſtertii, or quinarii, of braſs; but from the time of Trebonianus Gallus to that of Gallienus, when the firſt braſs ceaſes, the ſeſtertius does not weigh above the third part of an ounce; the larger coins are accounted double ſeſtertii; and after the time of Gallienus it totally vaniſhes. In the times of Valerian and Gallienus we find a new kind of coinage, mentioned by the name of *denarii æris*, or *Philippi ærei*. Two ſizes of denarii began to be uſed in the time of Caracalla; the larger of ſix ſeſtertii, or 24 aſſaria; the ſmaller of four ſeſtertii, or 16 aſſaria as uſual. In the time of Pupienus, the latter was reduced to ſuch a ſmall ſize as not to weigh more than 36 grains; though in Caracalla's time it weighed 56. After the time of Gordian III. the ſmaller coin fell into diſuſe, as breeding confuſion. The larger denarius of ſix ſeſtertii, though diminiſhed at laſt to the ſize of the early denarius, ſtill retained its value of ſix ſeſtertii, or 24 aſſaria. The *Philippus æreus* came at length in place of the ſeſtertius. It was alſo called *denarius*; from which we may learn not only their ſize, but that they were in value ten aſſaria as the firſt denarius. In the reign of Diocleſian, the place of the ſeſtertius was ſupplied by the *follis*, that emperor having reſtored the ſilver coin to its purity, and likewiſe given this form to the copper; but it would ſeem that this reſtoration of the coinage only took place towards the end of his reign; whence we have but few of his ſilver coins, and ſtill fewer of the *folles*, though the *denarii ærei* continue quite common down to the time of Conſtantine. The follis of Diocleſian ſeems to have weighed above half an ounce; and Mr Pinkerton is of opinion, that Diocleſian deſigned this coin to ſupply the place of the denarius æreus; which of courſe was worth ten aſſariæ, and ſix of them went to the ſilver denarius. From this time the aſſarium diminiſhes to the ſize of 30 grains; and ſoon after the follis appeared, the denarius æreus was entirely dropped, the former having gradually ſupplied its place. Some mints appear to have retained the uſe of the denarius longer than others; and in ſome the change was preceded, and gradually brought in, by waſhing the follis with ſilver or tin, as the denarius had formerly been. Pieces of this kind occur in the times of Diocleſian, Maximian I. and II. and Conſtantius I.; that is, for about ten years after the follis made its appearance. Some countries, however, retained the denarius æreus; others the follis; and ſome had a medium betwixt the two, or the follis waſhed in imitation of the denarius.

55 New coinage introduced by Conſtantine I.

Towards the end of the reign of Conſtantine I. a new coinage was introduced throughout the whole empire. The follis coined by this prince was of half an ounce weight; 24 of them going to the milliarenſis, or larger ſilver coin. The word *follis* ſignifies alſo a purſe, in which ſenſe we ſometimes find it mentioned in the Byzantine hiſtory. The common follis of ſilver, when it occurs by itſelf, means a purſe of 250 milliarenſes, as the ſeſtertium was 250 denarii; and by a law of Conſtantine I. every man paid to the ſtate a follis or purſe according to his income. The method of counting by purſes continues in Turkey to this day.

56 Of the dupondius.

The *dupondius* was only half the value of the ſeſtertius, or about one penny ſterling; and before the yellow braſs appeared it ſeems to have been ſtruck upon copper, and double the ſize of the as. There are ſome of this coin, ſtruck in the time of Julius Cæſar, in yellow braſs, weighing half an ounce, with a head of Venus Victrix upon one ſide; on the reverſe, a female figure, with ſerpents at her feet: while others have a Victory on the reverſe, with Q. Oppius Pr. After the time of Auguſtus, the dupondius was ſtruck in yellow braſs; which Pliny tells us was alſo the caſe in his time. The word dupondiarius ſeems to have been uſed by Pliny, and adopted, not to expreſs that the coin was *dupondius*, but that it was of dupondiary value. Neither was the former word confined to ſignify double weight, but was uſed alſo for double length or meaſure, as in the inſtance of *dupondius pes*, or two feet, &c. In the imperial times, therefore, *dupondius* was uſed, not to ſignify a coin of double the weight of the as, but of double the value. It was one of the moſt common of the Roman coins; and ſeems to have been very common even in Conſtantinople. In the time of Juſtinian, it ſeems there was a cuſtom of nicknaming young ſtudents of the law *dupondii*, againſt which the emperor made a law; but it is not known what gave riſe to the name. The dupondius, though of the ſame ſize with the as, is commonly of finer workmanſhip, the metal being greatly ſuperior in value. It continues to be of yellow braſs, as well as the ſeſtertius, to the time of Gallienus; but the as is always in copper.

57 Of the aſſarium.

The imperial as, or *aſſarium*, was worth only a halfpenny,

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halfpenny. At firſt it weighed half an ounce, and was always of copper till the time of Gallienus, when it was made of braſs, and weighed only the eighth part of an ounce. From the time of Gallienus to that of Diocleſian, it continued to diminiſh ſtill more, the ſize being then twenty to an ounce. This was the ſame with the lepta, or ſmalleſt coins but the νουμια, which weighed only ten grains.

58 Parts of the as.

The parts of the as occur but ſeldom: which may, indeed, be well expected, conſidering the low value of it; though there ſtill occur ſome of thoſe called ſemis, triens, quadrans, ſextans, and uncia, coined in the times of Nero and Domitian. There is no ſmall braſs from the time of Pertinax to that of Gallienus, excepting that of Trajanus Decius; but in the time of Gallienus it becomes extremely common; and the coins of ſmall braſs, as well as the larger, are always marked S. C. ſuch as want it being univerſally accounted forgeries, and were plated with ſilver, though the plating be now worn off. The ſmall pieces ſtruck for ſlaves during the time of the ſaturnalia, muſt alſo be diſtinguiſhed from the parts of the as. The S. C. upon theſe moſt probably ſignifies *Saturni Conſulto*, and were ſtruck in ridicule of the true coins, as the ſlaves on that occaſion had every privilege of irony.

59 Of the ſmalleſt Roman coins.

The ſeſtertius diminiſhes from Pertinax to Gallienus ſo faſt, that no parts of the as are ſtruck, itſelf being ſo ſmall. Trajanus Decius, indeed, coined ſome ſmall pieces, which went for the ſemis of the time. The ſmall braſs coins under Gallienus were called aſſaria, ſixty of which went to the ſilver denarius. They are about the ſize of the denarius, and ſome of them occur of the coinage of Gallus and his family, of half that ſize, which appear to have been ſtruck during the latter part of his reign, when the aſſarium was diminiſhed to a ſtill ſmaller ſize. It is probable, however, that ſome of theſe very ſmall coins had been ſtruck in all ages of the empire, in order to ſcatter among the people on ſolemn occaſions. Mr Pinkerton is of opinion that they are the *miſſilia*, though moſt other medalliſts think that they are medallions. "But if ſo (ſays our author), they were certainly called *miſſilia à non mittendo*; for it would be odd if fine medallions were ſcattered among the mob. It is a common cuſtom juſt now to ſtrike counters to ſcatter among the populace on ſuch occaſions, while medals are given to peers of the kingdom; and we may very juſtly reaſon from analogy on this occaſion."

60 Of the miſſilia.

The *aſſarion* or *lepton* of the Conſtantinopolitan empire was, as we have already obſerved, one of the ſmalleſt coins known in antiquity, weighing no more than 20 grains; and the *noumia* were the very ſmalleſt which have reached our times, being only one half of the former. By reaſon of their extreme ſmallneſs, they are very ſcarce; but Mr Pinkerton informs us, that he has in his poſſeſſion a fine one of Theodoſius II. which has on it the emperor's head in profile. Theodoſius P. F. AV.; on the reverſe a wreath, having in the centre VOT. XX.: MULT. XXX.

61 Coins of the lower empire.

The principal coin of the lower empire was the follis, which was divided into an half and quarter, named ημισοφολεος and τεταρτον; the latter of which is ſhown by Du Cange to have been a ſmall braſs coin, as the other is ſuppoſed to have been by Mr Pinkerton.—Beſides theſe, the follis was divided into eight oboli, 16 aſſaria or lepta, and 32 noumia, though in common computation it contained 40 of theſe laſt. This coin, notwithſtanding ſo many diviſions, was of no more value than a halfpenny.

Mr Pinkerton controverts an opinion, common among medalliſts, that the largeſt braſs coin or follis of the lower empire had 40 ſmall coins, expreſſed by the letter M upon it; the next had 30, expreſſed by the letter Λ; the half by the letter K; and the quarter marked I, which contained only 10. Mr Pinkerton informs us, that he has three coins of Anaſtaſius, all marked M in large; one of them weighs more than half an ounce; the ſecond 40 grains leſs; and the third of 160 grains, or one third of an ounce; but the ſize is ſo very unequal, that the laſt, which is very thick, does not appear above half the ſize of the firſt. There are pieces of Juſtinian which weigh a whole ounce; but the ſize of copper was increaſed as the ſilver became ſcarcer; and the value of the coinage cannot be deduced from the weight of the coins, as it is plain that our own coinage is not of half the value with regard to the metal. A great number of medallions were ſtruck by Conſtantius II. but there is no other copper larger than the half ounce, excepting that of Anaſtaſius, when the follis began to be ſtruck larger. All medaliſts allow the others to be medallions.

The metal employed in theſe very ſmall coins, though at firſt of braſs, was always a baſe and refuſe kind; but copper is generally made uſe of in the parts of the as from the earlieſt times to the lateſt; and if braſs be ſometimes employed, it is never ſuch as appears in the ſeſtertii and dupondiarii, which is very fine and beautiful, but only the refuſe. "Yellow braſs of the right ſort (ſays Mr Pinkerton), ſeems totally to have ceaſed in the Roman coinage with the ſeſtertius, under Gallienus, though a few ſmall coins of very bad metal appear under that hue as late as Julian II."

62 Roman ſilver.

Silver was coined in Rome only as late as the 485th year of the city, or 266 B. C. Varro indeed ſpeaks of ſilver having been coined by Servius Tullius, and the libella having been once in ſilver; but Pliny's authority muſt be accounted of more weight than that of this author, as he miſtakes the λιτρα of Sicily for Roman coins, having been current at Rome during the time of the firſt Punic war. Even Pliny, according to our author, very frequently miſtakes with regard to matters much antecedent to his own time; and among the moderns he criticiſes ſeverely Eraſmus and Hume. "Eraſmus (ſays he), who had been in England for ſome time, talks of leaden money being uſed here." Not even a leaden token was ſtruck in the reign of Henry VIII.; yet his authority has been followed with due deference to ſo great a name; for how could Eraſmus, who muſt have ſeen the matter with his own eyes, aſſert a direct falſehood? To give a later inſtance in a writer of reputation, Mr Hume, in Vol. VI. of his hiſtory, has theſe words, in treating of the reign of James I. "It appears that copper halfpence and farthings began to be coined in this reign. Tradeſmen had commonly carried on their retail buſineſs by leaden tokens. The ſmall ſilver penny was ſoon loſt; and at this time was nowhere to be found." Copper halfpence and farthings were not ſtruck till Charles II. 1672: there were ſmall tokens for

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for farthings ſtruck in copper by James I. but not one for the halfpenny. The ſilver farthings had ceaſed with Edward VI. but the ſilver halfpence continued the ſole coins till Charles II. It was by copper tokens that ſmall buſineſs was carried on. The ſilver penny was much uſed till the end of the reign of George I.; and ſo far from being nowhere to be found, is ſuperabundant of every reign ſince that period, not excepting even the preſent reign of George III. From theſe inſtances the reader may judge how ſtrangely writers of all ages blunder, when treating a ſubject of which they are entirely ignorant."

63 Denarii when firſt coined.

The firſt ſilver denarii coined at Rome, are ſuppoſed by our author to have been thoſe which are impreſſed with the ROMA; and he inclines to account thoſe the moſt ancient which have a double female head on the one ſide, and on the reverſe Jupiter in a car, with Victory holding the reins, and the word ROMA indented in a rude and ſingular manner. The double female head ſeems to denote Rome, in imitation of the Janus then upon the as. There are 15 of theſe in the cabinet of Dr Hunter; one of the largeſt weighs 98¼ grains: and the reſt, which ſeem to be of greateſt antiquity, are of various weights betwixt that and 84; the ſmaller and more modern weigh 58 or 59 grains; but Mr Pinkerton is of opinion, that the large ones are of the very firſt Roman coinage, and ſtruck during that interval of time betwixt the coinage of the firſt ſilver denarius and the as of two ounces. He takes the indentation of the word ROMA to be a mark of great antiquity; ſuch a mode being ſcarcely known any where elſe, except in Caulonia, Crotona, and other towns of Italy; all of them allowed to be ſtruck at leaſt 400 B. C. As theſe large coins are not double denarii, they muſt have been ſtruck prior to the ſmall ones; and Neumann has given an account of one of them recoined by Trajan, in which the indentation of ROMA is carefully preſerved. The firſt denarius was in value 10 aſes, when the as weighed three ounces; and allowing 90 grains at a medium for one of theſe large denarii, the proportion of copper to ſilver muſt have been as 1 to 160: but when the as fell to one ounce, the proportion was as 1 to 80; when it fell to half an ounce, ſo that 16 aſes went to the denarius, the proportion was as 1 to 64, at which it remained. Copper with us, in coinage, is to ſilver as 1 to 40; but in actual value as 1 to 72.

64 Value of the denarius and its parts.

At Rome the denarius was worth 8d.; the quinarius 4d.; and the ſeſtertius, whether ſilver or braſs, 2d. The denarius is the coin from which our penny is derived, and was the chief ſilver coin in Rome for 600 years. According to Celſus, ſeven denarii went to the Roman ounce, which in metals did not exceed 430 grains; but as all the denarii hitherto met with weigh at a medium only 60 grains, this would ſeem to make the Roman ounce only 420 grains; though perhaps this deficiency may be accounted for from the unavoidable waſte of metal even in the beſt preſerved of theſe coins. According to this proportion the Roman pound contained 84 denarii; but in tale there was a very conſiderable exceſs; for no fewer than 100 denarii went to the Roman pound. The Greek ounce appears to have been conſiderably larger than that of Rome, containing about 528 grains; yet notwithſtanding this apparently great odds, the difference in the coins was ſo ſmall, that the Greek money wnet current in Rome, and the Roman in Greece. The denarius at firſt went for 10 aſſes, and was marked X: it was afterwards raiſed to 16; which Mr Pinkerton ſuppoſes to have been about 175 B. C. Some are met with bearing the number XVI. nay, with every number up to CCCCLXXVI. Theſe large numbers are ſuppoſed to have been mint-marks of ſome kind or other. After being raiſed to 16 aſes, it continued at the ſame value till the time of Gallienus; ſo that till that time we are to look upon its conſtituent parts to be 16 aſes or aſſaria, eight dupondii, four braſs ſeſtertii, and two ſilver quinarii. Under the emperor Severus, however, or his ſucceſſor Caracalla, denarii were ſtruck of two ſizes, one of them a third heavier than the common; which we muſt of conſequence ſuppoſe to have borne a third more value. This large piece obtained the name of *argenteus*, and *argenteus Philippus*, or the "ſilver Philip;" the name of Philip having become common to almoſt every coin. The common denarii now began to be termed *minuti* and *argenti Philippi minutuli*, &c. to expreſs their being ſmaller than the reſt. Some have imagined that the large denarii were of the ſame value with the ſmall, only of worſe metal; but Mr Pinkerton obſerves, that among the few which have any difference of metal, the ſmalleſt are always the worſt. The firſt mention of the *minuti* is in the time of Alexander Severus, who reduced the price of pork from eight minuti at Rome to two and to one. The *minutus argenteus* of that age was about 40 grains; and from the badneſs of the metal was not worth above 4d. of our money. Thus the price of meat was by this prince reduced firſt to 8d. and then to 4d.

65 Reſtoration of the purity of the Roman coins.

According to Zozimus and other writers, the purity of the Roman coin was reſtored by Aurelian: but Mr Pinkerton controverts this opinion; thinking it more probable, that he only made the attempt without ſucceſs; or that his reformation might be entirely confined to gold, on which there is an evident change after the time of this emperor. His ſucceſſor Tacitus is ſaid to have allowed no braſs to be mixed with ſilver upon any account; yet the few coins of this emperor are very much alloyed. We are certain, however, that the emperor Diocleſian reſtored the ſilver to its ancient purity; the denarii ſtruck in his reign being very ſmall indeed, but of as fine ſilver as the moſt ancient coins of the empire. After Gordian III. the ſmall denarius entirely vaniſhed, while the large one was ſo much diminiſhed, that it reſembled the *minutus*, or ſmall one of Caracalla, in ſize. Gallienus introduced the *denarii ærei* inſtead of the *ſeſtertii*. The *argenteus*, though reduced more than one third in ſize, contained ſix denarii ærei, the old ſtandard of ſeſtertii. According to the writers of this period, and ſome time afterwards, the denarius or argenteus contained 60 aſſaria; whence it follows, that each denarius æreus had 10; and from this it probably had its name. The aſſaria are of the ſize of the argentei already mentioned; and ſhow the copper to have retained nearly its old proportion of value to the ſilver, viz. 1 to 60.

66 Reformation of the ſilver coin by Conſtantine.

A larger ſilver coin was introduced by Conſtantine I. who accommodated the new money to the pound of gold in ſuch a manner, that 1000 of the former in tale were equal to the latter in value; ſo that this new piece from thence obtained the name of the *milliarenſis*

milliarenſis or " thouſander." Its weight at a medium is 70 grains, or 70 to the pound of ſilver: but Mr Pinkerton is of opinion, that it might have contained 72 grains, of which two have now periſhed by the ſoftneſs of the ſilver; that the pound contained 72; or that two of the number might be allowed for coinage; while the alloy alone would pay for coining gold. The code ſays, that 60 went to the pound; but the numbers of this are quite corrupt. The *milliarenſis* was worth about a ſhilling ſterling. The argentei or denarii, however, were ſtill the moſt common currency; and having been originally rated at 100 to the pound of ſilver in tale, they from thence began to be called *centenionales*, or " hundreders." Thoſe of Conſtantine I. and II. Conſtans, and Conſtantius, weigh from 50 grains down to 40; thoſe of Julian and Jovian, from 40 to 30, and of the ſucceeding emperors from that time to Juſtinian, from 30 to 20. Under Heraclius they ceaſed entirely; and, from Juſtinian to their total abolition, had been brought down from 15 to 10 grains. A like decreaſe of weight took place in the milliarenſis; thoſe of Conſtantine and Conſtans being above 70 grains in weight; thoſe of Arcadius not above 60; and the milliarenſis of Juſtinian not more than 30 grains; but, from the weight of thoſe in Dr Hunter's cabinet, Mr Pinkerton deduces the medium to have been exactly 70$\frac{8}{11}$ grains. Theſe coins were alſo called *majorinæ*.

67 Account of the ſmall Roman coins.

The ſmaller ſilver coins of Rome were, 1. The *quinarius*, at firſt called *victoriatus*, from the image of Victory on its reverſe; and which it continued to bear from firſt to laſt. Its original value was five aſes, but it was afterwards raiſed to eight, when the value of the denarius increaſed to 16. According to Pliny, it was firſt coined in conſequence of the *lex Clodia*, about the 525th year of Rome. Some are of opinion, that it was called κερατιον under the Conſtantinopolitan empire, becauſe it was worth a κερατιον of gold, 144 of which went to the ounce: but this is denied by Mr Pinkerton, becauſe, at the time that the word κερατιον firſt appears in hiſtory, the denarius did not weigh above 30 grains; and of conſequence, as 25 muſt have gone to the gold ſolidus, of which there were ſix in the ounce, 130 denarii muſt have gone to the ounce of gold. He is therefore of opinion, that the word κερατιον, was only another name for the denarius when much reduced in ſize; probably owing to the great ſcarcity of ſilver in Conſtantinople, though in the ſame city there was plenty of gold; and of conſequence, the gold ſolidus was never diminiſhed. " For Monteſquieu (ſays our author) has well obſerved, that gold muſt be common where ſilver is rare. Hence gold was the common regulation of accounts in the Eaſtern empire." The δικερατιον met with in ancient authors, according to Mr Pinkerton, was merely an improper name for the *milliarenſis*; when, on account of the ſcarcity of ſilver, the denarius was reduced, and no milliarenſes coined: ſo that the current milliarenſis of former reigns happened to be double to the denarius or centenonialis. The quinarius diminiſhes in ſize along with the other coins: thoſe of Auguſtus weighing 30 grains, of Severus 25, of Conſtantine I. 20, of Juſtinian 12, and of Heraclius only 5. A new ſilver coinage ſeems to have taken place after the days of this emperor; as the little we then meet with, which in the beſt cabinets ſcarce exceeds a dozen of coins, conſiſts entirely of large unſhapely pieces of coarſe metal.

68 Diviſions of the denarius.

2. The conſular denarius had alſo four ſilver ſeſtertii, till the as fell to half an ounce, when it was thought proper to coin the ſeſtertius in braſs, as it continued to be ever afterwards. " The very laſt ſilver ſeſtertius (ſays Mr Pinkerton) which appears, is one with a head of Mercury, and H. S.; on the reverſe a caduceus P. SEPVLLIVS; who appears to be the P. SEPVLLIVS MACER of the denarii of Julius Cæſar. If ſo, as is moſt probable, the ſeſtertius was coined in ſilver down to Auguſtus; and it is of courſe not to be expected that any of braſs can appear till Auguſtus, under whom they are actually quite common. I have indeed ſeen no coin which could be a conſular braſs ſeſtertius; and though we have certainly braſs dupondii of Cæſar, yet it is reaſonable to infer, that the braſs ſeſtertius was firſt coined by Auguſtus. Not one ſilver ſeſtertius appears during the whole imperial period, yet we know that the ſeſtertius was the moſt common of all ſilver coins. The conſular ſeſtertii of ſilver, marked H. S. are not uncommon, nor the quinarii; but the latter are very ſcarce of all the emperors, if we except one inſtance, the ASIA RECEPTA of Auguſtus.

69 Roman gold.

" The Roman gold coinage was ſtill later than that of ſilver. Pliny tells us, that " gold was coined 62 years after ſilver; and the ſcruple went for 60 ſeſterces. It was afterwards thought proper to coin 40 pieces out of the pound of gold. And our princes have by degrees diminiſhed their weight to 45 in the pound." This account is confirmed by the pieces which ſtill remain; for we have that very coin weighing a ſcruple, which went for 20 ſeſterces. On one ſide is the head of Mars, and on the other an eagle; and it is marked XX. We have another coin of the ſame kind, but double, marked XXXX; and its triple, marked ⚴X or 60; the ⚴ being the old numeral character for 50." Mr Pinkerton, the diſcoverer of this, treats other medalliſts with great aſperity. Savot and Hardouin are mentioned by name; the latter (he ſays) is " ignorant of common ſenſe;" and neither he nor Savot could explain it but by reading backward; put the ⚴ for the Roman V, and thus making it XV. Other readings have been given by various medalliſts, but none have hit upon the true one excepting our author, though the coin itſelf led to it; being juſt three times the weight of that marked XX. We have likewiſe half the largeſt coin, which is marked XXX, and which weighs 26 grains; the ſmalleſt is only 17½; the XXXX weighs 34; and the LX or drachma 53. There is alſo the didrachm of this coinage, of 106 grains.

70 Account of the aurei.

The *aurei*, or Roman gold coins, were at firſt 48 in the pound; but they were afterwards diminiſhed in number to 40, owing to an augmentation in the weight of each coin. In the time of Sylla, the aureus weighed no leſs than from 164 to 168 grains, and there were only 30 in the pound; but ſuch confuſion in the coinage was introduced by that conqueror, that no perſon could know exactly what he was worth. Till this time the aureus ſeems to have continued of the value of 30 ſilver denarii, about one pound ſterling; for about that time it was enlarged a whole third, that

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that it might still be equivalent to the full number of denarii. But after Sylla had taken Athens, and the arts and manners of Greece became objects of imitation to the Romans, the aureus fell to 40 in the pound, probably when Sylla had abdicated his dictatorship. Thus, being reduced near to the scale of the Greek χρυσος, it passed for 20 denarii, as the latter did for as many drachmas, being in currency 13s. 4d. sterling. "This (says Mr Pinkerton) is the more probable, because we know from Suetonius, that the great Cæsar brought from Gaul so much gold, that it sold for nine times its weight of silver: but the Gallic gold was of a very base sort."

In the time of Claudius, the aureus was valued at 100 sestertii, or 25 silver denarii, at which it continued till the time of Heliogabalus, when it fell to about 92 grains at a medium, or rose in number to 55 in the pound. In the reign of Philip, during which the city completed its thousandth year, the aureus was coined of two or three sizes. These are impressed with a head of Rome on one side, and various figures on the other; but the workmanship is so rude, that they are supposed to have been struck in some of the more uncivilized provinces of the empire. The practice of having different gold coins, however, continued under Valerian, Gallienus, and his successors. In the time of Gallienus, they were of 30, 65, and from 86 to 93 grains; the double aurei being from 172 to 183½ grains; but the aureus properly so called was from 86 to 93; those of 30 and 32 being the *trientes aurei* of the *Historiæ Augustæ Scriptores;* while the larger, from 62 to 65, are to be accounted double trientes, and were perhaps called *minuti aurei.* The value of these different sizes of aurei is not known.

71 Alteration in the gold coin made by Aurelian.

That Aurelian made some alteration in the coin is certain; but Mr Pinkerton supposes it to have been only in the gold; because under him and his successor Probus, the common aureus was of 100 grains, a size confined to those emperors: there are likewise halves of about 50 grains; and double aurei, commonly of very fine workmanship, of upwards of 200 grains. In the time of Gallienus, the precious metal was so common, that this emperor vied in magnificence with Nero and Heliogabalus. Aurelian, who plundered the rich city of Palmyra, and thus became master of the treasures of the east, obtained such a profusion of gold, that he looked upon it to be produced by nature in greater plenty than silver. It is remarkable, that during this emperor's reign there was a rebellion among the money coiners, which could not be quelled but by the destruction of several thousands; which Mr Pinkerton ascribes to his having ordered the gold to be restored to its former size, but to go for no more silver than it formerly did. "So very little silver (says he) occurs of this period, that it is plain no alteration in the silver produced the war with the moneyers; and in the brass he made no change; or if he had, it were strange that such commotions should arise about so trifling a metal. But if, as appears from the coins, he ordered the aureus, which had fallen to 80 grains, to be raised to about 100, it is no wonder that the contractors should be in an uproar; for a whole quarter of their coinage, amounting as would seem, to all their profits, was lost. Aurelian judged, that when he found gold so common in the east, it was equally so in the west; and that the moneyers must have made a most exorbitant profit; but his ideas on this subject were partial and unjust: and after his short reign, which did not exceed five months after the alteration, the gold returned to its former course; though a few pieces occur of Aurelian's standard, struck, as would seem, in the commencement of the reign of Probus his successor.

From this time to that of Constantine I. the aureus weighed between 70 and 80 grains; but in his reign it was changed for the solidus, of which six went to the ounce of gold, which went for 14 milliarenses, and 25 denarii as before; the value of silver being now to gold as 14 to 1. This new coin continued of the same value to the final downfal of the Constantinopolitan empire; gold being always very plentiful in that city, though silver became more and more scarce. The solidus was worth 12s. sterling. Here again our author most severely criticises Mr Clarke and Mr Raper: the former (he says) with respect to the value of gold in the time of Constantine I. "has left all his senses behind him. In page 267, he absurdly asserts, that 20 denarii went to the solidus in the time of Theodosius I. and proceeds with this deplorable error to the end of his work. He then tells us, that only 14 denarii went to the solidus under Constantine I. &c." To Mr Raper, however, he is a little more merciful, as he owns, that "though he (Mr Raper) has strangely confounded the milliarensis with the denarius, he has yet kept common sense for his guide." Mr Pinkerton, indeed, argues with great probability, "that had any change in the coinage taken place between the time of Constantine and Theodosius I. that is, in less than 50 years, the laws of that period, which are all in the Theodosian code, must have noticed it." To this and other arguments upon the subject, Mr Pinkerton adds the following observation upon the value of gold and silver: "As a state advances to its height, gold increases in value; and as a state declines, it decreases, providing the metals are kept on a par as to purity. Hence we may argue, that gold decreased in its relation to silver perhaps four or five centuries, furnished most European kingdoms with gold in coin, which otherwise would, from their want of arts and of intercourse with the east, then the grand seminary of that metal, have almost been ignorant of what gold was. These gold coins were called *Bezants* in Europe, because sent from Byzantium or Constantinople; and were *solidi* of the old scale, six to the ounce. In Byzantine writers, the solidus is also called *nomisma*, or "the coin;" *crysinos*, because of gold; *hyperperos*, from its being refined with fire, or from its being of bright gold flaming like fire. The *solidi* also, as the *aurei* formerly, received names from the princes whose portraits they bore; as *Michelati*, *Manuelati*. *Solidus* is a term used also for the aureus by Apuleius, who lived in the time of Antoninus the Philosopher; nay, as early as in the prætorian edicts of the time of Trajan. It was then a distinction from the semissis or half. In the time of Valerian, when aurei of different sizes had been introduced, it became necessary to distinguish the particular aurei meant. Hence in the Imperial Rescripts, published by the *Historiæ Augustæ Scriptores*, Valerian uses the term *Philippeos nostri vultus*, for the common aurei. Aurelian uses the same term *aurei Philippei*,

Philippei, for the aurei which he had reſtored to their ſize in ſome degree. Gallienus uſes *aurei Valeriani* for his father's coins. *Aurei Antoniniani* are likewiſe put by Valerian for coins of the early Antonini, of ſuperior ſtandard to any then uſed.

72 Diviſion of the aureus.

In the firſt gold coinage at Rome, the aureus was divided into four parts; the ſemiſſis of 60 ſeſtertii; the tremiſſis, or third, of 40; the fourth, the name of which is not mentioned, of 30; and the ſcrupulum of 20. But in a ſhort time all of theſe fell into diſuſe, except the ſemiſſis or half, which is extremely ſcarce; ſo that it is probable that few have been ſtruck. It is an erroneous opinion (according to Mr Pinkerton), that the ſemiſſis was called a *denarius aureus*. The aureus itſelf indeed had this name; but the name of *quinarius* is applied to the ſemiſſis with greater propriety than the former. Trientes, or tremiſſis of gold, are found of Valerian and his ſon Gallienus, and weigh about 30 grains. Thoſe of Salonina the wife of Gallienus weigh 33 grains. Under the Conſtantinopolitan empire, tremiſſes again make their appearance; and from the time of Valentinian downwards, the thirds are the moſt common coins of gold, being worth about 4s. ſterling. The ſemiſſis is likewiſe mentioned, but none occur earlier than the time of Baſiliſcus. The gold tremiſſis was the pattern of the French and Spaniſh gold coins; as the ſilver denarius, in its diminiſhed ſtate, was of the Gothic and Saxon penny.

73 Account of the Roman method of coining.

We ſhall cloſe this account of the Roman money with ſome remarks concerning the mint, and method of coinage. This at firſt ſeems to have been under the direction of the quæſtor. About the time that ſilver was firſt coined in Rome, viz. about 266 B. C. the *triumviri monetales* were created. They were at firſt of ſenatorial rank, but were by Auguſtus choſen from among the equeſtrian; and the title of *triumviri* was continued till after the time of Caracalla; but under Aurelian there was probably but one maſter of the mint, called *rationalis*; and Mr Pinkerton is of opinion that the change took place under Gallienus. He ſeems alſo to have permitted the provincial cities to coin gold and ſilver, as well as to have altered the form of the mints in the capital, and to have ordered them all to ſtrike money with Latin legends, and of the ſame forms; as in his time we firſt meet with coins with mint marks of cities and offices. The violent inſurrection which took place in his reign has already been mentioned, as well as its probable cauſe; and Mr Gibbon has ſhown, that the concealed enemies of Aurelian took ſuch advantage of this inſurrection, that it coſt 7000 of his beſt troops before it could be quelled. About this time the *procurator monetæ* ſeems to have ſucceeded the *rationalis* as director of the mint. In the colonies, the direction of the mint ſeems to have been given to the decemviri, whoſe names frequently occur on colonial coins; "which (ſays Mr Pinkerton), though generally of rude invention, and ruder execution, are yet often intereſting and important."

The engraving of the ancient dies uſed in coinage was a work of much genius and labour; and at Rome Greek artiſts were generally employed in it; but it has been thought a matter of great ſurpriſe, that ſcarce any two ancient coins are to be found exactly the ſame. Hence ſome antiquaries have imagined, that only a ſingle coin was thrown off from each die. M. Beauvais informs us, that the only two Roman imperial coins of the firſt times which he had ſeen perfectly alike were thoſe of the emperor Galba. It is, however, the opinion of the beſt judges, that a perfect ſimilarity betwixt two medals is a very great reaſon for ſuppoſing one of them to be forged. "It muſt alſo be obſerved (ſays Mr Pinkerton), that the differences in coins, apparently from the ſame die, are often ſo minute as to eſcape an eye not uſed to microſcopic obſervations of this ſort. But it would be ſurpriſing if any two ancient coins were now found ſtruck with the ſame die; for out of each million iſſued, not above one has reached us. Dies ſoon give way by the violence of the work; and the ancients had no puncheons nor matrices, but were forced to engrave many dies for the ſame coin. Even in our mint, upon ſending for a ſhilling's worth of new halfpence, it will appear that three or four dies have been uſed. Sometimes the obverſe of the die gives way, ſometimes the reverſe; but among us it is renewed by puncheons, though with variations in the lettering or other minute ſtrokes; while the ancients were forced to recur to another die differently engraven. The engravers of the die were called *cælatores*; other officers employed in the mint were the *ſpectatores*, *expectatores*, or *nummularii*. The melters were ſtyled *fuſarii*, *flatuarii*, and *flaturarii*; thoſe who adjuſted the weight were called *æquatores monetarum*; thoſe who put the pieces into the die *ſuppoſitores*, and thoſe who ſtruck them *malleatores*. At the head of each office was an officer named *primicerius*, and the foreman was named *optio et exactor*."

In order to aſſiſt the high relief on the coins, the metal, after being melted and refined, was caſt into bullets, as appears from the ancient coins not being cut or filed on the edges, but often cracked, and always rough and unequal. Theſe bullets were then put into the die, and received the impreſſion by repeated ſtrokes of the hammer, though ſometimes a machine appears to have been uſed for this purpoſe: for Boiterue informs us, that there was a picture of the Roman mintage in a grotto near Baiæ, where a machine was repreſented holding up a large ſtone as if to let it fall ſuddenly, and ſtrike the coin at once. None of the ancient money was caſt in moulds, excepting the moſt ancient and very large Roman braſs, commonly called *weights*, and other Italian pieces of that ſort; all the reſt being mere forgeries of ancient and modern times. Some Roman moulds which have been found are a proof of this; and from theſe ſome medalliſts have erroneouſly imagined that the ancients firſt caſt their money in moulds, and then ſtamped it, in order to make the impreſſion more clear and ſharp.

The ancients had ſome knowledge of the method of crenating the edges of their coins, which they did by cutting out regular notches upon them; and of this kind we find ſome of the Syrian and ancient conſular coins, with a few others. The former were caſt in this ſhape, and then ſtruck; but the latter were crenated by inciſion, to prevent forgery, by ſhowing the inſide of the metal: however, the ancient forgers alſo found out a method of imitating this; for Mr Pinkerton informs us, that he had a Roman conſular coin, of which the inciſions, like the reſt, were plated with ſilver over the copper.

SECT.

Preſervation.

SECT. VI. *Of the Preſervation of Medals.*

WE now come to conſider what it is that diſtinguiſhes one medal from another, and why ſome are ſo highly prized more than others. This, in general, beſides its genuineneſs, conſiſts in the high degree of preſervation in which it is. This, by Mr Pinkerton, is called the *conſervation* of medals, and is by him regarded as *good* and as *perfect*. In this, he ſays that a true judge is ſo nice, that he will reject even the rareſt coins if in the leaſt defaced either in the figures or legend. Some, however, are obliged to content themſelves with thoſe which are a little rubbed, while thoſe of ſuperior taſte and abilities have in their cabinets only ſuch as are in the very ſtate in which they came from the mint; and ſuch, he ſays, are the cabinets of Sir Robert Auſtin, and Mr Walpole, of Roman ſilver, at Strawberryhill. It is abſolutely neceſſary, however, that a coin be in what is called *good* preſervation; which in the Greek or Roman emperors, and the colonial coins, is ſuppoſed to be when the legends can be read with ſome difficulty; but when the conſervation is perfect, and the coin juſt as it came from the mint, even the moſt common coins are valuable.

74
Braſs and copper beſt preſerved by the ruſt that covers them.

The fine ruſt, like varniſh, which covers the ſurface of braſs and copper coins, is found to be the beſt preſerver of them; and is brought on by lying in a certain kind of ſoil. Gold cannot be contaminated but by iron mold, which happens when the coin lies in a ſoil impregnated with iron; but ſilver is ſuſceptible of various kinds of ruſt, principally green and red; both of which yield to vinegar. In gold and ſilver coins the ruſt muſt be removed, as being prejudicial; but in braſs and copper it is preſervative and ornamental; a circumſtance taken notice of by the ancients.

75
Different kinds of this ruſt.

"This fine ruſt (ſays Mr Pinkerton), which is indeed a natural varniſh not imitable by the art of man, is ſometimes a delicate blue, like that of a turquoiſe; ſometimes of a bronze brown, equal to that obſervable in ancient ſtatues of bronze, and ſo highly prized; and ſometimes of an exquiſite green, a little on the azure hue, which laſt is the moſt beautiful of all. It is alſo found of a fine purple, of olive, and of a cream colour or pale yellow: which laſt is exquiſite, and ſhows the impreſſion to as much advantage as paper of cream colour, uſed in all great foreign preſſes, does copperplates and printing. The Neapolitan patina (the ruſt in queſtion) is of a light green; and when free from excreſcence or blemiſh is very beautiful. Sometimes the purple patina gleams through an upper coat of another colour, with as fine effect as a variegated ſilk or gem. In a few inſtances a ruſt of a deeper green is found; and it is ſometimes ſpotted with the red or bronze ſhade, which gives it quite the appearance of the Eaſt Indian ſtone called the *bloodſtone*. Theſe ruſts are all, when the real product of time, as hard as the metal itſelf, and preſerve it much better than any artificial varniſh could have done; concealing at the ſame time not the moſt minute particle of the impreſſion of the coin."

76
Medals how diminiſhed in value.

The value of medals is lowered when any of the letters of the legend are miſplaced; as a ſuſpicion of forgery is thus induced. Such is the caſe with many of thoſe of Claudius Gothicus. The ſame, or even greater, diminution in value takes place in ſuch coins as have not been well fixed in the die, which has occaſioned their ſlipping under the ſtrokes of the hammer, and thus made a double or triple image. Many coins of this kind are found in which the one ſide is perfectly well formed, but the other blundered in the manner juſt mentioned. Another blemiſh, but of ſmaller moment, and which to ſome may be rather a recommendation, is when the workmen through inattention have put another coin into the die without taking out the former. Thus the coin is convex on one ſide, and concave on the other, having the ſame figure upon both its ſides.

77
Countermarked medals.

The medals ſaid by the judges in this ſcience to be *countermarked* are very rare, and highly valued. They have a ſmall ſtamp impreſſed upon them, in ſome an head, in others a few leters, ſuch as AUG: N. PROBUS, &c. which marks are ſuppoſed to imply an alteration in the value of the coin; as was the caſe with the countermarked coins of Henry VIII. and Queen Mary of Scotland. Some have a ſmall hole through them; ſometimes with a little ring faſtened in it, having been uſed as ornaments; but this makes no alteration in their value. Neither is it any diminution in the value of a coin that it is ſplit at the edges; for coins of undoubted antiquity have often been found in this ſtate, the cauſe of which has been already explained. On the contrary, this cracking is generally conſidered as a great merit; but Mr Pinkerton ſuſpects that one of theſe cracked coins has given riſe to an error with reſpect to the wife of Carauſius who reigned for ſome time in Britain. The inſcription is read ORIUNA AUG: and there is a crack in the medal juſt before the O of oriuna. Without this crack Mr Pinkerton ſuppoſes that it would have been read FORTUNA AUG.

78
Silver and gold how tarniſhed.

Some particular ſoils have the property of giving ſilver a yellow colour as if it had been gilt. It naturally acquires a black colour through time, which any ſulphureous vapour will bring on in a few minutes. From its being ſo ſuſceptible of injuries, it was always mixed by the ancients with much alloy, in order to harden it. Hence the impreſſions of the ancient ſilver coins remain perfect to this day, while thoſe of modern coins are obliterated in a few years. On this account Mr Pinkerton expreſſes a wiſh, that modern ſtates would allow a much greater proportion of alloy in their ſilver coin than they uſually do. As gold admits of no ruſt except that from iron above-mentioned, the coins of this metal are generally in perfect conſervation, and freſh as from the mint.

79
How to cleanſe them.

To cleanſe gold coins from this ruſt, it is beſt to ſteep them in aquafortis, which, though a very powerful ſolvent of other metals, has no effect upon gold. Silver may be cleanſed by ſteeping for a day or two in vinegar, but more effectually by boiling in water with three parts of tartar and one of ſea ſalt; on both theſe metals, however, the ruſt is always in ſpots, and never forms an entire incruſtation as on braſs or copper. The coins of theſe two metals muſt never be cleanſed, as they would thus be rendered full of ſmall holes eaten by the ruſt. Sometimes, however, they are found ſo totally obſcured with ruſt, that nothing can be diſcovered upon them; in which caſe it is beſt to clear them with a graver; but it may alſo be done by boiling them for 24 hours in water with

three

How to distinguish true from counterfeits.

three parts of tartar and one of alum; not sea salt as in silver coins.

80 Why ancient coins are in such a high state of preservation.

The high state of preservation in which ancient coins are usually found, is thus accounted for by Mr Hancarville. He observes, that the chief reason is the custom of the ancients always to bury one or more coins with their dead, in order to pay for their passage over the river Styx. "From Phidon of Argos (says he) to Constantine I. are 36 generations: and from Magna Græcia to the Euphrates, from Cyrene to the Euxine sea, Grecian arts prevailed, and the inhabitants amounted to about 30,000,000. There died, therefore, in that time and region, not less than ten thousand millions of people, all of whom had coins of one sort or other buried with them. The tombs were sacred and untouched; and afterwards neglected, till modern curiosity or chance began to disclose them. The urn of Flavia Valentina, in Mr Towley's capital collection, contained seven brass coins of Antoninus Pius and Heliogabalus. Such are generally black, from being burnt with the dead. The best and freshest coins were used on these occasions from respect to the dead; and hence their fine conservation. At Syracuse a skeleton was found in a tomb, with a beautiful gold coin in its mouth; and innumerable other instances might be given, for hardly is a funeral urn found without coins. Other incidents also conspire to furnish us with numbers of ancient coins, though the above-recited circumstance be the chief cause of perfect conservation. In Sicily, the silver coins with the head of Proserpine were found in such numbers as to weigh 600 French livres or pounds. In the 16th century, 60,000 Roman coins were found at Modena, thought to be a military chest hid after the battle of Bedriacum, when Otho was defeated by Vitellius. Near Brest, in the year 1760, between 20 and 30,000 Roman coins were found. A treasure of gold coins of Lysimachus was found at Deva on the Marus; and Strabo, lib. vii. and Pausan. *in Attic.* tell that he was defeated by the Getæ; at which time this treasure seems to have fallen into their hands."

81 Number of ancient coins.

Thus Mr Pinkerton, from the authority of Mr Hancarville and others: but considering these vast numbers of coins found in various places, it seems surprising how so few should now remain in the cabinets of the curious, as the same author informs us that the whole of the different ancient coins known to us amount only to about 80,000, though he owns that the calculation cannot be esteemed accurate.

Sect. VII. *How to distinguish true Medals from counterfeits.*

The most difficult and the most important thing in the whole science of medals is the method of distinguishing the true from the counterfeit. The value put upon ancient coins made the forgery of them almost coeval with the science itself; and as no laws inflict a punishment upon such forgers, men of great genius and abilities have undertaken the trade: but whether to the real detriment of the science or not, is a matter of some doubt; for if only exact copies of genuine medals are sold for the originals, the imposition may be deemed trifling: but the case must be accounted very different, if people take it upon them to forge medals which never existed. At first the forgeries were extremely gross; and medals were forged of Priam, of Aristotle, Artemisia, Hannibal, and most of the other illustrious personages of antiquity. Most of these were done in such a manner, that the fraud could easily be discovered; but others have imposed even upon very learned men. Mr Pinkerton mentions a remarkable medal of the emperor Heraclius, representing him in a chariot on the reverse, with Greek and Latin inscriptions, which Joseph Scaliger and Lipsius imagined to have been struck in his own time, but which was certainly issued in Italy in the 15th century. "Other learned men (says our author) have been strangely misled, when speaking of coins; for to be learned in one subject excludes not gross ignorance in others. Budæus, de Asse, quotes a denarius of Cicero, M. TULL. Erasmus, in one of his Epistles, tells us with great gravity, that the gold coin of Brutus struck in Thrace, ΚΟΣΩΝ, bears the patriarch Noah coming out of the ark with his two sons, and takes the Roman eagle for the dove with the olive branch. Winkelman, in his letters informs us, that the small brass piece with Virgil's head, reverse EPO, is undoubtedly ancient Roman; and adds, that no knowledge of coins can be had out of Rome: but Winkelman, so conversant in statues, knew nothing of coins. It is from other artists and other productions that any danger of deceit arises. And there is no wonder that even the skilful are misled by such artists as have used this trade; for among them appear

82 Coins forged by excellent artists.

the names of Victor Gambello, Giovani del Cavino, called the PADUAN, and his son Alessandro Bassiano, likewise of Padua, Benvenuto Cellini, Alessandro Greco, Leo Aretino, Jacobo da Frezzo, Federigo Bonzagna, and Giovani Jacopo, his brother; Sebastiano Plumbo, Valerio de Vizenza, Gorlæus, a German, Carteron of Holland, and others, all or most of them of the 16th century; and Cavino the Paduan, who is the most famous, lived in the middle of that century. The forgeries of Cavino are held in no little esteem, being of wonderful execution. His and those of Carteron are the most numerous, many of the other artists here mentioned not having forged above two or three coins. Later forgers were Dervieu of Florence who confined himself to medallions, and Cogornier who gave coins of the 30 tyrants in small brass. The chief part of the forgeries of Greek medals which have come to my knowledge are of the first mentioned, and a very gross kind, representing persons who could never appear upon coin, such as Priam, Æneas, Plato, Alcibiades, Artemisia, and others. The real Greek coins were very little known or valued till the works of Goltzius appeared, which were happily posterior to the æra of the grand forgers. Why later forgers have seldom thought of counterfeiting them cannot be easily accounted for, if it is not owing to the masterly workmanship of the originals, which sets all imitation at defiance. Forgeries, however, of most ancient coins may be met with, and of the Greek among the rest.

83 Roman forgeries more conspicuous than Greek.

"The forgeries are more conspicuous among the Roman medals than any other kind of coins; but we are not to look upon all these as the work of modern artists. On the contrary, we are assured that many of them were fabricated in the times of the Romans themselves, some of them being even held in more estimation than the genuine coins themselves, on account

 of

How to distinguish true from counterfeits.

of their being plated, and otherwise executed in a manner to which modern forgers could never attain. Even the ancients held some of these counterfeits in such estimation, that Pliny informs us there were frequently many true denarii given for one false one."—Caracalla is said to have coined money of copper and lead plated with silver; and plated coins, the work of ancient forgers, occur of many Greek cities and princes; nay, there are even forgeries of barbaric coins. "Some Roman coins (says Mr Pinkerton), are found of iron or lead plated with brass, perhaps trials of the skill of the forger. Iron is the most common; but one decursio of Nero is known of lead plated with copper. Neumann justly observes, that no historic faith can be put in plated coins, and that most faulty reverses, &c. arise from plated coins not being noticed as such. Even of the Roman consular coins not very many have ever been forged. The celebrated silver denarius of Brutus, with the cap of liberty and two daggers, is the chief instance of a consular coin of which a counterfeit is known. But it is easily rejected by this mark: in the true coin the cap of liberty is below the guard or hilt of the daggers; in the false, the top of it rises above that hilt."

84 Denarius of Brutus.

85 Imperial medals.

The imperial series of medals is the grand object of modern medallic forgeries; and the deception was at first extended to the most eminent writers upon the subject. The counterfeits are by Mr Pinkerton divided into six classes.

I. Such as are known to be imitations, but valued on account of the artists by whom they are executed. In this class the medals of the Paduan rank highest; the others being so numerous, that a complete series of imperial medals of almost every kind, nay almost of every medallion, may be formed from among them. In France, particularly, by far the greater part of the cabinets are filled with counterfeits of this kind. They are distinguished from such as are genuine by the following marks: 1. The counterfeits are almost universally thinner. 2. They are never worn or damaged. 3. The letters are modern. 4. They are either destitute of varnish entirely, or have a false one, which is easily known by its being black, shining, and greasy, and very easily hurt with the touch of a needle, while the varnish of ancient medals is as hard as the metal itself. Instead of the greasy black varnish above mentioned, indeed, they have sometimes a light green one, spotted with a kind of iron marks, and is composed of sulphur, verdigrise, and vinegar. It may frequently be distinguished by the hairstrokes of the pencil with which it was laid on being visible upon it. 5. The sides are either filed or too much smoothed by art, or bear the marks of a small hammer. 6. The counterfeits are always exactly circular, which is not the case with ancient medals, especially after the time of Trajan.

86 Paduan forgeries how known.

The Paduan forgeries may be distinguished from those of inferior artists by the following marks: 1. The former are seldom thinner than the ancient. 2. They very seldom appear as worn or damaged, but the others very frequently, especially in the reverse, and legend of the reverse, which sometimes, as in forged Othos, appear as half consumed by time. 3. The letters in moulds taken from the antique coins have the rudeness of antiquity. 4. False varnish is commonly light green or black, and shines too much or too little. 5. The sides of forged coins are frequently quite smooth, and undistinguishable from the ancient, though to accomplish this requires but little art. 6. Counterfeit medals are frequently as irregular in their form as the genuine; but the Paduan are generally circular, though false coins have often little pieces cut off, in perfect imitation of the genuine. 7. In cast coins the letters do not go sharp down into the medal, and have no fixed outline; their minute angles, as well as those of the drapery, are commonly filled up, and have not the sharpness of the genuine kind. Where the letters or figures are faint, the coin is greatly to be suspected.

How to distinguish true from counterfeits.

The letters form the great criterion of medals, the ancient being very rude, but the modern otherwise; the reason of which, according to Cellini, is, that the ancients engraved all their matrices with the graver or burin, while the modern forgers strike theirs with a punch.

87 Letters the principal criterion of medals.

According to Vico, the false patina is green, black, russet, brown, gray, and iron colour. The green is made from verdigrise, the black is the smoke of sulphur, the gray is made of chalk steeped in urine, the coin being left for some days in the mixture. The russet is next to the natural, by reason of its being a kind of froth which the fire forces from ancient coins; but when false, it shines too much. To make it they frequently took the large brass coins of the Ptolemies, which were often corroded, and made them red hot in the fire; put the coins upon them, and a fine patina adhered. Our author does not say in what manner the iron-coloured patina was made. "Sometimes (adds he) they take an old defaced coin, covered with real patina, and stamp it anew; but the patina is then too bright in the cavities, and too dull in the protuberances. The trial of brass coins with the tongue is not to be despised; for if modern the patina tastes bitter or pungent, while if ancient it is quite tasteless."

88 Vico's account of false patina.

Mr Pinkerton informs us, that all medallions from Julius Cæsar to Adrian are much to be suspected of forgery; the true medals of the first 14 emperors being exceedingly valuable, and to be found only in the cabinets of princes.

II. The second class of counterfeit medals contains those cast from moulds taken from the Paduan forgeries, and others done by eminent masters. These are sometimes more difficult to be discovered than the former, because in casting them they can give any degree of thickness they please; and, filling the small sandholes with mastic, they retouch the letters with a graver, and cover the whole with varnish. The instructions already given for the former class, however, are also useful for those of the second, with this addition, that medals of this class are generally lighter than the genuine, because fire rarefies the metal in some degree, while that which is struck is rather condensed by the strokes. In gold and silver medals there cannot be any deception of this kind; because these metals admit not of patina, and consequently the varnish betrays the imposition. The marks of the file on the margin of those of the second class are a certain sign of forgery; though these do not always indicate the forgery to be of modern date, because the Romans often filed the edges of coins to accommodate them to the purposes of ornament, as quarter guineas are sometimes

89 Medals cast from the Paduan forgeries.

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times put into the bottom of punch ladles. It is common to imitate the holes of medals made by time by means of aquafortis; but this deſtroys the ſides of a coin more effectually than if it had been eat into naturally. The fraud, however, is not eaſily diſtinguiſhed.

90 Medals caſt from an antique.

III. *Medals caſt in moulds from an antique.*—In this mode ſome forgers, as Beauvais informs us, have been ſo very careful, that they would melt a common medal of the emperor whom they meant to counterfeit, leſt the quality of the metal ſhould betray them. "This (ſays Mr Pinkerton), has been done in the ſilver Septimius Severus, with the reverſe of a triumphal arch, for which a common coin of the ſame prince has been melted; and in other inſtances. Putting metals in the fire or upon hot iron to cleanſe them, gives them an appearance of being caſt; for ſome ſpots of the metal being ſofter than the reſt will run, which makes this one of the worſt methods of cleaning medals.—The directions given for diſcovering the two former deceptions hold good alſo in this.

91 Ancient medals retouched.

IV. *Ancient medals retouched and altered.*—This is a claſs of counterfeits more difficult to be diſcovered than any other. "The art (ſays Mr Pinkerton) exerted in this claſs is aſtoniſhing; and a connoiſſeur is the leſs apt to ſuſpect it, becauſe the coins themſelves are in fact ancient. The acute minds of the Italian artiſts exerted themſelves in this way, when the other forgeries became common and known. With graving tools they alter the portraits, the reverſes, and the inſcriptions themſelves, in a ſurpriſing manner. Of a Claudius ſtruck at Antioch they make an Otho; of a Fauſtina, a Titiana; of a Julia Severa, a Didia Clara; of a Macrinus, a Peſcennius, &c. Give them a Marcus Aurelius, he ſtarts up a Pertinax, by thickening the beard a little, and enlarging the noſe. In ſhort, wherever there is the leaſt reſemblance in perſons, reverſes, or legends, an artiſt may from a trivial medal generate a moſt ſcarce and valuable one. This fraud is diſtinguiſhable by the falſe varniſh which ſometimes maſks it; but, above all, by the letters of the legend, which are always altered. Though this be ſometimes done with an artifice almoſt miraculous, yet moſt commonly the characters ſtraggle, are diſunited, and not in a line."

In counterfeits of this kind ſometimes the obverſe is not touched, but the reverſe made hollow, and filled with maſtic coloured like the coin, and engraven with ſuch device and legend as was moſt likely to bring a great price; others are only retouched in ſome minute parts, by which, however, the value of the coin is much diminiſhed. "Againſt all theſe arts (ſays Mr Pinkerton), ſevere ſcrutiny muſt be made by the purchaſer upon the medal itſelf; and the inveſtigation and opinion of eminent antiquaries had upon its being altered, or genuine as it is iſſued from the mint.

92 Medals with new devices, or ſoldered.

V. *Medals impreſſed with new devices, or ſoldered.*—In the firſt article of this claſs the reverſes have been totally filed off, and new ones impreſſed with a die and hammer. This is done by putting the face or obverſe, whichever is not touched, upon different folds of paſteboard, afterwards applying the die and ſtriking it with a hammer. The forgery in this claſs is very eaſily diſcovered, as the devices and inſcriptions on the counterfeits are known not to exiſt on true medals: as the Pons Ælius on the reverſe of Adrian: the Expeditio Judaica of the ſame emperor, &c. The difference of fabrication in the face or reverſe will be diſcovered at the firſt glance by any perſon of ſkill.

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The ſoldered medals conſiſt of two halves belonging to different medals, ſawed through the middle and then joined with ſolder. This mode of counterfeiting is common in ſilver and braſs coins. "They will take an Antoninus, for example, and ſaw off the reverſe, then ſolder to the obverſe which they have treated in the ſame manner. This makes a medal, which, from an unknowing puchaſer, will bring a hundred times the price of the two coins which compoſe it. When the deceit is uſed in braſs coins, they take care that the metals be of one hue; though indeed ſome pretenders in this way ſometimes ſolder copper and braſs together, which at once reveals the deceit. Medals which have a portrait on each ſide, and which are generally valuable, are the moſt liable to a ſuſpicion of this fraud. To a very nice eye the minute ring of ſolder is always viſible; and upon inſerting a graver, the fabrication falls into halves."

In the ſame manner reverſes are ſometimes ſoldered to faces not originally belonging to them; as one mentioned by Pere Jobert, of Domitian with an amphitheatre, a reverſe of Titus joined to it. Another art is ſometimes made uſe of in this kind of counterfeits, of which there is an inſtance of the temple of Janus upon Nero's medals; where the middle braſs is taken off, and inſerted in a cavity made in the middle of a large coin of that prince. In the coins of the lower empire, however, the reverſes of medals are ſometimes ſo connected with their obverſes, that a ſuſpicion of forgery ſometimes occurs without any foundation. They are met with moſt commonly after the time of Gallienus, when ſuch a number of uſurpers aroſe, that it was difficult to obtain an exact portrait of their features; the coiners had not time, therefore, to ſtrike a medal for theſe as they could have done for other emperors who reigned longer. Hence, on the reverſe of a medal of Marius, who reigned only three days, there is PACATOR ORBIS, which ſhows that at that time they had reverſes ready fabricated, to be applied as occaſion might require.

VI. *Plated medals, or thoſe which have clefts.*—It has been already remarked, that many true medals are cracked in the edges; owing to the repeated ſtrokes of the hammer, and the little degree of ductility which the metal poſſeſſes. This the forgers attempt to imitate by a file; but it is eaſy to diſtinguiſh betwixt the natural and artificial cleft by means of a ſmall needle. The natural cleft is wide at the extremity, and appears to have a kind of almoſt imperceptible filaments; the edges of the crack correſponding with each other in a manner which no art can imitate. 93 Plated medals, &c.

The plated medals which have been forged in ancient times were long ſuppoſed to be capable of reſiſting every effort of modern imitation; but of late years, "ſome ingenious rogues (ſays Mr Pinkerton), thought of piercing falſe medals of ſilver with a red-hot needle, which gave a blackneſs to the inſide of the coin, and made it appear plated to an injudicious eye. This fraud is eaſily diſtinguiſhed by ſcraping the inſide of the metal." It is, however, very difficult to diſtinguiſh

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diſtinguiſh the forgeries of rude money when not caſt; and our author gives no other direction than to conſult a ſkilful medalliſt. Indeed, notwithſtanding all the directions already given, this ſeems to be a reſource which cannot by any means with ſafety be neglected.

94 Mr Pinkerton's directions for knowing medals.

A real and practical knowledge of coins "is only to be acquired (ſays he) by ſeeing a great number, and comparing the forged with the genuine. It cannot therefore be too much recommended to the young connoiſſeur, who wiſhes to acquire ſome knowledge in this way, to viſit all the ſales and cabinets he can, and to look upon all ancient medals with a very microſcopic eye. By theſe means only is to be acquired that ready knowledge which enables at firſt glance to pronounce upon a forgery, however ingenious. Nor let the ſcience of medals be from this concluded to be uncertain; for no knowledge is more certain and immediate, when it is properly ſtudied by examination of the real objects. A man who buys coins, truſting merely to his theoretic peruſal of medallic books, will find himſelf wofully miſtaken. He ought to ſtudy coins firſt, where only they can be ſtudied, in themſelves. Nor can it be matter of wonder or implication of caprice, that a medalliſt of ſkill ſhould at one perception pronounce upon the veracity or falſehood of a medal; for the powers of the human eye, employed in certain lines of ſcience, are amazing. Hence a ſtudent can diſtinguiſh a book among a thouſand ſimilar, and quite alike to every other eye: hence a ſhepherd can diſcern, &c.; hence the medalliſt can ſay in an inſtant, 'this is a true coin, and this is a falſe,' though to other people no diſtinction be perceptible."

95 Forgeries of modern coins.

Forgeries of modern coins and medals, Mr Pinkerton obſerves, are almoſt as numerous as of the ancient. The ſatiric coin of Louis XII. PERDAM BALYLONIS NOMEN, is a remarkable inſtance: the falſe coin is larger than the true, and bears date 1512. The rude coins of the middle ages are very eaſily forged, and forgeries have accordingly become common. Forged coins of Alfred and other early princes of England have appeared, ſome of which have been done with great art. "The two noted Engliſh pennies of Rich. I. ſays our author, are of this ſtamp; and yet have impoſed upon Meſſrs Folkes and Snelling, who have publiſhed them as genuine in the two beſt books upon Engliſh coins. But they were fabricated by a Mr White of Newgate-ſtreet, a noted collector, who contaminated an otherwiſe fair character by ſuch practices. Such forgeries, though eaſy, require a ſkill in the hiſtory and coinage of the times, which luckily can hardly fall to the lot of a common Jew or mechanic forger. But the practice is deteſtable, were no gain propoſed: and they who ſtoop to it muſt ſuppoſe, that to embarraſs the path of any ſcience with forgery and futility, implies no infamy. In forgeries of ancient coin, the fiction is perhaps ſufficiently atoned for by the vaſt ſkill required; and the artiſt may plauſibly allege, that his intention was not to deceive, but to excite his utmoſt powers, by an attempt to rival the ancient maſters. But no poſſible apology can be made for forging the rude money of more modern times. The crime is certainly greater than that which leads the common coiner to the gallows; inaſmuch as it is committed with more eaſe, and the profit is incomparably larger."

Value.

SECT. VIII. *Of the Value of Medals.*

ALL ancient coins and medals, though equally genuine, are not equally valuable. In medals as well as in every thing elſe, the ſcarcity of a coin ſtamps a value upon it which cannot otherwiſe be derived from its intrinſic worth. There are four or five degrees of rarity reckoned up; the higheſt of which is called *unique*. The cauſe is generally aſcribed to the fewneſs of number thrown off originally, or to their having been called in, and recoined in another form. To the former cauſe Mr Pinkerton aſcribes the ſcarcity of the copper of Otho and the gold of Peſcennius Niger; to the latter that of the coinage of Caligula; "though this laſt (ſays he) is not of ſingular rarity; which ſhows that even the power of the Roman ſenate could not annihilate an eſtabliſhed money; and that the firſt cauſe of rarity, ariſing from the ſmall quantity originally ſtruck, ought to be regarded as the principal."

96 Cauſes of the ſcarcity of medals in ancient cities.

In the ancient cities Mr Pinkerton aſcribes the ſcarcity of coin to the poverty or ſmallneſs of the ſtate; but the ſcarcity of ancient regal and imperial coins ariſes principally from the ſhortneſs of the reign; and ſometimes from the ſuperabundance of money before, which rendered it almoſt unneceſſary to coin any money during the reign of the prince. An example of this we have in the ſcarcity of the ſhillings of George III. which ſhows that ſhortneſs of reign does not always occaſion a ſcarcity of coin; and thus the coins of Harold II. who did not reign a year, are very numerous, while thoſe of Richard I. who reigned ten, are almoſt unique.

97 Rare coins ſometimes become common, and *vice verſa*.

Sometimes the rareſt coins loſe their value, and become common. This our author aſcribes to the high price given for them, which tempts the poſſeſſors to bring them to market; but chiefly to the diſcovering of hoards of them. The former cauſe took place with Queen Anne's farthings, ſome of which formerly ſold at five guineas; nay, if we could believe the newſpapers, one of them was ſome years ago ſold for 960l.; the latter with the coins of Canute, the Daniſh king of England; which were very rare till a hoard of them was diſcovered in the Orkneys. As diſcoveries of this kind, however, produce a temporary plenty, ſo when they are diſperſed the former ſcarcity returns; while, on the other hand, ſome of the common coins become rare through the mere circumſtance of neglect.

98 Silver coins in what caſes moſt eſteemed.

As double the number of copper coins of Greek cities are to be met with that there are of ſilver, the latter are of conſequence much more eſteemed: but the reverſe is the caſe with thoſe of the Greek princes. All the Greek civic coins of ſilver are very rare, excepting thoſe of Athens, Corinth, Meſſana, Dyrrhachium, Maſſilia, Syracuſe, and ſome others. Of the Greek monarchic coins, the moſt rare are the tetradrachms of the kings of Syria, the Ptolemies, the ſovereigns of Macedon and Bithynia, excepting thoſe of Alexander the Great and Lyſimachus. Thoſe of the kings of Cappadocia are of a ſmall ſize, and ſcarce to be met with. Of thoſe of Numidia and Mauritania, the coins of Juba, the father, are common; but thoſe of

Value. of the son, and nephew Ptolemy, scarce. Coins of the kings of Sicily, Parthia, and Judæa, are rare; the last very much so. We meet with no coins of the kings of Arabia and Comagene except in brass; those of the kings of Bosphorus are in electrum, and a few in brass, but all of them rare; as are likewise those of Philetenis king of Pergamus, and of the kings of Pontus. In the year 1777, a coin of Mithridates sold for 26l. 5s. Didrachms of all kings and cities are scarce excepting those of Corinth and her colonies; but the gold coins of Philip of Macedon, Alexander the Great, and Lysimachus, as has already been observed, are common. The silver tetradrachms of all kings bear a very high price. The didrachm of Alexander the Great is one of the scarcest of the smaller Greek silver coins; some of the other princes are not uncommon.

99 Greek copper coins. In most cases the copper money of the Greek monarchs is scarce; but that of Hiero I. of Syracuse is uncommonly plenty, as well as that of several of the Ptolemies.

100 Roman consular coins. The most rare of the consular Roman coins are those restored by Trajan: of the others the gold consular coins are the most rare, and the silver the most common; excepting the coin of Brutus with the cap of liberty, already mentioned, with some others. Some of the Roman imperial coins are very scarce, particularly those of Otho in brass; nor indeed does he occur at all on any coin struck at Rome: but the reason of this may with great probability be supposed to have been the shortness of his reign. His portrait upon the brass coins of Egypt and Antioch is very bad; as well as almost all the other imperial coins of Greek cities. The best likeness is on his gold and silver coins; the latter of which are very common. The Greek and Egyptian coins are all of small or middling sizes, and have reverses of various kinds: those of Antioch have Latin legends, as well as most of the other imperial coins of Antioch. They have no other reverse but the SC in a wreath; excepting in one instance or two of the large and middle brass, where the inscriptions are in Greek. Latin coins of Otho in brass, with figures on the reverse, are certainly false; though in the cabinet of D'Ennery at Paris there was an Otho in middle brass restored by Titus, which was esteemed genuine by connoisseurs.

101 Leaden Roman coins. The leaden coins of Rome are very scarce: Most of them are pieces struck or cast on occasion of the saturnalia; others are tickets for festivals and exhibitions, both private and public. The common tickets for theatres were made of lead, as were the *contorniati;* perpetual tickets, like the English silver tickets for the opera. Leaden medallions are also found below the foundations of pillars and other public buildings, in order to perpetuate the memory of the founders. From the time of Augustus also we find that leaden seals were used. The work of Ticorini upon this subject, entitled *Piombi Antiochi*, is much recommended by Mr Pinkerton.

102 Of coins blundered in the mintage. The Roman coins, which have been blundered in the manner formerly mentioned, are very rare, and undeservedly valued by the connoisseurs. The blunders in the legends of these coins, which in all probability are the mere effects of accident, have been so far mistaken by some medallists, that they have given rise to imaginary emperors who never existed. A coin of Faustina, which has on the reverse SOUSTI. S. C. puzzled all the German antiquaries, till at last Klotz gave it the following facetious interpretation: *Sine omni utilitate sectamini tantas ineptias.* Purchase.

103 Heptarchic coins of England. The heptarchic coins of England are generally rare, except those called *stycas*, which are very common, as well as those of Burgred king of Mercia. The coins of Alfred which bear his bust are scarce, and his other money much more so. Those of Hardyknute are so rare, that it was even denied that they had an existence; but Mr Pinkerton informs us, that there are three in the British museum, upon all of which the name HARTHCANUT is quite legible. No English coins of King John are to be met with, though there are some Irish ones; and only French coins of Richard I. "Leake (says Mr Pinkerton), made a strange blunder in ascribing coins of different kings with two faces, and otherwise spoiled in the stamping, to this prince; in which, as usual, he has been followed by a misled number."

104 Scottish coins. Coins of Alexander II. of Scotland are rather scarce, but those of Alexander III. are more plentiful. Those of John Baliol are rare, and none of Edward Baliol are to be found.

SECT. IX. *Of the Purchase of Medals.*

MEDALS are to be had at the shops of goldsmiths and silversmiths, with those who deal in curiosities, &c. but in great cities there are professed dealers in them. The best method of purchasing medals, however, is that of buying whole cabinets, which are every year exposed to auction in London. In these the rare medals are sold by themselves; but the common ones are put up in large lots, so that the dealers commonly purchase them. Mr Pinkerton thinks it would be better that medals were sold one by one; because a lot is often valued and purchased for the sake of a single coin; while the others separately would sell for perhaps four times the price of the whole lot. "If any man of common sense and honesty (says Mr Pinkerton), were to take up the trade of selling coins in London, he would make a fortune in a short time. This profitable business is now in the hands of one or two dealers, who ruin their own interest by making an elegant study a trade of knavery and imposition. If they buy 300 coins for 10s. they will ask 3s. for one of the worst of them! nay, sell forged coins as true to the ignorant. The simpletons complain of want of business. A knave is always a fool."

105 Price of gold coins of Carthage, &c. The gold coins of Carthage, Cyrene, and Syracuse, are worth about twice their intrinsic value as metal; but the other gold civic coins from 5l. to 30l. each. The only gold coins of Athens certainly known to exist are two lately procured by the king. One of these remains in possession of his majesty, but the other was given by the queen to Dr Hunter. There was another in the British museum, but suspected not to be genuine. Dr Hunter's coin, then, if sold, would bear the highest price that could be expected for a coin.

106 Of silver coins. The silver coins of Syracuse, Dyrrhachium, Massilia, Athens, and a few other states, are common; the drachmas and coins of lesser size are worth about five

Purchaſe. five ſhillings; the didrachms, tetradrachms, &c. from five to ten, according to their ſize and beauty; the largeſt, as might naturally be expected, being more valuable than the ſmall ones. The tetradrachms, when of cities whoſe coins are common, are worth from 7s. 6d. to 1l. 1s.; but it is impoſſible to put a value upon the rare civic coins; ten guineas have been given for a ſingle one.

107 Greek copper coins. The Greek copper coins are common, and are almoſt all of that kind called *ſmall braſs;* the middle ſize being ſcarce, and the largeſt in the ages prior to the Roman emperors extremely ſo. The common Greek coins of braſs bring from 3d. to 18d. according to their preſervation; but when of cities, whoſe coins are rare, much higher prices are given. "The want of a few cities, however (ſays Mr Pinkerton), is not thought to injure a collection; as indeed new names are diſcovered every dozen of years, ſo that no aſſortment can be perfect. To this it is owing that the rarity of the Grecian civic coins is not much attended to."

108 Gold coins of Philip and Alexander. The gold coins of Philip and Alexander the Great being very common, bear but from five to ten ſhillings above their intrinſic value; but thoſe of the other princes, being rare, ſell from 3l. to 30l. each, or even more.

The tetradrachms are the deareſt of the ſilver monarchic money, ſelling from five to ten ſhillings; and if very rare, from 3l. to 30l. Half theſe prices may be obtained for the drachmas, and the other denominations in proportion.

109 Greek copper coins more rare than the ſilver. The Greek copper coins are for the moſt part ſcarcer than the ſilver, except the Syro-Grecian, which are common, and almoſt all of the ſize called ſmall braſs. "They ought (ſays Mr Pinkerton), to bear a a high price; but the metal and ſimilarity to the copper civic coins, which are common, keep their actual purchaſe moderate, if the ſeller is not well inſtructed, and the buyer able and willing to pay the price of rarity."

The name of weights given to the ancient Roman aſes is, according to our author, exceedingly improper; as that people had weights of lead and braſs ſides, without the leaſt appearance of a portrait upon them. Theſe denote the weight by a certain number of knobs; and have likewiſe ſmall *fleurettes* engraved upon them. According to Mr Pinkerton, whenever we meet with a piece of metal ſtamped on both ſides with buſts and figures, we may lay it down as a certain rule that it is a coin; but when ſlightly ornamented and marked upon one ſide only, we may with equal certainty conclude it to be a weight.

110 Price of the ancient Roman aſes. The ancient Roman aſes are worth from 2s. to 2l. according to the ſingularity of their devices. Conſular gold coins are worth from 1l. to 5l. Pompey with his ſons 21l. and the two Bruti 25l. The ſilver coins are univerſally worth from a ſhilling to half a crown, excepting that of the cap of liberty and a few others, which, if genuine, will bring from 10s. to 5l. The conſular copper bears an equal price with the ſilver, but is more rare; the conſular ſilver coins reſtored by Trajan are worth 20s. each.

With regard to the Roman imperial coins, it is to be obſerved, that ſome of thoſe which belong to princes whoſe coins are numerous, may yet be rendered extremely valuable by uncommon reverſes. Mr Pinkerton particularly points out that of Auguſtus, with the legend C. Marivs Trogvs, which is worth three guineas, though the ſilver coins of that prince in general are not worth above a ſhilling. In like manner, the common gold coins of Trajan are not worth above twenty ſhillings; while thoſe with *Baſilica Ulpia, Forum Trajani, Divi Nerva et Trajanus, Pater, Divi Nerva et Platina Aug. Profectio Aug. Regna Aſſignata, Rex Parthus*, and ſome others, bear from three to ſix pounds. The ticket medals belong to the Roman ſenate, and are worth from three to ten ſhillings. The forged coins and medallions of the Paduan ſell from one to three ſhillings each. Arrangement, &c.

111 Barbaric coins. Of the coins of other nations, thoſe of Hilderic king of the Vandals are in ſilver, and worth 10s.; the ſmall braſs of Athanaric, 5s.; the gold of Theodoric 2l.; the ſecond braſs of Theodahat 5s.; the ſecond braſs of Badueta rare, and worth 10s.; the third braſs, 3s. The Britiſh coins are very rare, and worth from ten ſhillings to two guineas each, ſometimes much more. Medals with unknown characters are always ſcarce and dear. Saxon pennies of the heptarchy are rare, and worth from ten ſhillings to *ten pounds*, according to their ſcarcity and preſervation. The coins of the Engliſh kings are common; thoſe of Edward the Confeſſor, in particular; others are rare, and worth from ten ſhillings to two guineas, while two of Hardyknute are worth no leſs than ten guineas. The gold medals of Henry, in 1545, and the coronation of Edward, are worth 20l. each: the Mary of Trezzo, 3l.; Simon's head of Thurloe in gold is worth 12l.; his oval medal in gold upon Blake's naval victory at ſea is worth 30l.; and his trial piece, if brought to a ſale, would, in Mr Pinkerton's opinion, bring a ſtill higher price. The medals of Queen Anne, which are intrinſically worth about two guineas and a half, ſell for about 3l. each; the ſilver, of the ſize of a crown piece, ſell for 10s. and the copper from five to ten ſhillings. Daſſier's copper pieces ſell from two to five ſhillings, and a few bear a higher price.

112 Gold coins of Scotland. The Scottiſh gold coins ſell higher than the Engliſh, but the others are on a par. The ſhilling of Mary with the buſt is rare, and ſells for no leſs than 30l.; the half 3l.; and the royal 5l. 5s. The French teſtoon of Francis and Mary brings 10l. 10s. and the Scottiſh one of Mary and Henry would bring 50l. as would alſo the medal of James IV. The coronation medal of Francis and Mary is worth 20l. Briot's coronation medal ſold in 1755 only for two guineas at Dr Mead's ſale; but would now bring 20l. if ſold according to rarity.

113 Engliſh coins ſtruck in Ireland. The Engliſh coins ſtruck in Ireland are of much the ſame price with thoſe of the native country; but the St Patrick's halfpence and farthings are rather ſcarce, and the rare crown of white metal is worth 4l. The gun-money of James II. and all other Iriſh coins are very common.

Sect. X. *Arrangement of Medals, with the Inſtruction to be derived from them.*

Having thus given a full account of every thing in general relative to medals, we muſt now come to ſome particulars reſpecting their arrangement, and the entertainment

tainment which a medalliſt may expect from the trouble and expence he is at in making a collection.

It has already been obſerved, that one of the principal uſes of medals is the elucidation of ancient hiſtory. Hence the arrangement of his medals is the firſt thing that muſt occur in the formation of a cabinet. The moſt ancient medals with which we are acquainted are thoſe of Alexander I. of Macedon, who began to reign about 501 years before Chriſt. The ſeries ought of conſequence to begin with him, and to be ſucceeded by the medals of Sicily, Caria, Cyprus, Heraclia, and Pontus. Then follow Egypt, Syria, the Cimmerian Boſphorus, Thrace, Bithynia, Parthia, Armenia, Damaſcus, Cappadocia, Paphlagonia, Pergamus, Galatia, Cilicia, Sparta, Pæonia, Epirus, Illyricum, Gaul, and the Alps, including the ſpace of time from Alexander the Great to the birth of Chriſt, and which is to be accounted the third medallic ſeries of ancient monarchs. The laſt ſeries goes down to the fourth century, including ſome of the monarchs of Thrace, Boſphorus, and Parthia, with thoſe of Comagene, Edeſſa or Oſrhoene, Mauritania, and Judæa. A moſt diſtinct ſeries is formed by the Roman emperors, from Julius Cæſar to the deſtruction of Rome by the Goths; nay, for a much longer period, were it not that towards the latter part of it the coins become ſo barbarous as to deſtroy the beauty of the collection. Many ſeries may be formed of modern potentates.

114 Diadem an ancient emblem of ſovereign authority.

By means of medals we can with great certainty determine the various ornaments worn by ancient princes as badges of diſtinction. The Grecian kings have generally the diadem, without any other ornament; and though in general the ſide of the face is preſented to view, yet in ſome very ancient Greek and Roman conſular coins, full faces of excellent workmanſhip are met with. On ſeveral coins alſo two or three faces are to be ſeen, and theſe are always accounted very valuable.

The diadem, which was no more than a ribbon tied round the head with a floating knot behind, adorns all the Grecian princes from firſt to laſt, and is almoſt an infallible mark of ſovereign power. In the Roman conſular coins it is ſeen in conjunction with Numa and Ancus, but never afterwards till the time of Licinius, the colleague of Conſtantine. Diocleſian, indeed, according to Mr Gibbon, firſt wore the diadem, but his portrait upon coins is never adorned with it. So great an averſion had the Romans to kingly power, that they rather allowed their emperors to aſſume the radiated crown, the ſymbol of divinity, than to wear a diadem; but, after the time of Conſtantine, it becomes common. The radiated crown appears firſt on the poſthumous coins of Auguſtus as a mark of deification, but in ſomewhat more than a century became common.

The laurel crown, at firſt a badge of conqueſt, was afterwards permitted by the ſenate to be worn by Julius Cæſar, in order to hide the baldneſs of his head. From him all the emperors appear with it on their medals, even to our own times. It the lower empire the crown is ſometimes held by a hand above the head, as a mark of piety. Beſides theſe, the naval, mural, and civic crowns appear on the medals both of emperors and other eminent men, to denote ther great actions. The laurel crown is alſo ſometimes worn by he Greek princes. The Arſacidæ of Parthia wear a kind of ſaſh round the head, with their hair in rows of curls like a wig. The Armenian kings have the *tiara*, a kind of cap which was eſteemed the badge of imperial power in the eaſt. Conical caps are ſeen on the medals of Xerxes, a petty prince of Armenia, and Juba the father, the former having a diadem around it.

115 Symbols of divinity on the coins of Alexander and his ſucceſſors.

The impious vanity of Alexander and his ſucceſſors in aſſuming divine honours is manifeſt on their medals, where various ſymbols of divinity are met with. Some of them have an horn behind their ear, either to denote their ſtrength, or that they were the ſucceſſors of Alexander, to whom this badge might be applied as the ſon of Jupiter Ammon. This, however, Mr Pinkerton obſerves, is the only one of theſe ſymbols which certainly denotes an earthly ſovereign, it being doubted whether the reſt are not all figures of gods.—According to Eckhet, even the horn and diadem belong to Bacchus, who invented the latter to cure his headaches; and, according to the ſame author, the only monarch who appears on coins with the horn is Lyſimachus. We are informed, however, by Plutarch, that Pyrrhus had a creſt of goats horns to his helmet; and the goat, we know, was a ſymbol of Macedon. Perhaps the ſucceſſors of Alexander wore this badge of the horn in conſequence. The helmet likewiſe frequently appears on the heads of ſovereigns, and Conſtantine I. has helmets of various forms curiouſly ornamented.

The diadem is worn by moſt of the Greek queens, by Orodaltis, daughter of Lycomedes, king of Bithynia; and though the Roman empreſſes never appear with it, yet this is more than compenſated by the variety of their headdreſſes. Sometimes the buſt of an empreſs is ſupported by a creſcent, to imply that ſhe was the moon, as her huſband was the ſun of the ſtate. The toga, or vail drawn over the face, at firſt implied that the perſon was inveſted with the pontifical office; and accordingly we find it on the buſts of Julius Cæſar, while pontifex maximus. It likewiſe implies the augurſhip, the augurs having a particular kind of gown called *lana*, with which they covered their heads when obſerving an omen. In latter times this implies only conſecration, and is common in coins of empreſſes. It is firſt met with on the coins of Claudius Gothicus as the mark of conſecration of an emperor. The *nimbus*, or glory, now appropriated to ſaints, has been already mentioned. It is as ancient as Auguſtus, but is not to be met with on many of the imperial medals, even after it began to be appropriated to them. There is a curious coin, which has upon the reverſe of the common piece, with the head of Rome, URBS ROMA, in large braſs, Conſtantine I. ſitting amid Victories and genii, with a triple crown upon his head for Europe, Aſia, and Africa, with the legend SECURITAS ROMÆ.

116 Portraits upon medals.

In general only the buſt is given upon medals, though ſometimes half the body or more; in which latter caſe the hands often appear with enſigns of majeſty in them; ſuch as the globe, ſaid to have been introduced by Auguſtus as a ſymbol of univerſal dominion; the ſceptre, ſometimes confounded with the conſular ſtaff; a roll of parchment, the ſymbol of legiſlative

Arrangement, &c.

tive power; and an handkerchief, expressive of the power over the public games, where the emperor gave the signal. Some princes hold a thunderbolt, showing that their power on earth was equal to that of Jupiter in heaven; while others hold an image of Victory.

Medals likewise afford a good number of portraits of illustrious men; but they cannot easily be arranged in chronological order, so that a series of them is not to be expected. It is likewise vain to attempt the formation of a series of gods and goddesses to be found on ancient coins. Mr Pinkerton thinks it much better to arrange them under the several cities or kings whose names they bear. A collection of the portraits of illustrious men may likewise be formed from medals of modern date.

117 Reverses of Greek and Roman coins.

The reverses of ancient Greek and Roman coins afford an infinite variety of instruction and amusement. They contain figures of deities at full length, with their attributes and symbols, public symbols and diversions, plants, animals, &c. &c. and in short almost every object of nature or art. Some have the portrait of the queen, son, or daughter of the prince whose image appears on the face obverse; and these are esteemed highly by antiquaries, not only because every coin stamped with portraits on both sides is accounted valuable, but because they render it certain that the person represented on the reverse was the wife, son, or daughter of him who appears on the obverse; by which means they assist greatly in the adjusting of a series. Some, however, with two portraits are common, as Augustus, the reverse of Caligula; and Marcus Aurelius, reverse of Antoninus Pius.

We find more art and design in the reverses of the Roman medals than of the Greek; but on the other hand, the latter have more exquisite relief and workmanship. The very ancient coins have no reverses, excepting a rude mark struck into the metal, resembling that of an instrument with four blunt points on which the coin was struck; and was owing to its having been fixed by such an instrument on that side to receive the impression upon the other. To this succeeds the image of a dolphin, or some small animal, in one of the departments of the rude mark, or in an hollow square: and this again is succeeded by a more perfect image, without any mark of the hollow square. Some of the Greek coins are hollow in the reverse, as those of Caulonia, Crotona, Metapontum, and some other ancient cities of Magna Græcia. About 500 B. C. perfect reverses appear on the Greek coins, of exquisite relief and workmanship. "The very muscles of men and animals (says Mr Pinkerton), are seen, and will bear inspection with the largest magnifier as ancient gems. The ancients certainly had not eyes different from ours; and it is clear that they must have magnified objects. A drop of water forms a microscope; and it is probable this was the only one of the ancients. To Greek artists we are indebted for the beauty of the Roman imperial coins; and these are so highly finished, that on some reverses, as that of Nero's decursion, the *adventus* and *progressio* of various emperors, the *fundator pacis* of Severus, the features of the emperor, riding or walking, are as exact as on the obverse. But though the best Greek artists were called to Rome, yet the Greek coins under the Roman emperors are sometimes well executed, and always full of variety and curiosity. No Roman or Etruscan coins have been found of the globular form, or indented on the reverse like the early Greek. The first Greek are small pieces of silver, while the Roman are large masses of copper. The former are struck; the latter cast in moulds. The reverses of the Roman coins are very uniform, the prow of a ship, a car, or the like, till about the year 100 B. C. when various reverses appear on their consular coins in all metals. The variety and beauty of the Roman imperial reverses are well known. The medalist much values those which have a number of figures; as the *Puellæ Faustinianæ*, of Faustina, a gold coin no larger than a sixpence, which has 12 figures; that of Trajan, *regna assignata*, has four; the *congiarium* of Nerva five; the allocution of Trajan seven; of Hadrian 10; of Probus 12. Some Roman medals have small figures on both sides, as the *Apollini sancto* of Julian II. Such have not received any peculiar name among the medallists. Others have only a reverse, as the noted *spintriati*, which have numerals I. II. &c. on the obverse."

118 Of the deities represented upon ancient coins.

The *names* of the deities represented on the reverses of Greek coins are never expressed; perhaps, as Mr Pinkerton supposes, out of piety, a symbolical representation of their attributes being all that they thought proper to delineate; but the Roman coins always express the name, frequently with an adjunct, as VENERI VICTRICI, &c. In others, the name of the emperor or empress is added; as PUDICITIÆ AUGUSTÆ, round an image of modesty; VIRTUS AUGUSTI, a legend for an image of virtue.

The principal symbols of the divine attributes to be met with on the Greek medals are as follow:

1. Jupiter is known on the coins of Alexander the Great by his eagle and thunderbolts; but when the figure occurs only on the obverses of coins, he is distinguished by a laurel crown, and placid bearded countenance. Jupiter Ammon is known by the ram's horn twisting round his ear; a symbol of power and strength, assumed by some of the successors of Alexander the Great, particularly by Lysimachus.

2. Neptune is known by his trident, dolphin, or being drawn by sea horses; but he is seldom met with on the Grecian coins.

3. Apollo is distinguished by an harp, branch of laurel, or tripod; and sometimes by a bow and arrows. In the character of the sun, his head is surrounded with rays; but when the bust only occurs, he has a fair young face, and is crowned with laurel. He is frequent on the coins of the Syrian princes.

4. Mars is distinguished by his armour, and sometimes by a trophy on his shoulders. His head is armed with a helmet, and has a ferocious countenance.

5. Mercury is represented as a youth, with a small cap on his head, wings behind his ears and on his feet. He is known by the cap, which resembles a small hat, and the wings. He appears also with the caduceus, or wand twined with serpents, and the *marsupium*, or purse, which he holds in his hand.

6. Æsculapius is known by his bushy beard, and his leaning on a club with a serpent twisted round it. He

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He sometimes occurs with his wife Hygeia or Health, with their son *Telesphorus* or Convalescence between them.

7. Bacchus is known by his crown of ivy or vine, his diadem and horn, with a tiger and satyrs around him.

8. The figure of Hercules is common on the coins of Alexander the Great, and has frequently been mistaken for that of the prince himself. He appears sometimes as a youth and sometimes with a beard. He is known by the club, lion's skin, and remarkable apparent strength; sometimes he has a cup in his hand; and a poplar tree, as a symbol of vigour, is sometimes added to the portrait.

9. The Egyptian Serapis is known by his bushy beard, and a measure upon his head.

10. Apis is delineated in the form of a bull, with a flower of the lotos, the water lily of the Nile, supposed by Macrobius to be a symbol of creation; and Jamblichus tells us, that Osiris was thought to have his throne in it.

11. Harpocrates, the god of Silence, appears with his finger on his mouth; sometimes with the sistrum in his left hand; a symbol common to most of the Egyptian deities.

12. Canopus, another Egyptian deity, appears in the shape of a human head placed on a kind of pitcher. "This deified pitcher (says Mr Pinkerton), seems to refer to an anecdote of ancient superstition, which, I believe, is recorded by Plutarch. It seems some Persian and Egyptian priests had a contest which of their deities had the superiority. The Egyptian said, that a single vase, sacred to Serapis, would extinguish the whole power of the Persian deity of fire. The experiment was tried; and the wily Egyptian, boring holes in the vase and stopping them with wax, afterwards filled the vase with water; which, gushing through the holes as the wax melted, extinguished the Persian deity. Hence the vase was deified."

13. The *Holy Senate* and *Holy People*, appear frequently on the Greek imperial coins, sometimes represented as old men with beards, at others as youths.

The goddesses represented on medals are,

1. Juno, represented by a beautiful young woman, sometimes with a diadem, sometimes without any badge, which is reckoned a sufficient distinction, as the other goddesses all wear badges. Sometimes she appears as the goddess of marriage; and is then veiled to the middle, and sometimes to the toes. She is known by the peacock, a bird sacred to her from the fable of Argus.

2. Minerva is very common on the coins of Alexander the Great; and her bust has been mistaken by the celebrated painter Le Brun for the hero himself. She is very easily distinguished by the helmet. Her symbols are, her armour; the spear in her right hand, and the ægis, with a Medusa's head, in her left; an owl commonly standing by her.

3. Diana of Ephesus is commonly represented on the Greek imperial coins; and appears with a great number of breasts, supposed to denote universal Nature. She is supported by two deer, and carries a pannier of fruit upon her head. The bust of this goddess is known by the crescent on her brow, and sometimes by the bow and quiver at her side.

4. Venus is known by an apple, the prize of beauty, in her hand. Sometimes she is distinguished only by her total want of dress; but is always to be known by her extraordinary beauty, and is sometimes adorned with pearls about the neck.

5. Cupid is sometimes met with on the Syrian coins, and is known by his infancy and wings.

6. Cybele is known by a turreted crown and lion; or is seen in a chariot drawn by lions.

7. Ceres is known by her garland of wheat, and is common on the Sicilian coins; that island being remarkable for its fertility. Sometimes she has two serpents by her, and is sometimes drawn in a chariot by them. She carries in her hands the torches with which she is fabled to have gone in search of her daughter Proserpine.

8. Proserpine herself is sometimes met with on coins, with the name of κορη, or the *girl*.

9. The Egyptian Isis has a bud or flower on her head; a symbol of the perpetual bloom of the inhabitants of heaven. She carries also a sistrum in her hand.

10. The Sidonian Astarte appears on a globe supported on a chariot with two wheels, and drawn by two horses.

These are the deities most commonly represented on the Greek coins. The more uncommon are, Saturn with his scythe, or with a hook on the Heraclian coins; Vulcan with his tongs on the reverse of a coin of Thyatira, represented at work in the presence of Minerva. Adranus, a Sicilian god, is sometimes represented on coins with a dog. Anubis, an Egyptian deity, has a dog's head. Atis is known by his Phrygian bonnet; Castor and Pollux by a star on the head of each; Dis, by his old face, dishevelled hair and beard, and a hook; Flora by her crown of flowers; Nemesis by her wheel; and Pan by his horns and ears belonging to some kind of beast.

119 Table of symbols.

There are likewise to be found on medals many different symbols by themselves; of the most remarkable of which we shall give the following table, with their significations:

Symbols.	*Signification.*
1. Vases with sprigs, -	Solemn games.
2. Small chest or hamper, with a serpent leaping out,	Mystic rites of Bacchus.
3. Anchor on Seleucian medals.	Coin struck at Antioch, where an anchor was dug up.
4. Apollo on Syrian coins, on an inverted hamper,	Covered tripod.
5. Bee, - - -	Aristeus the son of Apollo.
6. Laurel, - - -	Apollo.
7. Reed, - - -	A river.
8. Ivy and grapes, - -	Bacchus.
9. Poppy, - - -	Ceres and Proserpine.
10. Corn, - - -	Ceres.
11. Owl and olive, - -	Minerva.
12. Dove, - - -	Venus.

13.

Arrangement, &c.

	Symbols.	Significations.
13.	Torch, - -	Diana, Ceres, or Proſerpine.
14.	Mudnis, or conic ſtone,	The ſun, Belus, or Venus.

Symbols of Countries, &c.

15.	Pomegranate flowers, -	Rhodes.
16.	Owl, - - -	Athens.
17.	Pegaſus, - - -	Corinth.
18.	Wolf's head, - -	Argos.
19.	Bull's head, - -	Bœotia.
20.	Minotaur's head and labyrinth,	Crete.
21.	Horſe's head, - -	Pharſalia.
22.	Lion, - - -	Marſeilles.
23.	Tortoiſe, - - -	Peloponneſus.
24.	Sphinx, - - -	Scio.
25.	Three legs joined, as in the Iſle of Man money, - -	Sicily.
26.	Horſe, - - -	Theſſaly.
27.	The creſcent, - -	Byzantium (A).
28.	Bull, - - -	Suppoſed to be a river.
29.	Enſign, with the letters COL.	A colony drawn from one legion.
30.	Bull, - - -	Apis, ſtrength or ſecurity.
31.	Caduceus, - - -	Peace and concord.
32.	Cornucopiæ, - -	Abundance.
33.	Pontifical hat, - -	Prieſthood.
34.	Parazonium, - -	Batoon of command.
35.	Globe on an altar with three ſtars, - - -	The world preſerved by the gods for the three ſons of Conſtant. I.
36.	Fort and gate, - -	Security.
37.	Tribuli, a kind of chevaux de frize, - - -	Unknown.
38.	Altar or tripod, - -	Piety.
39.	Dolphin, - - -	Apollo.
40.	Lectiſternia, - -	Feſtivals.
41.	Lituus, or twiſted wand, -	Augurſhip.
42.	Apex, or cap with ſtrings,	Pontificate.
43.	Thenſa, or chariot employed to carry images, - -	Conſecration of an empreſs.
44.	Peacock, - - -	Ditto.
45.	Eagle, - - -	Conſecration of an emperor.

Arrangement, &c.

120 Legends of medals.

The legends put upon medals are deſigned as explanations of them; but as the compaſs of even the largeſt coins does not admit of any great length of inſcription, it has always been found neceſſary to uſe abbreviations; and in readily decyphering theſe lies a conſiderable part of the difficulty of the ſcience. This, however, is greater in the Roman than in the Greek medals; for the Greeks commonly inſert as much of the word as is ſufficient to enable us eaſily to underſtand its meaning; but it is common for thoſe who attempt to explain letters that do not often occur, to fall into very ridiculous errors. Of this Mr Pinkerton gives a moſt remarkable inſtance in Fortunius Licetus, a learned man, who finding upon a coin of Adrian the letters, Γ. ΙΔ ſignifying the 14th year of that emperor's reign, imagined that they ſignified *Lucernas invenit Delta;* "Delta invented lanthorns;" and thence aſcribed the origin of lanthorns to the Egyptians. Tables explaining the meaning of the abbreviations found upon medals have been publiſhed by Patin, Urſatus, and others.

121 Extraordinary miſtake of Fortunius Licetus.

SECT. XI. *Of Medallions, Medalets*, &c.

BESIDES the ordinary coins of the ancients, which paſſed in common circulation through the country, there were others of a larger ſize, which are now termed *medallions*. Theſe were ſtruck on the commencement of the reign of a new emperor and other ſolemn occaſions: frequently alſo, by the Greeks in particular, as monuments of gratitude or of flattery. Sometimes they were mere trial or pattern pieces; and thoſe abound after the time of Maximian, with the words *Tres Monetæ* on the reverſe. The common opinion is, that all the Roman pieces of gold exceeding the denarius aureus, all in ſilver exceeding the denarius, and all in braſs exceeding the ſeſtertius, went under the denomination of *medallions:* but Mr Pinkerton thinks that many of theſe large pieces went in circulation, though not very commonly, as our five and two guinea pieces, ſilver crowns, &c. do in this country. The fineſt medallions were preſented by the mint maſters to the emperor, and by the emperor to his friends, as ſpecimens of fine workmanſhip. The beſt we have at preſent are of braſs, and many of them compoſed of two ſorts of metal; the centre being copper, with a ring of braſs around it, or the contrary; and the inſcription is ſometimes confined to one of the metals, ſometimes not. There is a remarkable difference between the Greek and Roman medallions in point of thickneſs; the latter being frequently three or four lines thick, while the other ſeldom exceed one. Very few medallions, however, were ſtruck by the Greeks before the time of the Roman emperors; but the Greek medallions of the emperors are more numerous tha

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(A) This appears on the early coins of Byzantium, with the legend ΒΥΖΑΝΤΙΝ. ΣΩΤ. "the preſerver of Byzantium." The reaſon of this was, that when Philip of Macedon beſieged the city, and was about to ſtorm it in a cloudy night, the moon ſhone out on a ſudden and diſcovered him; by which means the inhabitants had time to collect their forces and repulſe him. The Turks on entering Conſtantinople, found this badge in many places; and ſuſpecting ſome magical power in it, aſſumed the ſymbol, and its power, to themſelves; ſo that the creſcent is now the chief Turkiſh enſign.

thoſe of the Romans themſelves. All theſe pieces, however, are of ſuch high price that few private perſons are able to purchaſe them. In the laſt century Chriſtina queen of Sweden procured about 300. In the king of France's collection there are 1200; a number formerly ſuppoſed not to exiſt; and Dr Hunter's collection contains about 400, excluſive of the Egyptian.

Beſides theſe large pieces, there are ſmaller ones, of a ſize ſomewhat larger than our half-crowns; and by Italian medalliſts are called *medaglion cini*, or ſmall medallions. They are ſtill ſcarcer than the large kind.

122 Of medalets. There is ſtill a third kind, which have almoſt eſcaped the notice of medalliſts, viz. the ſmall coins or *miſſilia* ſcattered among the people on ſolemn occaſions; ſuch as thoſe ſtruck for the ſlaves on account of the ſaturnalia; counters for gaming; tickets for baths and feaſts; tokens in copper and in lead, &c. Theſe are diſtinguiſhed by Mr Pinkerton by the name of *medalets*. Many, or perhaps almoſt all, of thoſe ſtruck for the ſaturnalia were ſatirical; as the ſlaves had then a licenſe to ridicule not only their maſters but any perſon whatever. Mr Pinkerton mentions one of the moſt common pieces of this kind, which has on the obverſe the head of an old woman veiled, with a laurel crown; the reverſe only S. C. within a wreath. Baudelot is of opinion that it is the head of Acca Laurentia, the nurſe of Romulus, to whom a feſtival was ordained. "Perhaps (ſays Mr Pinkerton), it was ſtruck in ridicule of Julius Cæſar; for the manner of the laurel crown, and its high appearance over the head, perfectly reſemble that of Julius on his coins." Some have a ſhip upon one ſide; on the reverſe T, or a croſs, which was the image of Priapus; and occaſioned many falſe invectives againſt the firſt Chriſtians, who paid ſuch reſpect to the croſs. Some pieces have the heads of the emperors upon one ſide; on the reverſe only numerals, III. IV. V. &c. and the noted *ſpintriati* of Tacitus. Both theſe kinds appear tickets for the baths, as the number ſeems to denote the particular bath. Some have the head of a girl, with a veſſel uſed at the baths in her hand. The ſpintriati are ſo immodeſt, that few will bear mention. But ſome are merely ludicrous; as one which has an aſs with a bell about his neck, and a ſoldier riding him; another with two figures hoiſting a woman in a baſket into the air. Of thoſe that will juſt bear mention, is a man with titles around him, as chief of the games; and a woman in ridicule of the modeſt bath-girl above mentioned. There is alſo one marked XIX, on which appears an imperator triumphing in a car: this car is placed on the back of a camel; and behind the imperator is a monkey mimicking him.

123 Of the contorniati. A fourth claſs of medals are called *contorniati* from the Italian *contorniato*, "encircled;" becauſe of the hollow circle which commonly runs around them. They are diſtinguiſhed from medallions by their thinneſs, faint relief, reverſes ſometimes in relief, ſometimes hollow; and in general by the inferiority in their workmanſhip. The opinions of medalliſts concerning theſe pieces are very various; ſome ſuppoſe them to have been ſtruck by Gallienus to the memory of illuſtrious men and celebrated *athletæ*, at the time that he cauſed all the conſecration coins of his predeceſſors to be reſtored; others aſcribe their invention to Greece, &c. but Mr Pinkerton is of opinion that they were only tickets for places at public games. Many of them, notwithſtanding their inferior workmanſhip, are very valuable on account of their preſerving the portraits of ſome illuſtrious authors of antiquity, nowhere elſe to be found. Much dependance, however, cannot be put on the portraits of Greek authors and eminent men found upon ſome of them; for though we know that the buſts of Salluſt, Horace, &c. muſt have been ſtruck when their perſons were freſh in the memory of the artiſts, yet it was otherwiſe with Homer, Solon, Pythagoras, &c. which are to be found on ſome of them. Even theſe, however, are valuable, as being ancient and perhaps traditional portraits of theſe great men. The laſt whoſe portraits are ſuppoſed to have been delineated in this way, are Apollonius Tyaneus who flouriſhed in the time of Domitian, and Apuleius in that of Marcus Antoninus. Mr Pinkerton thinks it a confirmation of his opinion concerning theſe medals, that the reverſes always contain ſome device alluding to public games, as that of a charioteer driving a chariot, &c.

SECT. XII. *Directions for making Cabinets.*

WE muſt now proceed to the laſt part of our ſubject, viz. that of giving directions for the formation of cabinets. As we have already ſeen that the formation of any one muſt be attended with very conſiderable expence, it is neceſſary for every one who attempts this to proportion the cabinet to his own circumſtances. There are, properly ſpeaking, three kinds of cabinets. 1. Thoſe meant to contain a coin of every ſort that has been iſſued from the mint in every age and country; but this, which may be called the large and complete cabinet, is not to be purchaſed by private perſons. That of Dr Hunter already mentioned is perhaps one of the beſt private cabinets ever known; and coſt 23,000l. but as many duplicates were ſold as coſt 2000l. by which means the expence was reduced to 21,000l. The vaſt collection made by the king of France coſt upwards of 100,000l. 2. The ſmaller cabinet may be ſuppoſed to conſiſt only of middle and ſmall Roman braſs, Engliſh pennies, groats, &c. with a few medals of the more valuable kind, and may be ſuppoſed to incur an expence of from 200l. to 1000l. 3. The ſmalleſt kind is called a *caſket* of medals, and does not conſiſt of above 1000 at moſt of various kinds; and conſequently the expence muſt depend on the pleaſure of the proprietor.

In the formation of the grand cabinet, it muſt be obſerved that the Greek medals of every denomination do not admit of any arrangement by the metals like the Roman; not any regular ſeries of this kind being met with even in the moſt opulent cabinets. Hence in all collections the civic coins are ranged according to an alphabetical order; and the monarchic in a chronological one. The ſame rule is to be obſerved in the Roman conſular medals; they are ranged, like the coins of the Greek cities, in an alphabetical ſeries of the families. The Roman imperial coins are only

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only those capable of being arranged according to sizes and metals. Even from this must be excepted the minimi, or very smallest coins; which are so scarce, that the only regular series of them in the world is that belonging to the king of Spain, which was formed by a most skilful French medallist, and consists of all the metals. The arrangement of a grand cabinet, according to Mr Pinkerton, is as follows.

"I. The coins of cities and of free states in alphabetical order: whether using Greek, Roman, Punic, Etruscan, or Spanish characters.

"II. Kings in chronological series, both as to foundation of empire and seniority of reign.

"III. Heroes, heroines, founders of empires, and cities.

"IV. Other illustrious persons.

"V. Roman ases.

"VI. Coins of families, commonly called consular.

"VII. Imperial medallions.

"VIII. Imperial gold.

"IX. Imperial *minimi* of all metals.

"X. Imperial silver.

"XI. Imperial first brass.

"XII. Second brass.

"XIII. Third brass.

"XIV. Colonial coins, which are all of brass.

"XV. Greek cities under the emperors, of all metals and sizes. In a smaller cabinet they may be put with the Roman, according to their metal and size. Those without the emperor's head go to class I. though struck in Roman times.

"XVI. Egyptian coins struck under the Roman emperors, of all metals and sizes. They are mostly of a base metal called by the French *patin*; it is a kind of pot-metal or brittle brass.

"XVII. Contorniati, or ticket medals.

"XVIII. Coins of Gothic princes, &c. inscribed with Roman characters.

"XIX. Coins of southern nations using uncommon alphabets; as the Persian, Punic, Etruscan, and Spanish.

"XX. Coins of northern nations using uncommon characters, as the Runic and German.

"In the modern part no series can be formed of copper that will go back above two centuries; but sequences (chronological series) of gold and silver may be arranged of all the different empires, kingdoms, and states, as far as their several coinages will allow. Those of England and France will be the most perfect. Modern silver is commonly arranged in three sequences; the dollar, the groat, and the penny sizes. The medals of each modern country ought of course to be separated; though it is best to arrange each set in chronological order, let their size of metal be what they will. It may be remarked here, that our modern medals, of the size of a tea-saucer, are only so many monuments of barbarism. The ancient medallions are almost universally but little larger than our crown-piece, though three or four of them may extend to about two inches diameter, but very many modern medals to four inches and more. A large medal always declares an ignorant prince or an ignorant artist. Into the size of a crown-piece the ancients threw more miracles in this way than will ever appear in these monstrous productions."

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These directions will likewise apply to the formation of a cabinet of the second kind: but if the collector means to form a series of large Roman brass, he will find the coins of four or five emperors so scarce as not to be attainable in that series, even at any price. He must therefore supply their places with middle brass, as is allowed with regard to Otho, even in the best cabinets; there not being above three coins of that emperor in large brass known in the world: whereas of the middle brass, two or three hundred may exist. For this reason Mr Pinkerton concludes, that in cabinets of the second class, the collector may mingle the large and second brass together as he thinks proper, in order to save expence; though it would not do so well to unite such disproportionate sizes as the large and small. "In the small sequence, however (says he), there can be no harm in his mixing gold, silver, and brass, as chance or curiosity may lead him to purchase any of these metals. And though your starched bigotted medallist may sneer because such a sequence would controvert his formal and narrow way of thinking, common sense will authorize us to laugh at the pedant in our turn, and to pronounce such a series more various, rich, and interesting, than if the collector had arranged only one metal, and rejected a curious article because he did not collect gold or silver. In like manner, if, in the modern part of the smaller cabinet, any coin of a series is of high price, or of bad impression, there can be no impropriety in putting another of the same reign, which is cheaper, or better executed, though of a different denomination or of a little larger size. In short, the collector has no rules but in the Greek cities and Roman families, to observe alphabetical order and chronology in every thing else.

Tables of Ancient Coins.

The most ancient coins, according to Froelich, are distinguished by the following marks, which he accounts infallible. 1. Their oval circumference, and globulous swelling shape. 2. Antiquity of alphabet. 3. The characters being retrograde, or the first division of the legend in the common style, while the next is retrograde. 4. The indented square already described. 5. The simple structure of the mintage. 6. Some of the very old coins are hollowed on the reverse, with the image impressed on the front. 7. The dress, symbols, &c. frequently of the rudest design and execution.

Table I. *Ancient Greek Coins.*

1. Those without impression.

2. With one or more hollow indented marks on one side, and an impression in relief on the other.—Of Chalcedon on the Hellespont, Lebos, Abdera in Thrace, Acanthus in Macedon, those said to belong to Egium in Achaia. This class continues from about 900 to 700 B. C.

3. With an indented square divided into segments, having a small figure in one of them; the rest blank, with a figure in relief on the obverse.—Of Syracuse and other places adjacent.—Continue from 700 to 600 B. C.

4. Coins hollow on the reverſe, with figures in relief on the obverſe.—Of Caulonia, Crotona, Metapontum, &c. Suppoſed by ſome to be a local coinage of Magna Græcia; but probably of equal antiquity with the former.

5. Coins in which a ſquare die is uſed on one or both ſides.—Of Athens, Cyrene, Argos, &c.—Of Alexander I. and Archelaus I. of Macedon. Diſuſed in the reign of the latter about 420 B. C.

6. Complete coins, both in obverſe and reverſe, occur firſt in Sicily in the time of Gelo, about 491 B. C.

7. Coins of Alexander the Great and his ſucceſſors. About the time of this hero the Greek coins began to attain to perfection, and were ſtruck of uncommon beauty. It is remarkable, that on the coins of this monarch his own image ſeldom occurs. The only one yet found of Alexander with his portrait upon it, and ſtruck during his reign, is a ſilver hemidrachm in Dr Hunter's cabinet, which is repreſented Plate CCCXXXI. N° 3. After his death many coins bear his portrait. Trebellius Pollio informs us, that ſome coins, particularly thoſe of Alexander, uſed to be worn as amulets; and many medals are met with in cabinets, bored ſeemingly with that intention.

8. Coins of the Succeſſors of Alexander.—Thoſe of the Syrian monarchs almoſt equal the coins of Alexander himſelf in beauty. Thoſe of Antiochus VI. are ſuppoſed to be the moſt perfect patterns of male beauty to be met with any where. The Egyptian Ptolemies are ſomewhat inferior.

9. The coins of the Arſacidæ of Parthia done by Greek wo kmen.

10. The Greek imperial coins, being ſuch as have the head of an emperor or empreſs: ſuch as have not theſe impreſſions being claſſed with the civic coins, though ſtruck under the Roman power. None of the imperial coins occur in gold. Of ſilver there are thoſe of Antioch, Tyre, Sidon, Tarſus, Berytus, Cæſarea. Egyptian ſilver coins of baſe metal. Syrian ſilver coins, which ſometimes bear on the reverſe the club of Hercules. or the Tyrian ſhell-fiſh. Thoſe of Sidon bear the image of the goddeſs Aſtarte, or her chariot. Thoſe of Cæſarea in Cappadocia of better work than the Syrian Lycian coins of good workmanſhip: on the reverſe two harps and an owl ſitting upon them. Silver coins of Gelon in Sarmatia reſembling the Syrian. The ſituation of this town is very much unknown. It ſeems to have been ſituated on the north of the Euxine ſea, where ſome Sarmatic or Sclavonic tribes were mingled with the Scythians or Goths. The Greek imperial braſs coins are very numerous. A ſeries of almoſt all the emperors may be had from thoſe of Antioch, with a Latin legend on the obverſe and Greek on the reverſe. Thoſe of Bithynia and Phrygia remarkable for good workmanſhip. The coins of Tarſus remarkable for their curious views of objects, almoſt in perſpective. The Egyptian coins, from the time of Auguſtus to Nero, are worſe executed than afterwards. From Nero to Commodus they are frequently of admirable workmanſhip, and in a peculiar ſtyle, diſtinct both from the Greek and Roman. From the time of Commodus they decline, and are loſt after the reign of Conſtantius I. The Egyptian braſs coins of the Roman period are likewiſe of excellent workmanſhip, eſpecially in the time of Antoninus Pius.

TABLE II. *Roman Coins.*

I. The conſular coins, called alſo the coins of families, and arranged alphabetically in cabinets, according to the names of the families which appear on them. They are,

1. *Braſs Coins.*—Theſe conſiſt chiefly of large pieces of rude workmanſhip without any intereſting imagery. In cabinets they are generally kept in boxes apart by themſelves. The as bears the head of Janus; the ſemis of Jupiter with S; the triens of Minerva with four cyphers; the quadrans of Hercules with three cyphers; the ſextans of Mercury with two cyphers; and the uncia bears the head of Rome with one cypher. In all theſe pieces the prow of a ſhip is conſtantly the figure on the reverſe, with very few exceptions. Sometimes indeed they have a ſhell, two heads of barley, a frog, an anchor, or a dog, on the reverſe. About the time of Julius Cæſar both the obverſes and the reverſes of the coins began to be altered.

2. *Silver.*—Of this the denarius was the firſt and principal coin. It was ſtamped originally with X, denoting that the value was ten aſes. On the reverſe was Caſtor and Pollux, or a chariot of Victory. Afterwards the buſts of various deities make their appearance; and in the ſeventh century of Rome the portraits of illuſtrious perſons deceaſed are met with: but till the time of Julius Cæſar no figure of any living perſon is to be met with; Julius himſelf being the firſt who aſſumed that honour. The workmanſhip on the beſt and worſt ſilver is much the ſame. The reverſes are very curious, and point out many remarkable events in Roman hiſtory; but none of theſe occur till about a century before the Chriſtian era. The large denarii, with ROMA, are the moſt ancient; and ſome of theſe bear the Pelaſgic A, not the Roman. The ſilver ſeſtertii have a head of Mercury, with a caduceus on the reverſe. The quinarii have always a head of Jupiter, with a Victory on the reverſe.

3. *Gold.*—Moſt of theſe are of great value. The number of theſe exceeds not 100; thoſe of braſs 200; and of ſilver 2000. The aureus is the general gold coin; but two or three gold ſemiſſes of families likewiſe occur.

II. Roman imperial coins.

1. *Braſs.*—This is of three ſizes; large, middle, and ſmall. The firſt forms a moſt beautiful ſeries, but very expenſive. The various colours of the patina have the fineſt effect. It is the moſt important of all the Roman coins, and exceeds even the gold in value.

The middle braſs is next in value to the former; and in it are many rare and curious coins, particularly intereſting to Britons, as elucidating the hiſtory of the iſland. Of theſe are the triumphal arch of Claudius; the EXERC. BRITANNICUS of Adrian; the coins of Antoninus Pius, Commodus, Severus, with a Victory, VICTORIA BRITAN.: but eſpecially thoſe perſonifying the country BRITANNIA. "The number of Roman coins relating to Britain (ſays Mr Pinkerton) is remarkable, more than 20 having been ſtruck at various times; while thoſe perſonifying Italy, Gaul, Spain,

Spain, and other regions of the empire, exceed not four or six at most for each country." Only one country vies with Britain, and that is Dacia on the extreme north east of the empire, as Britain on the extreme north-west. No doubt this circumstance of remoteness in these two countries recommended them to this particular attention, as more expressive of the Roman power.

The small brass series abounds also with curious coins. They are scarce till the time of Valerian and Gallienus, but very common afterwards. Mr Pinkerton recommends, therefore, to form a series in silver as well as brass; both being the cheapest of all the Roman coins. "In this series (says he), it is a common fault to arrange many coins which have been plated with gold or silver, the forgeries of ancient times, but which time has worn off either wholly or in part." All real brass coins have the S. C. till the time of Gallienus; as the senate alone had the power of striking brass, while the emperor himself had that of gold and silver. When the S. C. therefore, is wanting, the coin was certainly once plated; as, in general, the different type and fabric, being those of gold and silver, sufficiently show themselves. With Pertinax, A. D. 192, there is a temporary cessation of small brass; nor after him do any princes occur in that series till Valerian, A. D. 254, excepting Trajanus Decius, A. D. 250 only. After Valerian the series is continuous and common. The brass coinage gradually declined in size from the time of Severus; so that parts of the as could not be struck, or at least it was held unnecessary to strike them. Trajanus Decius attempted in vain to restore the coinage; and Valerian and Gallienus were forced to issue denarii aerei and small assaria. The series of large and of middle brass are of two fixed and known sizes; the former about that of our crown, the latter of the half crown: though after Severus they gradually lessen. But the small brass takes in all parts of the as; and every brass coin not larger than our shilling belongs to this series. The *minimi*, indeed, or very smallest, it is proper to keep apart. The coins of Julius Cæsar in this size are of peculiarly fine workmanship. They bear his portrait reverse of Augustus, or the reverse has a crocodile EGYPTO CAPTA. There are several with Mark Antony, and some with Cleopatra; but the more common pieces are those with only numerals on the obverse, which go the length of XIII; probably tickets for the baths. A great many occur in the time of Nero; of which Mr Pinkerton particularizes one which has "on the reverse a table ornamented with griffins and other devices. Upon it is placed a wreath of laurel, and a beautiful vase, of which the embossed human figures are so minute, and finished so surprisingly, as to stamp these coins the most exquisite productions of the ancient mint." From the time of Nero to that of Vespasian no small brass occurs: but there are many of this emperor and of his son Titus; while Domitian has as many as Nero, and Domitia his wife has almost as many. Succeeding emperors to the time of Pertinax have also many brass coins; but from his time to that of Valerian there are no real small brass, excepting those of Trajanus Decius. After Gallienus there are a great many coins of this kind; and Mr Pinkerton mentions one in Dr Hunter's cabinet, of an unknown person named Nigrianus. The coin seems to have been struck at Carthage; and our author concludes that he was an African usurper, father to Nigrinianus.

2. *Silver*.—This series is very complete, and the cheapest of any; especially as the small brass becomes a fine supplement to it: the latter being had in plenty when the silver become scarce, and the silver being plentiful when the brass is scarce.

3. *Gold*.—The Roman imperial gold coins form a series of great beauty and perfection; but on account of their great price, are beyond the purchase of private persons.

4. *The colonial coins* occur only in brass; none, excepting that of Nemausus, having a right to coin silver. They begin in Spain with Julius Cæsar and Antony, and cease with Caligula, who took away the privilege of coinage from the Spanish colonies. The most beautiful are those of Corinth. The other remarkable colonial coins are those of Emerita, Ilice, Terraco, Cassandria, Babba, Berytus, Cæsarea, Patræ, Emisa, Heliopolis or Balbec, Ptolemais, Sidon, Tyre, Deulton, Dium, Troas, Rhesaina, Neapolis of Samaria, which bears a representation of Mount Gerizzim with the temple on it, Hippo in Africa, &c. On many of these coins we meet with fine representations of temples, triumphal arches, gods, goddesses, and illustrious persons. But coins with those representations are by no means common; the colonial coins till the time of Trajan bearing only a plough, or some other simple badge of a colony. Camelodunum is the only colony in Britain of which we have any coins.

5. The *minimi*.—This includes the smallest coins of all denominations, most of which do not exceed the size of a silver penny. They are the most curious of all; but no series of them was ever formed by any person except the abbé Rothelin, whose collection formed of all metals passed to the queen of Spain. The reason of the scarcity of these small coins is probably their diminutive size; by reason of which they are mostly lost.

It is surprising that numbers of Roman coins are found through all countries once subject to that powerful people. Some have been met with in the Orkneys, and many in the most remote parts of Europe, Asia, and Africa, known to the ancients.

TABLE III. *Coins of other ancient Nations*.

1. The Lydians appear to have invented coinage; though, perhaps, this honour may be disputed with them by the Greeks.

2. The Assyrians, Medes, Babylonians, Phœnicians, and Egyptians, had no coins. In the mouths of the mummies are only thin, unstamped, and round pieces of gold, to pay Charon's fare.

3. No Indian or Chinese coins are to be met with till a very late period; and even then so rude as scarce to be worth notice. Voltaire mentions a collection of ancient Chinese and Indian coins made by the emperor of China in 1700; but Mr Pinkerton supposes it to have consisted only of the Greek and Roman money which had been introduced into these countries.

4. The Lydian coins have no legends; so that mere conjecture only determines the ancient coins of electrum

 and

Ancient Coins.

and ſilver found in Aſia, and different from the Perſian, to belong to Lydia. Crœſus coined gold into a form which he called *ſtaters;* and Mr Pinkerton mentions a very ancient gold coin in Dr Hunter's cabinet, which he ſuppoſes to have been one of theſe. It has a globous figure, with indented marks on one ſide, and on the other a man kneeling, with a fiſh held out in the left hand, and a ſword depending in the right. It weighs four drachms; which Joſephus tells us was the weight of the Lydian gold coins. In the ſame collection are other gold coins little inferior in antiquity; the moſt ancient of which, our author ſuppoſes, may have been coined by the cities of Aſia Minor, as coinage paſſed through them to Greece. They are of admirable workmanſhip, and as much ſuperior to the beſt Sicilian coins, as the latter are to all the reſt in the world. Theſe gold coins are all extremely pale; owing to the want of knowledge in refining gold.

5. Perſian coins.—Theſe were firſt ſtruck by Darius Hyſtaſpes, whence they had the name of *darics.* They are of gold, and generally have the figure of an archer: they weigh about four drachms; and ſome occur with the indented mark on one ſide, while others have figures upon both. The ſilver coins have generally a king in a chariot of two horſes, with a charioteer, and ſometimes another figure on foot behind, on the obverſe: while the reverſe preſents a ſhip, ſometimes a ram, bull, or other animal. The gold coins, which only had the title of *darics*, are extremely ſcarce, having been melted down, as is ſuppoſed, and recoined by Alexander the Great on his conqueſt of Aſia.

There is a ſecond ſeries of Perſian coins beginning with Artaxares, or Artaxerxes, who overthrew the Parthian monarchy about the year 210. Theſe are large and thin, with the king's buſt on one ſide and the altar of Mithras on the other; generally with a human figure on each ſide. Theſe coins continue till the year 636, when Perſia was conquered by the Saracens. Theſe have only Perſian letters upon them, which have never been explained by any antiquaries. Mr Pinkerton ſays that they ſeem to partake of the ancient Greek, Gothic, and Alanic.

6. The Hebrew ſhekels, originally didrachms, but after the time of the Maccabees tetradrachms, are almoſt all forgeries of modern Jews, as well as the braſs coins with Samaritan characters upon them. They have all a ſprig upon one ſide and a vaſe on the other. Mr Pinkerton ſays, that the admiſſion of one of them into a cabinet would almoſt be a diſgrace to it.

7. Phœnician and Punic coins are very intereſting on account of the great power and wealth of theſe nations. The alphabets have been cleared by their relation to the Hebrew and Syriac languages.

8. The coins of Palmyra come under the ſame denomination with the former, Palmyra being a Syrian city.

9. The Etruſcan coins have the characters of that nation, which have been explained by their affinity to the Pelaſgic, or oldeſt Greek and Latin.

10. The Spaniſh coins are inſcribed with two or three alphabets allied to the old Greek or Punic; but the inſcriptions have not been ſufficiently explained.

11. Gauliſh coins.—Theſe are numerous, but the moſt ancient have no legends; and even after the Greek letters were introduced into Gaul by a colony at Marſeilles, the legends are very difficult to be explained.

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12. Britiſh coins.—From a paſſage in Cæſar's Commentaries, it has been inferred that the Britons uſed ſome kind of coins even in his time. Mr Pinkerton informs us, that ſome rude coins of copper very much mingled with tin are frequently found in England; which, he ſuppoſes, may be ſome of the ancient Britiſh money. They are of the ſize of a didrachm, the common form of the nummus aureus among the ancients. After the time of Cæſar, coinage increaſed among the Britons; and there are many found of Cunobelinus mentioned in the Roman hiſtory. Moſt of theſe have on one ſide CUNO, with an ear of wheat, a horſe, a kind of head of Janus, or other ſymbol; and have frequently alſo the letters CAMU; ſuppoſed to mean Camelodunum. Sometimes the word TASCIA occurs; the meaning of which has not yet been explained.

13. Gothic coins of France, Italy, and Spain, to the time of Charles the Great. Theſe have the Roman characters upon them. The Italian coins are moſtly of the ſize of ſmall braſs; and in this way we meet with coins of Athalaric, Theodahat, Witigez, and other Gothic princes. Many others occur, the inſcriptions of which, though meant for Roman, are ſo perverted as to be illegible.

TABLE IV. *Modern Coins.*

1. Of Japan.—Theſe are thin plates of gold and ſilver, of an oval figure, with ſmall marks or figures ſtamped on them.

2. China.—Theſe are only copper, about the ſize of a farthing, with a ſquare hole in the middle to put them on ſtrings. The inſcriptions on them do not expreſs the name of the ſovereign, but the year of his reign; as the *happy year*, the *illuſtrious year*, &c.

3. The Tartarian coins are rude, having only inſcriptions upon them; and they are all poſterior to the time of Jenghiz khan.

4. Coins of Thibet, Pegu, and Siam, are much the ſame, preſenting only inſcriptions without any figures. They are alſo of late date.

5. India.—Some old coins have been found in the neighbourhood of Calcutta, of gold, ſilver, copper, and tin, all mixed together. Theſe have commonly a warrior with a ſword on one ſide, and an Indian female idol on the other, of the ſame form with the celebrated ſculptures in the iſland of Elephanta; but it is impoſſible to tell what antiquity they are of. The modern coins are the pagoda of gold, worth little more than ſix ſhillings; the roupee of ſilver upwards of two ſhillings; and the caſh, of copper. There is a remarkable ſet of roupees, which ſhow the twelve ſigns; a lion on one, a bull on another, &c. but the occaſion on which they were ſtruck is unknown. The other coins of India have generally Perſian inſcriptions upon them.

6. Perſia.—The Perſic coins ſince its conqueſt by the Arabs continue on the Arabian model.

7. Arabia.—Some coins of the petty princes of Arabia are met with as old as the imperial ages of Rome; but till the time of Haroun Alraſhid, no regular

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gular coinage appears in the vaſt empire of the Saracens. Even then the reverſe has only an inſcription, and the obverſe is copied from any Greek or Syrian coin which happened to fall in the moneyer's way. The later Arabian coins are moſtly ſilver, with the name and titles of the prince on one ſide, and ſome inſcription from the Koran on the other. The more modern coins of this country are in the ſhape of a fiſh-hook, with Arabic inſcriptions.

8. Turkey.—No regular coinage was formed by the Turks till they became maſters of Conſtantinople. They reſemble thoſe of Perſia and Arabia, having merely inſcriptions on both ſides.

9. The coins of the African ſtates, at leaſt ſuch as profeſs the Mohammedan religion, have merely inſcriptions without any figures: thoſe of the internal parts are unknown; and no coinage was uſed among the Mexicans and Peruvians, the only civilized nations in America; but La Hontan mentions an American ſavage who had a ſquare medal of copper depending from his neck. Mr Pinkerton ſuppoſes it to have come from Japan.

10. Modern Italic coins. Beſides the Gothic princes mentioned in the former table, the exarchs of Ravenna coined money with the inſcription FELIX RAVENNA, &c. The Lombards iſſued no coins, but there are ſome ſtill extant of Charlemagne. The following liſt ſhows the origin of the coinage in various Italian ſtates.

Rome.—Papal coinage originates with Hadrian I. Size of ſilver pennies, with the Pope's name on one ſide, and SCOS PETRUS on the other. No coins appear from 975 to 1099, excepting of Leo IX. In 1303 appear pennies of the ſenate and people of Rome, with Peter on the one ſide and Paul on the other. There are groats of Clement V. with his portrait three quarters length; but the ſide-head begins with Sixtus V. in 1470. Gold was firſt coined by John XXII. in 1316. The coins of Alexander VI. Julius II. and Leo X. are remarkable for beauty and elegance.

Milan. Coinage began with Charlemagne. The firſt coin of the family of Viſconti occurs in 1330 under Azo. The ſet finiſhes with Louis XII.

Naples. Coinage begins in 840 and 880, with Duke Sergius and Biſhop Athanaſius. The next coins are of Roger of Sicily, and Roger II. in 1130, William I. II. and Tancred. Naples and Sicily were ſubdued in 1194 by the emperor of Germany; in 1255 Manfred appears; in 1266 Charles of Provence; and others till Joan in 1414: after which follow the houſe of Arragon, and later kings.

Venice begins in the 10th century. The firſt coins are ſilver pennies marked VENECI. Then follow the coins of Henrico Dandulo in 1192, of Ziani in 1205, &c. Gold was firſt coined at Venice in 1280, and copper in 1471; but the ſilver groats are as old as 1192.

Florence. Silver was coined here in the 12th century, or before; but in 1252 the firſt gold coins ſtruck in Europe after the 8th century made their appearance, and were named *florins* from the flower of the lily upon them. They were imitated by the popes, by France, and England. They have on one ſide St John the Baptiſt ſtanding, on the other a large *fleur de lis*, and it is not doubted that the French *fleurs de lis* took their origin from theſe coins. They weigh a drachm, and are no leſs than 24 carats fine, according to Italian writers, and are worth about 12 ſhillings.

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Geneva firſt began to coin money in 1129, under the government of Conrad. Thoſe of the dukes of Savoy began in the ſame century.

Aquileia. Coins were iſſued from this city by the patriarchs from 1204 to 1440.

Ferrara. Coins of the marquiſes from 1340.

11. French coins. During the race of Clovis, from 490 till 751, the coins are chiefly gold *trientes*, with ſome *ſolidi* and *ſemiſſes*. The former are of good workmanſhip, with the heads of kings. The reverſe has a croſs, with the name of the town where they were ſtruck.

The coins of the ſecond race begin with Pepin in 751, and continue till Hugh Capet in 987. The coins of the firſt race are elegant, but thoſe of the ſecond entirely the reverſe, being almoſt all ſilver pennies, and ſeldom bearing the portrait of the king. Thoſe of Charlemagne have only CAROLUS in the field; while the reverſe bears R. F. or ſome ſuch inſcription; though one piece ſtruck at Rome has a rude buſt of him. The coins of Louis le Debonnaire are better done.

The third race begins with Hugh Capet in 987, and extends to this time. The coinage did not begin to improve till 1226 under St Louis, when the groat appears. Its name in Italian is *groſſo*, in French *groſſe*, in Engliſh *groat*, or great coin; ſo called from its ſize in compariſon with the penny; and it paſſed from Italy to France, to Germany, and to England. After the conqueſt of France by the Engliſh, baſe coins of many kinds were introduced; and in the year 1574, in the time of Henry III. copper was firſt introduced into the French coinage. Beſides theſe, the other remarkable coins of France are, the blancs or billon groats, firſt iſſued in 1348; the *ecus a la couronne*, or crowns of gold, ſo called from the crown on one ſide, and begun by Charles VI. in 1384; thoſe of Ann of Bretagne in 1498: the *teſton*, or piece with the king's head, of Louis XII; the *Henri* of Henry II. with Gaul ſitting in armour, and a Victory in her hand. There are many coins of Cardinal Bourbon, elected king in 1589; and in 1642, Louis XIV. takes the title of CATALONIÆ PRINCEPS. The firſt *louis d'or* made its appearance in 1640; but ſuch was the poverty of France, if we believe certain authors, that in 1719 the duke of Orleans regent ſtruck copper for ſilver.

12. Spaniſh coins. The moſt early ſeries of theſe conſiſts almoſt entirely of trientes, finely done. On one ſide they have the head of the king with his name, and on the other a croſs, with the name of the town, commonly in Bætica, or the ſouth part of Spain, where there were a great many Roman colonies, and which was fertile to a proverb. The Moreſque coins of Spain, like thoſe of the reſt of the Mohammedan ſtates, preſent us only with inſipid inſcriptions on both ſides. Indeed the Mohammedan religion, by its abſolute refuſal to allow the repreſentation of any living creature, has prevented the progreſs of coinage in any degree throughout thoſe regions which it has overſpread,

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ſpread. The inſcriptions on the ancient Spaniſh coins are in the Cufic or old Arabic characters.

13. Portugal. No deſcription of the coins of this kingdom has yet appeared.

14. Germany. No account of the German coins has been publiſhed; though it is well known that not only the emperors, but many of the cities, particularly thoſe called *Hanſe-towns*, iſſued money; and many of the coins iſſued by the cities were ſuperior in elegance even to thoſe iſſued by the emperors.

15. Denmark. Here the coinage begins with Canute the Great in 1014. The pieces are at firſt extremely rude, ornamented only with rings and Runic characters. Theſe are ſucceeded by copper pieces, ſome of which have a croſs, others a paſtoral ſtaff, on one ſide, with the letter A on the other. Later coins have ſtrokes IIII, &c. all round them; but thoſe of Harold, Hardicanute, and Magnus Bonus, in 1041, are of neat workmanſhip, and have the portraits of the princes at half length. The coins of Nicolas, or Niel, as he is called by the Danes, are rude, as well as thoſe of Waldemar I. and the celebrated Margaret. In 1376 Olaf cauſed money to be ſtruck with a grinning full face, with a crowned O upon the other ſide. "The Swedes (ſays Mr Pinkerton) took theſe coins extremely ill, as they thought they grinned at them." Silver was firſt coined in Denmark by Philippa queen of Eric, and daughter to Henry IV. of England.

16. Sweden. The coinage of this kingdom began in 818 under Biorno, on the plan of Charlemagne. The coins are marked with a croſs. Next follow thoſe of Olaf in 1019; which Mr Pinkerton ſuppoſes to have been the firſt true Swediſh coins; and that the art of coinage firſt paſſed from England into Denmark in the time of Canute the Great, and from Denmark into Sweden. Theſe coins were ſtruck on the Engliſh model. During the time that Sweden was ſubject to Denmark, or miſerably haraſſed by the Danes, the coins of both kingdoms were the ſame; but after the time of Guſtavus Vaſa many elegant pieces appear. In 1634, dollars were coined with the portrait of Guſtavus Adolphus, who was killed two years before: on the reverſe they have the arms of Sweden, with the chemical marks of mercury and ſulphur. In 1716, 1717, and 1718, Charles XII. being in extreme want of money, iſſued ſmall copper coins with Saturn, Jupiter, Mars, &c. upon them, to go for dollars; and on account of this ſcheme, Baron Goertz, the ſuggeſtor of it, was brought to the block.

17. Norway. The coins of this country begin with Olaaf in 1006; after which time there are various coins of other princes; but copper was not coined till the year 1343.

Beſides the coins already mentioned, there are eccleſiaſtic coins of France, Germany, Denmark, Sweden, Norway, &c. Thoſe of Denmark and Sweden are numerous, but the Norwegian coins of this denomination are rare. Mr Pinkerton deſcribes a ſilver one in his poſſeſſion as having arms and a mitre, with the inſcription on one ſide, SANCTUS OLAWS REX NORVEY; on the reverſe, OLAWS DEI GRA. ARCEP. NID'SEN, meaning NIDROSIENSIS, or archbiſhop of *Nidros*, now Drontheim.

18. Bohemia. The coinage of this kingdom appears at a very early date, viz. in the year 909, under Duke Boleſlaus I. Theſe coins are followed by others of Boleſlaus II. and Emma his wife in 970; of Boleſlaus III. in 1002; Jaromir in 1020; Udalrich in 1030, and other princes. The *bracteate* money of Ottocar I. was coined in 1197.

19. Poland. The coinage of this country is nearly as ancient as that of Bohemia. The coins are on the German model, but no particular account of them has been publiſhed.

20. Ruſſia. None of the Ruſſian money appears to be more ancient than the 13th century. The firſt are the *kopecks* or ſilver pennies, which have upon them rude figures of animals on one ſide, and a man ſtanding with a bow or ſpear on the other. There are likewiſe coins of Moſcow ſtruck by Ariſtoteles the architect in 1482. The *roubles* or dollars and their halfs. There are ſome of the impoſtor Demetrius in 1605, which are very ſcarce.

21. Pruſſia. The firſt Pruſſian coins were ſtruck at Culm by the Teutonic knights in 1230. They were ſilver pennies, and upon the German plan. In the next century were ſtruck ſhillings, groats, and *ſchots*; the laſt were the largeſt, and are extremely rare. They have the Pruſſian ſhield, an eagle ſurmounting a croſs, with a roſe-ſhaped border, MONETA DOMINORUM PRUSSIÆ: on the reverſe is a croſs fleurie, within a border of a ſimilar kind, having the inſcription HONOR MAGISTRI, JUSTITIAM DILIGET.—Gold coins were ſtruck in the ſame century. In the time of Copernicus the money was ſo debaſed, that 12 or 13 marks were worth but one of pure ſilver.

22. England. The Engliſh coins are of various kinds.

1ſt. *Heptarchic*. Theſe are only of two ſorts, viz. the *ſkeatta* or penny of ſilver, and the *ſtyca* of copper. Few of the pennies appear till after the year 700; though ſome are met with which bear the name of Ethelbert I. king of Kent, as old as 560. At firſt they had only rude figures of ſerpents, but in latter times legends were likewiſe added. Moſt of theſe pennies have pagan ſymbols upon them. The ſtyca was only coined in Northumberland, and was a very ſmall piece, about the value of half a farthing.

2d. Coins of the *chief monarchs* of England. Mr Pinkerton denies that an end was put to the heptarchy by Egbert in 832, as is commonly ſuppoſed; though he owns that he was *chief monarch* of the country, as ſeveral others had been before him. Edgar, who reigned in 959, according to him, was the firſt king of England; and the coins of the chief monarchs form almoſt a complete ſeries from the time of Egbert to Edgar. The only chief monarch of whom there are no coins is Ethelbald, who reigned in 857. Moſt of theſe coins bear rude portraits; but the reverſes are ſometimes curious and intereſting. Some have views of cathedrals and other buildings; particularly one of Edward the Elder in 900; which has the cathedral of York with three rows of windows, round arched as the other Saxon and Norman buildings: the Gothic arch being quite unknown till after the 12th century. Some coins of Anlaf king of Northumberland have the famous raven, the Daniſh enſign: and thoſe

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those of other princes have frequently very curious reverses.

3d. *Ecclesiastic* coins appear of the archbishops of Canterbury, Wulfred in 804, Ceolnoth in 830, and Plegmund in 889.

4th. Coins of the *kings* of England. The silver penny, which had begun during the heptarchy, continued to be the general coin after the kingdom had been united under one head; and extends in a continued series from Egbert almost to the present reign. The only kings wanting are Edmund Ironside, Richard I. and John. At first the penny weighed $22\frac{1}{2}$ grains: but towards the close of the reign of Edward III. it fell to 18 grains; and in that of Edward IV. to 12. In the time of Edward VI. it was diminished to 8 grains; and in Queen Elizabeth's reign to $7\frac{1}{11}$; at which it still continues.

Halfpennies and farthings were first struck in silver by Edward I. in 1280; the former continued to the time of the commonwealth, but the latter ceased with Edward VI. The groat was introduced by Edward III. in 1354, and continues to this day, though not in common circulation. The half-groat or two-pence is of the same date, and also continues to the present time.

Shillings were first coined by Henry VII. in 1503. At first it was called *testoon*, from the *teste*, *tete*, or head of the king upon it; the name *shilling* being derived from the German *schelling*; under which appellation coins had been struck at Hamburgh in 1407. The crown was first coined in its present form by Henry VIII. Formerly it had appeared only in gold, whence the phrase of crowns of gold; though these indeed were the largest gold coins known for a long time in France and other countries on the continent, being worth about 10s. sterling. They had their name from the crown stamped on one side, and were first coined by Charles VI. in 1384, and continued till the time of Louis XIV. The half-crown, sixpence, and threepence, were coined by Edward VI. In 1558 Queen Elizabeth coined three halfpenny, and in 1561 three farthing pieces; but they were discontinued in 1582. From the year 1601 to the present time the coins of England remain the same.

Gold was coined in England by Henry III. in 1257; the piece was called a *goldpenny*, and was larger than the silver one; and the execution is by no means bad for the time. The series of gold coinage, however, commences properly from Edward III. In 1344, this monarch first struck florins, in imitation of those in Italy; and it is remarkable, that though these coins at the time they were first issued bore only six shillings value, they are now intrinsically worth 19s; so much has the value of gold increased since that time. The half and quarter florin were struck at the same time, but only the last has been found. The florin, however, being found inconvenient, gave place to the noble of 6s. 8d. value, and exactly half a mark. The latter had its name from being a limited sum in accounts; and was eight ounces in weight, two thirds of the money pound. It is sometimes also called *selibra*, as being one half of the commercial pound of 16 ounces. The noble had its name from the nobility of the metal; the gold of which it was coined being of the finest sort. Sometimes it was called *rose noble*, from both sides being impaled in an undulating circle. It continued with the half and quarter noble to be the only gold coin till the angels of Edward IV. appeared in 1465. These had their name from being stamped with the image of Michael and the dragon. The angelites of 3s. 4d. value were substituted in their place. In 1527 Henry VIII. added to the gold coined the crown and half-crown at their present value; and the same year he gave *sovereigns* of 22s. 6d. and *ryals* of 11s. 3d. angels at 7s. 6d. and nobles at their old value of 6s. 8d. In 1546 he caused sovereigns to be coined of the value of 20s. and half-sovereigns in proportion. His gold crown is about the size of our shilling, and the half-crown of sixpence, but thin. All his coins, however, gold as well as silver, are much debased; and it was not without much labour and trouble that Edward VI. brought it back to its former standard. On the union of the two crowns, James gave the sovereign the name of *unite*; the value continuing of 20s. as before. He coined also rose-ryals of 30s. value, spur-ryals of 15s. angels of 10s. and angelets of 5s. Under the commonwealth, the sovereign got the name of the *twenty-shilling* piece, and continued current till the coinage of guineas. These were so called from their being coined of Guinea gold, and were at first only to go for 20s. though by an universal but tacit consent they always passed for 21s. Half-guineas, double guineas, and five guinea pieces, were also coined during the same reign; which still continue, though the two latter are not in common circulation. Quarter guineas were coined by George I. and likewise by his present majesty; but they were found so troublesome on account of their small size, that they were stopped within a year or two, when received at the bank of England, and thus are not to be met with at present. A few pieces of 7s. value have likewise been coined, and are known by the lion above the helmet; but none have been issued. In 1688 the guinea rose to 21s. 6d. and continued to increase in value till 1696, when it was as high as 30s.; but after the recoinage in 1697 and 1698 it fell by degrees, and in 1717 was at its old standard of 21s. and at that time silver was fixed at its present standard value, viz. as 1 to $15\frac{1}{2}$ in weight.

Though the first money coined in Britain, as we have already observed, was copper, yet, excepting the Northumbrian stycas, no copper coin was found in England from the time of the Saxon conquest till the year 1672. An aversion to a copper coinage it seems was prevalent throughout the nation; and Queen Elizabeth, who without hesitation used base money for Ireland, yet scrupled at coining copper for England. This want of small coin occasioned such an increase of private tokens for halfpennies and farthings, that it became a serious object to government; and in 1594 a copper coinage was seriously thought of. This year a small copper coin was struck about the size of a silver twopence, with the queen's monogram on one side, and a rose on the other; the running legend on both sides being, THE PLEDGE OF A HALFPENNY. Of this there are patterns both in copper and silver, but both of them soon fell into disuse. On the 19th of May 1613, King James by royal proclamation issued farthing tokens. They are generally of the same size with the two pence, with two sceptres in saltier surmounted with

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with a crown, and the harp upon the other; with an intention, as it would ſeem, that if they were refuſed in England they might paſs in Ireland. In 1635 Charles I. coined thoſe with the roſe inſtead of the harp; but the circulation of theſe was entirely ſtopped by the vaſt number of counterfeits which appeared, and by the king's death in 1648. After this the private tokens began again to be circulated, till put a ſtop to by the coinage of farthings in 1672. The workmanſhip of the tokens is quite contemptible. In 1672 the halfpence as well as the farthings which had been ſtruck two years before began to circulate. They were of pure Swediſh copper, the dies engraved by Roettier; and they continued till the year 1684, when ſome diſputes aroſe about the copper lately obtained from the Engliſh mines. Tin farthings were coined with a ſtud of copper in the centre, and inſcribed round the edge as the crown pieces, with NUMMORUM FAMULUS. 1685 or 1686. In 1685 halfpence of the ſame kind were coined; and the tin coinage continued till the year 1692, to the value of more than 65,000l; but next year the tin was all called in by government, and the copper coinage recommenced. The farthings of Queen Anne are all trial pieces, excepting thoſe of 1714, the laſt year of her reign. "They are (ſays Mr Pinkerton) of exquiſite workmanſhip, exceeding moſt copper coins either ancient or modern, and will do honour to the engraver Mr Crcker to the end of time." The one, whoſe reverſe is Peace in a car, PAX MISSA PER ORBEM, is the moſt eſteemed; and next to it the BRITANNIA under a portal. The other halfpence and farthings are leſs valuable.

23. Scotland. Silver pennies of Alexander I. who reigned in 1107, are believed to exiſt; and there certainly are ſome of Alexander II. in 1214. There are likewiſe coins of David in 1124; but perhaps none of Malcom IV. his ſucceſſor, whoſe reign was very ſhort. There are many coins of William I. in 1165; and a large hoard of his pennies was found at Inverneſs in 1780.

The money of Scotland continued to be of the ſame value with that of England till the country was drained by the vaſt ranſom of David II. after which it became neceſſary to reduce its ſize; and ſo much did this diminution affect England, that Edward III. found himſelf obliged to leſſen the Engliſh coin alſo. The diminution of the Scottiſh coin, however, continued ſtill to go on until it became impracticable to keep par with that of England. In the firſt year of Robert III. it paſſed only for one half of its nominal value in England: in 1393, Richard II. ordered it only to go for the weight of the genuine metal it contained. In 1600 it had ſunk to ſuch a degree as to paſs only for a twelfth part of the Engliſh money, and continued at that low ebb till the coinage of Scotland was entirely cancelled by the union of the two kingdoms.

Of ſilver coins we have only pennies till the year 1293, when Edward I. having coined halfpence and farthings, Alexander III. of Scotland coined alſo halfpence, of which we have a few, but no farthings are to be met with; but there are ſilver farthings of Robert I. and David II. The latter introduced the groat and half-groat, which completed the ſet of Scottiſh ſilver. It continued unaltered till the tim of Queen Mary, when they all ceaſed to be coined in ſilver, on account of the high price of that metal. In 1553 ſhillings were firſt coined, with the buſt of the queen on one ſide and the arms of France and Scotland on the other. The ſilver crown was firſt coined in 1565, which went for 30s. Scots; leſſer pieces of 20s. and 10s. having likewiſe been ſtruck, and marks of ſilver, worth 3s. 4d. Engliſh, were alſo coined about the ſame time. Theſe coins have upon them the marks XXX. XX. X. to denote their value. They are commonly called Cruickſtone dollars, from the palm-tree upon them, miſtaken for a remarkable yew at Cruickſtone near Glaſgow, where Henry Darnly reſided. It is deſcribed, however, in the act as a palm, with a "ſhell-padoc" (a tortoiſe) crawling up. This alludes to Darnly's marriage with the queen, as the motto from Propertius DAT GLORIA VIRES alſo implies. The motto NEMO ME IMPUNE LACESSET firſt appears on the Scottiſh coins in 1578, and the invention is given to the celebrated Buchanan. In 1582, the crown of an ounce weight went for 40s. Scots, and was accordingly marked XL.; in 1597 the mark was L. the Scottiſh money being then only one-tenth of the Engliſh: the mark was LX in 1601, the value being then reduced to one twelfth, at which it has ever ſince continued. In the time of Charles I. half marks, 40 and 20 penny pieces, were coined. In 1675 the Scottiſh dollars firſt appeared, in value 56s. Scots, with halves and quarters of proportional value. In 1686, James VII. coined 60s. 40s. 20s. 10s. and 5s. pieces; but only thoſe of 40s. and 10s. are known, with theſe numbers under the buſt. At the union of the kingdoms, all the Scottiſh coins were called in, and recoined at Edinburgh, with the mark E under the buſt to diſtinguiſh it: ſince which there has been no coinage in Scotland. The Scottiſh ſilver coins are in general equal, if not ſuperior, in the workmanſhip to the Engliſh.

Gold was firſt iſſued by Robert II. about 30 years after Edward III. of England had coined the ſame metal in that country. The pieces were at firſt called St Andrews, from the figure of that tutelar ſaint upon the croſs, and who appears on the obverſe with the arms of Scotland, and on the reverſe a lion in a ſhield. The lion was another name for the largeſt gold coin in Scotland, from the arms of the kingdom upon it. The next was the unicorn, under James III.; which were followed by the bonnet-pieces of James V. Theſe laſt are of admirable workmanſhip, being almoſt equal to the ancient coins in this reſpect. In imitation of the French, the monarch we ſpeak of diminiſhed the ſize of the coin without leſſening its weight; an improvement not adopted by the Engliſh for a whole century. The laſt gold coined in Scotland was the piſtole and half piſtole, of twelve and ſix pounds Scots. Theſe coins have the ſun under the head. The gold coins of Scotland fell in the ſame proportion with the ſilver.

The copper coinage of Scotland is of more early date than that of England. It was preceded by money of *billon*, or copper waſhed with ſilver, called black money. James III. firſt coined black farthings in 1466; and this is recorded by hiſtorians as one of his greateſt faults. This kind of coinage, however, continued as late as the reign of James VI. In his time the

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the true copper coinage began; but as the value of Scottish money had now declined almost to the utmost, the pieces suddenly assumed a form almost resembling that of the French coins. The *bodle* so called from Bothwell the mintmaster, being equal in size to the *liard*, and worth two pennies Scottish, was struck. The billon coin, formerly called *bas piece*, and worth six pennies Scots, was now coined in copper, and termed the *baw-bee*. Thus it corresponded with the French half sol and English halfpenny, the Scots penny being now equivalent to the French *denier*. Some pieces named *Atkinsons* were coined by James VI. in 1582, when the Scottish money was to the English as 1 to 8; but on its being still farther reduced, they went for 8 pennies, a third more than the value of the baw-bee. Besides these there were the hardie and plack, the former being worth three and the latter four pennies Scots. This coinage continued through the reigns of Charles I. and II. but Scottish coins of the former are, perhaps, the scarcest of any.

24. Ireland. The first coins introduced into this kingdom seem to have been those of the Danes, and which have only a number of strokes around them instead of letters. In the tenth century, however, this coinage had been considerably improved; and in 930 and 994 there are pennies struck in Dublin, with the inscription ON DVFLI or DYFLI, *Duflin* or *Dyflin* being the Danish name of that city. There are likewise coins of the Irish princes themselves, and of the English monarchs, struck in Ireland as early as the ninth century; and it is asserted by some, that Ireland even in these days had been conquered by England; of which indeed, these coins seem to be a proof. None of the Irish coins of Henry II. are to be met with, but we have some of the coins of John; and from this time to that of Henry V. the Irish coins are known by a triangle enclosing the king's head, which appears also upon the coins of other nations at this period. The harp does not appear upon the Irish coins till the time of Henry VIII. Till the time of this monarch, the English and Irish coins are the same; but the same debasement of the coin which at that time took place in England extended also to Ireland; but in 1601 copper halfpence and farthings were coined also for this kingdom. These circulated in Ireland when James VI. issued his farthing-tokens of copper, the latter being of two sizes, that if they failed in England they might be sent to Ireland as pennies and halfpence. In 1635 a mint was established in Dublin by Charles I. but it was stopped by the Irish massacre, and the many disturbances which followed; since which time the scheme has not been resumed. After the massacre, St Patrick's halfpence and farthings were coined by the Papists, bearing the legends FLOREAT REX, and on the reverse ECCE GREX; on the farthing QUIESCAT PLEBS. Copper tokens were struck by towns and tradesmen, as in England and Scotland. In 1680, halfpence and farthings were issued by authority, with the harp and date. In 1689, James II. having invaded Ireland, instituted a mint, and coined shillings and half-crowns of all the refuse metal he could find, particularly some brass guns were employed, whence the coinage is commonly called *gun-money*. Even this metal, however, soon became so scarce, that a diminution in its size is quite apparent from June 1689 to July 1690; and as the month of their mintage is marked upon them, this decrease is easily perceived. In March 1690, pennies of lead mixed with tin were issued; and on the 15th of June the same year, crowns of white metal were coined; but these are now very scarce. In 1722, the patent for coining halfpence and farthings was given to William Wood, which excited such discontent in Ireland. From the small size allowed by the patent to these pieces, it was supposed that the patentee would have gained 60,000l. but as he caused them to be struck of a size still smaller, his gains were estimated at 100,000l. The coins, however, are of admirable workmanship, and very fine copper, bearing the best portrait of King George I. to be found any where. Sir Isaac Newton, at that time at the head of the mint, declared that they were superior to the English coins in every thing except the size. In 1737 the Irish halfpence and farthings, with the harp on the reverse, were coined, and continue to the present time. In 1760, there was such a scarcity of copper coin, that some private persons applied for leave to coin halfpence, which appeared with a very bad portrait of George II. and the words VOCE POPULI around it. No gold or silver has been coined in Ireland since the massacre of 1641.

Modern Medals.

TABLE V. *Modern Medals, properly so called.*

1. Scottish medals. These take the lead in the present article, the first modern medals of gold being those of David II. struck between the years 1330 and 1370. Only two of them are known to exist; one in the collection of Mr Barker of Birmingham, and the other in that of Dr Hunter. In 1487, there is a medal of James III. sent to the shrine of St Amboise in France. It is described as of two inches and a third in diameter; the weight near two ounces; having on the obverse a beardless king, with long hair, sitting on a throne, holding in one hand a naked sword; in the other a shield, with the Scottish arms. On the borders of the canopy above the throne is an inscription in Gothic letters, IN MI DEFFEN, being corrupt French for *In my defence;* a common motto in the Scottish arms. Above the canopy is VILLA BERWICHI: the reverse bears St Andrew and his cross, SALVUM FAC POPULUM TUUM DOMINE. There is also a medal of James IV. in the collar of St Michael, having on the reverse a Doric pillar surmounted by a young Janus, standing on a hill, beyond which is the sea, and land on either side. This, however, is by some suspected to be a forgery.

The most remarkable Scottish medals are those of the unfortunate Mary. The first is properly French, having been issued at her coronation as queen of France, along with her husband King Francis II. On the obverse of this piece there are portraits of Francis and Mary, face to face, with three legends around them, the outermost containing their titles; the middle one the following sentence: HORA NONA DOMINUS J. H. S. EXPIRAVIT HELLI CLAMANS; the innermost the name of the city (Paris). On the reverse are the arms of France and Scotland. Fine testoons were also coined upon the same plan, and are now so rare that Dr Hunter gave ten guineas for one which

which is in his collection. The same portraits appear on the fine crown of Mary and Henry, in 1565, which is so rare as to be esteemed a medal of the highest value; and Mr Pinkerton imagines, that if offered to sale it would bring 40 or 50 guineas.

Another remarkable medal of Mary represents her full faced, and weeping, with the inscription, O GOD GRANT PATIENCE IN THAT I SUFFER VRANG. The reverse has in the centre, QUHO CAN COMPARE WITH ME IN GRIEF, I DIE AND DAR NOCHT SEEK RELIEF; with this legend around, HOURT NOT THE (figure of a heart) QUHAIS JOY THOU ART. There are also many counters of this unfortunate princess, being thin silver pieces of the size of a shilling. "They all appear (says Mr Pinkerton) to have been done in France by the direction of Mary, who was fond of devices. Her cruel captivity could not debar her from intercourse with her friends in France, who must with pleasure have executed her orders, as affording her a little consolation,"

The coronation medal of Charles I. struck at Edinburgh for his inauguration, June 18. 1663, is remarkable as being the only one ever coined of Scottish gold, and the first in Britain struck with a legend on the edge. With respect to the workmanship, it is inferior to Simon's. Of these medals only three are known to exist, of which one is in the Museum. It is not uncommon in silver; in which case it sometimes wants the legend on the edge.

2. Italian medals. These appear in the 15th century, and from that time successively in most European countries. Vittore Pisano, a painter of Verona, is celebrated as the restorer of the art, but it remains to be accounted for how the medals of King David, already mentioned, came to exist so long before. Mr Pinkerton considers this artist rather as an inventor than a restorer, his medals having no resemblance to the ancient coins, as being large, and all cast. They were first modelled in wax, then a mould taken from the model in fine sand and other ingredients. After a good cast was procured, it was touched up, and made a model for the rest. These medals of Pisano, are almost always inscribed *Opus Pisani Pictoris*. The portraits of a great number of illustrious men were done by him in this manner; and in the British Museum is a large brass medal of Pisano by himself.—Other artists were Boldu, Marescotto, Matthæus de Pastus, Sperandes, Misaldone, &c. Towards the end of the century, however, the medals began to assume a more elegant appearance; and the papal ones are not only the most elegant but the most ancient series of all the modern medals. The improvement began in the reign of Alexander VI. so famous for his own crimes, and those of his nephew Cæsar Borgia. His successors, Julius II. Leo X. Hadrian VI. and Clement VII. had many of their medals designed by Raphael, Julio Romano, and other eminent painters, and the engraving executed by artists of equal merit. Among these were the celebrated Cellini, and the noted Paduan forgers of Roman coins, Cavino and Bassiano. In 1644, Cormanni, a medallic artist, was imprisoned on account of a piece which represented the Pope upon one side, and Olympia Maidalchina, the *relation* of his holiness, on the other. The unfortunate Cormanni poisoned himself. About this time the family of the Hamerani, originally from Germany, began to engrave the papal medals; which they did with surprising merit for several generations. Each of the daughters did a fine medal, as we are informed by Venuti.

Besides the papal medals, many have been issued by the various states of Italy. There are medals of Frederic II. of Sicily in 1501, of several Venetian generals in 1509, of Alfonso duke of Ferrara in 1511, and of the celebrated Andrew Doria in 1528.

3. French medals. Till the reign of Louis XIV. the medals of this country are neither fine nor numerous; but this monarch exceeds all modern princes in this way. Many of his pieces are well designed and executed, though objectionable on account of their falsehood.

4. Danish medals. These appear of Christian II. in 1516, of Frederic and Sophia in 1532, of Frederic I. and Christian III. in bonnets worn in the 16th century. The elephant of the house of Oldenburg is frequent upon Danish medals.

5. Swedish medals. These begin with Gustavus Vasa; and several of Christina are likewise to be met with. There are also some curious ones of Charles XII.

6. Dutch medals. These begin in 1566; and many of them are remarkable for maps and plans, which must be very interesting to posterity. "Had the Greeks and Romans (says Mr Pinkerton) given us maps and plans, what a fine system of ancient geography and topography a cabinet of medals must have been!"

7. Medals of Spain, Portugal, and Germany. The Spanish medals began with Gonsalo in 1503, many of which are curious and interesting. Under Charles V. there are many curious Spanish medals; but those of Germany begin with Frederic in 1453. They are extremely numerous; as we may easily suppose from the greatness of the empire, and the various states which compose it. There is a famous medal of Sebastian king of Portugal, famous for his unfortunate expedition into Africa in 1578; with his bust, full face, and three quarters in length. On the reverse is a shell-fish in the sea, with the moon and seven stars, bearing the inscription SERENA CALSA FAVENT. There is also a curious lozenge-shaped coin of the same with the arms of Portugal, and the king's name and title: On the reverse is a cross with the inscription IN HOC SIGNO VINCES, 1578.

8. Satiric medals. These began almost as soon as the knowledge of the art of coining medals was revived. They seem to have been almost unknown to the ancients. One indeed of the emperor Gallienus is supposed to have been satiric. It has on the front the emperor's bust, with the inscription GALLIENÆ AUG. the reverse is Peace in a car, PAX UBIQUE; but this has been proved to be only a blundered coin. Some other ancient medals, however, are not liable to this objection. The first modern satiric medal published was that of Frederic king of Sicily in 1501, against his antagonist Ferdinand king of Spain. It has on one side the head of Ferdinand, with the inscription FERDINANDUS R. AR. VETUS VULPES ORBIS; on the reverse a wolf carrying off a sheep, JVGVM MEVM SVAVE EST ET ONVS MEVM LEVE. Many others have been struck, of which the wit would now perhaps be difficult

Modern Medals.

difficult to be found out: but of all nations the Dutch have moſt diſtinguiſhed themſelves in this way; and paid very dear for their conduct, as they brought upon themſelves by one or two ſatiric medals the whole power of France under Louis XIV.

9. Engliſh medals. The firſt of theſe is in the duke of Devonſhire's collection. It is of a large ſize, and done on the plan of the early Italian medals. It has on the reverſe the arms of Kendal, with the inſcription TEMPORE OBSIDIONIS TURCORUM, MCCCCLXXX. On the other ſide is a portrait with IO KENDAL RHODI TVRCVPELLERIVS. It was found laſt century in Knareſborough foreſt; but Mr Pinkerton has no doubt of its having been done in Italy. The next is that of Henry VIII. in 1545, and is of gold, larger than the crown-piece, with the king's head upon the obverſe, and three legends within each other, including his titles, &c. The reverſe contains two inſcriptions, declaring him to be the head of the church; the one in Hebrew, the other in Greek. It was imitated exactly by Edward VI. whoſe coronation medal is the firſt we have. There are two medals of Philip and Mary, whoſe execution is tolerably good; but thoſe of Elizabeth are very poor. There are good medals of James I. and his queen; with a fine one of Charles I. and Henrietta, though the workmanſhip is much inferior to the antique. There are many good medals of Charles, with various devices upon their reverſes. Under the commonwealth the celebrated Simon produced medals which are deſervedly reckoned the moſt admirable pieces of modern workmanſhip. There are many good medals of Charles II. James II. and William III. Some are alſo found of James after his abdication. Some fine gold, ſilver, and copper medals, were iſſued in the time of Queen Anne; the two laſt affording a ſeries of all the great actions of the duke of Marlborough. About the year 1740, a ſeries of medals was engraved in London by Daſſier, a native of Geneva, containing all the kings of England; being 36 in number. They are done upon fine copper, and executed with great taſte. There are beſides many medals of private perſons in England; ſo that it may juſtly be ſaid, that this country for medals exceeds almoſt every other in Europe.

To this account of modern coins and medals we ſhall add that of another ſet called *ſiege pieces*, and which were iſſued during the time of a ſiege in caſes of urgent neceſſity. Theſe were formed of any kind of metal; ſometimes of no metal; and Patin mentions a remarkable one ſtruck at Leyden in 1574, when the place was beſieged by the Spaniards. It was of thick paper or paſteboard, having a lion rampant, with this inſcription, PVGNO PRO PATRIA, 1574; and on the reverſe, LVGDVNUM BATAVORVM. There are various ſiege-pieces of Charles I. both in gold and ſilver, ſome of the latter being of the value of 20 ſhillings.

The *nummi bracteati* are a ſpecies of modern coins ſomewhat between counters and money; and have their name from the word BRACTEA, a ſpangle or thin bit of metal. They are commonly little thin plates of ſilver, ſtamped as would ſeem with wooden dies upon one ſide only, with the rude impreſſion of various figures and inſcriptions. Moſt of them are eccleſiaſtic, and were ſtruck in Germany, Switzerland, Denmark, Sweden, Norway, and a few in Poland. They continued to be in uſe in Germany till the end of the 15th century; and ſome are ſtill uſed in Switzerland at this day.

Abbreviations.

TABLE of ABBREVIATIONS uſed in the Legends of Medals; from Mr Pinkerton.

GREEK COINS.

A.

Α. Athens, Argos, Aulus, Aſylum; primi or firſt; as Εφεσιων Α. Ασιας "Epheſians, firſt people of Aſia.

Α. Abaſſus, Abdera, Abydus on Helleſpont

ΑΒ. Abydus in Egypt

ΑΒΥ. Abydus on Helleſpont

ΑΘ. ΑΘΕ. Athens

ΑΙΓ. Ægina

ΑΙΓΟΣΠΟ Aigoſpotamos

ΑΙΛ. Ælius, Ælia Capitolina

ΑΙΝ. Ænos

ΑΚ.—ΑΚΡΑΤΑΝ. Agrigentum

ΑΚΙ Acilium

ΑΚΤ. Actium

ΑΛΕ. Alexandria

ΑΜ. Amyntas

ΑΜΒΡ. Ambracia

ΑΜΦΙ. Amphilochia

ΑΝΘ. Ανθυπατον, Proconſul

ΑΝΤΙΣ. Antiſſa

ΑΝΑ. Anactoria

ΑΝΤΙ. Antium

ΑΝ. Ancyra

ΑΝΤ. Antoninus, Antioch

ΑΞ. Axus in Crete

ΑΟΝ. Aonitæ

ΑΟΥΕ. Avenio, *Pell.*

ΑΠ. Appius

ΑΠΑ. Apamea

ΑΠΟ. Apollonia

ΑΠΤΑ. Aptara

ΑΡ. Aradus, Harma

ΑΡΓΕ. Argennos

ΑΡΓ. Argos

ΑΡΙ. Aricanda

ΑΡΙΜ. Ariminum

ΑΡΣΙ. Arſinoë

ΑΡΥ. Aryca

ΑΡΧ. Αρχιερευς or Αρχον, high prieſt or magiſtrate

ΑΣΙΑΡΧ. Aſiarchæ, preſidents of the games of Aſia (B)

ΑΣ. Aſylum

Α. Σ. Πρωτοι Συριας, Firſt of Syria

ΑΣΚ. Aſcalon

ΑΤ. Atabyrium

ΑΤΑΡ. Atarnæ

ΑΥΓ. Auguſtus

ΑΥΡΗΛ. Aurelius

ΑΥ ΑΥΤ. Αυτοκρατορ Emperor

ΑΥΤΟΝ. Αυτονομοι, enjoying their own laws

ΑΦΙ. Aphyta

ΑΦΡ. Africanus

ΑΧ. Achaii

B.

Β. Βουλης, Council: Berytus: Bithynia

ΒΑΓΗΔΑΟ Bagadaonia

ΒΑΛ. Valerius

ΒΗ. Berytus

ΒΙΤΟΝ. Bitontum

ΒΟΙ. Bœotia

ΒΡΥΝ. Brunduſium

ΒΥ. Byzantium

Γ.

Γ. ΓΡ. ΓΡΑΜ. Grammaticus, or keeper of the records

Γ. Gaius, or Caius

ΓΑ. Gallus, Gallerius, Gallienus

Γ. Γνωριμου, Illuſtrious

ΓΕΛ. Gelas

ΓΕΡ. Germanicus

ΓΝ. Gneius

ΓΟΡΤΥ. Gortyna

ΓΡΑ. Graviſca

Δ.

Δ. Decimus, Dymæ

ΔΑΚ. Dacicus

ΔΑΜ. Damaſcus

ΔΑΡ. Dardanum

ΔΗ. Δημος, the people

ΔΗΜΑΡΧ. ΕΞΟΥΣ. with Tribunitian power

ΔΕ. Decelia

ΔΕΚ. Decius

(B) There were alſo Syriarchæ, Lyciarchæ, Galatarchæ, Bithyniarchæ, Cappadociarchæ, &c. *Morel. Spec.*

Abbreviations.

ΔΕΡ. Derbe in Lycaonia
ΔΗ. Delos
ΔΙ. Dioſpolis
ΔΡΕ. Drepanum
ΔΥΡ. Dyrrhachium

E.

Ε. Eryce
Ε. ΕΡΕΣ. Ereſus
ΕΛΕΥ. Eleuſis
ΕΛΕΥΘ. Ελευθεροι, Free
ΕΠΙ, Epidaurus
ΕΡΙ. Eriza in Caria
ΕΡΧ. Erchia
ΕΡΥ. Erythræ
ΕΤ. ΕΤΟ. Ετους, Year
ΕΤ. Etenna in Pamphylia
ΕΧ. Εχουσια, Power
ΕΥ. ΕΥΒΟ. Eubœa
ΕΥΣ. Ευσεβης, Pious
ΕΥΤ. Ευτυχης, Happy
ΕΦ. ΕΦΕ. Epheſus

Z.

ΖΑ. Zacynthus
ΖΑΝΚΛ. Zancle, Meſſana anciently ſo called

H.

Η. Elium
ΗΓ. Ηγεμονος, Preſident
ΗΡΑΚ. Heraclea

Θ.

ΘΑ. Thaſus
ΘΕ. Theſpiæ
ΘΕΣ. Theſſalonica
ΘΕ. ΘΗΒ. Thebæ

I.

Ι. ΙΕΡ. Ιερας, Sacred
ΙΕΡΑΠΥ. Hyerapytha
ΙΚΑΡ. Hiccara
ΙΛΙ. Ilium
ΙΟΥ. Julis, a city, or Julius
ΙΟΥΛ. Julia
ΙΠΑ. Hippana
ΙΡ. Irene Inſ. *Pellerin.*
ΙΣ. Iſus, Iſtiæa

K.

Κ. Caius; Κουιντος, Quintus
Κ. ΚΑΙΣ. Cæſar
Κ. Κ. Κοινον Κιλικιας, Community of Cilicia
ΚΑΙΛ. Cælius
ΚΑΛ. Chalcedon
ΚΑΛΛΙ. Callipolis
ΚΑΜΑ. Camara
ΚΑΝ. Canata
ΚΑΠ. Capua
ΚΑΠΠ. Cappadocia
ΚΑΡ. Carrhæ
ΚΑΡΤ. Carthago
ΚΑΥ. Caulonia
ΚΕ. Ceos
ΚΕΦ. Cephalædis
ΚΙ. Cianus, Cibæum
ΚΙΛ. Cilbiani
ΚΛ. Clæonæ, Claudius
ΚΛΑ. Clazomene
ΚΝΙ. Cnidus
ΚΟ. Corinth
ΚΟΙΝ. Κοινον, Community
ΚΟΛ. Κολωνιας, Colony, Colophon
ΚΟΜ. Commodus
ΚΟΡ. Corcyra
ΚΡ. Cragus in Lycia
ΚΡΑ. Cranos
ΚΡΗ. Crete
ΚΤΗ. Ctemenæ, *Pell.*
ΚΥ. Cuma, Cydonium, Cyon
ΚΥΘ. Cythnus
ΚΥΠ. Cyprus
ΚΥΡ. Cyrene

Λ.

Λ. or L. Λυκαβαντος, Year
Λ. Lucius
ΛΑ. Lacedæmon
ΛΑΜ. Lamea; Lampſacus
ΛΑΡ. Lariſſa
ΛΑΡΙ. Larinum
ΛΕ. ΛΕΥ. Leucas
ΛΕΟΝ. Leontium
ΛΗΜ. Lemnos
ΛΙΠ. Lipara
ΛΙΥΙ. Liviopolis
ΛΟ. ΛΩΚ. Locri
ΛΟΓ. Longone
ΛΥΓ. ΛΥΚ. Lyctus

M.

Μ. Marcus, Malea, Megalopolis, Mazaka
ΜΑ. Maronea, Maſſilia, Macedonia
ΜΑΓ. Magneſia
ΜΑΚΡΟ. Macrocephali
ΜΑΜ. Mamertini
ΜΑΣΣ. Maſſilio
ΜΑΖ. Mazara
ΜΕ. Menelais, on Syrian regal coins
ΜΕΝΕΚ. Menecrates
ΜΕ. ΜΕΓ. Megara, Megalopolis, Melite
ΜΕΓ. Μεγαλος, Great
ΜΕΣ. Meſſana
ΜΕΤΑ. Metapontum
Μ. ΜΗΤΡΟ. Metropolis
ΜΙ. Miletus
ΜΚ. Maſſaka of Cappadocia, on coins of Mithridates VI.
ΜΟΡ. Morgantia
ΜΥ. Mycenæ
ΜΥΡ. Myrlea
ΜΥΤΙ. Mytilene

N.

Ν. Naupactos
ΝΑΞ. Naxos
ΝΑΥΑΡΧ. Ναυαρχιδοι, enjoying a ſea port
ΝΕ Nemea
Ν. ΝΕΩΚ. Neocori
ΝΕΟΠ. Neopolis
ΝΕΡ. Nerva
ΝΙΚ. Nicæum, Nicomedia
ΝΥΣ. Nyſæi, on coins of Scythopolis, *Pell.*

O.

ΟΙ. Œthæi
ΟΝ. Οντος, Being
ΟΠΕΛ. Opelius
ΟΠ. Opus
ΟΡΥ. Orycus
ΟΡΧ. Orchomenus
ΟΡΠ. or ΥΠ. Ουπατος or Υπατος, Conſul
ΟΥΕΡ. Verus
ΟΥΗ. Verus
ΟΥΕΣΠ. Veſpaſianus
ΟΥΙΤΕΛ. Vitellius
ΟΦΡΥ. Ophrynium

Π.

Π. Παρα, Προς, upon
Π. ΠΟΠΛ. Publius
Π. ΠΑ. Paphos or Paros
ΠΑΙΣ. Pæſtum
ΠΑΝ. Panormus
ΠΑΡ. Paropinum
ΠΑΡΙ. Paros
ΠΑΡΘ. Parthicus
ΠΕ. Perinthus
ΠΕΛ. Pella
ΠΕΡ. Pergus
ΠΕΡΤ. Pertinax
ΠΕΣΚ. Peſcennius
Π. ΠΗ. Peluſium
ΠΙΝ. Pinamytæ
ΠΛΑ. Plateæ
ΠΟ. Pontus
ΠΟΛΥ. Polyrrhenum
ΠΟΣ. Poſidonia
ΠΡΑΣ. Praſſus
Π. ΠΡΥ. Πρυτανος, Præfect
ΠΡ. ΠΡΕΣ. Πρεσβεος, Legate
ΠΡΟ. Proconneſus
ΠΡΟΔΙ. Προδικος, Curator
Π. ΠΡΩΤ. Προτος, Firſt
ΠΤ. Ptolemais
ΠΥ. Pylos

P.

ΡΟ. Rhodes

Σ.

Σ.ΣΑ. Salamis, Samos, Syria
ΣΑ. Samoſate
ΣΑΛΑΠ. Salapia
ΣΑΡ. Sardis
ΣΕ. Seriphus, Segeſte
ΣΕΒ. Σεβαστος, Auguſtus
ΣΕΛ. Selinus, Seleucia
ΣΕΠΤ. Septimius
ΣΙ. Siphnos
ΣΙΔ. Side
ΣΙΝΩ. Sinope
ΣΜΥ. Smyrna
ΣΤΡ. ΣΤΡΑ. Στρατηγος, Prætor
ΣΥΒ. Sybaris
ΣΥ. ΣΥΡΑ. Syracuſe
ΣΥΡ. Syria
ΣΩ. Solæ

T.

Τ. Titus
ΤΑΒΑΛ. Tabala
ΤΑ. ΤΑΝΑ. Tanagra
ΤΑΡ. Tarentum, Tarſus
ΤΑΥΡ. Tauromenum
ΤΕ. Tementis
ΤΕΡ. Terina
ΤΗ. Tenus
ΤΙ. ΤΙΒ. Tiberius
ΤΡΑ. Trallis
ΤΡΙ. Tripolis
ΤΡΟ. Troizene
ΤΥΑΝ. Tyana
ΤΥ. Tyndarus
ΤΥΡ. Tyre (monogram)

Υ.

ΥΕ. ΥΕΛ. Velia
ΥΠ. ΥΠΑΤ. Υπατος, Conſul

Φ.

Φ. Philip, Phœſtus, Philuntium
ΦΑ. Phaſelis
ΦΑΡ. Pharſalus
ΦΙ. Vibius, Philippopolis
ΦΙΝΕ. Phineium
ΦΛ. Flavius
ΦΟΚ. Phocæum
ΦΟΥΛ. Fulvia
ΦΥ. Phycus in Cyrene

X.

Χ. Chios
ΧΑΛ. Chalcis
ΧΕΡ. Cherſoneſus
ΧΙ. Chytri in Crete

Greek Numerals.

Α.	1.	Ι.	10.	Ρ.	100.
Β.	2.	Κ.	20.	Σ. or C	200.
Γ.	3.	Λ.	30.	Τ.	300.
Δ.	4.	Μ.	40.	Υ.	400.
Ε.	5.	Ν.	50.	Φ.	500.
ϛ. or ϛ	6.	Ξ.	60.	Χ.	600.
Ζ.	7.	Ο.	70.	Ψ.	700.
Η.	8.	Π.	80.	Ω.	800.
Θ.	9.	ϙ or ϟ	90.	ϡ.	900.

Example,

Abbreviations.

Examples. I is 10: add A to I, and IA makes 11: so IB, 12; IΓ, 13, &c. K is 20, KA, 21, &c. PIA makes 111. The English word AIR marks the grand initial numerals. On coins the numerals are often placed in retrograde order; which makes no difference in the value, as every letter is appropriated to its number. Thus TAΓ or ΓAT imply the same, 333. But this advantage being unknown to the Roman numerals and Arabic cyphers, is apt to puzzle the beginner.

ROMAN COINS.

A

A. AULUS: in the exergue it implies the first mint, as ANT. A. coined at Antioch in the first mint
A. A. A. F. F. Auro, Argento, Ære, Flando, Feriundo
A. or AN. Annus
A. A. Apollo Augusti
A. F. A N. Auli filius, Auli nepos
ABN. Abnepos
ACT. Actiacus, or Actium
AD. FRV. EMV. Ad fruges emundas
ADIAB. Adiabenicus
ADOP. Adoptatus
ADQ. Adquisita
ADV. Adventus
AED. Ædes
AED. P. Ædilitia potestate
AED. S. Ædes sacræ
AED. CVR. Ædilis Curulis
AED. PL. Ædilis Plebis
AEL. Ælius
AEM. or AIMIL. Æmilius
AET. Æternitas
AFR. Africa, or Africanus
ALBIN. ALBINUS
ALIM. ITAL. Alimenta Italiæ
ANN. AVG. Annona Augusti
A. N. F. F. Annum Novum Faustum Felicem
ANIC. Anicius
ANN. DCCCLXIIII. NAT. VRB. P. CIR. CON. Anno 864 Natali Urbis Populo Circenses constituti
ANT. AVG. Antonius Augur
ANT. Antonius, or Antoninus
AP. Appius
A. P. F. Argento Publico Feriundo
A. POP. FRVG. AC. A Populo Fruges Acceptæ
AQ. or AQL. Aquilius
AQVA MAR. Aqua Martia
ARAB. ADQ. Arabia Adquisita
ARR. Arrius
AVG. Augur, Augustus, Augusta
AVG. D. F. Augustus Divi Filius
AVGG. Two Augusti
AVGGG. Three Augusti
AVR. or AVREL. Aurelius

B.

B. The mark of the second mint in any city
BON. EVENT. Bonus Eventus
B. R. P. NAT. Bono Reipublicæ Nato
BRIT. BRITANNICUS
BRVT. Brutus

C.

C. Caius, Colonia
C. A. Cæsarea Augusta
C. CAE. or CAES. Cæsar
CAESS. Cæsares
CARTH. Carthage
CEN. Censor
CENS. P. Censor Perpetuus
CEST. Cestius, or Cestianus
CIR. CON. Circum Condidit, or Circenses Concessit
CIVIB. ET SIGN. MILIT. A. PARTH. RECVP. Civibus et Signis Militaribus a Parthis Recuperatis
CN. Cneius
COEL. Cœlius.
CON. OB. Constantinopoli Obsignata, or Constantinopoli Officina secunda, or Conflata Obryzo
COL. Colonia
CON. SVO. Conservatori suo
CONCORD. Concordia
CL. V. Clypeus Votivus
COMM. Commodus
CLOD. Clodius
CL. or CLAVD. Claudius
COS. Consul
COSS. Consules
CORN. Cornelius
CVR. X. F. Curavit Denarium Faciendum

D.

D. Decimus, Divus, Designatus
DAC. Dacicus
D. F. Dacia felix
D. M. Diis Manibus
DES. or DESIG. Designatus
DICT. Dictator
DOMIT. Domitianus
D. N. Dominus noster
DID. Didius
D. P. Dii Penates
DV. Divus

E.

EID. MAR. Idus Martiæ
EX. CONS. D. Ex Consensu Decuriorum
EX. S. C. Ex Senatus Consulto
EQ. ORDIN. Equestris Ordinis.
EX. A. PV. Ex Argento, or Auctoritate Publica
EXER. Exercitus
ETR. Etruscus

F.

F. Filius, or Filia, or Felix, or Faciundum, or Fecit
FEL. Felix
FELIC. Felicitas
FL. Flavius
FLAM. Flamen
FORT. RED. Fortunæ Reduci
FOVRI. Fourius for Furius
FONT. Fonteius
FRVGIF. Frugiferæ (Cereri)
FVL. Fulvius
FVLG. Fulgerator

G.

G. Gneius, Genius, Gaudium
GA. Gaditanus
G. D. Germanicus Dacicus
GEN. Genius
GERM. Germanicus
GL. E. R. Gloria Exercitus Romani
GL. P. R. Gloria Populi Romani
GOTH. Gothicus
G. P. R. Genio Populi Romani
G. T. A. Genius Tutelaris Ægypti, or Africæ

H.

HEL. Helvius
HEL. Heliopolis
HER. Herennius, or Herennia
HO. Honos
HS. Sestertius

I.

I. Imperator, Jovi, Julius
IAN. CLV. Janum clusit for clausit
IMP. Imperator
IMPP. Imperatores
I. S. M. R. Juno Sospita, Mater or Magna Regina
IT. Italia, Iterum
ITE. Iterum
IVL. Julius or Julia
IVST. Justus
I-I. S. Sestertius
I. O. M. SACR. Jovi Optimo, Maximo, Sacrum
II. VIR. Duumvir
III. VIR. R. P. C. Triumvir Reipublicæ Constituendæ
IIII. VIR. A. P. F. Quatuorvir, or Quatuorviri, Auro, or Argento, or Ære, Publico Feriundo.
IVN. Junior

L.

L. Lucius
LAT. Latinus
LEG. PROPR. Legatus Proprætoris
LEG. I. &c. Legio Prima, &c.
LEP. Lepidus
LENT. CVR. X. P. Lentulus Curavit Denarium Faciundum
LIBERO P. Libero Patri
LIB. PVB. Libertas Publica
LIC. Licinius
L. S. DEN. Lucius Sicinius Dentatus
LVC. Lucifera
LVD. CIR. Ludi Circenses
LVD. EQ. Ludi Equestres
LVD. SAEC. F. Ludos Sæculares Fecit

M.

M. Marcus, or Marius
MAR. CL. Marcellus Clodius
M. F. Marci Filius
M. OTACIL. Marcia Otacilia
MAG. or MAGN. Magnus
MAC. Macellum
MAX. Maximus
MAR. Martia (aqua)
MAX. VLT. Marti Ultori
MES. Messius
METAL. Metallum
MINAT. Minatius
MINER. Minerva

M. M. I. V.

Abbreviations.

M. M. I. V. Municipes Municipii Julii Uticenfis
MON. or MONET. Moneta

N.

N. Nepos or Nofter
N. C. Nobiliffimus Cæfar
NAT. VRB. Natalis Urbis
NEP. Nepos
NEP. RED. Neptuno Reduci

O.

O. Optimo
OB. C. S. Ob Cives Servatos
OF. Officina
OPEL. Opelius
ORB. TERR. Orbis Terrarum

P.

P. or POT. Poteftate
PAC. ORB. TER. Pacatori Orbis Terrarum
PAPI. Papius or Papirius
PARTH. Parthicus
PERP. Perpetuus
PERT. or PERTIN. Pertinax
PESC. Pefcennius
P. F. Pius Felix
PLAET. Plætonius
P. L. N. Pecunia Londini Notata
P. LON. S. Pecunia Londini Signata
P. M. or PONT. MAX. Pontifex Maximus
POMP. Pompeius
P. P. Pater Patriæ
PR. Prætor
P. R. Populus Romanus
PRAEF. CLAS. ET. OR. MARIT. Præfectus Claffis et Oræ Maritimæ
PRINC. IVVENT. Princeps Juventutis
PRIV. Privernum
PROC. Proconful
PRON. Pronepos
PROP. Proprætor
PROQ. Proquæftor
PROV. DEOR. Providentia Deorum
PVPIEN. Pupienus

Q

Q. Quintus, or Quæftor
Q. C. M. P. I. Quintus Cæcilius Metellus Pius Imperator
Q. DESIG. Quæftor Defignatus
Q. P. Quæftor Prætorius
Q. PR. Quæftor Provincialis

R.

R. ROMA, Reftituit
RECEP. Receptis, or Receptus
REST. Reftituti
ROM. ET AVG. Romæ et Augufto
R. P. Refpublica

S.

SAEC. AVR. Sæculum Aureum
SAEC. FEL. Sæculi Felicitas
SAL. Salus
SALL. Salluftia
SARM. Sarmaticus
S. C. Senatus Confulto
SCIP. ASIA. Scipio Afiaticus
SEC. ORB. Securitas Orbis
SEC. PERP. Securitas Perpetua
SEC. TEMP. Securitas Temporum
SEN. Senior
SEPT. Septimius
SER. Servius
SEV. Severus
SEX. Sextus
SIC. V. SIC X. Sicut Quinquennalia, fic Decennalia
SIG. Signis
S. M. Signata Moneta
S. P. Q. R. Senatus Populufque Romanus
STABIL. Stabilita (terra)
SVL. Sulla.

T.

T. Titus, Tribunus
TER. Terentius, or Tertium
TEMP. Temporum
TI. Tiberium
TR. or TREV. Treveris
TREB. Trebonianus
TR. MIL. Tribunus Militaris
TR. P. or TRIB. POT. Tribunicia Poteftate

V.

V. Quintum
V. C. Vir Clariffimus
VESP. Vefpafianus
VIB. Vibius
VICT. Victoria
VII. VIR. EPVL. Septemvir Epulonum
VIL. PVB. Villa Publica
VIRT. Virtus
VN. MR. Venerandæ Memoriæ
VOT. X. MVLT. XX. Votis Decennalibus Multiplicatis Vicennalibus

X.

X. Decem, Denarius
XV. VIR. SACR. FAC. Quindecim Vir Sacris Faciundis.

Abbreviations on the Exergue; from Bouduri and Monaldini. Pinkerton.

A. Officina Prima
ALE. Alexandria
AMB. Antiochenfis Moneta Secundæ Officinæ
AN. ANT. ANTI. Antiochia
ANB. Antiochiæ Secunda Officina: to ANH. Antiochiæ Octavia Officina
A. P. L. (In officina) Prima percuffa Lugduni
AQ. AQL. Aquileiæ
AQ. O. B. F. Aquileiæ Officinæ Secundæ Fabrica
AQ. P. S. Aquileiæ Pecunia Signata
A. AR. ARL. Arelate
A. SISC. Prima (in officina) Sifciæ
B. SIRM. Secunda Sirmii
B. S. L. C. Secunda Signata Lugduni
C. Θ. Conftantinopoli Nona
COMOB. Conflata Moneta Obryzo. Only on gold or filver from a gold die
CON. Conftantinopoli
CONOB. Conflata Obryzo. Only on gold.
CONS. Conftantinopoli
KART. Carthago
K. O. Carthaginenfis Officina
L. LC. LVC. LVG. Lucduni, Lugduni
L. LON. Londini
L. P. Lugdunenfis vel Londinenfis Pecunia
LVC. P. S. Lugduni Pecunia Signata
MDPS. Mediolani Pecunia Signata
M. K. V. T. Moneta Kartaginenfis Urbs (in officina) Tertia
M. L. Moneta Lugdunenfis vel Londinenfis
MOSTT. Moneta Officinæ Secundæ Treverorum
MSTR. Moneta Signata Treveris
O. Officina
OFF. III. CONST. Officina Tertia Conftantinopoli
PARL. Percuffa or Pecunia Arelate
PLON. Pecunia Londinenfis
PLVG. Pecunia Lugdunenfis
P. R. Pecunia Romana, or Percuffa Romæ
P. T. Pecunia Treverenfis
Q. AR. Quincta Arelatenfis (officina)
R. RO. ROM. Romæ
RA. Ravennæ
ROPS. Romæ Pecunia Signata
S. AR. Signata Arelate
S. CONST. Signata Conftantinopoli
SIS. Sifciæ
SS. P. Sifcienfis Pecunia
SISC. V. Sifcia Urbs
SMA. Signata Moneta Antiochiæ
S. M. HER. Signata Moneta Heracleæ
S. M. N. Signata Moneta Nicomediæ
S. M. R. Signata Moneta Romæ
S. T. Signata Treveris
TESOB. Teffalonicæ Officina Secunda
THEOPO. Theopoli
TR. Treveris
TROB. Treveris Officina Secunda

A Lift of Roman Colonies whofe Coins remain; and Abbreviations on thefe Coins.

Abdera in Spain
Acci in Spain
Achulla in Africa
Ælia Capitolina in Judæa
Agrippina in Germany
Antiochia in Pifidia
——— in Syria
Apamea in Bithynia
Arna in Theffaly
Aftigi in Spain
Babba in Mauritania Tingitana
Berytus in Phœnicia
Bilbilis in Spain
Boftra in Arabia
Bracara Augufta in Spain
Buthrotum in Epirus
Cabellio in Gaul
Cæfar-Augufta in Spain
Cæfarea in Paleftine

Calagurris

Abbreviations.

Calagurris in Spain
Calpe in Spain
Camalodunum in Britain
Carrhæ in Mesopotamia
Carteia in Spain
Carthago in Africa
Carthago Nova in Spain
Cascantum in Spain
Cassandria in Macedon
Celsa in Spain
Clunia in Spain
Coillu in Numidia
Comana in Cappadocia
Corinthus in Greece
Cremna in Pisidia
Culla in Thrace
Damascus in Cœlesyria
Dertosa in Spain
Deulton in Thrace
Dium in Macedon
Ebora in Spain
Edessa in Mesopotamia
Emerita in Spain
Emesa in Phœnicia
Ergavica in Spain
Germe in Galatia
Graccuris in Spain
Hadrumetum in Africa
Heliopolis in Cœlesyria
Hippo Regius in Africa
Iconium in Lycaonia
Ilerda in Spain
Illergavonia in Spain
Illeci in Spain
Iol in Mauritania
Italica in Spain
Lælia in Spain
Laodicea in Syria
Leptis in Africa
Lugdunum in Gaul
Neapolis in Palestine
Nemausus in Gaul
Nesibis in Mesopotamia
Norba Cæsarea in Mauritania
Obulco in Spain
Oea in Africa
Olba in Pamphylia
Osca in Spain
Osicarda in Spain
Panormus in Sicily
Parium in Mysia
Parlais in Lycaonia
Patricia (Corduba) in Spain
Pella in Macedon
Philippi in Macedon
Philippopolis in Arabia
Ptolemais in Phœnicia
Rhesæna in Mesopotamia
Romula (Hispalis) in Spain
Ruscino in Gaul
Sabaria in Hungary
Saguntum in Spain
Sebaste in Palestine
Segobriga in Spain
Sidon in Phœnicia
Singara in Mesopotamia
Sinope in Pontus
Stobi in Macedon
Tarraco in Spain
Thessalonica in Macedon
Traducta (Julia) in Spain
Troas in Phrygia
Turiaso in Spain
Tyana in Cappadocia
Tyrus in Phœnicia
Valentia in Spain
Vienna in Gaul
Viminacium in Mœsia
Utica in Africa

Abbreviations on Colonial Coins.

ACCI. Accitana Colonia, *Guadix in Spain*
ADI. Adjutrix *legio*
AEL. MVN. COEL. Ælium Municipium Cœla, *near Sestos on the Hellespont*
AST. Astigitana, *Eceja* in Andalusia
B. A. Braccara Augusti, *Brague in Portugal*
C. A. Cæsarea Antiochiæ
C. A. A. P. or PATR. Colonia Augusta Aroë Patrensis
CAB. Cabellio
C. A. BVT. Colonia Augusti Buthrotum, *in Epirus*
C. A. C. Colonia Augusta Cæsarea
C. A. I. Colonia Augusta Julia, *Cadiz*
C. A. E. Colonia Aug. Emerita, *Merida*
CAL. Calagurris, *Calahorra in Spain*
C. A. O. A. F. Colonia Antoniana Oea Aug. Felix, *Tripoli in Africa*
C. A. PI. MET. SID. Colonia Amelia Pia Metropolis Sidon
C. A. R. Colonia Augusta Rauracorum, or Colonia Asta Regia: Augst in Switzerland, or Ast near Xeres de la Frontera in Spain
C. C. A. Colonia Cæsarea Augusta, *Saragossa in Spain*
C. C. COL. LUG. Claudia Copia Colonia Lugdunensis
C. C. I. B. Colonia Campestris Julia Babba, *in Mauritania*
C. C. I. B. D. D. Colonia Campestris Julia Babba, Decreto Decurionum
C. C. I. H. P. A. Colonia Concordia Julia Hadrumetina, Pia Augusta
C. CIV. D. D. P. Corona Civica data Decreto Publico
C. C. N. A. Colonia Carthago Nova Augusta
C. C. N. C. D. D. Colonia Concordia, Norba Cæsareana, Decreto Decurionum
C. COR. Colonia Corinthus
C. C. T. Ducentesima Remissa
C. C. S. Colonia Claudia Sabaria, *in Hungary*
C. F. P. D. Colonia Flavia Pacensis Develtum, *Develtum in Thrace*
C. G. I. H. P. A. Colonia Gemella Julia Hadriana, Pariana, Augusta
C. I. C. A. Colonia Julia Concordia, Apamea
C. I. A. D. Colonia Julia Augusta Dertona, *Tortona near Milan*
C. I. AV. Colonia Julia Aug. *Cadiz*
C. I. AVG. F. SIN. Colonia Julia Augusta Felix Sinope
C. I. B. Colonia Julia Balba, *in Mauritania*
C. I. C. A. P. A. Colonia Julia Carthago Augusta Pia Antiqua, or Corinth, or Carthago Nova
C. I. CAL. Colonia Julia Calpe, *Gibraltar*
C. I. F. Colonia Julia Felix, *Cadiz*
C. I. G. A. Colonia Julia Gemella (c) Augusta
C. I. I. A. Colonia Immunis Illici Augusta, *Elche in Spain.*
C. I. N. C. Colonia Julia Norba Cæsareana, or Alcantara: sometimes it means Col. Julia Nova Carthago
C. I. V. Colonia Julia Valentia, *Valencia in Spain*
C. V. T. Colonia Victrix Tarraco
C. L. I. COR. Colonia Laus Julia Corinthus
C. L. I. N. AVG. Colonia Laus Julia Nova Augusta, *Laus or Lodi in Lucania*
C. M. L. Colonia Metropolis Laodicea, *in Cœlesyria*
CO. DAM. METRO. Colonia Damascus Metropolis
COHH. PRET. VII. P. VI. F. Cohortes Prætorianæ Septimum Piæ, Sextum Felices
COH. I. CR. Cohors prima Cretensis
COH. PRET. PHIL. Cohors Prætoriana Philippensium
COL. AEL. A. H. MET. Colonia Ælia Augusta Hadrumetina Metropolis, *in Africa*
COL. AEL. CAP. COMM. P. F. Colonia Ælia Capitolina Commodiana Pia Felix
COL. ALEX. TROAS. Colonia Alexandriana Troas
COL. AMAS. or AMS. Colonia Amastriana, *in Paphlagonia*
COL. ANT. *Antioch in Pisidia*
COL. ARELAT. SEXTAN. Colonia Arelate Sextanorum, *Arles*
COL. AST. AVG. Colonia Astingitana Augusta, *Eceja in Spain.*

COL.

(c) Gemella implies a colony drawn from two others.

Abbreviations.

COL. AVG. FEL. BER. Colonia Augusta Felix Berytus
COL. AVG. FIR. Colonia Aug. firma, *Eceja*.
COL. AVG. IVL. PHILIP. Colonia Augusta Julia Philippensis
COL. AVG. PAT. TREVIR. Colonia Augusta Paterna Trevirorum, *Trêves in Germany, sent from Paternum in Italy*
COL. AVR. KAR. COMM. P. F. Colonia Aurelia Karrhæ Commodiana Pia Felix, or Carneatum Commagene, or *Carrhæ in Asia*
COL. B. A. Colonia Braccara Augusta, *Brague*
COL. BRYT. L. V. Colonia Berytus Legio Quinta
COL. CABE. Colonia Cabellio.
COL. CAES. AVG. Colonia Cæsarea Augusta, *in Palestine*
COL. CAMALODVN. Colonia Camalodunum, *England*
COL. CASILIN. Colonia Casilinum, *Castellazo in Italy*
COL. CL. PTOL. Colonia Claudia Ptolemais, *Acre in Phœnicia*
COL. DAMAS. METRO. Colonia Damascus Metropolis
COL. F. I. A. P. BARCIN. Colonia Flavia Julia Augusta Pia, Barcino *or Barcelona*
COL. FL. PAC. DEVLT. Colonia Flavia Pacensis Deultum, *Develtum in Thrace*
COL. HA. ME. T. Colonia Hadriana Mercurialis Thænitana, Mercuriali, *Fermo in Italy, and Thenes in Africa*
COL. H. (or HEL.) LEG. H. Colonia Heliopolis Legio Heliopolitana
COL. HEL. I. O. M. H. Colonia Heliopolis Jovi Optimo Maximo Heliopolitano
COL. IVL. AVG. C. I. F. COMAN. Colonia Julia Augusta Concordia Invicta Felix Comanorum, *drawn from Concordia in Italy, and sent to Comana in Cappadocia*
COL. IVL. AVG. FEL. CREMNA. Colonia Julia Augusta Felix Cremna, *in Pamphylia*
COL. IVL. CER. SAC. AVG. FEL. CAP. OECVM. ISE. HEL. Colonia Julia Certamen Sacrum Augustum Felix Capitolenum Oecumenicum Iselasticum Heliopolitanum
COL. IVL. CONC. APAM. AVG. D. D. Colonia Julia Concordia Apamea Augusta Decreto Decurionum
COL. IVL. PATER. NAR. Colonia Julia Paterna Narbonensis
COL. NEM. Colonia Nemausus
COL. NICEPH. COND. Colonia Nicephorium Condita, *in Mesopotamia*
COL. PATR. Colonia Patrensis *or* Patricia, *Patras in Greece*, or *Cordova in Spain*
COL. P. F. AVG. F. CAES. MET. Colonia Prima Flavia Aug. Felix Cæsarea Metropolis, *in Palestine*.
COL. P. FL. AVG. CAES. METROP. P. S. P. *same as above*, P. S. P. *is* Provinciæ Syriæ Palestinæ.
COL. PR. F. A. CAESAR. Colonia Prima Flavia Augusta Cæsarea, *in Palestine*
COL. R. F. AUG. FL. C. METROP. Colonia Romana Felix Aug. Flavia Cæsarea Metropolis. *The same*
COL. ROM. Colonia Romulea, or *Seville*
COL. ROM. LVG. Colonia Romana Lugdunum
COL. RVS. LEG. VI. Colonia Ruscino Legio Sexta, *Roussillon in France*
COL. SABAR. Colonia Saburiæ
COL. SABAS. Sebaste, *in Palestine*
COL. SER. G. NEAPOL. Colonia Servii Galbæ Neapolis, *in Palestine*
COL. V. I. CELSA, or COL. VIC. IVL. CELSA. Colonia Victrix Julia Celsa, *Kelsa in Spain*
COL. VIC. IVL. LEP. Colonia Victrix Julia Leptis, *in Africa*
COL. VIM. AN. I. or II, &c. Colonia Viminacium Anno primo, *Widin in Servia*
COL. VLP. TRA. Colonia Ulpia Trajana: *Kellen*, or *Warhal in Transilvania*
CO. P. F. COE. METRO. Colonia Prima Flavia Cæsarea Metropolis
CO. P. I. A. Colonia Pacensis Julia Augusta, *or* Col. Octaviana
C. R. I. F. S. Colonia Romana Julia Felix Sinope
C. T. T. Colonia Togata Tarraco
C. V. IL. Colonia Victrix Illice, *Elche in Spain*
D. Decuriones
D. C. A. Divus Cæs. Aug.
DERT. Dertosa
GEN. COL. NER. PATR. Genio Coloniæ Neronianæ Patrensis
G. L. S. Genio Loci Sacrum
M. H. ILLERGAVONIA DYRT. Municipium Hibera Illergavonia Dertosa, *Tortosa in Catalonia*
M. M. I. V. Municipes Municipii Julii Uticensis
M. R. Municipium Ravennatium
MVN. CAL. IVL. Municipium Calagurris Julia, *in Spain*
MVN. CLVN. Municipium Clunia, *Crunna in Spain*
MVN. FANE. ÆL. Municipium Fanestre Aelium, *Fano*
MVN. STOB. Municipium Stobense, *Stobi in Macedon*
MV. TV. Municipium Turiaso, *in Spain*
N. TR. ALEXANDRIANE COL. BOSTR. Nerviæ Trojanæ Alexandrianæ Coloniæ Bostræ, *in Palestine*
SEP. COL. LAVD. Septimia Colonia Laudicea, *or* Laodicea
SEP. TYR. MET. Septima Tyrus Metropolis.

Explanation of the Plates.

Explanation of Plates.

Plates CCCXXXI. and CCCXXXII.

Fig. 1. A Persian daric
2. A drachm of Egina
3. A silver hemidrachm of Alexander the Great
4. Tigranes the younger of Armenia, with his sister
5. One of the coins of the Arsacidæ of Parthia
6. A coin of the Sassanidæ of Persia. First published by Mr Pinkerton
7. Denarius of Cneius Pompey from Mr Pinkerton, reverse. Received by Spain
8. A brass coin of Cunobelinus
9. Pescennius Niger. Struck at Antioch; unique. In Dr Hunter's cabinet; published by Mr Pinkerton
10. A silver coin of Carausius
11. Reverse of Claudius in first brass
12. Reverse of Adrian
13. Of Antoninus Pius
14. Of Commodus
15. Of Severus
16. A Saxon penny
17. A Saxon styca
18. 19. Ancient pennies, supposed to be Scottish
20. A penny of William of Scotland
21. A penny of Robert the Great
22. An Irish penny

23. The

Explanation of Plates.

23. The gold penny of Henry III.
24. The large noble of the first coinage of Edward III.
25. The gold medal of David II. of Scotland
26. The ryal of Queen Mary of Scotland
27. Letters on Anglo-Saxon coins
28. Abbreviations on ditto
29. Monetarius

Medallion.

Impressions of MEDALS. See CASTING.

MEDALLION, or MEDALION, a medal of an extraordinary size, supposed to be anciently struck by the emperors for their friends, and for foreign princes and ambassadors. But, that the smallness of their number might not endanger the loss of the devices they bore, the Romans generally took care to stamp the subject of them upon their ordinary coins.

Medallions, in respect of the other coins, were the same as modern medals in respect of modern money: they were exempted from all commerce, and had no other value than what was set upon them by the fancy of the owner. Medallions are so scarce, that there cannot be any set made of them, even though the metals and sizes should be mixed promiscuously.

MEDEA, in fabulous history, a celebrated sorceress, daughter of Æetes king of Colchis. Her mother's name, according to the more received opinion of Hesiod and Hyginus, was Idyia, or, according to others, Ephyre, Hecate, Asterodia, Antiope, and Neæra. She was the niece of Circe. When Jason came to Colchis in quest of the golden fleece, Medea became enamoured of him, and it was to her well-directed labours that the Argonauts owed their preservation. Medea had an interview with her lover in the temple of Hecate; where they bound themselves by the most solemn oaths to eternal fidelity. No sooner had Jason overcome all the difficulties which Æetes had placed in his way, than Medea embarked with the conquerors for Greece. To stop the pursuit of her father, she tore to pieces her brother Absyrtus, and left his mangled limbs in the way through which Æetes was to pass. This act of barbarity, some have attributed to Jason, and not to her. When Jason reached Iolchos his native country, the return and victories of the Argonauts were celebrated with universal rejoicings: but Æson the father of Jason was unable to assist at the solemnity on account of the infirmities of his age. Medea, at her husband's request, removed the weakness of Æson; and by drawing away the blood from his veins, and filling them again with the juice of certain herbs, she restored him to the vigour and sprightliness of youth. This sudden change in Æson astonished the inhabitants of Iolchos; and the daughters of Pelias were also desirous to see their father restored by the same power to the vigour of youth. Medea, willing to revenge the injuries which her husband's family had suffered from Pelias, increased their curiosity; and betrayed them into the murder of their father as preparatory to his rejuvenescence, which she afterwards refused to accomplish. This action greatly irritated the people of Iolchos; and Medea with her husband fled to Corinth to avoid their resentment. Here they lived for 10 years with mutual attachment, when the love of Jason for Glauce the king's daughter interrupted their harmony, and Medea was divorced. Medea revenged the infidelity of Jason, by causing the death of Glauce, and the destruction of her family. She also killed two of her children in their father's presence; and when Jason attempted to punish the barbarity of the mother, she fled through the air upon a chariot drawn by winged dragons. From Corinth Medea came to Athens, where, after she had undergone the necessary purification of her murder, she married King Ægeus, or (according to others) lived in an adulterous manner with him. From her conduct with Ægeus, Medea had a son who was called *Medus*. Soon after, when Theseus wished to make himself known to his father, Medea, jealous of his fame and fearful of his power, attempted to poison him at a feast which had been prepared for his entertainment. Her attempts, however, failed of success, and the sight of the sword which Theseus wore by his side convinced Ægeus that the stranger against whose life he had so basely conspired was his own son. The father and the son were reconciled; and Medea, to avoid the punishment which her wickedness deserved, mounted her fiery chariot and disappeared through the air. She came to Colchis; where, according to some, she was reconciled to Jason, who had sought her in her native country after her sudden departure from Corinth. She died at Colchis, as Justin mentions, when she had been restored to the confidence of her family. After death she married Achilles in the Elysian fields, according to the tradition mentioned by Simonides. The murder of Mermerus and Pheres, the youngest of Jason's children by Medea, is not to be attributed to the mother, according to Elian; but to the Corinthians, who assassinated them in the temple of Juno Acræa. To avoid the resentment of the gods, and to deliver themselves from the pestilence which visited their country after so horrid a massacre, they engaged the poet Euripides for five talents to write a tragedy, which cleared them of the murder, and represented Medea as the cruel assassin of her own children. And besides, that this opinion might be the better credited, festivals were appointed, in which the mother was represented with all the barbarity of a fury murdering her own sons.

MEDEOLA, CLIMBING AFRICAN ASPARAGUS, a genus of plants belonging to the hexandria class, and in the natural method ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

Medallion || Media.

MEDIA, now the province of GHILAN in Persia, once the seat of a potent empire, was bounded, according to Ptolemy, on the north by part of the Caspian sea; on the south by Persis, Susiana, and Assyria; on the east by Parthia and Hyrcania; and on the west by Armenia Major. It was anciently divided into several provinces, viz. Tropatene, Charomithrene, Darites, Media. rites, Marciane, Amariace, and Syro-Media. By a later division, however, all these were reduced to two; the one called *Media Magna*, the other *Media Atropatia*, or simply *Atropatene*. Media Magna was bounded by Persis, Parthia, Hyrcania, the Hyrcanian sea, and Atropatene, and contained the cities of Ecbatan, Laodicea, Apamea, Raga, Rageia or Ragea, &c. Atropatene lay between the Caspian mountains and the Caspian sea.

This country originally took its name from Madai, the third son of Japhet; as is plain from Scripture, where the Medes are constantly called *Madai*. Among profane authors, some derive the name *Media*, from one Medus the son of Jason and Medea; others from a city called *Media*. Sextus Rufus tells us that in his time it was called *Medena*, and from others we learn that it was also called *Aria*. The most probable history of the Medes is as follows.

This people lived in subjection to the Assyrians till the reign of Sennacherib, when they threw off the yoke, and lived for some time in a state of anarchy. But at last, rapine and violence, the natural consequences of such a situation, prevailed so much that they were constrained to have recourse to some kind of government, that they might be enabled to live in safety. Accordingly, about 699 B. C. one Dejoces having procured himself to be chosen king, united the scattered tribes into which the Medes were at that time divided; and having applied himself as much as possible to the civilization of his barbarous subjects, left the throne to his son Phraortes, after a reign of 53 years.

The new king, who was of a warlike and enterprising disposition, subdued almost all the Upper Asia lying between Mount Taurus and the river Halys which runs through Cappadocia into the Euxine sea. Elated with this good success, he invaded Assyria, the empire of which was now much declined, and greatly weakened by the revolt of many nations which had followed the example of the Medes. Nebuchadonosor or Chyniladan, however, the reigning prince, having assembled what forces he could, engaged Phraortes, defeated, took him prisoner, and put him to death; after which, entering Media, he laid waste the country, took the metropolis of Ecbatan itself, and levelled it with the ground.

On the death of Phraortes, his son Cyaxares was placed on the throne. He was no less valiant and enterprising than his father, and had better success against the Assyrians. With the remains of that army which had been defeated under his father, he not only drove the conquerors out of Media, but obliged Chyniladan to shut himself up in Nineveh. To this place he immediately laid close siege; but was obliged to give over the enterprise on account of an irruption of the Scythians into his own country. Cyaxares engaged these new enemies with great resolution; but was utterly defeated; and the conquerors overran not only all Media, but the greatest part of Upper Asia, extending their conquests into Syria, and as far as the confines of Egypt. They continued masters of all this vast tract of country for 28 years, till at last Media was delivered from their yoke by a general massacre at the instigation of Cyaxares.

Mediana || Medicinal Springs.

After this deliverance, the Medes soon repossessed themselves of the territories they had lost; and once more extended their frontiers to the river Halys, their ancient boundary to the westward. After this we find the Medes engaged in a war with the Lydians; which, however, ended without any remarkable transaction: but on the conclusion of it, Cyaxares having entered into a strict alliance with Nebuchadnezzar king of Babylon, returned in conjunction with the Babylonians before Nineveh: which they took and levelled with the ground, putting most of the inhabitants to the sword.

After this victory the Babylonian and Median empires seem to have been united: however, after the death of Nebuchadnezzar, or rather in his lifetime, a war ensued, which was not extinguished but by the dissolution of the Babylonian empire. The Medes, under Astyages the son of Cyaxares I. withstood the power of the Babylonian monarchs: and under Cyrus and Cyaxares II. utterly destroyed their empire by the taking of BABYLON, as is related under that article. After the death of Cyaxares, the kingdom fell to Cyrus, by whom the seat of the empire was transferred to PERSIA, under which article the history of Media now falls to be considered, as also the manners, &c. of the inhabitants.

MEDIANA, the name of a vein or little vessel, made by the union of the cephalic and basilic, in the bend of the elbow.

MEDIASTINUM, in *Anatomy*, a double membrane, formed by a duplicature of the pleura; serving to divide the thorax and the lungs into two parts, and to sustain the viscera, and prevent their falling from one side of the thorax to the other. See ANATOMY, N° 117.

MEDIATE, or INTERMEDIATE, something that stands betwixt and connects two or more terms considered as extremes; in which sense it stands opposed to *immediate*.

MEDIATOR, a person that manages or transacts between two parties at variance, in order to reconcile them. The word, in Scripture, is applied, 1. To Jesus Christ, who is the only intercessor and peace-maker between God and man, (1 Tim. ii. 5.) 2. To Moses, who interposed between the Lord and his people, to declare unto them his word; (Deut. v. 5. iii. 19.)

MEDICAGO, SNAIL-TREFOIL, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*. For the properties and culture of LUCERN, a species of this genus, see AGRICULTURE, *Index*.

MEDICINAL, any thing belonging to medicine.

MEDICINAL Springs, a general name for any fountain, the waters of which are of use for removing certain disorders. They are commonly either chalybeate or sulphureous. See SPRINGS and WATER.

MEDICINE.

MEDICINE is the art of preventing, curing, or alleviating, thoſe diſeaſes to which the human ſpecies are ſubjected.

History of Medicine.

1 Origin of medicine among the Jews;

THE fabulous hiſtory of the ancients derives this art immediately from their gods; and, even among the moderns, ſome are of opinion that it may juſtly be conſidered as of divine revelation. But without adopting any ſuppoſition of which no probable evidence can be given, we may conclude that mankind were naturally led to it from caſual obſervation on the diſeaſes to which they found themſelves ſubjected; and that therefore, to a certain degree at leaſt, it is as ancient as the human race. But at what period it began to be practiſed as an art, by particular individuals following it as a profeſſion, is not known. The moſt ancient phyſicians we read of were thoſe who embalmed the patriarch Jacob by order of his ſon Joſeph. The ſacred writer ſtyles theſe phyſicians *ſervants* to Joſeph: whence we may be aſſured that they were not *prieſts*, as the firſt phyſicians are generally ſuppoſed to have been; for in that age we know the Egyptian prieſts were in ſuch high favour, that they retained their liberty, when, through a public calamity, all the reſt of the people were made ſlaves to the prince.

It is not probable, therefore, that among the Egyptians religion and medicine were originally conjoined; and if we ſuppoſe the Jews not to have invented the art, but received it from ſome other nation, it is as little probable that the prieſts of that nation were their phyſicians as thoſe of Egypt.

That the Jewiſh phyſicians were abſolutely diſtinct from their prieſts, is very certain. Yet as the Jews reſided for ſuch a long time in Egypt, it is probable they would retain many of the Egyptian cuſtoms, from which it would be very difficult to free them. We read, however, that when King Aſa was diſeaſed in his feet, "he ſought not to the Lord, but to the phyſicians." Hence we may conclude, that among the Jews the medical art was looked upon as a mere human invention; and it was thought that the Deity never cured diſeaſes by making people acquainted with the virtues of this or that herb, but only by his miraculous power. That the ſame opinion prevailed among the nations who were neighbours to the Jews, is alſo probable from what we read of Ahaziah king of Judah, who having ſent meſſengers to inquire of Baalzebub god of Ekron concerning his diſeaſe, he did not deſire any remedy from him or his prieſts, but ſimply to know whether he ſhould recover or not.

What ſeems moſt probable on this ſubject therefore is, that religion and medicine came to be mixed together only in conſequence of that degeneracy into ignorance and ſuperſtition which took place among all nations. The Egyptians, we know, came at laſt to be ſunk in the moſt ridiculous and abſurd ſuperſtition; and then, indeed, it is not wonderful that we ſhould find their prieſts commencing phyſicians, and mingling charms, incantations, &c. with their remedies. That this was the caſe, long after the days of Joſeph, we are very certain; and indeed it ſeems as natural for ignorance and barbariſm to combine religion with phyſic, as it is for a civilized and enlightened people to keep them ſeparate. Hence we ſee, that among all modern barbarians their prieſts or conjurors are their only phyſicians.

Origin of Medicine.

2 Among the Egyptians;

We are ſo little acquainted with the ſtate of phyſic among the Egyptians, that it is needleſs to ſay much concerning them. They attributed the invention of medicine, as they did alſo that of many other arts, to Thoth, the HERMES or MERCURY of the Greeks. He is ſaid to have written many things in hieroglyphic characters upon certain pillars, in order to perpetuate his knowledge, and render it uſeful to others. Theſe were tranſcribed by Agathodemon, or the ſecond Mercury, the father of Tat, who is ſaid to have compoſed books of them, that were kept in the moſt ſacred places of the Egyptian temples. The exiſtence of ſuch a perſon, however, is very doubtful, and many of the books aſcribed to him were accounted forgeries as long ago as the days of Galen; there is alſo great reaſon to ſuſpect that thoſe books were written many ages after Hermes, and when phyſic had made conſiderable advances. Many of the books attributed to him are trifling and ridiculous; and though ſometimes he is allowed to have all the honour of inventing the art, he is on other occaſions obliged to ſhare it with Oſiris, Iſis, and Apis or Serapis.

After all, the Egyptian phyſic appears to have been little elſe than a collection of abſurd ſuperſtitions. Origen informs us, that they believed there were 36 demons, or gods of the air, who divided the human body among them; that they had names for each of them; and that by invoking them according to the part affected, the patient was cured. Of natural medicines we hear none recommended by the father of Egyptian phyſic; except the herb *moly*, which he gave to Ulyſſes in order to ſecure him from the enchantments of Circe; and the herb *mercury*, of which he firſt diſcovered the uſe. His ſucceſſors made uſe of veneſection, cathartics, emetics, and clyſters. There is no proof, however, that this practice was eſtabliſhed by Hermes; on the contrary, the Egyptians themſelves pretended that the firſt hint of thoſe remedies was taken from ſome obſervations on brute animals. Veneſection was taught them by the hippopotamus, which is ſaid to perform this operation upon itſelf. On certain occaſions, he comes out of the river, and ſtrikes his leg againſt a ſharp-pointed reed. As he takes care to direct the ſtroke againſt a vein, the conſequence muſt be a conſiderable effuſion of blood; and this being ſuffered to run as long as the creature thinks proper, he at laſt ſtops up the orifice with mud. The hint of clyſters was taken from the Ibis, a bird which is ſaid to give itſelf clyſters with its bill, &c. They uſed veneſection, however, but very little, probably on account of the

warmth

Origin of Medicine. warmth of the climate; and the exhibition of the remedies above mentioned, joined with abstinence, formed the most of their practice.

3 Among the Greeks. The Greeks too had several persons to whom they attributed the invention of physic, particularly Prometheus, Apollo or Pæan, and Æsculapius; which last was the most celebrated of any. But here we must observe, that as the Greeks were a very warlike people, their physic seems to have been little else than what is now called *surgery*, or the cure of wounds, fractures, &c. Hence Æsculapius, and his pupils Chiron, Machaon, and Podalirius, are celebrated by Homer only for their skill in curing these, without any mention of their attempting the cures of internal diseases. We are not, however, to suppose that they confined themselves entirely to surgery. They no doubt would occasionally prescribe for internal disorders; but as they were most frequently conversant with wounds, we may naturally suppose the greatest part of their skill to have consisted in knowing how to cure these. If we may believe the poets, indeed, the knowledge of medicine seems to have been very generally diffused. Almost all the heroes of antiquity are reported to have been physicians as well as warriors. Most of them were taught physic by the centaur Chiron. From him Hercules received instructions in the medicinal art, in which he is said to have been no less expert than in feats of arms. Several plants were called by his name; from which some think it probable that he found out their virtues, though others are of opinion that they bore the name of this renowned hero on account of their great efficacy in removing diseases. Aristæus king of Arcadia was also one of Chiron's scholars; and is supposed to have discovered the use of the drug called *silphium*, by some thought to be asafœtida. Theseus, Telamon, Jason, Peleus, and his son Achilles, were all renowned for their knowledge in the art of physic. The last is said to have discovered the use of verdegrise in cleansing foul ulcers. All of them, however, seem to have been inferior in knowledge to Palamedes, who hindered the plague from coming into the Grecian camp after it had ravaged most of the cities of the Hellespont, and even Troy itself. His method was to confine his soldiers to a spare diet, and to oblige them to use much exercise.

The practice of these ancient Greek physicians, notwithstanding the praises bestowed on them by their poets, seems to have been very limited, and in some cases even pernicious. All the external remedies applied to Homer's wounded heroes were fomentations; while inwardly their physicians gave them wine, sometimes mingled with cheese scraped down. A great deal of their physic also consisted in charms, incantations, amulets, &c. of which, as they are common to all superstitious and ignorant nations, it is superfluous to take any farther notice.

In this way the art of medicine continued among the Greeks for many ages. As its first professors knew nothing of the animal economy, and as little of the theory of diseases, it is plain, that whatever they did must have been in consequence of mere random trials, or empiricism, in the strict and proper sense of the word. Indeed, it is evidently impossible that this or almost any other art could originate from another source than trials of this kind. Accordingly, we find, that some ancient nations were accustomed to expose their sick in temples, and by the sides of highways, that they might receive the advice of every one who passed. Among the Greeks, however, Æsculapius was reckoned the most eminent practitioner of his time, and his name continued to be revered after his death. He was ranked amongst the gods; and the principal knowledge of the medical art remained with his family to the time of Hippocrates, who reckoned himself the seventeenth in a lineal descent from Æsculapius, and who was truly the first who treated of medicine in a regular and rational manner.

Hippocrates. 4 Æsculapius.

5 Hippocrates. Hippocrates, who is supposed to have lived 400 years before the birth of Christ, is the most ancient author whose writings expressly on the subject of the medical art are preserved; and he is therefore justly considered as the father of physic. All the accounts which we have prior to this time, if not evidently fabulous, are at the utmost highly conjectural. Even the medical knowledge of Pythagoras, so much celebrated as a philosopher, can hardly be considered as resting on any other foundation. But from the time of Hippocrates, medicine, separated from philosophy and religion, seems to have assumed the form of a science, and to have been practised as a profession. It may not, therefore, be improper to give a particular account of the state of medical science as transmitted to us in his writings. The writings of Hippocrates, however, it may be remarked, are even more than preserved. Many things have been represented as written by Hippocrates which are probably spurious. Nor is it wonderful that attempts should have been made to increase the value of manuscripts, by attributing them to a name of such eminence. But although what are transmitted to us under the title of his works may have been written by different hands, yet the presumption is, that most, if not all of them, are of nearly as early a date, and contain the prevailing opinions of those times. 6 His writings.

According to the most authentic accounts, Hippocrates was a native of the island of Cos, and born in the beginning of the 88th Olympiad. In the writings transmitted to us as his, we find a general principle adopted, to which he gives the name of *Nature*. To this principle he ascribes a mighty power. "Nature (says he) is of itself sufficient to every animal. She performs every thing that is necessary to them, without needing the least instruction from any one how to do it." Upon this footing, as if Nature had been a principle endowed with knowledge, he gives her the title of *just*; and ascribes virtues or powers to her, which are her servants, and by means of which she performs all her operations in the bodies of animals: and distributes the blood, spirits, and heat, through all parts of the body, which by these means receive life and sensation. And in other places he tells us, that it is this faculty which gives nourishment, preservation, and growth, to all things.

7 His idea of nature. The manner in which nature acts, or commands her subservient power to act, is by attracting what is good and agreeable to each species, and by retaining, preparing, and changing it; and on the other side in rejecting whatever is superfluous or hurtful, after she has separated it from the good. This is the foundation of the doctrine of depuration, concoction, and crisis in fevers,

Hippocrates.

fevers, ſo much inſiſted upon by Hippocrates and many other phyſicians. He ſuppoſes alſo, that every thing has an inclination to be joined to what agrees with it, and to remove from every thing contrary to it; and likewiſe that there is an affinity between the ſeveral parts of the body, by which they mutually ſympathize with each other. When he comes to explain what this principle called *nature* is, he is obliged to reſolve it into *heat*, which, he ſays, appears to have ſomething immortal in it.

8 Of the cauſes of diſeaſe.

As far as he attempts to explain the cauſes of diſeaſe, he refers much to the humours of the body, particularly to the blood and the bile. He treats alſo of the effects of ſleep, watchings, exerciſe, and reſt, and all the benefit or miſchief we may receive from them. Of all the cauſes of diſeaſes, however, mentioned by Hippocrates, the moſt general are diet and air. On the ſubject of diet he has compoſed ſeveral books, and in the choice of this he was exactly careful; and the more ſo, as his practice turned almoſt wholly upon it. He alſo conſidered the air very much; he examined what winds blew ordinarily or extraordinarily; he conſidered the irregularity of the ſeaſons, the riſing and ſetting of ſtars, or the time of certain conſtellations; alſo the time of the ſolſtices, and of the equinoxes; thoſe days, in his opinion, producing great alterations in certain diſtempers.

9 His diviſions of diſeaſes.

He does not, however, pretend to explain how, from theſe cauſes, that variety of diſtempers ariſes which is daily to be obſerved. All that can be gathered from him with regard to this is, that the different cauſes above mentioned, when applied to the different parts of the body, produce a great variety of diſtempers. Some of theſe diſtempers he accounted *mortal*, others *dangerous*, and the reſt eaſily *curable*, according to the cauſe from whence they ſpring, and the parts on which they fall. In ſeveral places alſo he diſtinguiſhes diſeaſes, from the time of their duration, into *acute* or *ſhort*, and *chronical* or *long*. He likewiſe diſtinguiſhes diſeaſes by the particular places where they prevail, whether ordinary or extraordinary. The firſt, that is, thoſe that are frequent and familiar to certain places, he called *endemic* diſeaſes; and the latter, which ravaged extraordinarily ſometimes in one place, ſometimes in another, which ſeized great numbers at certain times, he called *epidemic*, that is, *popular* diſeaſes; and of this kind the moſt terrible is the plague. He likewiſe mentions a third kind, the oppoſite of the former; and theſe he calls *ſporadic*, or ſtraggling diſeaſes: theſe laſt include all the different ſorts of diſtempers which invade at any one ſeaſon, which are ſometimes of one ſort, and ſometimes of another. He diſtinguiſhed between thoſe diſeaſes which are hereditary, or born with us, and thoſe which are contracted afterwards; and likewiſe between thoſe of a *kindly* and thoſe of a *malignant* nature, the former of which are eaſily and frequently cured, but the latter give the phyſicians a great deal of trouble, and are ſeldom overcome by all their care.

Hippocrates remarked four ſtages in diſtempers; viz. the beginning of the diſeaſe, its augmentation, its ſtate or height, and its declination. In ſuch diſeaſes as terminate fatally, death comes in place of the declination. In the third ſtage, therefore, the change is moſt conſiderable, as it determines the fate of the ſick perſon; and this is moſt commonly done by means of a *criſis*. By this word he underſtood any ſudden change in ſickneſs, whether for the better or for the worſe, whether health or death ſucceed immediately. Such a change, he ſays, is made at that time by *nature*, either abſolving or condemning the patient. Hence we may conclude, that Hippocrates imagined diſeaſes to be only a diſturbance of the animal economy, with which Nature was perpetually at variance, and uſing her utmoſt endeavours to expel the offending cauſe. Her manner of acting on theſe occaſions is to reduce to their natural ſtate thoſe humours whoſe diſcord occaſions the diſturbance of the whole body, whether in relation to their quantity, quality, mixture, motion, or any other way in which they become offenſive. The principal means employed by nature for this end is what Hippocrates calls *concoction*. By this he underſtood the bringing the morbific matter lodged in the humours to ſuch a ſtate, as to be eaſily fitted for expulſion by whatever means nature might think moſt proper. When matters are brought to this paſs, whatever is ſuperfluous or hurtful immediately empties itſelf, or nature points out to phyſicians the way by which ſuch an evacuation is to be accompliſhed. The criſis takes place either by bleeding, ſtool, vomit, ſweat, urine, tumors or abſceſſes, ſcabs, pimples, ſpots, &c. But theſe evacuations are not to be looked upon as the effects of a true criſis, unleſs they are in conſiderable quantity; ſmall diſcharges not being ſufficient to make a criſis. On the contrary, ſmall diſcharges are a ſign that nature is depreſſed by the load of humours, and that ſhe lets them go through weakneſs and continual irritation. What comes forth in this manner is crude, becauſe the diſtemper is yet too ſtrong; and while matters remain in this ſtate, nothing but a bad or imperfect criſis is to be expected. This ſhows that the diſtemper triumphs, or at leaſt is equal in ſtrength to nature, which prognoſticates death, or a prolongation of the diſeaſe. In this laſt caſe, however, nature often has an opportunity of attempting a new criſis more happy than the former, after having made freſh efforts to advance the concoction of the humours.—It muſt here be obſerved, however, that, according to Hippocrates, concoction cannot be made but in a certain time, as every fruit has a limited time to ripen; for he compares the humours which nature has digeſted to fruits come to maturity.

10 His opinion of a criſis.

The time required for concoction depends on the differences among diſtempers mentioned above. In thoſe which Hippocrates calls *very acute*, the digeſtion or criſis happens by the fourth day; in thoſe which are only *acute*, it happens on the 7th, 11th, or 14th day; which laſt is the longeſt period generally allowed by Hippocrates in diſtempers that are truly acute: though in ſome places he ſtretches it to the 20th or 21ſt, nay, ſometimes to the 40th or 60th day. All diſeaſes that exceed this laſt term are called *chronical*. And while in thoſe diſeaſes that exceed 14 days, he conſiders every fourth day as critical, or at leaſt remarkable, by which we may judge whether the criſis on the following fourth day will be favourable or not; ſo in thoſe which run from 20 to 40 he reckons only the ſevenths, and in thoſe that exceed 40 he begins to reckon by 20. Beyond the 120th he thinks that the number of days has no power over the criſis. They are

Hippocrates.

are then referred to the general changes of the ſeaſons; ſome terminating about the equinoxes; others about the ſolſtices; others about the riſing or ſetting of the ſtars of certain conſtellations; or if numbers have yet any place, he reckons by months, or even whole years. Thus (he ſays), certain diſeaſes in children have their criſis in the ſeventh month after their birth, and others in their ſeventh or even their 14th year.

Though Hippocrates mentions the 21ſt as one of the critical days in acute diſtempers, as already noticed; yet, in other places of his works, he mentions alſo the 20th. The reaſon he gives for this in one of thoſe places of his work is, that the days of ſickneſs were not quite entire. In general, however, he is much attached to the odd days: inſomuch that in one of his aphoriſms he tells us, "The ſweats that come out upon the 3d, 5th, 7th, 9th, 11th, 14th, 17th, 21ſt, 27th, 31ſt, or 34th days, are beneficial; but thoſe that come out upon other days ſignify that the ſick ſhall be brought low, that his diſeaſe ſhall be very tedious, and that he ſhall be ſubject to relapſes." He further ſays, "That the fever which leaves the ſick upon any but an odd day is uſually apt to relapſe." Sometimes, however, he confeſſes that it is otherwiſe; and he gives an inſtance of a ſalutary criſis happening on the ſixth day. But theſe are very rare inſtances, and therefore cannot, in his opinion, overthrow the general rule.

Beſides the criſis, however, or the change which determines the fate of the patient, Hippocrates often ſpeaks of another, which only changes the ſpecies of the diſtemper, without reſtoring the patient to health; as when a vertigo is turned to an epilepſy, a tertian fever to a quartan, or to a continued, &c.

11
His accuracy in prognoſtics;

But what has chiefly contributed to procure the great reſpect generally paid to Hippocrates, is his induſtry in obſerving the moſt minute circumſtances of diſeaſes, and his exactneſs in nicely deſcribing every thing that happened before, and every accident that appeared at the ſame time with them; and likewiſe what appeared to give eaſe, and what to increaſe the malady: which is what we call *writing the hiſtory of a diſeaſe*.—Thus he not only diſtinguiſhed one diſeaſe from another by the ſigns which properly belonged to each; but by comparing the ſame ſort of diſtemper which happened to ſeveral perſons, and the accidents which uſually appeared before and after, he could often foretel a diſeaſe before it began, and afterwards give a right judgement of the event of it. By this way of prognoſticating, he came to be exceedingly admired: and this he carried to ſuch a height, that it may juſtly be ſaid to be his maſter-piece; and Celſus, who lived after him, remarks, that ſucceeding phyſicians, though they found out ſeveral new things relating to the management of diſeaſes, yet were obliged to the writings of Hippocrates for all that they knew of ſigns.

From the look;

The firſt thing Hippocrates conſidered, when called to a patient, was his looks.—It was a good ſign with him to have a viſage reſembling that of a perſon in health, and the ſame with what the ſick man had before he was attacked by the diſeaſe. As it varied from this, ſo much the greater danger was apprehended. The following is the deſcription which he gives of the looks of a dying man.—"When a patient (ſays he) has his noſe ſharp, his eyes ſunk, his temples hollow, his ears cold and contracted, the ſkin of his forehead tenſe and dry, and the colour of his face tending to a pale-green, or lead colour, one may pronounce for certain that death is very near at hand; unleſs the ſtrength of the patient has been exhauſted all at once by long watchings, or by a looſeneſs, or being a long time without eating." This obſervation has been confirmed by ſucceeding phyſicians, who have, from him, denominated it the *Hippocratic face*. The lips hanging relaxed and cold, are likewiſe looked upon by Hippocrates as a confirmation of the foregoing prognoſtic. He took alſo his ſigns from the diſpoſition of the eyes in particular. When a patient cannot bear the light; when he ſheds tears involuntarily; when, in ſleeping, ſome part of the white of the eye is ſeen, unleſs he uſually ſleeps after that manner, or has a looſeneſs upon him: theſe ſigns, as well as the foregoing ones, prognoſticate danger. The eyes deadened, as it were with a miſt ſpread over them, or their brightneſs loſt, likewiſe preſages death, or great weakneſs. The eyes ſparkling, fierce, and fixed, denote the patient to be delirious, or that he ſoon will be ſeized with a frenzy. When the patient ſees any thing red, and like ſparks of fire and lightning paſs before his eyes, you may expect an hæmorrhagy; and this often happens before thoſe criſes which are to be attended by a loſs of blood.

From the poſture in bed;

The condition of the patient is alſo ſhown by his poſture in bed. If you find him lying on one ſide, his body, neck, legs, and arms, a little contracted, which is the poſture of a man in health, it is a good ſign: on the contrary, if he lies on his back, his arms ſtretched out, and his legs hanging down, it is a ſign of great weakneſs; and particularly when the patient ſlides or lets himſelf fall down towards the feet, it denotes the approach of death. When a patient in a burning fever is continually feeling about with his hands and fingers, and moves them up before his face and eyes as if he was going to take away ſomething that paſſed before them; or on his bed-covering, as if he was picking or ſearching for little ſtraws, or taking away ſome filth, or drawing out little flocks of wool; all this is a ſign that he is delirious, and that he will die. Amongſt the other ſigns of a preſent or approaching delirium he alſo adds this: When a patient who naturally ſpeaks little begins to talk more than he uſed to do, or when one that talks much becomes ſilent, this change is to be reckoned a ſort of delirium, or is a ſign that the patient will ſoon fall into one. The frequent trembling or ſtarting of the tendons of the wriſt, preſage likewiſe a delirium. As to the different ſorts of delirium, Hippocrates is much more afraid of thoſe that run upon mournful ſubjects, than ſuch as are accompanied with mirth.

From reſpiration;

When a patient breathes faſt, and is oppreſſed, it is a ſign that he is in pain, and that the parts above the diaphragm are inflamed. Breathing long, or when the patient is a great while in taking his breath, ſhows him to be delirious; but eaſy and natural reſpiration is always a good ſign in acute diſeaſes. Hippocrates depended much on reſpiration in making his prognoſtics; and therefore has taken care in ſeveral places to deſcribe the different manner of a patient's breathing. Continual watchings in acute diſeaſes, are ſigns of preſent pain, or a delirium near at hand.

Hippocrates. From excrementitious difcharges.

Hippocrates alfo drew figns from all excrements, whatever they are, that are feparated from the body of man. His moft remarkable prognoftics, however, were from the urine. The patient's urine, in his opinion, is beft when the fediment is white, foft to the touch, and of an equal confiftence. If it continue fo during the courfe of the diftemper, and till the time of the crifis, the patient is in no danger, and will foon be well. This is what Hippocrates called *concocted urine*, or what denotes the concoction of the humours; and he obferved, that this concoction of the urine feldom appeared thoroughly, but on the days of the crifis which happily put an end to the diftemper. "We ought (faid Hippocrates) to compare the urine with the purulent matter which runs from ulcers. As the pus, which is white, and of the fame quality with the fediment of the urine we are now fpeaking of, is a fign that the ulcer is on the point of clofing; fo that which is clear, and of another colour than white, and of an ill fmell, is a fign that the ulcer is virulent, and in the fame manner difficult to be cured: the urines that are like this we have defcribed are only thofe which may be named good; all the reft are ill, and differ from one another only in the degrees of more and lefs. The firft never appear but when nature has overcome the difeafe; and are a fign of the concoction of humours, without which you cannot hope for a certain cure. On the contrary, the laft are made as long as the crudity remains, and the humours continue unconcocted. Among the urines of this laft fort, the beft are reddifh, with a fediment that is foft and of an equal confiftence; which denotes, that the difeafe will be fomewhat tedious, but without danger. The worft are thofe which are very red, and at the fame time clear and without fediment; or that are muddy and troubled in the making. In urine there is often a fort of cloud hanging in the veffel in which it is received; the higher this rifes, or the farther diftant it is from the bottom, or the more different from the colour of the laudable fediment abovementioned, the more there is of crudity. That which is yellow, or of a fandy colour, denotes abundance of bile; that which is black is the worft, efpecially if it has an ill fmell, and is either altogether muddy or altogether clear. That whofe fediment is like large ground wheat, or little flakes or fcales fpread one upon another, or bran, prefages ill, efpecially the laft. The fat or oil that fometimes fwims upon the top of the urine, and appears in a form fomething like a fpider's web, is a fign of a confumption of the flefh and folid parts. The making of a great quantity of urine is the fign of a crifis, and fometimes the quality of it fhows how the bladder is affected. We muft alfo obferve, that Hippocrates compared the ftate of the tongue with the urine; that is to fay, when the tongue was yellow, and charged with bile, the urine he knew muft of courfe be of the fame colour; and when the tongue was red and moift, the urine was of its natural colour.

Urine.

Fæces.

Among his prognoftics from the excretions by ftool are the following. Thofe that are foft, yellowifh, of fome confiftence, and not of an extraordinary ill fmell, that anfwer to the quantity of what is taken inwardly, and that are voided at the ufual hours, are the beft of all. They ought alfo to be of a thicker confiftence when the diftemper is near the crifis; and it ought to be taken for a good prognoftic, when fome worms, particularly the round and long, are evacuated at the fame time with them. The prognofis, however, may ftill be favourable, though the matter excreted be thin and liquid, provided it make not too much noife in coming out, and the evacuation be not in a fmall quantity nor too often; nor in fo great abundance, nor fo often, as to make the patient faint. All matter that is watery, white, of a pale green or red colour, or frothy and vifcous, is bad. That which is blackifh, or of a livid hue, is the moft pernicious. That which is pure black, and nothing elfe but a difcharge of black bile, always prognofticates very ill; this humour, from what part foever it comes, fhowing the ill difpofition of the inteftines. The matter that is of feveral different colours, denotes the length of the diftemper; and, at the fame time, that it may be of dangerous confequence. Hippocrates places in the fame clafs the matter that is bilious or yellow, and mixed with blood, or green and black, or like the dregs or fcrapings of the guts. The ftools that confift of pure bile, or entirely of phlegm, he alfo looks upon to be very bad.

Matter ejected by vomiting ought to be mixed with bile and phlegm; where one of thefe humours only is obferved, it is worfe. That which is black, livid, green, or of the colour of a leek, indicates alarming confequences. The fame is to be faid of that which fmells very ill; and if at the fame time it be livid, death is not far off. The vomiting of blood is very often a mortal fymptom.

Expectoration.

The fpittings which give eafe in difeafes of the lungs and in pleurifies, are thofe that come up readily and without difficulty; and it is good if they be mixed at the beginning with much yellow: but if they appear of the fame colour, or are red, a great while after the beginning of the diftemper, if they are falt and acrimonious, and caufe violent coughings, they are not good. Spittings purely yellow are bad; and thofe that are white, vifcous, and frothy, give no eafe. Whitenefs is a good fign of concoction in regard to fpittings; but they ought not at all to be vifcous, nor too thick, nor too clear. We may make the fame judgment of the excrements of the nofe according to their concoction and crudity. Spittings that are black, green, and red, are of very bad confequence. In inflammations of the lungs, thofe that are mixed with bile and blood prefage well if they appear at the beginning, but are bad if they arife not about the feventh day. But the worft fign in thefe diftempers is, when there is no expectoration at all, and the too great quantity of matter that is ready to be difcharged this way makes a rattling in the breaft. After fpitting of blood, the difcharge of purulent matter often follows, which brings on a confumption, and at laft death.

Sweat.

A kind good fweat is that which arifes on the day of the crifis, and is difcharged in abundance all over the body, and at the fame time from all parts of the body, and thus carries off the fever: A cold fweat is alarming, efpecially in acute fevers, for in others it is only a fign of long continuance. When the patient fweats no where but on the head and neck, it is a fign that the difeafe will be long and dangerous. A gentle fweat in fome particular part, of the head and breaft, for inftance, gives no relief, but denotes the feat of the diftemper, or the weaknefs of the part. This

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This kind of ſweat was called by Hippocrates *ephidroſis*.

The hypochondria, or the abdomen in general, ought always to be ſoft and even, as well on the right ſide as on the left. When there is any hardneſs or unevenneſs in thoſe parts, or heat and ſwellings, or when the patient cannot endure to have it touched, it is a ſign the inteſtines are indiſpoſed.

From the pulſe.

Hippocrates alſo inquired into the ſtate of the pulſe, or the beating of the arteries. The moſt ancient phyſicians, however, and even Hippocrates himſelf, for a long time, by this word underſtood the violent pulſation that is felt in an inflamed part, without putting the fingers to it. It is obſerved by Galen, and other phyſicians, that Hippocrates touches on the ſubject of the pulſe more ſlightly than any other on which he treats. But that our celebrated phyſician underſtood ſomething even on this ſubject, is eaſily gathered from ſeveral paſſages in his writings; as when he obſerves, that in acute fevers the pulſe is very quick and very great; and when he makes mention, in the ſame place, of trembling pulſes, and thoſe that beat ſlowly. He likewiſe obſerves, that in ſome diſeaſes incident to women, when the pulſe ſtrikes the finger faintly, and in a languiſhing manner, it is a ſign of approaching death. He remarks alſo, in the *Coacæ Prænotiones*, that he whoſe vein, that is to ſay, whoſe artery of the elbow, beats, is juſt going to run mad, or elſe that the perſon is at that time very much under the influence of anger.

From this account of Hippocrates, it will appear, that he was not near ſo much taken up with reaſoning on the phenomena of diſeaſes, as with reporting them. He was content to obſerve theſe phenomena accurately, to diſtinguiſh diſeaſes by them, and judged of the event by comparing them exactly together. For his ſkill in prognoſtics he was indeed very remarkable, as we have already mentioned, inſomuch that he and his pupils were looked upon by the vulgar as prophets. What adds very much to his reputation is, that he lived in an age when phyſic was altogether buried in ſuperſtition, and yet he did not ſuffer himſelf to be carried away by it; on the contrary, on many occaſions, he expreſſes his abhorrence of it.

12
His maxims for the preſervation of health.

Having thus ſeen in what Hippocrates makes the difference between health and ſickneſs to conſiſt, and likewiſe the moſt remarkable ſigns from whence he drew his prognoſtics, we muſt now conſider the means he preſcribed for the preſervation of health, and the cure of diſeaſes. One of his principal maxims was this, That, to preſerve health, we ought not to overcharge ourſelves with too much eating, nor neglect the uſe of exerciſe and labour. In the next place, That we ought by no means to accuſtom ourſelves to too nice and exact a method of living; becauſe thoſe who have once begun to act by this rule, if they vary in the leaſt from it, find themſelves very ill; which does not happen to thoſe who take a little more liberty, and live ſomewhat more irregularly. Notwithſtanding this he does not neglect to inquire diligently into the articles which thoſe who were in health uſed for food in his time.

Diet.

Here we cannot help taking notice of the prodigious diſparity between the delicacy of the people in our days and in thoſe of Hippocrates: for he takes great pains to tell the difference between the fleſh of a dog, a fox, a horſe, and an aſs; which he would not have done if at that time they had not been uſed for victuals, at leaſt by the common people. Beſides theſe, however, Hippocrates ſpeaks of all other kinds of proviſion that are now in uſe; for example, ſalads, milk, whey, cheeſe, fleſh as well of birds as of four-footed beaſts, freſh and ſalt fiſh, eggs, all kinds of pulſe, and the different kinds of grain we feed on, as well as the different ſorts of bread that are made of it. He alſo ſpeaks very often of a ſort of liquid food, or broth, made of barley-meal, or ſome other grain, which they ſteeped for ſome time, and then boiled in water. With regard to drink, he takes a great deal of pains to diſtinguiſh the good waters from the bad. The beſt, in his opinion, ought to be clear, light, without ſmell or taſte, and taken out of the fountains that turn towards the eaſt. The ſalt waters, thoſe that he calls hard, and thoſe that riſe out of fenny ground, are the worſt of all; he condemns alſo thoſe that come from melted ſnow. But though Hippocrates makes all thoſe diſtinctions, he adviſes thoſe who are in health to drink of the firſt water that comes in their way. He ſpeaks alſo of alum waters, and thoſe that are hot; but does not enlarge upon their qualities. He adviſes to mix wine with an equal quantity of water: and this (he ſays) is the juſt proportion; by uſing which the wine will expel what is hurtful to the body, and the water will ſerve to temper the acrimony of the humours.

Exerciſe.

For thoſe that are in health, and likewiſe for ſuch as are ſick, Hippocrates adviſes exerciſe. The books, however, which treat on this ſubject, M. Le Clerc conjectures to have been written by Herodicus, who firſt introduced gymnaſtic exerciſe into medicine, and who is ſaid by Hippocrates himſelf to have killed ſeveral people by forcing them to walk while they were afflicted with fevers and other imflammatory diſorders. The advices given in them conſiſt chiefly in directions for the times in which we ought to walk, and the condition we ought to be in before it; when we ought to walk ſlowly, and when to run, &c.; and all this with deſign to bring the body down, or diſſipate the humours. Wreſtling, although a violent exerciſe, is numbered with the reſt. In the ſame place alſo mention is made of a play of the hands and fingers, which was thought good for health, and called *chironomie;* and of another diverſion which was performed round a ſort of ball hung up, which they called *corycus*, and which they ſtruck forward with both their hands.

Excretions.

With regard to thoſe things which ought to be ſeparated from, or retained in the human body, Hippocrates obſerves, that people ought to take great care not to load themſelves with excrements, or keep them in too long; and beſides the exerciſe above-mentioned, which carries off one part of them, and which he preſcribes chiefly on this account, he adviſes people to excite and rouſe up nature when ſhe flagged, and did not endeavour to expel the reſt, or take care of the impediments by which ſhe was reſiſted. For this reaſon he preſcribed meats proper for looſening the belly; and when theſe were not ſufficient, he directed the uſe of clyſters and ſuppoſitories. For thin and emaciated perſons he directed clyſters compoſed only of milk and oily unctuous ſubſtances, which they mixed with a decoction

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coction of chick-peaſe; but for ſuch as were plethoric, they only made uſe of ſalt or ſea-water.

As a preſervative againſt diſtempers, Hippocrates alſo adviſed the uſe of vomits, which he directed to be taken once or twice a month during the time of winter and ſpring. The moſt ſimple of theſe were made of a decoction of hyſſop, with an addition of a little vinegar and ſalt. He made thoſe that were of a ſtrong and vigorous conſtitution take this liquor in a morning faſting; but ſuch as were thin and weakly took it after ſupper.—Venery, in his opinion, is wholeſome, provided people conſult their ſtrength, and do not purſue it to exceſs; which he finds fault with on all occaſions, and would have exceſs avoided alſo in relation to ſleep and watching. In his writings are likewiſe to be found ſeveral remarks concerning good and bad air; and he makes it appear that the good or bad diſpoſition of this element does not depend ſolely on the difference of the climate, but on the ſituation of every place in particular. He ſpeaks alſo of the good and bad effects of the paſſions, and recommends moderation in regard to them.

From what we have already related concerning the opinions of Hippocrates, it may naturally be concluded, that for the moſt part he would be contented with obſerving what the ſtrength of nature is able to accompliſh without being aſſiſted by the phyſician. That this was really the caſe, may be eaſily perceived from a peruſal of his books entitled, "Of epidemical diſtempers;" which are, as it were, journals of the practice of Hippocrates: for there we find him often doing nothing more than deſcribing the ſymptoms of a diſtemper, and informing us what has happened to the patient day after day, even to his death or recovery, without ſpeaking a word of any kind of remedy. Sometimes, however, he did indeed make uſe of remedies; but theſe were exceedingly ſimple and few, in compariſon of what have been given by ſucceeding practitioners. Theſe remedies we ſhall preſently conſider, after we have given an abridgement of the principal maxims on which his practice was founded.

13 His maxims for the cure of diſeaſes.

Hippocrates aſſerted in the firſt place, That contraries, or oppoſites, are the remedies for each other; and this maxim he explains by an aphoriſm; in which he ſays, that evacuations cure thoſe diſtempers which come from repletion, and repletion thoſe that are cauſed by evacuation. So heat is deſtroyed by cold, and cold by heat, &c. In the ſecond place, he aſſerted that phyſic is an addition of what is wanting, and a ſubtraction or retrenchment of what is ſuperfluous: an axiom which is thus explained, that there are ſome juices or humours, which in particular caſes ought to be evacuated, or driven out of the body, or dried up; and ſome others which ought to be reſtored to the body, or cauſed to be produced there again. As to the method to be taken for this addition or retrenchment, he gives this general caution, That you ought to be careful how you fill up, or evacuate, all at once, or too quickly, or too much; and that it is equally dangerous to heat or cool again on a ſudden; or rather, you ought not to do it: every thing that runs to an exceſs being an enemy to nature. In the fourth place, Hippocrates allowed that we ought ſometimes to dilate, and ſometimes to lock up: to dilate, or open the paſſages by which the humours are voided naturally, when they are not ſufficiently opened, or when they are cloſed; and, on the contrary, to lock up or ſtraiten the paſſages that are relaxed, when the juices that paſs there ought not to paſs, or when they paſs in too great quantity. He adds, that we ought ſometimes to ſmooth, and ſometimes to make rough; ſometimes to harden, and ſometimes to ſoften again, ſometimes to make more fine or ſupple; ſometimes to thicken; ſometimes to rouſe up, and at other times to ſtupify or take away the ſenſe; all in relation to the ſolid parts of the body, or to the humours. He gives alſo this farther leſſon, That we ought to have regard to the courſe the humours take, from whence they come, and whither they go; and in conſequence of that, when they go where they ought not, that we make them take a turn about, or carry them another way, almoſt like the turning the courſe of a river: or, upon other occaſions, that we endeavour if poſſible to recal, or make the ſame humours return back again; drawing upward ſuch as have a tendency downward, and drawing downward ſuch as tend upward. We ought alſo to carry off, by convenient ways, that which is neceſſary to be carried off; and not let the humours once evacuated enter into the veſſels again. Hippocrates gives alſo the following inſtruction, That when we do any thing according to reaſon, though the ſucceſs be not anſwerable, we ought not eaſily, or too haſtily, to alter the manner of acting, as long as the reaſons for it are yet good. But as this maxim might ſometimes prove deceitful, he gives the following as a corrector to it: "We ought (ſays he) to mind with a great deal of attention what gives eaſe, and what creates pain; what is eaſily ſupported, and what cannot be endured." We ought not to do any thing raſhly; but ought often to pauſe, or wait, without doing any thing: by this way, if you do the patient no good, you will at leaſt do him no hurt.

Theſe are the principal and moſt general maxims of the practice of Hippocrates, and which proceed upon the ſuppoſition laid down at the beginning, viz. that nature cures diſeaſes. We next proceed to conſider particularly the remedies employed by him, which will ſerve to give us further inſtructions concerning his practice.

14 His maxims reſpecting diet.

Diet was the firſt, the principal, and often the only remedy made uſe of by this great phyſician to anſwer moſt of the intentions above mentioned: by means of it he oppoſed the moiſt to dry, hot to cold, &c.; and what he looked upon to be the moſt conſiderable point was, that thus he ſupported nature, and aſſiſted her to overcome the malady. The dietetic part of medicine was ſo much the invention of Hippocrates himſelf, that he was very deſirous to be accounted the author of it; and the better to make it appear that it was a new remedy in his days, he ſays expreſsly, that the ancients had wrote almoſt nothing concerning the diet of the ſick, having omitted this point, though it was one of the moſt eſſential parts of the art.

15 Diet in acute diſeaſes.

The diet preſcribed by Hippocrates for patients labouring under acute diſtempers, differed from that which he ordered for thoſe afflicted with chronical ones. In the former, which require a more particular exactneſs in relation to diet, he preferred liquid food to that which was ſolid, eſpecially in fevers. For theſe he uſed a ſort of broth made of cleanſed barley; and to this he gave the name of *ptiſan*. The manner in which the ancients prepared a ptiſan was as follows:

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They firſt ſteeped the barley in water till it was plumped up; and afterwards they dried it in the ſun, and beat it to take off the huſk. They next ground it; and having let the flour boil a long time in the water, they put it out into the ſun, and when it was dry they preſſed it cloſe. It is properly this flour ſo prepared that is called *ptiſan*. They did almoſt the ſame thing with wheat, rice, lentils, and other grain: but they gave theſe ptiſans the name of the grain from whence they were extracted, as *ptiſan of lentils*, *rice*, &c. while the ptiſan of barley was called ſimply *ptiſan*, on account of the excellency of it. When they wanted to uſe it, they boiled one part of it in 10 or 15 of water; and when it began to grow plump in boiling, they added a little vinegar, and a very ſmall quantity of aniſe or leek, to keep it from clogging or filling the ſtomach with wind. Hippocrates preſcribed this broth for women that have pains in their belly after delivery. "Boil ſome of this ptiſan (ſays he), with ſome leek, and the fat of a goat, and give it to the woman in bed." This will not be thought very ſingular, if we reflect on what has been hinted above concerning the indelicate manner of living in thoſe times. He preferred the ptiſan to all other food in fevers, becauſe it ſoftened and moiſtened much, and was beſides of eaſy digeſtion. If he was concerned in a continual fever, he would have the patient begin with a ptiſan of a pretty thick conſiſtence, and go on by little and little, leſſening the quantity of barley-flour as the height of the diſtemper approached; ſo that he did not feed the patient but with what he called the *juice of the ptiſan*; that is, the ptiſan ſtrained, where there was but very little of the flour remaining, in order that nature being diſcharged in part from the care of digeſting the aliments, ſhe might the more eaſily hold out to the end, and overcome the diſtemper, or the cauſe of it. With regard to the quantity, he cauſed the ptiſan to be taken twice a-day by ſuch patients as in health uſed to take two meals a-day, not thinking it convenient that thoſe who were ſick ſhould eat oftener than when they were well. He alſo would not allow eating twice a day to thoſe who ate but once in that time when in health. In the paroxyſm of a fever he gave nothing at all; and in all diſtempers where there are exacerbations, he forbade nouriſhment while the exacerbations continued. He let children eat more; but thoſe who were grown up to man's eſtate, or were of an advanced age, leſs; making allowance, however, for the cuſtom of each particular perſon, or for that of the country.

But though he was of opinion that too much food ought not to be allowed to the ſick, he did not agree with ſome phyſicians who preſcribed long abſtinence, eſpecially in the beginning of fevers. The reaſon he gave for this was, that the contrary practice weakened the patients too much during the firſt days of the diſtemper, by which means their phyſicians were obliged to allow them more food when the illneſs was at its height, which in his opinion was improper. Beſides, in acute diſtempers, and particularly in fevers, Hippocrates made choice of refreſhing and moiſtening nouriſhment; and amongſt other things preſcribed orange, melon, ſpinach, gourd, &c. This ſort of food he gave to thoſe that were in a condition to eat, or could take ſomething more than a ptiſan.

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Drink.

The drink he commonly gave to his patients was made of eight parts of water and one of honey. In ſome diſtempers he added a little vinegar; but beſides theſe, they had another ſort named κυκεων, or *mixture*. One preſcription of this ſort we find intended for a conſumptive perſon; it conſiſted of rue, aniſe, celery, coriander, juice of pomegranate, the roughest red wine, water, flour of wheat and barley, with old cheeſe made of goats milk. Hippocrates did not approve of giving plain water to the ſick; but though he generally preſcribed the drinks above mentioned, he did not abſolutely forbid the uſe of wine, even in acute diſtempers and fevers, provided the patients were not delirious nor had pains in their head. Beſides, he took care to diſtinguiſh the wines proper in theſe caſes: preferring to all other ſorts white-wine that was clear and had a great deal of water, with neither ſweetneſs nor flavour.

16 Diet in chronic diſeaſes.

Theſe are the moſt remarkable particulars concerning the diet preſcribed by Hippocrates in acute diſtempers; in chronical ones he made very much uſe of milk and whey; though we are not certain whether this was done on account of the nouriſhment expected from them, or that he accounted them medicines.

17 His maxims reſpecting bathing.

There were many diſeaſes for which he judged the bath was a proper remedy; and he takes notice of all the circumſtances that are neceſſary in order to cauſe the patient receive benefit from it, among which the following are the principal. The patient that bathes himſelf muſt remain ſtill and quiet in his place without ſpeaking while the aſſiſtants throw water over his head or are wiping him dry; for which laſt purpoſe he deſired them to keep ſponges, inſtead of that inſtrument called by the ancients *ſtrigil*, which ſerved to rub off from the ſkin the dirt and naſtineſs left upon it by the unguents and oils with which they anointed themſelves. He muſt alſo take care not to catch cold; and muſt not bathe immediately after eating and drinking, nor eat or drink immediately after coming out of the bath. Regard muſt alſo be had whether the patient has been accuſtomed to bathe while in health, and whether he has been benefited or hurt by it. Laſtly, he muſt abſtain from the bath when the body is too open, or too coſtive, or when he is too weak; or if he has an inclination to vomit, a great loſs of appetite, or bleeds at the noſe. The advantage of the bath, according to Hippocrates, conſiſts in moiſtening and refreſhing, taking away wearineſs, making the ſkin ſoft and the joints pliant; in provoking urine, and opening the other excretories. He allows two baths in a day to thoſe who have been accuſtomed to it in health.

18 His maxims reſpecting exerciſe.

In chronical diſtempers Hippocrates approved very much of exerciſe, though he did not allow it in acute ones: but even in theſe he did not think that a patient ought always to lie in bed; but tells us, that "we muſt ſometimes puſh the timorous out of bed, and rouſe up the lazy."

19 His maxims reſpecting purgation.

When he found that diet and exerciſe were not ſufficient to eaſe nature of a burden of corrupted humours, he was obliged to make uſe of other means, of which *purgation* was one. By this word he underſtood all the contrivances that are made uſe of to diſcharge the ſtomach and bowels; though it commonly ſignifies only

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only the evacuation by ſtool. This evacuation he imagined to be occaſioned by the purgative medicines attracting the humours to themſelves. When firſt taken into the body, he thought they attracted that humour which was moſt ſimilar to them, and then the others, one after another.—Moſt of the purgatives uſed in his time were emetics alſo, or at leaſt were very violent in their operation downwards. Theſe were the white and black hellebore; the firſt of which is now reckoned among the poiſons. He uſed alſo the Cnidian berries, cneorum peplium, thapſia; the juice of hippophaë, a ſort of rhamnus; elaterium, or juice of the wild cucumber; flowers of braſs, coloquintida, ſcammony, the magneſian ſtone, &c.

As theſe purgatives were all very ſtrong, Hippocrates was extremely cautious in their exhibition. He did not preſcribe them in the dog-days; nor did he ever purge women with child, and very ſeldom children or old people. He principally uſed purgatives in chronical diſtempers; but was much more wary in acute ones. In his books entitled "Of Epidemical Diſtempers," there are very few patients mentioned to whom he gave purgative medicines. He alſo takes notice expreſsly, that theſe medicines having been given in caſes of the diſtempers of which he was treating, had produced very bad effects. We are not, however, from this to conclude, that Hippocrates abſolutely condemned purging in acute diſtempers; for in ſome places he expreſsly mentions his having given them with ſucceſs. He was of opinion, for inſtance, that purging was good in a pleuriſy when the pain was ſeated below the diaphragm; and in this caſe he gave black hellebore, or ſome peplium mixed with the juice of *laſerpitium*.

The principal rule Hippocrates gives with relation to purging is, that we ought only to purge off the humours that are concocted, and not thoſe that are yet crude, taking particular care not to do it at the beginning of the diſtemper, leſt the humours ſhould be diſturbed or ſtirred up, which happens pretty often. He was not, however, the firſt who remarked that it would be of ill conſequence to ſtir the humours in the beginning of an acute diſtemper. The Egyptian phyſicians had before obſerved the ſame thing. By the *beginning* of a diſtemper, Hippocrates underſtood all the time from the firſt day to the fourth complete.

Hippocrates imagined that each purgative medicine was adapted to the carrying off ſome particular humour; and hence the diſtinction of purgatives into hydragogue, cholagogue, &c. which is now juſtly exploded. In conſequence of this notion, he contended that we knew if a purgative had drawn from the body what was fit to be evacuated according as the patient was found well or ill upon it. If we found ourſelves well, it was a ſign that the medicine had effectually expelled the offending humour. On the contrary, if we were ill, he imagined, whatever quantity of humour came away, that the humour which cauſed the illneſs ſtill remained; not judging of the goodneſs or badneſs of a purge by the quantity of matters that were voided by it, but by their quality and the effect that followed after it.

Vomits were alſo pretty much uſed as medicines by Hippocrates. We have already ſeen what thoſe were which he preſcribed to people in health by way of preventives. With regard to the ſick, he ſometimes adviſed them to the ſame, when his intentions were only to cleanſe the ſtomach. But when he had a mind to recal the humours, as he termed it, from the inmoſt receſſes of the body, he made uſe of briſker remedies. Among theſe was white hellebore; and this indeed he moſt frequently uſed to excite vomiting. He gave this root particularly to melancholy and mad people; and from the great uſe made of it in theſe caſes by Hippocrates and other ancient phyſicians, the phraſe *to have need of hellebore*, became a proverbial expreſſion for being out of one's ſenſes. He gave it alſo in defluxions, which come, according to him, from the brain, and throw themſelves on the noſtrils or ears, or fill the mouth with ſaliva, or that cauſe ſtubborn pains in the head, and a wearineſs or an extraordinary heavineſs, or a weakneſs of the knees, or a ſwelling all over the body. He gave it to conſumptive perſons in broth of lentils, to ſuch as were afflicted with the dropſy called *leucophlegmatia*, and in other chronical diſorders. But we do not find that he made uſe of it in acute diſtempers, except in the cholera morbus, where he ſays he preſcribed it with benefit. Some took this medicine faſting; but moſt took it after ſupper, as was commonly practiſed with regard to vomits taken by way of prevention. The reaſon why he gave this medicine moſt commonly after eating was, that by mixing with the aliments, its acrimony might be ſomewhat abated, and it might operate with leſs violence on the membranes of the ſtomach. With the ſame intention alſo he ſometimes gave a plant called *ſeſamoides*, and ſometimes mixed it with hellebore. Laſtly, in certain caſes he gave what he called *ſoft* or *ſweet* hellebore. This term had ſome relation to the quality of the hellebore, or perhaps the quantity he gave.

When Hippocrates intended only to keep the body open, or evacuate the contents of the inteſtines, he made uſe of ſimples; as for example, the herb mercury, or cabbage; the juice or decoction of which he ordered to be drank. For the ſame purpoſe he uſed whey, and alſo cows and aſſes milk; adding a little ſalt to it, and ſometimes letting it boil a little. If he gave aſſes milk alone, he cauſed a great quantity of it to be taken, ſo that it muſt of neceſſity looſen the body. In one place he preſcribes no leſs than nine pounds of it to be taken as a laxative, but does not ſpecify the time in which it was to be taken. With the ſame intention he made uſe of ſuppoſitories and clyſters. The former were compounded of honey, the juice of the herb mercury, of nitre, powder of colocynth, and other ſharp ingredients, to irritate the anus. Theſe they formed into a ball, or into a long cylindrical maſs like a finger. The clyſters he made uſe of for ſick people were ſometimes the ſame with thoſe already mentioned as preventives for people in health. At other times he mixed the decoction of herbs with nitre, honey, and oil, or other ingredients, according as he imagined he could by that means attract, waſh, irritate, or ſoften. The quantity of liquor he ordered was about 36 ounces; from which it is probable he did not intend that it ſhould all be uſed at one time.

On ſome occaſions Hippocrates propoſed to purge the head alone. This practice he employed, after purging the reſt of the body, in an apoplexy, inveterate

 pains

pains of the head, a certain ſort of jaundice, a conſumption, and the greateſt part of chronical diſtempers. For that purpoſe he made uſe of the juices of ſeveral plants, as celery; to which he ſometimes added aromatic drugs, making the patients ſnuff up this mixture into their noſtrils. He uſed alſo powders compounded of myrrh, the flowers of braſs, and white hellebore, which he cauſed them put up into the noſe, to make them ſneeze, and to draw the phlegm from the brain. For the ſame purpoſe alſo he uſed what he calls *tetragonon*, that is, "ſomething having four angles;" but what this was, is now altogether unknown, and was ſo even in the days of Galen. The latter phyſician, however, conjectures it to be antimony, or certain flakes found in it.

In the diſtemper called *empyema* (or a collection of matter in the breaſt), he made uſe of a very rough medicine. He commanded the patient to draw in his tongue as much as he was able; and when that was done, he endeavoured to put into the hollow of the lungs a liquor that irritated the part, which raiſing a violent cough, forced the lungs to diſcharge the purulent matter contained in them. The materials that he uſed for this purpoſe were of different ſorts; ſometimes he took the root of arum, which he ordered to be boiled with a little ſalt, in a ſufficient quantity of water and oil; diſſolving a little honey in it. At other times, when he intended to purge more ſtrongly, he took the flowers of copper and hellebore; after that he ſhook the patient violently by the ſhoulders, the better to looſen the pus. This remedy, according to Galen, he received from the Cnidian phyſicians; and it has never been uſed by the ſucceeding ones, probably becauſe the patients could not ſuffer it.

20 His maxims reſpecting blood-letting.

Blood-letting was another method of evacuation pretty much uſed by Hippocrates. Another aim he had in this, beſides the mere evacuation, was to divert or recal the courſe of the blood when he imagined it was going where it ought not. A third end of bleeding was to procure a free motion of the blood and ſpirits.

Hippocrates had alſo a fourth intention for bleeding, and this was refreſhment. So in the iliac paſſion, he orders bleeding in the arm and in the head; to the end, ſays he, that the ſuperior venter, or the breaſt, may ceaſe to be overheated. With regard to this evacuation, his conduct was much the ſame as to purging, in reſpect of time and perſons. We ought, ſays he, to let blood in acute diſeaſes, when they are violent, if the party be luſty and in the flower of his age. We ought alſo to have regard to the time, both in reſpect to the diſeaſe and to the ſeaſon in which we let blood. He alſo informs us, that blood ought to be let in great pains, and particularly in inflammations. Among theſe he reckons ſuch as fall upon the principal viſcera, as the liver, lungs, and ſpleen, as alſo the quinſy and pleuriſy, if the pain of the latter be above the diaphragm. In theſe caſes he would have the patients blooded till they faint, eſpecially if the pain be very acute; or rather he adviſes that the orifice ſhould not be cloſed till the colour of the blood alters, ſo that from livid it turn red, or from red livid. In a quinſy he blooded in both arms at once. Difficulty of breathing he alſo reckons among the diſtempers that require bleeding; and he mentions another ſort of inflammation of the lungs, which he calls a ſwelling or tumor of the lungs ariſing from heat; in which caſe he adviſes to bleed in all parts of the body; and directs it particularly by the arms, tongue, and noſtrils. To make bleeding the more uſeful in all pains, he directed to open the vein neareſt the part affected; in a pleuriſy he directs to take blood from the arm of the ſide affected; and for the ſame reaſon, in pains of the head, he directs the veins of the noſe and forehead to be opened. When the pain was not urgent, and bleeding was adviſed by way of prevention, he directed the blood to be taken from the parts fartheſt off, with a deſign to divert the blood inſenſibly from the ſeat of pain. The higheſt burning fevers, which ſhow neither ſigns of inflammation nor pain, he does not rank among thoſe diſtempers which require bleeding. On the contrary, he maintains that a fever itſelf is in ſome caſes a reaſon againſt bleeding. If any one, ſays he, has an ulcer in the head, he muſt bleed, *unleſs he has a fever*. He ſays farther, thoſe that loſe their ſpeech of a ſudden muſt be blooded, unleſs they have a fever. Perhaps he was afraid of bleeding in fevers, becauſe he ſuppoſed that they were produced by the bile and pituita, which grew hot, and afterwards heated the whole body, which is, ſays he, what we call *fever*, and which, in his opinion, cannot well be evacuated by bleeding. In other places alſo he looks upon the preſence or abundance of bile to be an objection to bleeding; and he orders to forbear veneſection even in a pleuriſy, if there be bile. To this we muſt add, that Hippocrates diſtinguiſhed very particularly between a fever which followed no other diſtemper, but was itſelf the original malady, and a fever which came upon inflammation. In the early ages of phyſic, the firſt only were properly called *fevers*: the others took their names from the parts affected; as *pleuriſy*, *peripneumony*, *hepatitis*, *nephritis*, &c. which names ſignify that the pleura, the lungs, the liver, or the kidneys, are diſeaſed, but do not intimate the fever which accompanies the diſeaſe. In this latter ſort of fever Hippocrates conſtantly ordered bleeding, but not in the former. Hence, in his books on Epidemic Diſtempers, we find but few directions for bleeding in the acute diſtempers, and particularly in the great number of continual and burning fevers there treated of. In the firſt and third book we find but one ſingle inſtance of bleeding, and that in a pleuriſy; in which, too, he ſtaid till the eighth day of the diſtemper. Galen, however, and moſt other commentators on Hippocrates, are of opinion that he generally blooded his patients plentifully in the beginning of acute diſorders, though he takes no notice of it in his writings. But had this been the caſe, he would not perhaps have had the opportunity of ſeeing ſo many fevers terminate by criſes, or natural evacuations, which happen of themſelves on certain days. Hippocrates, in fact, laid ſo much weight upon the aſſiſtance of nature and the method of diet, which was his favourite medicine, that he thought if they took care to diet the patients according to rule, they might leave the reſt to nature. Theſe are his principles, from which he never deviates; ſo that his writings on Epidemical Diſeaſes ſeem to have been compoſed only with an intention to leave to poſterity an exact model of management in purſuance of theſe principles.

With

Hippocrates.

With regard to the rules laid down by Hippocrates for bleeding, we muſt farther take notice, that in all diſeaſes which had their ſeat above the liver, he blooded in the arm, or in ſome of the upper parts of the body; but for thoſe that were ſituated below it he opened the veins of the foot, ankle, or ham. If the belly was too looſe, and bleeding was at the ſame time thought neceſſary, he ordered the looſeneſs to be ſtopped before bleeding.

Almoſt all theſe inſtances, however, regard ſcarce any thing but acute diſtempers; but we find ſeveral concerning chronical diſeaſes. "A young man complained of great pain in his belly, with a rumbling while he was faſting, which ceaſed after eating: this pain and rumbling continuing, his meat did him no good; but, on the contrary, he daily waſted and grew lean. Several medicines, as well purges as vomits, were given him in vain. At length it was reſolved to bleed him by intervals, firſt in one arm and then in the other, till he had ſcarcely any blood left, and by this method he was perfectly cured."

Hippocrates let blood alſo in a dropſy, even in a tympany; and in both caſes he preſcribes bleeding in the arm. In a diſeaſe occaſioned by an overgrown ſpleen, he propoſes bleeding ſeveral times repeated at a vein of the arm which he calls the *ſplenetic;* and in one ſpecies of jaundice, he propoſes bleeding under the tongue. On ſome occaſions he took away great quantities of blood, as appears from what we have already obſerved. Sometimes he continued the blooding till the patient fainted: at other times he would blood in both arms at once; at others, he did it in ſeveral places of the body, and at ſeveral times. The veins he opened were thoſe of the arm, the hands, the ankles on both ſides, the hams, the forehead, behind the head, the tongue, the noſe, behind the ears, under the breaſts, and thoſe of the arms; beſides which, he burnt others, and opened ſeveral arteries. He likewiſe uſed cupping-veſſels, with intent to recal or withdraw the humours which fell upon any part. Sometimes he contented himſelf with the bare attraction made by the cupping-veſſels, but ſometimes alſo he made ſcarifications.

21 His maxims reſpecting diuretics and ſudorifics.

When bleeding and purging, which were the principal and moſt general means uſed by Hippocrates for taking off a plethora, proved inſufficient for that purpoſe, he had recourſe to diuretics and ſudorifics. The former were of different ſorts, according to the conſtitution of the perſons: ſometimes baths, and ſometimes ſweet wine, were employed to provoke urine; ſometimes the nouriſhment which we take contributes to it: and amongſt thoſe herbs which are commonly eaten, Hippocrates recommends garlic, leeks, onions, cucumbers, melons, gourds, fennel, and all other things which have a biting taſte and a ſtrong ſmell. With theſe he numbers honey, mixed with water or vinegar, and all ſalt meats. But, on ſome occaſions, he took four cantharides, and, pulling off their wings and feet, gave them in wine and honey. Theſe remedies were given in a great number of chronical diſtempers after purging, when he thought the blood was overcharged with a ſort of moiſture which he calls *ichor;* or in ſuppreſſions of urine, and when it was made in leſs quantity than it ought. There were alſo ſome caſes in which he would force ſweat as well as urine; but he neither mentions the diſeaſes in which ſudorifics are proper, nor lets us know what medicines are to be uſed for this purpoſe, except in one ſingle paſſage, where he mentions ſweating, by pouring upon the head a great quantity of water till the feet ſweat; that is, till the ſweat diffuſes itſelf over the whole body, running from head to foot. After this he would have them eat boiled meat, and drink pure wine, and being well covered with clothes, lay themſelves down to reſt. The diſeaſe for which he propoſes the above mentioned remedy is a fever; which is not, according to him, produced by bile or pituita, but by mere laſſitude, or ſome other ſimilar cauſe; from whence we may conclude that he did not approve of ſweating in any other kind of fever.

Other remedies which Hippocrates tells us he made uſe of were thoſe that purged neither bile nor phlegm, but act by cooling, drying, heating, moiſtening, or by cloſing and thickening, reſolving and diſſipating. Theſe medicines, however, he does not particularly mention; and it is probable they were only ſome particular kinds of food. To theſe he joined *hypnotics*, or ſuch things as procure ſleep; but theſe laſt were uſed very ſeldom, and, it is moſt probable, were only different preparations of poppies.

22 The uſe he made of ſpecifics.

Laſtly, beſides the medicines already mentioned, which acted in a ſenſible manner, Hippocrates made uſe of others called *ſpecifics;* whoſe action he did not underſtand, and for the uſe of which he could give no reaſon but his own experience, or that of other phyſicians. Theſe he had learned from his predeceſſors the deſcendants of Æſculapius, who, being *empirics*, did not trouble themſelves about inquiring into the operation of remedies, provided their patients were cured.

23 His external applications.

Of the external remedies preſcribed by Hippocrates, fomentations were the chief. Theſe were of two kinds. The one was a ſort of bath, in which the patient ſat in a veſſel full of a decoction of ſimples appropriated to his malady; ſo that the part affected was ſoaked in the decoction. This was chiefly uſed in diſtempers of the womb, of the arms, the bladder, the reins, and generally all the parts below the diaphragm. The ſecond way of fomenting was, to take warm water and put it into a ſkin or bladder, or even into a copper or earthen veſſel, and to apply it to the part affected; as, for example, in a pleuriſy. They uſed likewiſe a large ſponge, which they dipped in the water or other hot liquor, and ſqueezed out part of the liquor before they applied it. The ſame uſe they made of barley, vetches, or bran, which were boiled in ſome proper liquor, and applied in a linen bag. Theſe are called *moiſt* fomentations. The dry ones were made of ſalt or millet, heated conſiderably, and applied to the part. Another kind of fomentation was the vapour of ſome hot liquor; an inſtance of which we find in his firſt book of the Diſtempers of Women. He caſt, at ſeveral times, bits of red-hot iron into urine, and, covering up the patient cloſe, cauſed her to receive the ſteam below. His deſign in theſe kinds of fomentations was to warm the part, to reſolve or diſſipate, and draw out the peccant matter, to mollify and aſſuage pain, to open the paſſages, or even to ſhut them, according as the fomentations were emollient or aſtringent.

24 Fomentations.

Fumigations

Hippocrates.

25 Fumigations. Fumigations were likewiſe very often uſed by Hippocrates. In the quinſy, he burned hyſſop with ſulphur and pitch, and cauſed the ſmoke to be drawn into the throat by a funnel; and by this means he brought away abundance of phlegm through the mouth and through the noſe. For this purpoſe he took nitre, marjoram, and creſs-ſeeds, which he boiled in water, vinegar, and oil, and, while it was on the fire, cauſed the patient to draw in the ſteam by a pipe. In his works we find a great number of fumigants for the diſtempers of women, to promote the menſtrual flux, to check it, to help conception, and to eaſe pains in the matrix, or the ſuffocation of it. On theſe occaſions he uſed ſuch aromatics as were then known, viz. cinnamon, caſſia, myrrh, and ſeveral odoriferous plants; likewiſe ſome minerals, ſuch as nitre, ſulphur, and pitch, and cauſed the patient to receive the vapours through a funnel into the uterus.

26 Gargles. Gargles, a kind of fomentations for the mouth, were alſo known to Hippocrates. In the quinſy he uſed a gargle made of marjoram, ſavory, celery, mint, and nitre, boiled with water and a little vinegar. When this was ſtrained, they added honey to it, and waſhed their mouths frequently with it.

27 Oils and ointments. Oils and ointments were likewiſe much uſed by Hippocrates, with a view to mollify and abate pain, to ripen boils, reſolve tumours, refreſh after wearineſs, make the body ſupple, &c. For this purpoſe, ſometimes pure oil of olives was uſed; ſometimes certain ſimples were infuſed in it, as the leaves of myrtle and roſes; and the latter kind of oil was in much requeſt among the ancients. There were other ſorts of oils ſometimes in uſe, however, which were much more compounded. Hippocrates ſpeaks of one named Suſinum, which was made of the flowers of the iris, of ſome aromatics, and of an ointment of narciſſus made with the flowers of narciſſus and aromatics infuſed in oil. But the moſt compounded of all his ointments was that called *netopon*, which he made particularly for women; and conſiſted of a great number of ingredients. Another ointment, to which he gave the name of *ceratum*, was compoſed of oil and wax. An ointment which he recommends for the ſoftening a tumor, and the cleanſing a wound, was made by the following receipt: "Take the quantity of a nut of the marrow or fat of a ſheep, of maſtic or turpentine the quantity of a bean, and as much wax; melt theſe over a fire, with oil of roſes, for a ceratum." Sometimes he added pitch and wax, and, with a ſufficient quantity of oil, made a compoſition ſomewhat more conſiſtent than the former, which he called *cerapiſſus*.

28 Cataplaſms. *Cataplaſms* were a ſort of remedies leſs conſiſtent than the two former. They were made of powders or herbs ſteeped or boiled in water or ſome other liquor, to which ſometimes oil was added. They were uſed with a view to ſoften or reſolve tumors, ripen abſceſſes, &c. though they had alſo cooling cataplaſms made of the leaves of beets or oak, fig or olive-trees, boiled in water.

29 Collyria. Laſtly, To complete the catalogue of the external remedies uſed by Hippocrates, we ſhall mention a ſort of medicine called *collyrium*. It was compounded of powders, to which was added a ſmall quantity of ſome ointment, or juice of a plant, to make a ſolid or dry maſs; the form of which was long and round, which was kept for uſe. Another compoſition of much the ſame nature was a ſort of lozenge of the bigneſs of a ſmall piece of money, which was burnt upon coals for a perfume, and powdered for particular uſes. In his works we find likewiſe deſcriptions of powders for ſeveral uſes, to take off fungous fleſh, and to blow into the eyes in ophthalmies, &c.

Theſe were almoſt all the medicines uſed by Hippocrates for external purpoſes. The compound medicines given inwardly were either liquid, ſolid, or lambative. The liquid ones were prepared either by decoction or infuſion in a proper liquor, which, when ſtrained, were kept for uſe; or by macerating certain powders in ſuch liquors, and ſo taking them together, or by mixing different kinds of liquors together. The ſolid medicines conſiſted of juices inſpiſſated; of gums, reſins, or powders, made up with them or with honey, or ſomething proper to give the neceſſary conſiſtence to the medicine. Theſe were made up in a form and quantity fit to be ſwallowed with eaſe. The lambative was of a conſiſtence between ſolid and fluid; and the patients were obliged to keep it for ſome time to diſſolve in the mouth, that they might ſwallow it leiſurely. This remedy was uſed to take off the acrimony of thoſe humours which ſometimes fall upon this part, and provoke coughing and other inconveniences. The baſis of this laſt compoſition was honey. It is worth our obſervation, that the compound medicines of Hippocrates were but very few, and compoſed only of four or five ingredients at moſt; and that he not only underſtood pharmacy, or the art of compounding medicines, but prepared ſuch as he uſed himſelf, or cauſed his ſervants prepare them in his houſe by his directions.

We have thus given ſome account of the ſtate of medicine as practiſed and taught by Hippocrates, who, as we have already obſerved, has for many ages been juſtly conſidered as the father of phyſic. For when we attend to the ſtate in which he found medicine, and the condition in which he left it, we can hardly beſtow ſufficient admiration on the judgement and accuracy of his obſervations. After a life ſpent in unwearied induſtry, he is ſaid to have died at Lariſſa, a city in Theſſaly, in the 101ſt year of his age, 361 years before the birth of Chriſt.

After the days of Hippocrates, medicine in ancient Greece gradually derived improvement from the labour of other phyſicians of eminence. And we may particularly mention three to whom its future progreſs ſeems to have been not a little indebted, viz. Praxagoras, Eraſiſtratus, and Herophilus.

The firſt phyſician of eminence who differed conſiderably in his practice from Hippocrates was Praxagoras. 30 Praxagoras. Cœlius Aurelianus acquaints us, that he made great uſe of vomits in his practice, inſomuch as to exhibit them in the iliac paſſion till the excrements were diſcharged by the mouth. In this diſtemper he alſo adviſed, when all other means failed, to open the belly, cut the inteſtine, take out the indurated fæces, and then to ſew up all again; but this practice has not probably been followed by any ſubſequent phyſician.

Eraſiſtratus was a phyſician of great eminence, 31 Eraſiſtratus. and flouriſhed in the time of Seleucus, one of the ſucceſſors of Alexander the Great. According to Galen, Eraſiſtratus. Galen, he entirely baniſhed veneſection from medicine; though ſome affirm that he did not totally diſcard it, but only uſed it leſs frequently than other phyſicians. His reaſons for diſapproving of veneſection are as follow: It is difficult to ſucceed in veneſection, becauſe we cannot always ſee the vein we intend to open, and becauſe we are not ſure but we may open an artery inſtead of a vein. We cannot aſcertain the true quantity to be taken. If we take too little, the intention is by no means anſwered: if we take too much, we run a riſk of deſtroying the patient. The evacuation of the venous blood alſo is ſucceeded by that of the ſpirits, which on that occaſion he ſuppoſes to paſs from the arteries into the veins. It muſt likewiſe, he contends, be obſerved, that as the inflammation is formed in the arteries by the blood coagulated in their orifices, veneſection muſt of courſe be uſeleſs and of no effect.

As Eraſiſtratus did not approve of veneſection, ſo neither did he of purgatives, excepting very rarely, but exhibited clyſters and vomits; as did alſo his maſter Chryſippus. He was of opinion, however, that the clyſters ſhould be mild; and condemned the large quantity and acrid quality of thoſe uſed by preceding practitioners. The reaſon why purgatives were not much uſed by him was, that he imagined purging and veneſection could anſwer no other purpoſe than diminiſhing the fulneſs of the veſſels; and for this purpoſe he aſſerted that there were more effectual means than either phlebotomy or purging. He aſſerted that the humours diſcharged by cathartics were not the ſame in the body that they appeared after the diſcharge; but that the medicines changed their nature, and produced a kind of corruption in them. This opinion has ſince been embraced by a great number of phyſicians. He did not believe that purgatives acted by attraction; but ſubſtituted in the place of this principle what Mr Le Clerc imagines to be the ſame with Ariſtotle's *fuga vacui*. The principal remedy ſubſtituted by him in place of purging and veneſection was abſtinence. When this, in conjunction with clyſters and vomits, was not ſufficient to eradicate the diſeaſe, he then had recourſe to exerciſe. All this was done with a view to diminiſh plenitude, which, according to him, was the moſt frequent cauſe of all diſeaſes. Galen alſo informs us, that Eraſiſtratus had ſo great an opinion of the virtues of ſuccory in diſeaſes of the viſcera and lower belly, and eſpecially in thoſe of the liver, that he took particular pains to deſcribe the method of boiling it, which was, to boil it in water till it was tender; then to put it into boiling water a ſecond time, in order to deſtroy its bitterneſs; afterwards to take it out of the water, and preſerve it in a veſſel with oil; and laſtly, when it is to be uſed, add a little weak vinegar to it. Nay, ſo minute and circumſtantial was Eraſiſtratus with regard to the preparation of his favourite ſuccory, that he gave orders to tie ſeveral of the plants together, becauſe that was the more commodious method of boiling them. The reſt of Eraſiſtratus's practice conſiſted almoſt entirely of regimen; to which he added ſome topical remedies, ſuch as cataplaſms, fomentations, and unctions. In ſhort, as he could neither endure compounded medicines, nor ſuperſtitious and fine-ſpun reaſonings, he reduced medicine to a very ſimple and compendious art.

With regard to ſurgery, Eraſiſtratus appears to Herophilus. have been very bold; and as an anatomiſt he is ſaid to have been exceedingly cruel, inſomuch that he is repreſented by ſome as having diſſected criminals while yet alive *. In a ſcirrhous liver, or in tumors of that organ, Cœlius Aurelianus obſerves, that Eraſiſtratus made an inciſion through the ſkin and integuments, and having opened the abdomen he applied medicines immediately to the part affected. But though he was thus bold in performing operations on the liver, yet he did not approve of the paracenteſis or tapping in the dropſy; becauſe (ſaid he) the waters being evacuated, the liver, which is inflamed and become hard like a ſtone, is more preſſed by the adjacent parts which the waters kept at a diſtance from it, ſo that by this means the patient dies. He declared alſo againſt drawing teeth which were not looſe; and uſed to tell thoſe who talked with him on this operation, That in the temple of Apollo there was to be ſeen an inſtrument of lead for drawing teeth; in order to inſinuate that we muſt not attempt the extirpation of any but ſuch as are looſe, and call for no greater force for their extirpation than what may be ſuppoſed in an inſtrument of lead.

* See Anatomy, *Hiſt.*

32 Herophilus.

Herophilus, the diſciple of Praxagoras, and contemporary of Eraſiſtratus, followed a leſs ſimple practice: he made ſo great uſe of medicines both ſimple and compound, that neither he nor his diſciples would undertake the cure of any diſorder without them. He ſeems alſo to have been the firſt who treated accurately of the doctrine of pulſes, of which Hippocrates had but a ſuperficial knowledge. Galen, however, affirms, that on this ſubject he involved himſelf in difficulties and advanced abſurdities; which indeed we are not greatly to wonder at, conſidering the time in which he lived. He took notice of a diſeaſe at that time pretty rare, and to which he aſcribes certain ſudden deaths. He calls it a *palſy of the heart;* and perhaps it may be the ſame diſeaſe with what is now termed the *angina pectoris*.

According to Celſus, it was about this time that medicine was firſt divided into three branches, viz. the dietetic, the pharmaceutical, and the chirurgical medicine. The firſt of theſe employed a proper regimen in the cure of diſeaſes; the ſecond, medicines; and the third, the operation of the hands. The ſame author informs us, that theſe three branches became now the buſineſs of as many diſtinct claſſes of men; ſo that from this time we may date the origin of the three profeſſions of phyſicians, apothecaries, and ſurgeons.—Before this diviſion, thoſe called *phyſicians* diſcharged all the ſeveral offices belonging to the three profeſſions; and there were only two kinds of them, viz. one called *αρχιτεκτονικοι*, who only gave their advice to the patients, and directions to thoſe of an inferior claſs, who were called *δημιουργοι*, and worked with their hands either in the performing operations, or in the compoſition and application of remedies.

33 The Empirics.

The firſt grand revolution which happened in the medicinal art after the days of Herophilus and Eraſiſtratus was occaſioned by the founding of the empiric ſect by Serapion of Alexandria about 287 years before Chriſt. The diviſion into dogmatiſts and empirics had indeed ſubſiſted before; but about this time the latter party began to grow ſtrong, and to have champions

34 Serapion.

Serapion.

pions publicly aſſerting its cauſe. Galen informs us, that Serapion uſed Hippocrates very ill in his writings, in which he diſcovered an exceſs of pride, ſelf-ſufficiency, and contempt for all the phyſicians that went before him. We have ſome ſketches of his practice in Cœlius Aurelianus, from which we may infer that he retained the medicines of Hippocrates and the other phyſicians who went before him, though he rejected their reaſoning. We know not what arguments he advanced for the ſupport of his ſentiments, ſince his works are loſt, as well as thoſe of the other empirics; and we ſhould know nothing at all of any of them, if their adverſaries had not quoted them in order to confute them.

The empirics admitted only one general method of obtaining ſkill in the medical art, which was by experience, called by the Greeks εμπειρια. From this word they took their name, and refuſed to be called after the founder or any champion of their ſect. They defined experience a knowledge derived from the evidence of ſenſe. It was either fortuitous, or acquired by deſign. For acquiring practical ſkill they recommended what they called τηρησις, or one's own obſervation, and the reading of hiſtories or caſes faithfully related by others. Hence they thought that we might be enabled to know a diſeaſe by its reſemblance to others; and, when new diſeaſes occurred, to conclude what was proper to be done from the ſymptoms they had in common with others that were before known. They aſſerted, that obſervation ought principally to be employed in two different ways; firſt in diſcovering what things are ſalutary, and what are of an indifferent nature; and, ſecondly, what particular diſeaſe is produced by a certain concurrence of ſymptoms; for they did not call every ſymptom a diſeaſe, but only ſuch a combination of them as from long experience they found to accompany each other, and produced ſuch diſorders as began and terminated in the ſame manner.

On the other hand, the dogmatiſt affirmed, that there was a neceſſity for knowing the latent as well as the evident cauſes of diſeaſes, and that the phyſician ought to underſtand the natural actions and functions of the human body, which neceſſarily preſuppoſes a knowledge of the internal parts. By ſecret or latent cauſes they meant ſuch as related to the elements or principles of which our bodies are compoſed, and which are the origin of a good or bad ſtate of health. They aſſerted that it was impoſſible to know how to cure a diſeaſe without knowing the cauſe whence it proceeded; becauſe undoubtedly it behoved diſeaſes to vary prodigiouſly in themſelves according to the different cauſes by which they were produced.

35 Aſclepiades.

The next remarkable perſon in the hiſtory of phyſic is Aſclepiades, who flouriſhed in the century immediately preceding the birth of Chriſt. He introduced the philoſophy of Democritus and Epicurus into medicine, and ridiculed the doctrines of Hippocrates. He aſſerted, that matter conſidered in itſelf was of an unchangeable nature; and that all perceptible bodies were compoſed of a number of ſmaller ones, between which there were interſperſed an infinity of ſmall ſpaces totally void of all matter. He thought that the ſoul itſelf was compoſed of theſe ſmall bodies. He laughed at the principle called *Nature* by Hippocrates, and alſo at the imaginary faculties ſaid by him to be ſubſervient to her; and ſtill more at what he called *Attraction*. This laſt principle Aſclepiades denied in every inſtance, even in that of the loadſtone and ſteel, imagining that this phenomenon proceeded from a concourſe of corpuſcles, and a particular diſpoſition or modification of their pores. He alſo maintained, that nothing happened or was produced without ſome cauſe; and that what was called *nature* was in reality no more than *matter* and *motion*. From this laſt principle he inferred that Hippocrates knew not what he ſaid when he ſpoke of Nature as an intelligent being, and aſcribed qualities of different kinds to her. For the ſame reaſon he ridiculed the doctrine of Hippocrates with regard to criſes; and aſſerted that the termination of diſeaſes might be as well accounted for from mere matter and motion. He maintained, that we were deceived if we imagined that nature always did good; ſince it was evident that ſhe often did a great deal of harm. As for the days particularly fixed upon by Hippocrates for criſes, or thoſe on which we uſually obſerve a change either for the better or the worſe, Aſclepiades denied that ſuch alterations happened on thoſe days rather than on others. Nay, he aſſerted that the criſis did not happen at any time of its own accord, or by the particular determination of nature for the cure of the diſorder, but that it depended rather on the addreſs and dexterity of the phyſician; that we ought never to wait till a diſtemper terminates of its own accord, but that the phyſician by his care and medicines muſt haſten on and advance the cure.—According to him, Hippocrates and other ancient phyſicians attended their patients rather with a view to obſerve in what manner they died than in order to cure them; and this under pretence that Nature ought to do all herſelf, without any aſſiſtance.

Aſclepiades.

According to Aſclepiades, the particular aſſemblage of the various corpuſcles above mentioned, and repreſented as of different figures, is the reaſon why there are ſeveral pores or interſtices within the common maſs, formed by theſe corpuſcles; and why theſe pores are of a different ſize. This being taken for granted, as theſe pores are in all the bodies we obſerve, it muſt of courſe follow that the human body has ſome peculiar to itſelf, which, as well as thoſe of all other bodies, contain certain minute bodies, which paſs and repaſs by thoſe pores that communicate with each other; and as theſe pores or interſtices are larger or ſmaller, ſo the corpuſcles which paſs through them differ proportionably as to largeneſs and minuteneſs. The blood conſiſts of the largeſt of theſe corpuſcles, and the ſpirits, or the heat, of the ſmalleſt.

From theſe principles he infers, that as long as the corpuſcles are freely received by the pores, the body remains in its natural ſtate; and on the contrary, it begins to recede from that ſtate, when the corpuſcles find any obſtacle to their paſſage. Health therefore depends on the juſt proportion between the pores and the corpuſcles they are deſtined to receive and tranſmit; as diſeaſes, on the contrary, proceed from a diſproportion between theſe pores and the corpuſcles. The moſt uſual obſtacle on this occaſion proceeds from the corpuſcles embracing each other, and being retained in ſome of their ordinary paſſages, whether theſe corpuſcles

Asclepiades. cles arrive in too large a number, are of irregular figures, move too fast or too slow, &c.

Among the diseases produced by the corpuscles stopping of their own accord, Asclepiades reckoned phrensies, lethargies, pleurisies, and burning fevers. Pains, in particular, are classed among the accidents which derive their origin from a stagnation of the largest of all the corpuscles of which the blood consists. Among the disorders produced by the bad state and disposition of the pores, he placed deliquiums, languors, extenuations, leanness, and dropsies. These last disorders he thought proceeded from the pores being too much relaxed and opened: the dropsy in particular, he thinks, proceeds from the flesh being perforated with various small holes, which convert the nourishment received into them into water. Hunger, and especially that species of it called *fames canina*, proceeds from an opening of the large pores of the stomach and belly; and thirst from an opening of their small ones. Upon the same principles he accounted for intermittent fevers. According to him, quotidian fevers are caused by a retention of the largest corpuscles, those of the tertian kind by a retention of corpuscles somewhat smaller, and quartan fevers are produced by a retention of the smallest corpuscles of all.

The practice of Asclepiades was suited to remove these imaginary causes of disorders. He composed a book concerning common remedies, which he principally reduced to three, viz. gestation, friction, and the use of wine. By various exercises he proposed to render the pores more open, and to make the juices and small bodies, which cause diseases by their retention, pass more freely; and while the former physicians had not recourse to gestation till towards the end of long-continued disorders, and when the patients, though entirely free from fever, were yet too weak to take sufficient exercise by walking, Asclepiades used gestation from the very beginning of the most burning fevers. He laid it down as a maxim, that one fever was to be cured by another; that the strength of the patient was to be exhausted by making him watch and endure thirst to such a degree, that, for the two first days of the disorder, he would not allow them to cool their mouths with a drop of water. Celsus also observes, that though Asclepiades treated his patients like a butcher during the first days of the disorder, he indulged them so far afterwards as even to give directions for making their beds in the softest manner. On several occasions Asclepiades used frictions to open the pores. The dropsy was one of the distempers in which this remedy was used; but the most singular attempt was, by this means, to lull phrenetic patients asleep. But though he enjoined exercise so much to the sick, he denied it to those in health; a conduct not a little surprising and extraordinary. He allowed wine freely to patients in fevers, provided the violence of the distemper was somewhat abated. Nor did he forbid it to those who were afflicted with a phrensy: nay, he ordered them to drink it till they were intoxicated, pretending by that means to make them sleep; because, he said, wine had a narcotic quality and procured sleep, which he thought absolutely necessary for those who laboured under that disorder. To lethargic patients he used it on purpose to excite them, and rouse their senses: he also made them smell strong-scented substances, such as vinegar, castor, and rue, in order to make them sneeze; and applied to their heads cataplasms of mustard made up with vinegar. Asclepiades, &c.

Besides these remedies, Asclepiades enjoined his patients abstinence to an extreme degree. For the first three days, according to Celsus, he allowed them no aliment whatever; but on the fourth began to give them victuals. According to Cælius Aurelianus, however, he began to nourish his patients as soon as the accession of the disease was diminished, not waiting till an entire remission; giving to some aliments on the first, to some on the second, to some on the third, and so on to the seventh day. It seems almost incredible to us, that people should be able to fast till this last mentioned term; but Celsus assures us, that abstinence till the seventh day was enjoined even by the predecessors of Asclepiades.

The next great revolution which happened in the medicinal art, was brought about by Themison, the disciple of Asclepiades, who lived not long before the time of Celsus, during the end of the reign of Augustus, or beginning of that of Tiberius. The sect founded by him was called *methodic*, because he endeavoured to find a method of rendering medicine more easy than formerly. 36 Methodic sect.

He maintained, that a knowledge of the causes of diseases was not necessary, provided we have a due regard to what diseases have in common and analogous to one another. In consequence of this principle, he divided all diseases into two, or at most three, kinds. The first included diseases arising from stricture; the second, those arising from relaxation; and the third, those of a mixed nature, or such as partook both of stricture and relaxation. 37 Themison.

Themison also asserted, that diseases are sometimes acute, and sometimes chronical; that for a certain time they increase; that at a certain time they are at their height; and that at last they were observed to diminish. Acute diseases, therefore, according to him, must be treated in one way, and chronical diseases in another; one method must be followed with such as are in their augmentation, another with such as are at their height, and a third with such as are in their declension. He asserted, that the whole of medicine consisted in the observation of that small number of rules which are founded upon things altogether evident. He said, that all disorders, whatever their nature was, if included under any of the kinds above mentioned, ought to be treated precisely in the same way, in whatever country and with whatever symptoms they happen to arise. Upon these principles, he defined medicine to be a method of conducting to the knowledge of what diseases have in common with each other.

Themison was old when he laid the foundation of the methodic sect; and it was only brought to perfection by Thessalus, who lived under the emperor Nero. Galen and Pliny accuse this physician of intolerable insolence and vanity, and report that he gave himself the air of despising all other physicians; and so intolerable was his vanity, that he assumed the title of *the conqueror of physicians*, which he caused to be put upon his tomb in the Appian way. Never was mountebank (says Pliny) attended by a greater number of spectators 38 Thessalus.

ſpectators than Theſſalus had generally about him; and this circumſtance is the leſs to be wondered at, if we conſider that he promiſed to teach the whole art of medicine in leſs than ſix months. In reality, the art might be learned much ſooner if it comprehended no more than what the methodics thought neceſſary: for they cut off the examination of the cauſes of diſeaſes followed by the dogmatics; and ſubſtituted in the room of the laborious obſervations of the empirics, indications drawn from the analogy of diſeaſes, and the mutual reſemblance they bear to each other. The

39 Soranus. moſt ſkilful of all the methodic ſect, and he who put the laſt hand to it, was Soranus. He lived under the emperors Trajan and Adrian, and was a native of Epheſus.

40 Celſus. One of the moſt celebrated medical writers of antiquity was Celſus, whom we have already had occaſion to mention. Moſt writers agree that he lived in the time of Tiberius, but his country is uncertain. It is even diſputed whether or not he was a profeſſed phyſician. Certain it is, however, that his books on medicine are the moſt valuable of all the ancients next to thoſe of Hippocrates. From the latter, indeed, he has taken ſo much, as to acquire the name of the *Latin Hippocrates;* but he has not attached himſelf to him ſo cloſely as to reject the aſſiſtance of other authors. In many particulars he has preferred Aſclepiades. With him he laughs at the critical days of Hippocrates, and aſcribes the invention of them to a fooliſh and ſuperſtitious attachment to the Pythagorean doctrine of numbers. He alſo rejected the doctrine of Hippocrates with regard to veneſection, of which he made a much more general uſe; but did not take away ſo much blood at a time, thinking it much better to repeat the operation than weaken the patient by too great an evacuation at once. He uſed cupping alſo much more frequently, and differed from him with regard to purgatives. In the beginning of diſorders, he ſaid, the patients ought to endure hunger and thirſt: but afterwards they were to be nouriſhed with good aliments; of which, however, they were not to take too much, nor fill themſelves ſuddenly, after having faſted long. He does not ſpecify how long the patient ought to practiſe abſtinence; but affirms, that in this particular it is neceſſary to have a regard to the diſeaſe, the patient, the ſeaſon, the climate, and other circumſtances of a like nature. The ſigns drawn from the pulſe he looked upon to be very precarious and uncertain. "Some (ſays he) lay great ſtreſs upon the beating of the veins or the arteries; which is a deceitful circumſtance, ſince that beating is ſlow or quick, and varies very much, according to the age, ſex, and conſtitution of the patient. It even ſometimes happens that the pulſe is weak and languid when the ſtomach is diſordered, or in the beginning of a fever. On the contrary, the pulſe is often high, and in a violent commotion, when one has been expoſed to the ſun, or comes out of a bath, or from uſing exerciſe; or when one is under the influence of anger, fear, or any other paſſion. Beſides, the pulſe is eaſily changed by the arrival of the phyſician, in conſequence of the patient's anxiety to know what judgement he will paſs upon his caſe. To prevent this, the phyſician muſt not feel the patient's pulſe on his firſt arrival: he muſt firſt ſit down by him, aſſume a cheerful air, inform himſelf of his condition; and if he is under any dread, endeavour to remove it by encouraging diſcourſe; after which he may examine the beating of the artery. This nevertheleſs does not hinder us from concluding, that if the ſight of the phyſician alone can produce ſo remarkable a change in the pulſe, a thouſand other cauſes may produce the ſame effect." But although Celſus thought for himſelf, and in not a few particulars differed from his predeceſſors, yet in his writings, which are not only ſtill preſerved, but have gone through almoſt innumerable editions, we have a compendious view of the practice of almoſt all his predeceſſors: and he treats of the healing art in all its branches, whether performed *manu, victu, vel medicamentis.* His writings, therefore, will naturally be conſulted by every one who wiſhes either to become acquainted with the practice of the ancients prior to the fall of the Roman empire, or to read medical Latin in its greateſt purity.

About the 131ſt year after Chriſt, in the reign of the emperor Adrian, lived the celebrated Galen, a native of Pergamus, whoſe name makes ſuch a conſpicuous figure in the hiſtory of phyſic. At this time the dogmatic, empiric, methodic, and other ſects, had each their abettors. The methodics were held in great eſteem, and looked upon to be ſuperior to the dogmatics, who were ſtrangely divided among themſelves, ſome of them following Hippocrates, others Eraſiſtratus, and others Aſclepiades. The empirics made the leaſt conſiderable figure of any. Galen undertook the reformation of medicine, and reſtored dogmatiſm. He ſeems to have been of that ſect which was called *eclectic*, from their chooſing out of different authors what they eſteemed good in them, without being particularly attached to any one more than the reſt. This declaration he indeed ſets out with; but, notwithſtanding this, he follows Hippocrates much more than any other, or rather follows nobody elſe but him. Though before his time ſeveral phyſicians had commented on the works of Hippocrates, yet Galen pretends that none of them had underſtood his meaning. His firſt attempt therefore was to explain the works of Hippocrates; with which view he wrote a great deal, and after this ſet about compoſing a ſyſtem of his own. In one of his books entitled, "Of the eſtabliſhment of medicine," he defines the art to be one which teaches to preſerve health and cure diſeaſes. In another book, however, he propoſes the following definition: "Medicine (ſays he) is a ſcience which teaches what is ſound, and what is not ſo; and what is of an indifferent nature, or holds a medium between what is ſound and what is the reverſe." He affirmed, that there are three things which conſtitute the object of medicine, and which the phyſician ought to conſider as ſound, as not ſound, or of a neutral and indifferent nature. Theſe are the body itſelf, the ſigns, and the cauſes. He eſteems the human body ſound, when it is in a good ſtate or habit with regard to the ſimple parts of which it is compoſed, and when beſides there is a juſt proportion between the organs formed of theſe ſimple parts. On the contrary, the body is reckoned to be unſound, when it recedes from this ſtate, and the juſt proportion above mentioned. It is in a ſtate of neutrality or indifference, when it is in a medium between ſoundneſs and its oppoſite ſtate. The ſalutary 41 Galen.

ſigns

Galen.

ſigns are ſuch as indicate preſent health, and prognoſticate that the man may remain in that ſtate for ſome time to come. The inſalubrious ſigns, on the contrary, indicate a preſent diſorder, or lay a foundation for ſuſpecting the approach of one. The neutral ſigns, or ſuch as are of an indifferent nature, denote neither health nor indiſpoſition, either for the preſent, or for the time to come. In like manner he ſpeaks of cauſes ſalutary, unſalutary, and indifferent.

Theſe three diſpoſitions of the human body, that is, ſoundneſs, its reverſe, and a neutral ſtate, comprehend all the differences between health and diſorder or indiſpoſition: and each of theſe three ſtates or diſpoſitions has a certain extent peculiar to itſelf. A ſound habit of body, according to the definition of it already given, is very rare, and perhaps never to be met with; but this does not hinder us to ſuppoſe ſuch a model for regulating our judgement with reſpect to different conſtitutions. On this principle Galen eſtabliſhes eight other principal conſtitutions, all of which differ more or leſs from the perfect model above mentioned. The four firſt are ſuch as have one of the four qualities of hot, cold, moiſt, or dry, prevailing in too great a degree; and accordingly receive their denomination from that quality which prevails over the reſt. The four other ſpecies of conſtitutions receive their denominations from a combination of the above mentioned; ſo that, according to his definition, there may be a hot and dry, a hot and moiſt, a cold and moiſt, and a cold and dry, conſtitution. Beſides theſe differences, there are certain others which reſult from occult and latent cauſes, and which, by Galen, are ſaid to ariſe from an *idioſyncraſy* of conſtitution. It is owing to this idioſyncraſy that ſome have an averſion to one kind of aliment and ſome to another; that ſome cannot endure particular ſmells, &c. But though theſe eight laſt-mentioned conſtitutions fall ſhort of the perfection of the firſt, it does not thence follow, that thoſe to whom they belong are to be claſſed among the valetudinary and diſeaſed. A diſeaſe only begins when the deviation becomes ſo great as to hinder the due action of ſome parts.

Galen deſcribes at great length the ſigns of a good or bad conſtitution, as well as thoſe of what he calls a *neutral habit*. Theſe ſigns are drawn from the original qualities of cold, hot, moiſt, and dry, and from their juſt proportion or diſproportion with reſpect to the bulk, figure, and ſituation, of the organical parts. With Hippocrates he eſtabliſhes three principles of an animal body; the parts, the humours, and the ſpirits. By the parts he properly meant no more than the ſolid parts; and theſe he divided into ſimilar and organical. Like Hippocrates, he alſo acknowledged four humours; the blood, the phlegm, the yellow bile and black bile. He eſtabliſhed three different kinds of ſpirits; the natural, the vital, and the animal. The firſt of theſe are, according to him, nothing elſe but a ſubtle vapour ariſing from the blood, which draws its origin from the liver, the organ or inſtrument of ſanguification. After theſe ſpirits are conveyed to the heart, they, in conjunction with the air we draw into the lungs, become the matter of the ſecond ſpecies, that is, of the vital ſpirits, which are again changed into thoſe of the animal kind in the brain. He ſuppoſed that theſe three ſpecies of ſpirits ſerved as inſtruments to three kinds of faculties, which reſide in the reſpective parts where theſe faculties are formed. The natural faculty is the firſt of theſe, which he placed in the liver, and imagined to preſide over the nutrition, growth, and generation, of the animal. The vital faculty he lodged in the heart, and ſuppoſed that by means of the arteries it communicated warmth and life to all the body. The animal faculty, the nobleſt of all the three, and with which the reaſoning or governing faculty was joined, according to him, has its ſeat in the brain; and, by means of the nerves, diſtributes a power of motion and ſenſation to all the parts, and preſides over all the other faculties. The original ſource or principle of motion in all theſe faculties, Galen, as well as Hippocrates, defines to be *Nature*.

Upon theſe principles Galen defined a diſeaſe to be "ſuch a preternatural diſpoſition or affection of the parts of the body, as primarily, and of itſelf, hinders their natural and proper action." He eſtabliſhed three principal kinds of diſeaſes: the firſt relates to the ſimilar parts; the ſecond, to the organical; and the third is common to both theſe parts. The firſt kind of diſeaſes conſiſts in the intemperature of the ſimilar parts; and this is divided into an intemperature *without matter*, and an intemperature *with matter*. The firſt diſcovers itſelf when a part has more or leſs heat or cold than it ought to have without that change of quality in the part being ſupported and maintained by any matter. Thus, for inſtance, a perſon's head may be overheated and indiſpoſed by being expoſed to the heat of the ſun, without that heat being maintained by the continuance or congeſtion of any hot humour in the part. The ſecond ſort of intemperature is when any part is not only rendered hot or cold, but alſo filled with a hot or cold humour, which are the cauſes of the heat or cold felt in the part. Galen alſo acknowledged a ſimple intemperature: that is, when one of the original qualities, ſuch as heat or cold, exceeds the natural ſtandard alone and ſeparately; and a compound intemperature, when two qualities are joined together, ſuch as heat and dryneſs, or coldneſs and humidity. He alſo eſtabliſhed an equal and unequal temperature. The former is that which is equally in all the body, or in any particular part of it, and which creates no pain, becauſe it is become habitual, ſuch as dryneſs in the hectic conſtitution. The latter is diſtinguiſhed from the former, in that it does not equally ſubſiſt in the whole of the body, or in the whole of a part. Of this kind of intemperature we have examples in certain fevers, where heat and cold, equally, and almoſt at the ſame time, attack the ſame part; or in other fevers, which render the ſurface of the body cold as ice, while the internal parts burn with heat; or laſtly, in caſes where the ſtomach is cold and the liver hot.

The ſecond kind of diſorders, relating to the organical parts, reſults from irregularities of theſe parts, with reſpect to the number, bulk, figure, ſituation, &c.; as when one has ſix fingers, or only four; when one has any part larger or ſmaller than it ought to be, &c. The third kind, which is common both to the ſimilar and the organical parts, is a ſolution of continuity, which happens when any ſimilar or compound part is cut, bruiſed, or corroded.

Galen.

Like Hippocrates, Galen diſtinguiſhed diſeaſes into acute and chronical; and, with reſpect to their nature and genius, into benign and malignant; alſo into epidemic, endemic, and ſporadic.

After having diſtinguiſhed the kinds of diſeaſes, Galen comes to explain their cauſes; which he divides into external and internal. The external cauſes of diſeaſes, according to him, are ſix things, which contribute to the preſervation of health when they are well diſpoſed and properly uſed, but produce a contrary effect when they are imprudently uſed or ill diſpoſed. Theſe ſix things are, the air, aliments and drink, motion and reſt, ſleeping and watching, retention and excretion, and laſtly the paſſions. All theſe are called the *procatarctic* or *beginning* cauſes, becauſe they put in motion the internal cauſes; which are of two kinds, the *antecedent* and the *conjunct*. The former is diſcovered only by reaſoning; and conſiſts for the moſt part in a peccancy of the humours, either by plentitude or cacochymy, i. e. a bad ſtate of them. When the humours are in too large a quantity, it is called a *plethora;* but we muſt obſerve, that this word equally denotes too large a quantity of all the humours together, or a redundance of one particular humour which prevails over the reſt. According to theſe principles, there may be a ſanguine, a bilious, a pituitous, or a melancholy plenitude: but there is this difference between the ſanguine and the three other plenitudes, that the blood, which is the matter of the former, may far ſurpaſs the reſt: whereas, if any of the three laſt mentioned ones do ſo, the caſe is no longer called *plenitude*, but *cacochymia;* becauſe theſe humours, abounding more than they ought, corrupt the blood. The cauſes he alſo divides into ſuch as are manifeſt and evident, and ſuch as are latent and obſcure. The firſt are ſuch as ſpontaneouſly come under the cognizance of our ſenſes when they act or produce their effects: the ſecond are not of themſelves perceptible, but may be diſcovered by reaſoning: the third ſort, i. e. ſuch as he calls *occult* or *concealed*, cannot be diſcovered at all. Among this laſt he places the cauſe of the hydrophobia.

He next proceeds to conſider the ſymptoms of diſeaſes. A ſymptom he defines to be "a preternatural affection depending upon a diſeaſe, or which follows it as a ſhadow does a body." He acknowledged three kinds of ſymptoms: the firſt and moſt conſiderable of theſe conſiſted in the action of the parts being injured or hindered; the ſecond in a change of the quality of the parts, their actions in the mean time remaining entire: the third related to defects in point of excretion and retention.

After having treated of ſymptoms, Galen treats of the *ſigns* of diſeaſes. Theſe are divided into *diagnoſtic* and *prognoſtic*. The firſt are ſo called becauſe they enable us to know diſeaſes, and diſtinguiſh them from each other. They are of two ſorts, *pathognomonic* or *adjunct*. The firſt are peculiar to every diſeaſe, make known its preciſe ſpecies, and always accompany it, ſo that they begin and end with it. The ſecond are common to ſeveral diſeaſes, and only ſerve to point out the difference between diſeaſes of the ſame ſpecies. In a pleuriſy, for inſtance, the pathognomonic ſigns are a cough, a difficulty of breathing, a pain of the ſide, and a continued fever; the adjunct ſigns are the various ſorts of matter expectorated, which is ſometimes bloody, ſometimes bilious, &c.— The diagnoſtic ſigns were drawn from the defective or diſordered diſpoſition of the parts, or from the diſeaſes themſelves; ſecondly, from the cauſes of diſeaſes; thirdly, from their ſymptoms; and laſtly, from the particular diſpoſitions of each body, from things which prove prejudicial and thoſe that do ſervice, and from epidemical diſeaſes.—The prognoſtic ſigns he gathered from the ſpecies, virulence, and peculiar genius of the diſeaſe: but as we have already ſpoken ſo largely concerning the prognoſtics of Hippocrates, it is ſuperfluous to be particular on thoſe of Galen.— His method of cure differed little from that of Hippocrates: but from the ſpecimen already given of Galen's method of teaching the medical art, it is evident that his ſyſtem was little elſe than a collection of ſpeculations, diſtinctions, and reaſonings; whereas that of Hippocrates was founded immediately upon facts, which he had either obſerved himſelf, or had learned from the obſervation of others.

Oribaſius, &c.

The ſyſtem of Galen, however, notwithſtanding its defects and abſurdities, remained almoſt uncontradicted for a very long period. Indeed it may be conſidered as having been the prevailing ſyſtem till the inundation of the Goths and Vandals put an almoſt entire ſtop to the cultivation of letters in Europe. But during the general prevalence of the ſyſtem of Galen, there appeared ſome writers to whom medicine was indebted for improvements, at leaſt in certain particulars. Among the moſt diſtinguiſhed of theſe we may mention Oribaſius, Ætius, Alexander, and Paulus.

Oribaſius flouriſhed about the year 360, and was 42 Oribaſius.
phyſician to the emperor Julian. He ſpeaks very fully of the effects of bleeding by way of ſcarification, a thing little taken notice of by former writers; from his own experience he aſſures us that he had found it ſucceſsful in a ſuppreſſion of the menſes, defluxions of the eyes, headach, and ſtraitneſs of breathing even when the perſon was extremely old. He tells his own caſe particularly, when the plague raged in Aſia and he himſelf was taken ill. On the ſecond day he ſcarified his leg, and took away two pounds of blood; by which means he entirely recovered, as did ſeveral others who uſed it. In this author alſo we find the firſt deſcription of a ſurpriſing and terrible diſtemper, which he termed λυκανθρωπια, a ſpecies of melancholy and madneſs, which he deſcribes thus. "The perſons affected get out of their houſes in the night-time, and in every thing imitate wolves, and wander among the ſepulchres of the dead till day-break. You may know them by theſe ſymptoms: Their looks are pale; their eyes heavy, hollow, dry, without the leaſt moiſture of a tear; their tongue exceedingly parched and dry, no ſpittle in their mouth, extreme thirſt; their legs, from the falls and the bruiſes they receive, full of incurable ſores and ulcers."

Ætius lived very near the end of the fifth, or in the 43 Ætius.
beginning of the ſixth century. Many paſſages in his writings ſerve to ſhow us how much the actual and potential cautery were uſed by the phyſicians of that age. In a palſy, he ſays, that he ſhould not at all heſitate to make an eſchar either way, and this in ſeveral places; one in the nape, where the ſpinal marrow takes its riſe, two on each ſide of it; three or four

Alexander.

four on the top of the head, one juſt in the middle, and three others round it. He adds, that in this caſe, if the ulcers continue running a conſiderable time, he ſhould not doubt of a perfect recovery. He is ſtill more particular when he comes to order this application for an inveterate aſthma, after all other remedies have been tried in vain. One, he ſays, ſhould be made on each ſide near the middle of the joining of the clavicle, taking care not to touch the wind-pipe: two other little ones are then to be made near the carotids under the chin, one on each ſide, ſo that the cauſtic may penetrate no further than the ſkin; two others under the breaſts, between the third and fourth ribs; and again, two more backwards towards the fifth and ſixth ribs. Beſides theſe there ought to be one in the middle of the thorax, near the beginning of the xiphoid cartilage, over the orifice of the ſtomach; one on each ſide between the eighth and ninth ribs; and three others in the back, one in the middle, and the two others juſt below it, on each ſide of the vertebræ. Thoſe below the neck ought to be pretty large, not very ſuperficial, not very deep: and all theſe ulcers ſhould be kept open for a very long time.

Ætius takes notice of the worms bred in different parts of the body called *dracunculi*, which were unknown to Galen. He ſeems alſo to be the firſt Greek writer among the Chriſtians, who gives us any ſpecimen of medicinal ſpells and charms; ſuch as that of a finger of St Blaſius for removing a bone which ſticks in the throat, and another in relation to a fiſtula. He gives a remedy for the gout, which he calls the *grand drier;* the patient is to uſe it for a whole year, and obſerve the following diet each month. "In September, he muſt eat and drink milk: In October, he muſt eat garlic; in November, abſtain from bathing; in December, he muſt eat no cabbage; in January, he is to take a glaſs of pure wine in the morning; in February, to eat no beet; in March, to mix ſweet things both in eatables and drinkables; in April, not to eat horſe-radiſh, nor in May the fiſh called *polypus;* in June, he is to drink cold water in a morning; in July, to avoid venery; and laſtly, in Auguſt, to eat no mallows." This may ſufficiently ſhow the quackery of thoſe times, and how ſuperſtition was beginning to mix itſelf with the art.

44 Alexander.

Alexander, who flouriſhed in the reign of Juſtinian, is a more original author than either of the two former. He confines himſelf directly to the deſcribing the ſigns of diſeaſes, and the methods of cure, without meddling with anatomy, the materia medica, or ſurgery, as all the reſt did. He employs a whole book in treating of the gout. One method he takes of relieving this diſeaſe is by purging; and in moſt of the purges he recommends hermodactyls, of which he has a great opinion. In a cauſus, or burning fever, where the bile is predominant, the matter fit for evacuation, and the fever not violent, he prefers purging to bleeding, and ſays that he has often ordered purging in acute fevers with ſurpriſing ſucceſs. In the cauſus alſo, if a ſyncope happens from crude and redundant humours, he recommends bleeding. In a ſyncope ſucceeding the ſuppreſſion of any uſual evacuation, he recommends bleeding, with frictions. The diagnoſtics upon which he founds this practice are the following: viz. a face paler and more ſwelled than uſual, a bloated habit of body, with a ſmall ſluggiſh pulſe, having long intervals between the ſtrokes. In tertian, and much more in quartan fevers, he recommends vomits above all other remedies, and affirms that by this remedy alone he has cured the moſt inveterate quartans. On the bulimus, or canine appetite, he makes a new obſervation, viz. that it is ſometimes cauſed by worms. He mentions the caſe of a woman who laboured under this ravenous appetite, and had a perpetual gnawing at her ſtomach and pain in her head: after taking *hiera*, ſhe voided a worm above a dozen of cubits long, and was entirely cured of her complaints.—He is alſo the firſt author who takes notice of *rhubarb;* which he recommends in a weakneſs of the liver and in dyſentery.—Alexander is recommended by Dr Freind as one of the beſt practical writers among the ancients, and well worthy the peruſal of any modern.

Arabian Phyſicians.

45 Paulus.

Paulus was born in the iſland Ægina, and lived in the 7th century. He tranſcribes a great deal from Alexander and other phyſicians. His deſcriptions are ſhort and accurate. He treats particularly of women's diſorders; and ſeems to be the firſt inſtance upon record of a profeſſed *man-midwife*, for ſo he was called by the Arabians: and accordingly he begins his book with the diſorders incident to pregnant women. He treats alſo very fully of ſurgery; and gives ſome directions, according to Dr Freind, not to be found in the more ancient writers.

46 Arabian Phyſicians.

After the downfal of the Roman empire, and when the inundation of Goths and Vandals had almoſt completely exterminated literature of every kind in Europe, medicine, though a practical art, ſhared the ſame fate with more abſtract ſciences. Learning in general, baniſhed from the ſeat of arms, took refuge among the eaſtern nations, where the arts of peace ſtill continued to be cultivated. To the Arabian phyſicians, as they have been called, we are indebted both for the preſervation of medical ſcience, as it ſubſiſted among the Greeks and Romans, and likewiſe for the deſcription of ſome new diſeaſes, particularly the ſmall-pox. Among the moſt eminent of the Arabians, we may mention Rhaſes, Avicenna, Albucaſis, and Avenzoar. But of their writings it would be tedious, and is unneceſſary, to give any particular account.—They were for the moſt part, indeed, only copiers of the Greeks. We are, however, indebted to them for ſome improvements. They were the firſt who introduced chemical remedies, though of theſe they uſed but few, nor did they make any conſiderable progreſs in the chemical art. Anatomy was not in the leaſt improved by them, nor did ſurgery receive any advancement till the time of Albucaſis, who lived probably in the 12th century. They added a great deal to botany and the materia medica, by the introduction of new drugs, of the aromatic kind eſpecially, from the eaſt, many of which are of conſiderable uſe. They alſo found out the way of making ſugar; and by help of that, ſyrups; which two new materials are of great uſe in mixing up compound medicines.

47 Rhaſes.

With regard to their practice, in ſome few particulars they deviated from the Greeks. Their purging medicines were much milder than thoſe formerly in uſe; and even when they did preſcribe the old ones, they gave them in a much leſs doſe than the Greek and Roman phyſicians. The ſame reflection may be made concerning

Arabian Phyſicians. concerning their manner of bleeding, which was never to that exceſſive degree practiſed by the Greeks. They deviated from Hippocrates, however, in one very trivial circumſtance, which produced a violent controverſy. The queſtion was, Whether blood in a pleuriſy ought to be drawn from the arm of the affected ſide or the oppoſite? Hippocrates had directed it to be drawn from the arm of the affected ſide; but the Arabians, following ſome other ancient phyſicians, ordered it to be drawn from the oppoſite one. Such was the ignorance of thoſe ages, that the univerſity of Salamanca in Spain made a decree, that no one ſhould dare to let blood but in the contrary arm; and endeavoured to procure an edict from the emperor Charles V. to ſecond it; alleging that the other method was of no leſs pernicious conſequence to medicine, than Luther's hereſy had been to religion.

In conſequence of the general decay of learning in the weſtern parts of the world, the Greek writers were entirely neglected, becauſe nobody could read the language; and the Arabians, though principally copiers from them, enjoyed all the reputation that was due to the others. The Arabian phyſic was introduced into Europe very early, with the moſt extravagant applauſe: and not only this, but other branches of their learning, came into repute in the weſt; inſomuch that in the 11th century, the ſtudies of natural philoſophy and the liberal arts were called *the ſtudies of the Saracens.* This was owing partly to the cruſades undertaken againſt them by the European princes; and partly to the ſettlement of the Moors in Spain, and

48 College of Salernum. the intercourſe they and other Arabians had with the Italians. For, long before the time of the cruſades, probably in the middle of the 7th century, there were Hebrew, Arabic, and Latin profeſſors of phyſic ſettled at Salernum: which place ſoon grew into ſuch credit, that Charles the Great thought proper to found a college there in the year 802; the only one at that

49 Conſtantine. time in Europe. Conſtantine the African flouriſhed there towards the latter end of the 11th century. He was a native of Carthage; but travelled into the eaſt, and ſpent 30 years in Babylon and Bagdad, by which means he became maſter of the oriental languages and learning. He returned to Carthage; but being informed of an attempt againſt his life, made his eſcape into Apulia, where he was recommended to Robert Guiſcard, created in 1060 duke of that country, who made him his ſecretary. He was reputed to be very well verſed in the Greek, as well as in the eaſtern tongues; and ſeems to have been the firſt who introduced either the Greek or Arabian phyſic into Italy. His works, however, contain nothing that is new, or material; though he was then accounted a very learned man.

50 State of medicine in the 15th and 16th centuries. From this time to the end of the 15th and beginning of the 16th century, the hiſtory of phyſic furniſhes us with no intereſting particulars. This period, however, is famous for the introduction of chemiſtry into medicine, and the deſcription of three new diſtempers, the ſweating ſickneſs, the venereal diſeaſe, and the ſcurvy. The ſweating ſickneſs began in 1485

51 Sweating ſickneſs in England. in the army of Henry VII. upon his landing at Milford-haven, and ſpread itſelf at London from the 21ſt of September to the end of October. It returned there five times, and always in ſummer; firſt in 1495, then in 1506, afterwards in 1517, when it was ſo violent that it killed many in the ſpace of three hours, ſo that numbers of the nobility died, and of the commonalty in ſeveral towns often the one-half periſhed. It appeared the fourth time in 1528, and then proved mortal in ſix hours; many of the courtiers died of it, and Henry VIII. himſelf was in danger. In 1529, and only then, it infeſted the Netherlands and Germany, in which laſt country it did much miſchief. The laſt return of it was in 1551, and in Weſtminſter it carried off 120 in a day. Dr Caius deſcribes it as a peſtilent contagious fever, of the duration of one natural day; the ſweat he reckoned to be only a natural ſymptom, or criſis of the diſtemper. It firſt affected ſome particular part, attended with inward heat and burning, unquenchable thirſt, reſtleſſneſs, ſickneſs at ſtomach, but ſeldom vomiting, headach, delirium, then faintneſs, and exceſſive drowſineſs. The pulſe was quick and vehement, and the breath ſhort and laborious.—Children, poor and old people, were rarely ſubject to it. Of others, ſcarce any eſcaped the attack, and moſt of them died. Even by travelling into France or Flanders they did not eſcape; and what is ſtill more ſtrange, the Scots were ſaid not to be affected; abroad the Engliſh only were ſeized, and foreigners in England were free. At firſt the phyſicians were much puzzled how to treat this diſeaſe. The only cure they ever found, however, was to carry on the ſweat for a long time; for, if ſtopped, it was dangerous or fatal. The way, therefore, was for the patient to lie ſtill, and not expoſe himſelf to cold. If nature was not ſtrong enough to force out the ſweat, it was neceſſary to aſſiſt her by art, with clothes, wine, &c. The violence of the diſtemper was over in 15 hours; but there was no ſecurity for the patient till 24 were paſſed. In ſome ſtrong conſtitutions there was a neceſſity to repeat the ſweating, even to 12 times. The removing out of bed was attended with great danger; ſome who had not ſweated enough fell into very bad fevers.—No fleſh meat was to be allowed in all the time of the diſtemper; nor drink for the firſt five hours. In the ſeventh, the diſtemper increaſed; in the ninth the delirium came on, and ſleep was by all means to be avoided. However terrible this diſtemper appeared at firſt, it ſeldom proved obſtinate, if treated in the above-mentioned manner.

In the beginning of the 16th century, the famous chemiſt Paracelſus introduced a new ſyſtem into medicine, founded on the principles of chemiſtry. The Galenical ſyſtem had prevailed till his time; but the practice had greatly degenerated, and was become quite trifling and frivolous. The phyſicians in general rejected the uſe of opium, mercury, and other efficacious remedies. Paracelſus, who made uſe of theſe, had therefore greatly the advantage over them; and now all things relating to medicine were explained on imaginary chemical principles. It will eaſily be conceived that a practice founded in this manner could be no other than the moſt dangerous quackery. At this time, however, it was neceſſary; for now a new diſeaſe overran the world, and threatened greater deſtruction than almoſt all the old ones put together, both by the violence of its ſymptoms, and its baffling the moſt powerful remedies at that time known.—This was the venereal diſeaſe, which is ſuppoſed to have been imported 52 Paracelſus.

Moderns.

Moderns. imported from the West Indies by the companions of Christopher Columbus. Its first remarkable appearance was at the siege of Naples in 1494, from whence it was soon after propagated through Europe, Asia, and Africa. The symptoms with which it made the attack at that time were exceedingly violent, much more so than they are at present; and consequently were utterly unconquerable by the Galenists. The quacks and chemists, who boldly ventured on mercury, though they no doubt destroyed numbers by their excessive use of it, yet showed that a remedy for this terrible distemper was at last found out, and that a proper method of treating it might soon be fallen upon. Shortly after, the West Indian specific, guaiacum, was discovered: the materia medica was enriched with that and many other valuable medicines, both from the East and West Indies: which contributed considerably to the improvement of the practice of physic. At this period, as sea voyages of considerable duration were more frequent, the scurvy became a more common distemper, and was of course more accurately described. But probably, from supposed analogy to the contagions which at that time were new in Europe, very erroneous ideas were entertained with regard to its being of an infectious nature: And it is not impossible, that from its being attended also with ulcers, it was on some occasions confounded with syphilitic complaints.

53 Appearance of the venereal disease.

54 Progress of medicine in the 17th and 18th centuries.

The revival of learning, which now took place throughout Europe, the appearance of these new distempers, and the natural fondness of mankind for novelty, contributed greatly to promote the advancement of medicine as well as other sciences. While at the same time, the introduction of the art of printing rendered the communication of new opinions as well as new practices so easy a matter, that to enumerate even the names of those who have been justly rendered eminent for medical knowledge would be a very tedious task. It was not, however, till 1628 that Dr William Harvey of London demonstrated and communicated to the public one of the most important discoveries respecting the animal economy, the circulation of the blood. This discovery, more effectually than any reasoning, overturned all the systems which had subsisted prior to that time. It may justly be reckoned the most important discovery that has hitherto been made in the healing art: for there can be no doubt that it puts the explanation of the phenomena of the animal body, both in a state of health and disease, on a more solid and rational footing than formerly. It has not, however, prevented the rise of numerous fanciful and absurd systems. These, though fashionable for a short time, and strenuously supported by blind adherents, have yet in no long period fallen into deserved contempt. And notwithstanding the abilities and industry of Stahl, Hoffman, Boerhaave, and Cullen, we may confidently venture to assert that no general system has yet been proposed which is not liable to innumerable and unsurmountable objections. Very great progress has indeed been made in explaining the philosophy of the human body, from ascertaining by decisive experiment the influence of the circulating, the nervous, and the lymphatic systems in the animal economy. But every attempt hitherto made to establish any general theory in medicine, that is to conduct the cure of every disease on a few general principles, has equally deviated from truth with those of Hippocrates and Galen; and has equally tended to mislead those who have adopted it. Many systems of our own days, such for example as that of Brown, though adopted with enthusiasm by the young and inexperienced, have evidently been attended with the most pernicious consequences in practice. Indeed we may with confidence venture to assert, that from the very nature of the subject itself, medicine does not admit of such simplicity. No one can deny that the human body consists of a very great number of different parts, both solids and fluids. It is, however, equally certain, that each of these is from many different causes liable to deviations from the sound state. And although some slight changes may take place without what can be called a morbid affection, yet we well know, that every change taking place to a certain degree in any one part will necessarily and unavoidably produce an affection of the whole. Hence we may without hesitation venture to affirm, that every general theory which can be proposed, attempting to explain the phenomena, and conduct the cure of all diseases on a few general principles, though for some time it may have strenuous advocates, will yet in the end be found to be both ill-grounded and pernicious.

55 Discovery of the circulation.

The art of medicine has been much more usefully improved by careful attention to the history, theory, and practice of particular diseases, and by endeavouring to ascertain from cautious observation the symptoms by which they are to be distinguished, the causes by which they are induced, and the means by which they are to be prevented, alleviated, or cured. On this footing, therefore, we shall endeavour to give a brief account of at least the most important affections to which the human body is subjected, delivering what appear to us to be the best established facts and observations respecting each.

But before entering on the consideration of particular diseases, or what has commonly been styled the practice of medicine, it is necessary to give a general view of the most important functions of the animal body, and of the chief morbid affections to which they are subjected; a branch which has usually been named the *Theory* or *Institutions of Medicine*.

Theory of Medicine, or an Account of the principal Functions of the Animal Body.

WHILE the functions of living animals, but particularly of the human species, are very numerous, the accounts given of these both in a state of health and disease are very various. Without, therefore, pretending to enumerate the contradictory opinions of different authors, we shall here present the reader with a view of this subject, Functions of the Body.

ſubject, chiefly extracted from the *Conſpectus Medicinæ Theoreticæ* of Dr James Gregory, who has collected from other writers the opinions at preſent moſt generally adopted.

56
Diviſion of the functions into animal, vital, and natural.

In this work, which was firſt publiſhed in 1780, and afterwards reprinted under an enlarged form in 1782, Dr Gregory introduces his ſubject by obſerving, that ſome functions of the human body relate to itſelf only, and others to external things. To the latter claſs belong thoſe which by phyſicians are called the *animal functions;* to which are to be referred all our ſenſes, as well as the power of voluntary motion, by which we become acquainted with the univerſe, and enjoy this earth. Among the functions which relate to the body, ſome have been named *vital*, ſuch as the circulation of the blood and reſpiration; becauſe, without the conſtant continuance of theſe life cannot ſubſiſt; others, intended for repai ing the waſte of the ſyſtem, have been termed the *natural functions:* for by the conſtant attrition of the ſolids and the evaporation of the fluid parts of the body, we ſtand in need of nouriſhment to ſupply this waſte; after which the putrid and excrementitious parts muſt be thrown out by the proper paſſages. The digeſtion of the food, ſecretion of the humours, and excretion of the putrid parts of the food, are referred to this claſs; which, though neceſſary to life, may yet be interrupted for a conſiderable time without danger. This diviſion of the functions into animal, vital, and natural, is of very ancient date, and is perhaps one of the beſt that has yet been propoſed.

57
Diſtinction of diſeaſes into ſimple and compound.

A *diſeaſe* takes place, when the body has ſo far declined from a ſound ſtate, that its functions are either quite impeded, or performed with difficulty. A diſeaſe therefore may happen to any part of the body either ſolid or fluid, or to any one of the functions: and thoſe may occur either ſingly, or ſeveral of them may be diſeaſed at the ſame time; whence the diſtinction of diſeaſes into *ſimple* and *compound*.

We have examples of the moſt ſimple kinds of diſeaſes, in the rupture or other injury of any of the corporeal organs, by which means they become leſs fit for performing their offices; or, though the organs themſelves ſhould remain ſound, if the ſolids or fluids have degenerated from a healthy ſtate; or if, having loſt their proper qualities, they have acquired others of a different, perhaps of a noxious nature; or laſtly, if the moving powers ſhall become too weak or too ſtrong, or direct their force in a way contrary to what nature requires.

58
Symptoms.

The moſt ſimple diſeaſes are either productive of others, or of *ſymptoms*, by which alone they become known to us. Every thing in which a ſick perſon is obſerved to differ from one in health is called a *ſymptom;* and the moſt remarkable of theſe ſymptoms, which moſt conſtantly appear, define and conſtitute the diſeaſe.

The cauſes of diſeaſes are various; often obſcure, and ſometimes totally unknown. The moſt full and perfect proximate cauſe is that which, when preſent, produces a diſeaſe, when taken away removes it, and when changed, changes it.—There are alſo remote cauſes, which phyſicians have been accuſtomed to divide into the *prediſponent* and *exciting* ones. The

59
Prediſponent cauſe.

Cauſes of Diſeaſes.

former are thoſe which only render the body fit for a diſeaſe, or which put it into ſuch a ſtate that it will readily receive one. The exciting cauſe is that which immediately produces the diſeaſe in a body already diſpoſed to receive it.

60
Exciting cauſe.

The prediſponent cauſe is always inherent in the body itſelf, though perhaps it originally came from without; thus heat or cold, a very ſparing or a very luxurious diet, and many other particulars, may operate as cauſes of prediſpoſition, inducing plethora, inanition, or the like. But the exciting cauſe may either come from within or without.

From the combined action of the prediſponent and exciting cauſes comes the *proximate* cauſe, which neither of the two taken ſingly is often able to produce.—

61
Proximate cauſe.

A body prediſpoſed to diſeaſe therefore has already declined ſomewhat from a ſtate of perfect health, although none of its functions are impeded in ſuch a manner that we can truly ſay the perſon is diſeaſed. Yet ſometimes the prediſponent cauſe, by continuing long, may arrive at ſuch a height, that it alone, without the addition of any exciting cauſe, may produce a real diſeaſe.—The exciting cauſe alſo, though it ſhould not be able immediately to bring on a diſeaſe; yet if it continues long, will by degrees deſtroy the ſtrongeſt conſtitution, and render it liable to various diſeaſes; becauſe it either produces a prediſponent cauſe, or is converted into it, ſo that the ſame thing may ſometimes be an exciting cauſe, ſometimes a prediſponent one, or rather a cauſe of prediſpoſition; of which the inclemencies of the weather, ſloth, luxury, &c. are examples.

62
Hereditary diſeaſes.

Diſeaſes, however, ſeem to have their origin from the very conſtitution of the animal machine; and hence many diſeaſes are common to every body when a proper exciting cauſe occurs, though ſome people are much more liable to certain diſeaſes than others. Some are hereditary; for as healthy parents naturally produce healthy children, ſo diſeaſed parents as naturally produce a diſeaſed offspring. Some of theſe diſeaſes appear in the earlieſt infancy; others occur equally at all ages; nor are there wanting ſome which lurk unſuſpected even to the lateſt old age, at laſt breaking out with the utmoſt violence. Some diſeaſes are born with us, even though they have no proper foundation in our conſtitution, as when a fœtus receives ſome hurt by an injury done to the mother; while others, neither born with us nor having any foundation in the conſtitution, are ſucked in with the nurſe's milk.

63
Diſeaſes from age and ſex.

Many diſeaſes accompany the different ſtages of life; and hence ſome are proper to infancy, youth, and old age. Some alſo are proper to each of the ſexes: eſpecially the female ſex, proceeding, no doubt, from the general conſtitution of the body, but particularly from the ſtate of the parts ſubſervient to generation. Hence the diſeaſes peculiar to virgins, to menſtruating women, to women with child, to lying-in women, to nurſes, and to old women.

64
Diſeaſes from climate.

The climate itſelf, under which people live, produces ſome diſeaſes; and every climate has a tendency to produce particular diſeaſes, either from its exceſs of heat or cold, or from the mutability of the weather. An immenſe number of diſeaſes alſo may be produced by impure air, or ſuch as is loaded with putrid, marſhy, and other noxious vapours. The ſame

Causes of Diseases.

same thing may happen likewise from corrupted aliment, whether meat or drink; though even the best and most nutritious aliment will hurt if taken in too great quantity; not to mention poisons, which are endowed with such pernicious qualities, that even when taken in a very small quantity they produce the most grievous diseases, or perhaps even death itself. Lastly, from innumerable accidents and dangers to which mankind are exposed, they frequently come off with broken limbs, wounds, and contusions, sometimes quite incurable; and these misfortunes, though proceeding from an external cause at first, often terminate in internal diseases.

65 Diseases from accidents.

Hitherto we have mentioned only the dangers which come from without; but those are not less, nor fewer in number, which come from within. At every breath, man pours forth a deadly poison both to himself and others. Neither are the effluvia of the lungs alone hurtful: there flows out from every pore of the body a most subtile and poisonous matter, perhaps of a putrescent nature, which being long accumulated, and not allowed to diffuse itself through the air, infects the body with most grievous diseases; nor does it stop here, but produces a contagion which spreads devastation far and wide among mankind. From too much or too little exercise of our animal powers also no small danger ensues. By inactivity either of body or mind, the vigour of both is impaired; nor is the danger much less from too great employment. By moderate use, all the faculties of the mind, as well as all the parts of the body, are improved and strengthened; and here nature has appointed certain limits, so that exercise can neither be too much neglected, nor too much increased, with impunity. Hence those who use violent exercise, as well as those who spend their time in sloth and idleness, are equally liable to diseases; but each to diseases of a different kind: and hence also the bad effects of too great or too little employment of the mental powers.

66 Diseases from passions of the mind.

Besides the dangers arising from those actions of the body and mind which are in our own power, there are others arising from those which are quite involuntary. Thus, passions of the mind, either when carried to too great excess, or when long continued, equally destroy the health; nay, will even sometimes bring on sudden death. Sleep also, which is of the greatest service in restoring the exhausted strength of the body, proves noxious either from its too great or too little quantity. In the most healthy body, also, many things always require to be evacuated. The retention of these is hurtful, as well as too profuse an evacuation, or the excretion of those things either spontaneously or artificially which nature directs to be retained. As the solid parts sometimes become flabby, soft, almost dissolved, and unfit for their proper offices; so the fluids are sometimes inspissated, and formed even into the hardest solid masses. Hence impeded actions of the organs, vehement pain, various and grievous diseases. Lastly, some animals are to be reckoned among the causes of diseases: such particularly, as support their life at the expence of others: and these either invade us from without, or take up their residence within the body, gnawing the bowels while the person is yet alive, not only with great danger and distress to the patient, but sometimes even producing death itself.

Animal Solids.

67 *Vis medicatrix naturæ.*

Man, however, is not left without defence against so many and so great dangers. The human body is possessed of a most wonderful power, by which it preserves itself from diseases, keeps off many, and in a very short time cures some already begun, while others are by the same means more slowly brought to a happy conclusion. This power, called the *autocrateia*, or *vis medicatrix naturæ*, is well known both to physicians and philosophers. This alone is often sufficient for curing many diseases, and is of service in all. Nay, even the best medicines operate only by exciting and properly directing this force; for no medicine will act on a dead carcase. But though physicians justly put confidence in this power, and though it generally cures diseases of a slighter nature, it is not to be thought that those of the more grievous kind are to be left to the unassisted efforts of the *vis medicatrix*. Physicians therefore have a twofold error to avoid, either despising the powers of nature too much, or putting too great confidence in them; because in many diseases these efforts are either too feeble or too violent, insomuch that sometimes they are more to be dreaded than even the disease itself. So far therefore is it from being the duty of a physician always to follow the footsteps of nature, that it is often necessary for him to take a directly contrary course, and oppose her efforts with all his might.

68 Chemical analysis of the animal solids.

After a general view of the functions of the animal body, of the nature and causes of disease, and of the powers by which these are to be combated, Dr Gregory proceeds to treat of the solid materials of which the body is formed. He tells us, that the animal solid, when chemically examined, yields earth, oil, salt, water, phlogiston or inflammable air, and a great quantity of mephitic air. These elements are found in various proportions in the different parts of the body; and hence these parts are endowed with very different mechanical powers, from the hardest and most solid bone to the soft and almost fluid retina. Nay, it is principally in this difference of proportion between the quantities of the different elements, that the difference between the solid and fluid parts of the animal consist, the former having much more earth and less water in their composition than the latter. The cohesion, he thinks, is owing to something like a chemical attraction of the elements for one another; and its cause is neither to be sought for in the gluten, fixed air, nor earth. This attraction, however, is not so strong but that even during life the body tends to dissolution; and immediately after death putrefaction commences, provided only there be as much moisture in it as will allow an intestine motion to go on. The greater the heat, the sooner does putrefaction take place, and with the greater rapidity does it proceed; the mephitic air flies off, and together with it certain saline particles; after which, the cohesion of the body being totally destroyed, the whole falls into a putrid colluvies, of which at length all the volatile parts being dissipated, nothing but the earth is left behind.

This analysis, he owns, is far from being perfect, and is by no means in the language of modern chemistry.

Animal Solids.

try. But no modern chemist has ever been able, by combining the chemical principles of flesh, to reproduce a compound any thing like what the flesh originally was: yet, however imperfect the analysis may be, it still has the advantage of showing in some measure the nature and causes of certain diseases, and thus leads physicians to the knowledge of proper remedies.

69 Qualities of the animal solids.

The solid parts are fitted for the purposes of life in three several ways; namely, by their cohesion, their flexibility, and their elasticity, all of which are various in the various parts of the body. Most of the functions of life consist in various motions. In some the most violent and powerful motions are required; and therefore such a degree of cohesion is necessary in these parts as will be sufficient for allowing them to perform their offices without any danger of laceration. It is therefore necessary that some of the solid parts should be more flexible than others; and it is likewise necessary that these parts, along with their flexibility, should have a power of recovering their former shape and situation, after the removal of the force by which they were altered.

These variations in flexibility, within certain limits, seldom produce any material consequence with regard to the health: though sometimes, by exceeding the proper bounds, they may bring on real and very dangerous diseases; and this either by an excess or diminution of their cohesion, flexibility, or elasticity. By augmenting the cohesion, the elasticity is also for the most part augmented, but the flexibility diminished; by diminishing the cohesion, the flexibility becomes greater, but the elasticity is diminished.

The cause of these affections, though various, may be reduced to the following heads. Either the chemical composition of the matter itself is changed; or, the composition remaining the same, the particles of the solid may be so disposed, that they shall more or less strongly attract one another. As to the composition, almost all the elements my exist in the body in an undue proportion, and thus each contribute its share to the general disorder. But of many of these things we know very little; only it is apparent, that the fluid parts, which consist chiefly of water, and the solid, which are made up of various elements, are often in very different proportions: the more water, the less is the cohesion or elasticity, but the greater the flexibility; and the reverse happens, if the solid or earthy part predominates.

70 Causes affecting the solids.

The remote causes of these different states, whether predisponent or exciting, are very various. In the first place, idiosyncrasy itself, or the innate constitution of the body, contributes very much to produce the above-mentioned effects. Some have naturally a much harder and drier temperament of the body than others; men, for instance, more than women; which can with the utmost difficulty, indeed scarce by any means whatever, admit of an alteration. The same thing takes place at different periods of life; for, from first to last, the human body becomes always drier and more rigid. Much also depends on the diet made use of, which always produces a corresponding state of the solids in proportion to its being more or less watery. Neither are there wanting strong reasons for believing, that not only the habit of the body, but even the disposition of the mind, depends very much on the diet we make use of. The good or bad concoction of the aliment also, the application of the nourishment prepared from it, and likewise the state of the air with regard to moisture or dryness, affect the temperament of the body not a little; and hence those who inhabit mountains or dry countries, are very different from the inhabitants of low marshy places. Lastly, the manner of living contributes somewhat to this effect: Exercise presses out and exhales the moisture of the body, if in too great quantity; on the contrary, sloth and laziness produce an effect directly opposite, and cause a redundancy of fluid.

But, putting the chemical composition of the solid parts out of the question altogether, they may be affected by many other causes. The condensation, for instance, or compression of the particles, whether by mechanical causes or by means of cold or heat, makes a considerable alteration in the strength and elasticity of every solid body. How much mechanical pressure contributes to this may be understood from the experiments of Sir Clifton Wintringham: and hence also are we to deduce the reason of many facts of the highest importance in the animal economy; namely, the growth, state, decrease of the body; its rigidity daily increasing; and at last the unavoidable death incident to old age from a continuance of the same causes.

Perhaps the different density of the solids is in some measure owing to Nature herself; but it seems to depend more on the powers of exercise or inactivity in changing the state of the solids, the effects of which on the body whether good or bad, may hence be easily understood.

Heat relaxes and expands all bodies, but cold renders them more dense and hard; the effects of which on the human body are well known to most people. Though the body is found to preserve a certain degree of heat almost in every situation, yet its surface must unavoidably be affected by the temperature of the circumambient atmosphere; and we have not the least reason to doubt that every part of the body may thus feel the effects of that temperature. What a difference is there between one who, exposed to the south wind, becomes lazy and languid, scarce able to drag along his limbs; and one who feels the force of the cold north wind, which renders the whole body alert, strong, and fit for action?

That these various causes, each of which is capable of affecting the constitution of the body when taken singly, will produce much greater effects when combined, is sufficiently evident. The experiments of Bryan Robinson, the effects of the warm bath, and indeed daily experience, show it fully.

It is not yet certainly known what is the ultimate structure of the minutest parts of the animal-solid; whether it consists of straight fibres or threads, whose length is very considerable in proportion to their breadth, variously interwoven with one another, as Boerhaave supposes; or of spiral ones, admirably convoluted and interwoven with one another, as some microscopical experiments seem to show; or whether the cellular texture be formed of fibres or *laminæ*, and from thence the greatest part of the body, as the celebrated Haller hath endeavoured to prove.

The

Animal Solids.

71 Cellular texture.

The cellular texture is obſerved throughout the whole body: it ſurrounds and connects the fibres themſelves, which are ſufficiently apparent in many of the organs; and ſlightly joins the different parts which ought to have any kind of motion upon the neighbouring ones. By a condenſation of this ſubſtance alſo, the ſtrongeſt, and what ſeem the thinneſt, membranes are formed; the moſt ſimple of which being accurately examined, diſcover the cellular ſtructure. This cellular ſubſtance ſometimes increaſes to a ſurpriſing degree, and all parts formed of it, membranes, veſſels, &c. eſpecially by a gentle diſtenſion; for a ſudden and violent diſtenſion either breaks it altogether, or renders it thinner. Sometimes alſo it grows between neighbouring parts, and joins thoſe which nature has left free. Preternatural concretions of this kind are often obſerved after an inflammation of the lungs or of the abdominal viſcera; and theſe new membranes are found to be truly cellular. This ſubſtance, when cut, or by any other means divided, grows together of its own accord; but if, by reaſon of very great inflammation and ſuppuration, a large portion of the cellular texture has been deſtroyed, it is never again completely renewed, and an ugly ſcar is left. It is even ſaid, that this ſubſtance, in certain caſes, is capable of joining the parts either of the ſame body with one another, or of a foreign body with them; and upon this, if on any foundation, reſts the art of Taliacotius and that of tranſplanting teeth, lately ſo much talked of.

The cellular texture is in ſome places merely a kind of net-work, in others filled with fat. Wherever too great bulk or compreſſion would have been inconvenient or dangerous, as in the head, lungs, eyes, eyebrows, penis, ſcrotum, &c. there it collects no fat, but is lax, and purely reticulated; but between the muſcles of the body and limbs below the ſkin, in the abdomen, eſpecially in the omentum and about the kidneys, very much fat is ſecreted and collected.

72 Animal fat.

The fat is principally a pure animal oil, not very different from the expreſſed and mild vegetable ones; during life it is fluid, but of different degrees of thickneſs in different parts of the body. It is ſecreted from the blood, and is often ſuddenly reabſorbed into it, though pure oil is very rarely obſerved in the blood. It is indeed very probable, that oil, by digeſtion, partly in the primæ viæ, and partly in the lungs, is converted into gluten, and this again into oil by means of ſecretion; though no glandular organs ſecreting the fat can be ſhown by anatomiſts. It is however, probable, that there are ſuch organs; and that the cellular texture has ſome peculiar ſtructure in thoſe parts which are deſtined to contain the fat already ſecreted, without ſuffering it to paſs into other places; for it never paſſes into thoſe parts which are purely reticulated, although the cellular texture is eaſily permeable by air or water over the whole body from head to foot.

The fat is augmented by the uſe of much animal-food, or of any other that is oily and nouriſhing, provided the digeſtion be good; by the uſe of ſtrong drink, eſpecially malt-liquor; by much reſt of body and mind, much ſleep and inactivity, caſtration, cold, repeated bloodletting, and in general by whatever diminiſhes the vital and animal powers. Much, however, depends on the conſtitution of the body itſelf; nor is is poſſible to fatten a human creature at pleaſure like an ox. A certain degree of fatneſs, according to the age of the perſon, is a ſign and effect of good health; but when too great, it becomes a diſeaſe of itſelf, and the cauſe of other diſeaſes. It may always be very certainly removed by ſtrong exerciſe, little ſleep, and a ſpare diet. The fat commonly makes up a conſiderable part of the bulk of the body, and ſometimes by far the greateſt part. Its uſe ſeems to be to make the motion of the body more eaſy and free, by leſſening the friction of the moving parts, and thus preventing the abraſion of the ſolids, which would otherwiſe happen. It is alſo of uſe to hinder the parts from growing together, which ſometimes happens, when by an ulcer or any other accident a part of the cellular texture containing the fat is deſtroyed. Beſides all this, the fat contributes not a little to the beauty of the body, by filling up the large interſtices between the muſcles, which would otherwiſe give the perſon a deformed and ſhocking appearace. It is thought to be nutritious, when abſorbed from its cells into the blood; but of this we have no certain proof. It ſeems to have ſome power of defending from the cold; at leaſt, nature has beſtowed it in very great quantity on thoſe animals which inhabit the colder regions, as whales, bears, &c.

73 Vital ſolids.

Thoſe parts of the body which enjoy ſenſe and mobility, are called *living* or *vital* ſolids. They are the brain, cerebellum, medulla oblongata, ſpinal marrow, the nerves ariſing from theſe and diffuſed throughout the whole body, and which are diſtributed through the various organs of ſenſe and through the muſcles, and laſtly the muſcles themſelves. Senſation is much more general than mobility, as being common to all the parts already mentioned. Mobility is proper to the muſcular fibres alone: wherever there is ſenſation, therefore, we may believe that there are nerves; and wherever there is mobility, we may believe that muſcular fibres exiſt. Nay, even mobility itſelf ſeems to originate from the connection which the muſcles have with the nerves; for ſoon after the nerves are compreſſed, or tied, or cut, the muſcles to which they are diſtributed loſe their faculties; which happens, too, when the brain itſelf, or the origin of the nerves, is affected. Some reckon that the muſcles are produced from the nerves, and conſiſt of the ſame kind of matter. Both indeed have a ſimilar ſtructure, as being fibrous and of a white colour: for the muſcles when well freed from the blood, of which they contain a great abundance, are of this colour as well as the nerves; neither can the nervous fibres by any means be diſtinguiſhed from the muſcular fibres themſelves. Both have alſo ſenſation; and both ſtimulants and ſedatives act in the ſame manner, whether they be applied to the muſcles themſelves or to the nerves. Theſe circumſtances have led Dr Cullen and many others to conſider the muſcular fibre as being merely a continuation of nerve. But to this opinion there are many ſtrong objections; though there can be no doubt that the contraction of the muſcular fibre is intimately connected with nervous influence.

It is difficult for us to diſcover the origin of many parts of the body, or to aſcertain whether they are produced all at the ſame time or one after another: yet it muſt be owned, that many of the muſcular parts are obſerved to have attained a remarkable degree of

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ſtrength, while the brain is ſtill ſoft and almoſt fluid; and that the action of theſe muſcular parts is required for the action and growth of the brain. The muſcles are alſo of a much firmer contexture than the nerves; and enjoy a power of their own, namely, that of irritability, of which the nerves never participate. Of neceſſity, therefore, either the muſcles muſt be conſtructed of ſome kind of matter different from that of the nerves; or if both are made of the ſame materials, their organization muſt be exceedingly different. But if the ſubſtance of the muſcles and nerves be totally different, we may eaſily be convinced that much of the one is always mixed with the other; for it is impoſſible to prick a muſcle, even with the ſmalleſt needle, without wounding or lacerating many nervous fibres at the ſame time. Since, therefore, there is ſuch a cloſe connection between the muſcles and nerves both as to their functions and ſtructure, they are deſervedly reckoned by phyſiologiſts to be parts of the ſame genus, called the *genus nervoſum*, or *nervous ſyſtem*.

74 Senſe of feeling.

After treating of ſenſe in general, Dr Gregory proceeds to conſider particularly each of the ſenſes both external and internal. He begins with the ſenſe of feeling, as being the moſt ſimple, and at the ſame time in common to every part of the nervous ſyſtem. In ſome places, however, it is much more acute than in others; in the ſkin, for inſtance, and eſpecially in the points of the fingers. Theſe are reckoned to have *nervous papillæ*, which by the influx of the blood are ſomewhat erected in the action of contact, in order to give a more acute ſenſation; though indeed this opinion ſeems rather to be founded on a conjecture derived from the ſtructure of the tongue, which is not only the organ of taſte, but alſo a moſt delicate organ of touch, than upon any certain obſervations.

75 Pain.

From the ſenſe of feeling, as well as all the other ſenſes, either pain or pleaſure may ariſe; nay, to this ſenſe we commonly refer both pain and almoſt all other troubleſome ſenſations, though in truth pain may ariſe from every vehement ſenſation. It is brought on by any great force applied to the ſentient part; whether this force comes from within or from without. Whatever, therefore, pricks, cuts, lacerates, diſtends, compreſſes, bruiſes, ſtrikes, gnaws, burns, or in any manner of way ſtimulates, may create pain. Hence it is ſo frequently conjoined with ſo many diſeaſes, and is often more intolerable than even the diſeaſe itſelf. A moderate degree of pain ſtimulates the affected part, and by degrees the whole body; produces a greater flux of blood to the part affected, by increaſing the action of its veſſels; and it ſeems alſo to increaſe the ſenſibility of the part affected to future impreſſions. It often ſtimulates to ſuch motions as are both neceſſary and healthful. Hence, pain is ſometimes to be reckoned among thoſe things which guard our life. When very violent, however, it produces too great irritation, inflammation and its conſequences, fever, and all thoſe evils which flow from too great force of the circulation; it diſorders the whole nervous ſyſtem, and produces ſpaſms, watching, convulſions, delirium, debility, and fainting. Neither the mind nor body can long bear very vehement pain; and indeed Nature has appointed certain limits, beyond which ſhe will not permit pain to be carried, without bringing on delirium, convulſions, ſyncope, or even death, to reſcue the miſerable ſufferer from his torments.

Long-continued pain, even though in a more gentle degree, often brings on debility, torpor, palſy, and rigidity of the affected part. But if not too violent, nor accompanied with fever, ſickneſs, or anxiety, it ſometimes ſeems to contribute to the clearneſs and acuteneſs of the judgement, as ſome people teſtify who have been afflicted with the gout.

76 Anxiety.

Anxiety is another diſagreeable ſenſation, quite different from pain, as being more obtuſe and leſs capable of being referred to any particular part, though frequently more intolerable than any pain. But we muſt take care to diſtinguiſh between this anxiety of which we treat in a medical ſenſe, and that which is ſpoken of in common diſcourſe. The latter does not at all depend on the ſtate of the body, but belongs entirely to the mind; and ariſes from a ſenſe of danger, or a foreſight of any misfortune. The former is truly corporeal; and derives, no leſs than pain, its origin from a certain ſtate of the body. Notwithſtanding this difference, however, it is very poſſible for both theſe kinds of anxiety to be preſent at the ſame time, or for the one to be the cauſe of the other. A very great bodily anxiety will ſtrike fear and deſpondency into the moſt reſolute mind; and mental anxiety, on the contrary, if very violent and long-continued, may induce the former, by deſtroying the powers of the body, eſpecially thoſe which promote the circulation of the blood.

Anxiety, in the medical ſenſe of the word, ariſes in the firſt place from every cauſe diſturbing or impeding the motion of the blood through the heart and large veſſels near it. Anxiety, therefore, may ariſe from many diſeaſes of the heart and its veſſels, ſuch as its enlargement, too great conſtriction, oſſification, polypus, palpitation, ſyncope, inflammation, debility, and alſo ſome affections of the mind. It is likewiſe produced by every difficulty of breathing, from whatever cauſe it may ariſe; becauſe then the blood paſſes leſs freely through the lungs: anxiety of this kind is felt deep in the breaſt. It is ſaid alſo to ariſe from the difficult paſſage of the blood through the liver or other abdominal viſcera.

A certain kind of anxiety is very common and troubleſome to hypochondriacal people; and ariſes from the ſtomach and inteſtines being either loaded with indigeſted and corrupted food, or diſtended with air produced by fermentation and extricated from the aliments. By ſuch a load, or diſtention, the ſtomach, which is a very delicate organ, becomes greatly affected. Beſides, the free deſcent of the diaphragm is thus hindered, and reſpiration obſtructed. Anxiety of this kind is uſually very much and ſuddenly relieved by the expulſion of the air; by which, as well as by other ſigns of a bad digeſtion, it is eaſily known. In theſe caſes the anxiety is uſually, though with little accuracy, referred to the ſtomach.

Anxiety alſo frequently accompanies fevers of every kind, ſometimes in a greater and ſometimes in a leſſer degree. In this caſe it ariſes as well from the general debility as from the blood being driven from the ſurface of the body and accumulated in the large veſſels; as in the beginning of an intermittent fever. Or it may ariſe from an affection of the ſtomach, when

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when overloaded with crude, corrupted aliment; or distended and nauseated with too much drink, especially medicated drink. As the fever increases, the anxiety of the patient becomes greater and greater; remarkably so, according to the testimony of physicians, either immediately before the crisis or on the night preceding it; as before the breaking out of exanthemata, hæmorrhagy, sweat, or diarrhœa, which sometimes remove fevers. The patient feels likewise an anxiety from the striking in of any eruption or critical metastasis. This sensation also accompanies fevers and most other diseases, when the vital power is exhausted, and death approaches, of which it is the forerunner and the sign. It happens at that time, because the vital powers, unable to perform their functions, cannot make the blood circulate. But what kind of anxiety this is, the other signs of approaching death show very evidently. Moreover, even in the time of sleep, anxiety may arise from the same causes: hence frightful dreams, which frequently disturb our repose with surprise and terror.

77 Itching.

Itching, an uneasy sensation, with a desire of scratching the place affected, is often very troublesome, although it seems to be more a-kin to pleasure than to pain. As pain proceeds from too great an irritation, either chemical or mechanical, so does itching proceed from a slight one. Titillation, or friction, of a woollen shirt, for instance, upon the skin of a person unaccustomed to it, and of a delicate constitution, excites itching; as do also many acrid fossils, vegetables, and animals. Hence an itching is the first sensation after the application of cantharides, although the same, when augmented becomes painful. The same effect is produced by any thing acrid thrown out upon the skin; as in exanthematic fevers, the disease called the *itch*, &c. Lice, worms, especially ascarides, irritating either the skin or the intestines, excite a troublesome itching.

Too acute a sensation over the whole body is very rarely if ever observed. In a particular part the sense of feeling is often more acute than it ought to be, either from the cuticle itself being too thin and soft, or being removed; or from the part itself being inflamed, or exposed to too great heat. It becomes obtuse, or is even quite destroyed over the whole body, or in great part of it, from various affections of the brain and nerves; as when they are wounded, compressed, or defective in vital power. This is called *anæsthesia*, and sometimes accompanies palsy.

This sense may be deficient in a particular part, either from the nerve being diseased, or from its being compressed or wounded, or from the part itself being exposed to too great a degree of cold;—or from the scarf-skin which covers it being vitiated, either becoming too thick or hard, by the handling of rough, or hard, or hot bodies, as is the case with glass-makers and smiths; or from the elevation of the cuticle from the subjacent cutis, or true skin itself, by the interposition of blood, serum, or pus; or from the cutis being macerated, relaxed, or become torpid, which sometimes happens to hydropic persons; or lastly, from the whole organ being corrupted by gangrene, burning, cold, or contusion. This sense is very rarely depraved, unless perhaps in the case of delirium, when all the functions of the brain are disturbed in a surprising manner.

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78 Taste.

The sense next to be considered is that of taste, the principal organ of which is the tongue; the nearer the tip of it, the more acute is the sense, and the nearer the glottis so much the more obtuse. It must be owned, however, that some kind of acrid substances, the taste of which is scarcely perceived upon the tip of the tongue, excite a most vehement sensation about its roots, or even in the throat itself. The tongue is endowed with many large and beautiful nervous papillæ, which seem to be the chief seat of this sense, and in the act of tasting are elevated and erected, in order to give the more acute sensation.

Nothing can be tasted which is not soluble in the saliva, that, being applied in a fluid form, it may pervade the involucra of the tongue, and affect its nervous pulp; and hence insoluble earths are quite insipid. Neither is it sufficient for a body to be soluble that it may be tasted: it must also have something in it saline, or at least acrid, in order to stimulate the nervous substance; and hence, whatever has less salt than the saliva is totally insipid.

The taste is rarely found to be too acute, unless through a fault in the epidermis which covers the tongue. If this be removed or wounded, or covered with ulcers, aphthæ, &c. then the taste, becoming too acute, is painful: or sometimes no other sensation than that of pain is felt. It may be impaired, as well as the sense of feeling, from various diseases of the brain and nerves; of which, however, the instances are but rare. In some people it is much more dull than in others; and in such the sense of smelling is usually deficient also. The taste is most commonly deficient on account of the want of saliva; for a dry tongue cannot perceive any taste: hence this sense is very dull in many diseases, especially in fevers, catarrhs, &c. as well on account of the defect of saliva as of appetite, which is of so much service in a state of health; or by reason of the tongue being covered with a viscid mucus.

The taste is frequently depraved; when, for example, we have a perception of taste without the application of any thing to the tongue; or if any thing be applied to it, when we perceive a taste different from what it ought to be. This happens for the most part from a vitiated condition of the saliva, which is itself tasted in the mouth. Hence we may perceive a sweet, saline, bitter, putrid, or rancid taste, according to the state of the saliva: which may be corrupted either from the general vitiated condition of the mass of humours, or the glands which secrete it; of the mouth itself; or even of the stomach, the vapours and eructations of which rise into the mouth, especially when the stomach is diseased.

Besides the faults of the saliva, however, the taste may be vitiated from other causes; as, for instance, the condition of the nervous papillæ. This, however, is as yet but little known to us; for the taste is sometimes plainly vitiated when at the same time the saliva appears quite insipid when tasted by other people.

Physicians, in almost every disease, but especially in fevers, inquire into the state of the tongue; not, indeed, without the greatest reason: for from this they can judge of the condition of the stomach; of the thirst, or rather the occasion the patient has for drink, when, on account of his delirium or stupor, he neither feels his thirst

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thirſt, nor is able to call for drink. And, laſtly, from an inſpection of the tongue, phyſicians endeavour to form ſome judgement concerning the nature, increaſe, and remiſſion of the fever.

79 Smell.

After the ſenſe of taſte, we ſhall next treat of that of ſmell. Its ſeat is in that very ſoft and delicate membrane, filled with nerves and blood-veſſels, which covers the internal parts of the noſe, and the various ſinuſes and cavities proceeding from thence. This ſenſe is more acute about the middle of the ſeptum, and the *oſſa ſpongioſa*, where the membrane is thicker and ſofter, than in the deeper cavities, where the membrane is thinner, leſs nervous, and leſs filled with blood-veſſels; although even theſe do not ſeem to be altogether deſtitute of the ſenſe of ſmelling.

As by our taſte we judge of the ſoluble parts of bodies, ſo by our ſmell we judge of thoſe very volatile and ſubtile parts which fly off into the air; and like the organ of taſte, that of ſmell is kept moiſt, that it may have the more exquiſite ſenſation, partly by its proper mucus, and partly by the tears which deſcend from the eyes.

Some kinds of odours greatly affect the nervous ſyſtem, and produce the moſt ſurpriſing effects. Some gratefully excite it, and immediately recruit the ſpirits when almoſt ſinking; while ſome produce fainting, nay, as it is alleged, even ſudden death. To this head alſo are we to refer thoſe antipathies, which, though truly ridiculous, are often not to be ſubdued by any force of mind.

This ſenſe is ſometimes too acute, as well from ſome diſeaſe in the organ itſelf, which happens more rarely, as from the too great ſenſibility of the nervous ſyſtem in general, as is ſometimes obſerved in nervous fevers, phrenitis, and hyſteria. It is more frequently, however, too dull, either from diſeaſes of the brain and nerves, as from ſome violence done to the head, or from ſome internal cauſe; or it may proceed from a dryneſs of the organ itſelf, either on account of the cuſtomary humours being ſuppreſſed or turned another way, or from the membranes being oppreſſed with too great a quantity of mucus or of tears. Of both theſe caſes we have inſtances in the catarrh, where at firſt the noſtrils are dry, but afterwards are deluged with a thin humour, or ſtopped up with a thick one. But in theſe, and many other examples, the membrane of the noſe itſelf is affected with inflammation, relaxation, or too great tenſion, by which the nerves, which conſtitute a great part of it, muſt be vitiated. It is evident alſo, that whatever obſtructs the free entrance of the air into the noſtrils, or impedes its paſſage through them, muſt prove detrimental to the ſenſe of ſmelling.

80 Hearing.

The ſenſe of hearing is more frequently vitiated than almoſt any of the reſt, as having a moſt delicate organ, and one compoſed of many and very ſmall parts, of which an account is given under the article ANATOMY.—It frequently becomes too acute; either from the general habit of the body being too irritable, ſuch as often happens to hyſterical and lying-in-women; or from too great a ſenſibility of the brain itſelf, which is not unfrequently obſerved in fevers, as well as in phrenitis, and ſometimes in the true mania; or it may be from a diſeaſe of the ear itſelf, as when it is affected with inflammation, pain, or too great tenſion.—It may

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be rendered dull, or even be altogether deſtroyed, ſo that the perſon ſhall become totally deaf, from the ſame cauſes acting with different degrees of force. This happens eſpecially from the want of the external ear; or from the meatus auditorius being ſtopped up with mucus, wax, or other matters; or from the ſides of the canal growing together, as ſometimes happens after ſuppuration or the ſmall-pox; or by the membrane of the tympanum becoming rigid or relaxed, or being eroded or ruptured; or the tympanum itſelf, or the Euſtachian tube, may from certain cauſes be obſtructed; or ſome of the little bones or membranes, or ſome of the muſcles of the labyrinth, may be affected with concretion, ſpaſm, palſy, or torpor; or laſtly, it may happen from diſeaſes of the brain and nerves, all the organs of hearing remaining ſound. Hence deafneſs is often a nervous diſeaſe, coming ſuddenly on, and going off ſpontaneouſly. Hence alſo it is common in old people, all of whoſe ſolid parts are too rigid, while their nervous parts have too little ſenſibility.

Perſons labouring under fevers, eſpecially of the typhous kind, often become deaf. When this comes on along with other ſigns of an oppreſſed brain, and a great proſtration of ſtrength, it may be a very bad ſymptom; but for the moſt part it is a very good one, even though accompanied with ſome degree of torpor or ſleepineſs.

A very common diſeaſe in the ſenſe of hearing is when certain ſounds, like thoſe of a drum, a bell, the falling of water, &c. are heard without any tremor in the air, or without a ſound perſon's hearing any thing. This diſeaſe is called *tinnitus aurium*, of which various kinds have been obſerved. For the moſt part it is a very ſlight tranſient diſorder; but ſometimes it is moſt obſtinate, long-continued, and troubleſome. It often ariſes from the ſlighteſt cauſe, ſuch as any thing partially ſtopping up the meatus auditorius or Euſtachian tube itſelf, ſo that acceſs is in part denied to the air; whence it happens that the latter ſtrikes the membrane of the tympanum, or perhaps the interior parts, unequally, and with too much force. Hence *bombi*, a kind of tinnitus, are heard even by the moſt healthy when they yawn.

A much more frequent and troubleſome ſpecies of tinnitus accompanies many diſeaſes both of the febrile and nervous kind. This is occaſioned partly by the increaſed impetus of the blood towards the head, with an increaſe of ſenſibility in the nervous ſyſtem itſelf, ſo that the very beatings of the arteries are heard; and partly from the increaſed ſenſation and mobility of the nerves and muſcles of the labyrinth: whence it happens, that the parts which ought to be at reſt until excited by the tremor of the air, begin to move of their own accord, and impart their motion to other parts which are already in a morbid ſtate of too great ſenſibility.

A tinnitus ſometimes ariſes from any vehement affection of the mind; ſometimes from a diſorder in the ſtomach; ſometimes from a rheumatic diſorder affecting the ears and head; or from a catarrh, which commonly affects the Euſtachian tube. Sometimes, however, the tinnitus alone affects the patient; and even this is a diſeaſe of no ſmall conſequence. Theſe various cauſes, however, both of this and other diſorders of the hearing,

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hearing, are often very difficult to be diſtinguiſhed, as well on account of the inacceſſible ſituation of the organ, as on account of the little knowledge we have of its action. But from whatever cauſe it ariſes, both this and the other affections of the hearing can neither be cured certainly nor eaſily, but by the removal of the cauſe, whatever it may be.

81 Sight.

Concerning the nature of the ſenſe of ſight, the reader may conſult the articles ANATOMY and OPTICS. Of this ſenſe ſome ſlight diſorders, or rather varieties, are often obſerved. Thoſe perſons are called *ſhort-ſighted* who cannot ſee diſtinctly unleſs the object be very near them. This diſorder ariſes from too great a refraction of the rays by reaſon of their being too ſoon collected into a focus by the cryſtalline lens, and diverging again before they fall upon the retina, by which means they make an indiſtinct picture upon it. The moſt common cauſe is too great a convexity of the eye or ſome of its humours, as too prominent a cornea. It is a diſorder common to young people, which is ſometimes removed when they grow older. As ſoon as the firſt approaches of ſhort-ſightedneſs are obſerved, it is ſuppoſed it may be obviated by the perſon's accuſtoming himſelf to view remote objects, and keeping his eyes off very ſmall and near ones; as, on the contrary, it may be brought on by the oppoſite cuſtom; becauſe the eye accommodates itſelf ſomewhat to the diſtances of thoſe objects which it is accuſtomed to view. But a concave glaſs, which cauſes the rays of light to diverge more than naturally they would before falling upon the cornea, is the moſt ſimple and certain remedy.

Long-ſighted people are thoſe who cannot ſee an object diſtinctly unleſs it be at a conſiderable diſtance from them. This ariſes from cauſes contrary to the former; namely, the eye being too flat, ſo that there is no room for refracting the rays and bringing them into a focus. Hence this defect is common in old people, and remedied by the uſe of convex glaſſes.

Thoſe are called *nyctalopes* who ſee better with a very weak than with a ſtrong light. It is a defect very ſeldom to be met with in the human race, though every perſon is ſenſible of it who hath been long kept in the dark and is then ſuddenly brought into the light. The diſeaſe ariſes from too great a ſenſibility of the retina, and the pupil being too open.

The ſight is liable to many and grievous diſorders. It is ſharpened beyond meaſure, ſo that the perſon either perceives nothing diſtinctly, or with great pain, from the ſame cauſes that induce a ſimilar diſorder in the other ſenſes; namely, exceſſive ſenſibility in the general habit of body; or a particular ſtate of the brain common in phrenitis, or even in thoſe afflicted with fevers ariſing from inflammation or too great excitement; though more frequently from the condition of the eye itſelf, one becomes unable to bear the light. The inflammation of the tunica adnata, and the forepart of the ſclerotica, is communicated to the back parts of it, and from thence to the choroides and retina itſelf. Hence the light becomes intolerable, and viſion is attended with pain and great irritation, ſometimes inducing or augmenting a delirium.

The ſenſe of ſeeing is made dull, or even totally aboliſhed, by age; the aqueous humour not being ſupplied in ſufficient quantity, and the cornea and lens, or the vitreous humour, becoming ſhrivelled or decayed. It may likewiſe happen from the cornea becoming dry and opaque; which is to be imputed to the languid motion of the blood, and to great numbers of the ſmall veſſels being obſtructed or having their ſides concreted;—or from the cryſtalline lens becoming yellow like amber, and the retina itſelf leſs ſenſible, for old age diminiſhes every ſenſation. It is totally aboliſhed by injuries of the brain, the optic nerve, or the retina, even though the ſtructure of the organ ſhould remain ſound. This diſeaſe is called an *amauroſis*; and is eaſily known by the dilatation and immobility of the pupil, the humours of the eye remaining clear. It is commonly owing to congeſtion of blood; and ſometimes, where no congeſtion of blood can be diſcovered, to mere torpor of the nerves. If it be only a torpor of part of the retina, we ſee black ſpots in thoſe things at which we look; or flies ſeem to paſs before our eyes, a very bad ſign in fevers, and almoſt always mortal. The ſight is aboliſhed alſo by the obſcurity or opacity of any of the parts through which the rays ought to paſs and be refracted; as if the cornea loſe its tranſparency by being covered with ſpots; or the aqueous humours become corrupted with blood, ſerum, or pus; or the lens (which often happens and which is called a *cataract*) becomes of a gray or brown colour, or the vitreous humour be in like manner corrupted; or laſtly, when all the humours being diſſolved, confuſed, and mixed together, by inflammation and ſuppuration, either do not ſuffer the light to paſs at all, or to paſs imperfectly and unequally; whence either no image is formed on the retina, or it appears obſcure, diſtorted, imperfect, and ill-coloured.

The ſight is alſo depraved, when things appear to it of a colour different from their own, or even in another ſituation and of another ſhape than they ought to have. This happens from the humours being tinctured with any unuſual colour, as is ſaid to happen in ſome inſtances of jaundice; or from an extravaſation and mixture of the blood with the aqueous humour. A ſurpriſing depravation alſo, or conſtant and perpetual defect of viſion, is not unfrequently obſerved in men otherwiſe very healthy, and who ſee quite clearly; namely, that they cannot diſtinguiſh certain colours, green, for example, from red. Another depravation is, when, without any light being admitted to the eyes, ſparks, ſmall drops of a flame or gold colour, and various other colours, are obſerved to float before us. This is generally a very ſlight and tranſient diſorder, common to thoſe whoſe conſtitutions are very irritable; and ariſes from the ſlight impulſe, as it would ſeem, on the retina, by the veſſels beating more vehemently than uſual. A fiery circle is obſerved by preſſing the eye with the finger after the eye lids are ſhut. The ſame reaſon, perhaps, may be given for thoſe ſparks which are ſeen by perſons labouring under the falling-ſickneſs, and increaſing to the ſize of an immenſe and luminous beam before they fall down in convulſions. A ſimilar beam thoſe who have recovered from hanging or drowning teſtify that they have obſerved: for by reaſon of the reſpiration being ſuppreſſed, the veſſels of the head ſwell and compreſs the whole brain and nervous parts of the head. Sparks of the ſame kind, and theſe too of no good omen,

External Senses.

omen, are observed in patients labouring under a fever, where a phrenitis or fierce delirium is at hand; and likewise in those who are threatened with palsy, apoplexy or epilepsy.—A distinct but false perception, namely of visible things which do not exist, is to be imputed to some injury of the brain, to madness or a delirium, not to any disease of the eye.

A very frequent defect of vision remains to be mentioned; namely, squinting. A person is said to squint who has the axes of the eyes more oblique than usual, and directed to different points. Hence a great deformity, and often an imperfect and confused vision by which the objects are sometimes seen double. It is an evil for the most part born with the person, and often corrected by those attempts which an infant makes to see more pleasantly and distinctly; and this even without being conscious of its own defects. It is also easily learned, especially in infants, even without their own knowledge, by that kind of imitation which has a great influence over the human race, especially in their tender years.—It is by no means, however, so easily unlearned.

Squinting is frequently occasioned by a spasm, palsy, rigidity, &c. of the muscles which manage the eye; by epilepsy; by certain diseases of the head, the hydrocephalus especially; or by any great injury done to the head. Sometimes, though very rarely, it comes on suddenly without any known cause, It is very probable, however, that squinting often arises from a fault of the retinæ, when their central points, for instance, and those similarly placed with respect to the centre, do not agree. In this case there must be a contortion of the eye, that the object may not be seen double. This seems also to be the reason why squinting is much increased when the person brings the object near his eye in order to view it more perfectly. Or if the central point of either, or both, of the retinæ be insensible or nearly so, it is necessary for the person to distort his eyes that he may have any distinct vision of objects. If the optic nerve had not entered the retina obliquely, but passed directly through its centre, we would all either have squinted or seen double.

82 Vertigo.

Physicians have referred to the sense of vision that most troublesome sensation which we call a *vertigo;* though it seems rather to belong to that of feeling, or of consciousness; for in many instances the disorder is not removed either in the dark or by shutting the eyelids. The vertigo takes place when external objects really at rest seem to reel, to whirl round, to tremble, or to move in any manner of way. If the disorder be very violent, the person is neither able to see, on account of a dimness of sight; nor can he stand, as the powers fail which ought to govern the limbs. A nausea also usually accompanies the vertigo, and the one generally produces the other.

This disorder is observed to be both the symptom and forerunner of some dangerous diseases; such as apoplexy, epilepsy, hysteria; hæmorrhages from the nose and other parts; suppressions of the menses; plethora; fevers, as well such as are accompanied with debility as those in which there is an increased impetus of the blood towards the head. An injury done to the head also, but rarely one done to the eyes, unless as it affects the whole head, brings on a vertigo. A vertigo may be likewise produced by a very great and sudden loss of blood or other fluid; by debility; syncope; various diseases of the alimentary canal, of the stomach especially; poisons admitted into the body, particularly of the narcotic kind, as opium, stramonium, wine, &c. and hence vertigo is a symptom of every kind of drunkenness. Various motions also, either of the head or the whole body, being tossed in a ship, especially if the vessel be small and the sea runs high, produce a vertigo. In these and similar examples, the unusual and inordinate motions of the blood are communicated to the nervous parts which are in the head; or these being affected by sympathy from the neighbouring parts, produce a confused sensation as if of a rotatory motion. Nay, it is often produced from an affection of the mind itself, as from beholding any thing turned swiftly round, or a great cataract, or looking down a precipice, or even by intense thought without looking at any thing.

Internal Senses.

Though a vertigo be for the most part a symptom and concomitant of other diseases, yet it is sometimes a primary disease, returning at intervals, increasing gradually, and equally impeding and destroying the functions of the body and mind.

After having treated of the external senses, we shall next proceed to consider those properly called *internal;* which are, the *memory*, the *imagination*, and the *judgement*. The first is lessened, disturbed, or even totally destroyed, in many diseases, especially those which affect the brain; as in apoplexy, palsy, internal tumours of the head, external violence applied, fevers, especially those in which there is an increased motion of the blood towards the head, or where the brain is any other way very much affected. It is very rarely, however, depraved in such a manner that ideas are not represented to the mind in their proper order; or if at any time such a disorder occurs, it is considered rather as a disorder of the imagination, or as a delirium, than a failure of the memory. The mind is said to be disordered when the perceptions of memory or imagination are confounded with those of sense, and of consequence those things believed to be now present which are really past or which never existed; or when the sense of the person concerning ordinary things is different from that of other people. The general name for such disorders is *vesania:* if from fever, it is called *delirium.* A general fury without a fever, is called *mania* or *madness:* but a partial madness, on one or two points, the judgement remaining sound in all other respects, is called *melancholia.* There is, however, no exact and accurate limits between a sound mind and madness. All immoderate vivacity borders upon madness; and, on the other hand, a sorrowful and gloomy disposition approaches to melancholy. 83 Memory.

Delirium accompanies fevers of many different kinds. Sometimes it is slight, easily removed, and scarce to be accounted a bad sign. Often, however, it is very violent, and one of the very worst of signs, requiring the utmost care and attention. 84 Delirium.

A delirium is either fierce or mild. The fierce delirium is preceded and accompanied by a redness of the countenance, a pain of the head, a great beating of the arteries, and noise in the ears; the eyes in the mean time looking red, inflamed, fierce, shining, and unable to bear the light; there is either no sleep at all, Delirium. all; or ſleep troubled with horrid dreams; the wonted manners are changed; an unuſual peeviſhneſs and ill-nature prevail. The depravation of judgement is firſt obſerved between ſleep and waking, and by the perſon's crediting his imagination, while the perceptions of ſenſe are neglected, and the ideas of memory occur in an irregular manner. Fury at laſt takes place, and ſometimes an unuſual and incredible degree of bodily ſtrength, ſo that ſeveral attendants can ſcarce keep a ſingle patient in his bed.

The mild delirium, on the contrary, is often accompanied with a weak pulſe, a pale collapſed countenance, and a vertigo when the patient ſits in an erect poſture; he is ſeldom angry, but often ſtupid, and ſometimes remarkably grieved and fearful. The loſs of judgement, as in the former kind, is firſt perceived when the patient is half awake; but a temporary recovery enſues upon the admiſſion of the light and the converſation of his friends. The patient mutters much to himſelf, and attends little to the things around him; at laſt, becoming quite ſtupid, he neither feels the ſenſations of hunger or thirſt, nor any of the other propenſities of nature, by which means the urine and excrements are voided involuntarily. As the diſorder increaſes, it terminates in ſubſultus tendinum, tremors, convulſions, torpor, and death. The other ſpecies of delirium alſo frequently terminates in death, when the ſpirits and ſtrength of the patient begin to fail.

The ſymptoms accompanying either of theſe kinds of delirium ſhow an unuſual, inordinate, and unequal motion of the blood through the brain, and a great change in that ſtate of it which is neceſſary to the exerciſe of the mental powers. It is very probable, that an inflammation of the brain, more or leſs violent and general, ſometimes takes place, although the ſigns of univerſal inflammation are frequently ſlight. This we learn from the diſſection of dead bodies, which often ſhow an unuſual redneſs of the brain or of ſome of its parts, or ſometimes an effuſion or ſuppuration.

The ſtate of the brain, however, may be much affected, and delirium induced, by many other cauſes beſides the motion of the blood. In many fevers, typhus, for inſtance, the nervous ſyſtem itſelf is much ſooner and more affected than the blood's motion; and though the morbid affections of the nervous ſyſtem are as inviſible to the ſenſes as the healthy ſtate of it, the ſymptoms of its injuries plainly ſhow that its action, or *excitement*, as ſome call it, is unequal and inordinate. In this way, too, delirium is produced by ſeveral poiſons.

85 Melancholy and mania.

The pathology of melancholy and mania is much more obſcure; as coming on without any fever, or diſturbance in the blood's motion. Often alſo they are hereditary, depending on the original ſtructure of the body, eſpecially of the brain; the fault of which, however, cannot be detected by the niceſt anatomiſt. But it is well known, that various diſeaſes of the brain, obſtructions, tumors, either of the brain itſelf, or of the cranium preſſing upon it, any injury done to the head, and, as ſome phyſicians relate, the hardneſs and dryneſs of the brain, and ſome peculiar irritations affecting the nervous ſyſtem, are capable of bringing on this malady. And indeed ſo great are the irritations affecting the nervous ſyſtem in mad people, that they often ſleep little or none for a long time.—Yet even this ſo defective and imperfect knowledge of the diſeaſes of the brain and nerves, is by no means free from difficulties. For though we know that the brain, or a certain part of it, is hurt, or that it is irritated by a ſwelling, or a pointed bone growing into it, nobody can foretel how great, or what may be the nature of the malady from ſuch a hurt: for examples are not wanting of people who, after loſing a large part of the brain, have recovered and lived a long time; there are many inſtances alſo of perſons who have perceived no inconvenience from a large portion of that viſcus being corrupted, until at length they have fallen ſuddenly down and died in convulſions.

Idiotiſm.

86 Idiotiſm.

Another diſeaſe of the internal ſenſes, quite different from theſe, is *fatuity* or *idiotiſm*. Thoſe are called *idiots* who are deſtitute either of judgement or memory, or elſe have theſe faculties unequal to the common offices of life. A weak memory, however, is by no means eſſential to idiotiſm. For there are ſome inſtances of idiots who have had very correct and very extenſive memories. A kind of idiotiſm is natural and common to all infants; neither is it to be accounted a diſeaſe; but if it laſt beyond the ſtate of infancy, it is a real diſeaſe, and for the moſt part incurable. It has the ſame cauſes with the other diſeaſes of the internal ſenſes; although theſe can ſcarcely be detected by the eye or by the knife of the anatomiſt. It frequently accompanies, or is the effect of, epilepſy. Hence, if the epilepſy derives its origin from cauſes not ſeated in the head, as from worms lodging in the inteſtines, the fatuity may be cured by diſlodging theſe, and removing the epilepſy. It is not unlikely that the fatuity of children, and the dotage of old men, may ariſe from the brain being in the former too ſoft, and in the latter too hard; or perhaps in the one caſe not evolved, and in the other ſomewhat decayed.

87 Diſorders in the muſcular power.

The muſcular power may be diſeaſed in a great number of ways. The mobility itſelf may be too great; but this muſt be carefully diſtinguiſhed from vigour. By mobility is meant the eaſe with which the muſcular fibres are excited into contraction. The vigour, on the other hand, is that power with which the contraction is performed. They are ſometimes joined, but more frequently ſeparate, and for the moſt part the exceſſes of each are owing to contrary cauſes.

88 Mobility.

Too great mobility is when motions are excited by a very ſlight ſtimulus, or when very violent motions are produced by the cuſtomary ſtimulus. A certain habit of body, ſometimes hereditary, renders people liable to this diſeaſe. Women have a greater ſhare of mobility than men. Infants have a great deal of mobility, often too great; youth has leſs than infancy, but more than man's eſtate; though old age has commonly too little. A lazy, ſedentary life, full diet, a ſuppreſſion of the uſual evacuations, fulneſs of the blood-veſſels, and ſometimes their being ſuddenly emptied, laxity, flaccidity of the ſolids in general, but ſometimes too great a tenſion of the moving fibres, the uſe of diluents, eſpecially when warm, or heat applied in any manner, produce too great mobility. And this may be either general or particular, according as the cauſes have been applied to the whole body, or only to a part of it.

89 Vigour.

Vigour in general is rarely morbid; although ſometimes certain muſcular parts appear to have too great ſtrength. In maniacs and phrenitics, an immenſe ſtrength

Disorders in the Muscular Power.

strength is observed in all the muscles, especially in those which serve for voluntary motion; this is not unjustly reckoned morbid. The reason of this excess is very obscure; however, it is plainly to be referred to a diseased state of the brain.

A more frequent and more important excess of vigour is observed in those muscular fibres that do not obey the will, such as those which move the blood. Its circulation is thus often increased, not without great inconvenience and danger to the patient. But a slighter excess of this kind, pervading the whole body, renders people apt to receive inflammatory diseases, and is usually called a *phlogistic diathesis*. But this is better observed when local, as in inflammation itself.

Too great vigour of the muscular fibres may arise from the nervous power increased beyond measure, as in mania, phrenitis, or violent affections of the mind; from too great a tension of the fibres, by which they more easily and vehemently conceive motions, as of the arteries when filled with too much blood; from catching cold, by being exposed either to cold or heat, as usually happens in the spring; or lastly, though the nervous power and tension of the fibres should not at all be changed, their action may become too great, from a stimulus more violent than usual being applied, or from the usual stimulus, if the fibres themselves have already acquired too great a share of mobility.

90 Torpor.

The opposite to too great mobility is torpor, and to too great vigour is debility. Torpor is such a diminution of mobility as renders the parts unequal to their functions. It arises from causes directly opposite to mobility; such as, a harder and more rigid contexture of the parts themselves, or even sometimes from one too lax and flaccid; from old age; from some peculiar temperament of body, such as one phlegmatic, frigid, or insensible; too great and incessant labour, cold, spare diet, and an exhausted body. This evil is the more to be dreaded, because, the powers of the body being deficient, nature is neither able to make any effort of herself, nor are the remedies, in other cases the most efficacious, capable of affording her any assistance.

91 Debility.

Debility takes place, when the motion of the muscles, either voluntary or involuntary, is not performed with sufficient strength. A greater or lesser share of debility, either general or of some particular part, accompanies almost all diseases, and is indeed no small part of them: for it is hardly possible that a disease can subsist for any length of time without inducing some degree of debility. When a state of debility is induced, it renders a man obnoxious to innumerable disorders, and throws him as it were defenceless in their way. It often depends on the original structure of the body, so that it can be corrected neither by regimen nor medicines of any kind. A different degree of strength also accompanies the different ages of mankind; and thus, in some cases, debility cannot be reckoned morbid. But a truly morbid and unusual debility arises from the nervous energy being diminished; from diseases of the brain and nerves, or of the muscles through which they are distributed; from a decay of the nerves themselves; from a want of the due tension of the fibres, or the fibres themselves becoming torpid; from the body exhausted by spare diet, want, evacuations; or lastly, from diseases affecting the whole body, or some particular parts of it.

Disorders in the Muscular Power.

92 Palsy.

The highest degree of debility, namely, when the strength of the muscles is altogether or nearly destroyed, is called *paralysis* or *palsy*; and is either universal, or belonging only to some particular muscles. An universal palsy arises from diseases of the brain and nerves, sometimes very obscure, and not to be discovered by the anatomist; for the nervous power itself is often deficient, even when the structure of the nerves remains unhurt; yet often a compression, obstruction, or injury of the vessels, extravasation of blood, or serum, collections of pus, swellings, &c. are discovered. It frequently arises from certain poisons acting on the nerves; from the fumes of metals; from the diseases of parts, and affections of the muscles, very remote from the brain, as in the colic of Poictou. A palsy of single muscles, but less perfect, often arises without any defect of the brain or nerves, from any violent and continued pain, inflammation, too great tension, relaxation, rest, or destruction of the texture of the parts, such as commonly happens after the rheumatism, gout, luxations, fractures of the bones, and ischuria.

An *universal* palsy, however, as it is called, seldom affects the whole body, even though it should originate from a disease of the brain. We most commonly see those who are paralytic affected only on one side, which is called an *hemiplegia*. It is said that the side of the body opposite to the diseased side of the brain is most commonly affected. If all the parts below the head become paralytic, it is called a *paraplegia*. In these diseases the senses for the most part remain; though sometimes they are abolished, and at others rendered dull. Sometimes, though rarely, and which is an exceeding bad symptom, the motion, sensation, pulse, and heat of the paralytic limbs are lost; in which case the arteries themselves become paralytic. A palsy of the whole body, as far as regards the voluntary motions, with anæsthesia and sleep, is called an *apoplexy*. This proceeds from some injury of the brain: though a state very similar to it is induced by narcotics, opium, wine itself, or any generous liquor taken to excess; and lastly, by breathing in air corrupted by noxious impregnations, such as a large proportion of carbonic acid, hydrogenous gas, or similar active aeriform fluids.

93 Spasm.

Another disease to which muscular motion is liable, and that neither slight nor unfrequent, is called *spasm*. This is a violent and irregular motion of the muscles. Of spasms there are two kinds, the tonic and clonic. The latter is frequently called a *convulsion*; in order to distinguish it from the other, which is more peculiarly called *spasm*.

Spasm therefore is a violent, constant, and preternatural contraction of the muscular fibres; but a convulsion is an unusual and violent contraction alternated with relaxation. People are rendered liable to spasm by too sensible a habit of body, or too great mobility; and hence it is a disease common in women, in infants, and in weak, luxurious, lazy, and plethoric people. It is brought on those already predisposed to it, by any kind of stimulus applied to the brain, or to any nerve, muscle, or nervous part connected with it: of

Disorders of Sleep.

of which we have examples in dentition; worms lodged in the inteftines, and irritating them; any acrid matter infecting the blood, or much affecting the ftomach and inteftines; the irritation of any nerve, or of the brain itfelf, by an exoftofis, fwelling, too great fulnefs of the veffels, pain, vehement affections of the mind, fudden evacuation, or poifons admitted into the body. Frequently, however, the malady originates from flight caufes, little known, and not eafily obferved.

Spafm is both the caufe and effect, and frequently conftitutes the greateft part, of many difeafes. It is often very difficult either to be known or cured; becaufe it is fo multiform, and produces as many different fymptoms as there are organs affected; of which it furprifingly difturbs, impedes, or increafes the functions. It is a difeafe feated in the original ftamina of the conftitution; and neither to be removed by flight remedies, nor in a fhort time.

94 Sleep.

With regard to fleep, its ufe is fufficiently apparent from the effects which it produces in the body. It reftores the powers both of mind and body when exhaufted by exercife, giving vigour to the one, and reftoring its wonted alacrity to the other. It renders the mufcles again active and moveable, after they have become wearied, rigid, painful, and trembling by hard labour. It moderates the quicknefs of the pulfe, which ufually increafes at night, and brings it back to its morning ftandard. It feems alfo to affift the digeftion of the aliment; leffens both the fecretions and excretions; and renders the fluids thicker than otherwife they would be, efpecially in a body endowed with much fenfibility or mobility. Hence fleep is not only ufeful, but abfolutely neceffary for preferving life and health; and is a moft excellent remedy both for alleviating, and totally removing, many difeafes.

Want of fleep is hurtful in many different ways, efpecially to the nervous fyftem. It renders the organs of fenfe both external and internal, as well as thofe of every kind of motion, unfit for performing their offices. Hence the fenfations are either abolifhed, or become imperfect or depraved; and hence imbecility of mind, defect of memory, a kind of delirium, mania itfelf, pain of the head, weaknefs of the joints, an imperfect or inordinate action of the vital organs, quicknefs of pulfe, heat, fever, depraved digeftion, atrophy, leannefs, and an increafe or perturbation of the fecretions and excretions.

Sleep may be prevented both in healthy and fick people from various caufes; fuch as ftrong light, noife, pain, anger, joy, grief, fear, anxiety, hunger, thirft, vehement defire, motion of the body, memory, imagination, intenfe thought, &c. On the other hand, fleep is brought on by a flight impreffion on the organs of fenfe, or none at all; by the humming of bees, the noife of falling water, cold and infipid difcourfe; or laftly, by fuch an exercife of the memory as is neither too laborious nor difturbing to the mind.—Too great an impulfe of the blood towards the head, fuch as often happens in fevers, prevents fleep; but a free and equal diftribution of the blood through the whole body, efpecially the extreme parts, frequently brings it on. Whatever weakens the body alfo favours fleep; and hence various kinds of evacuations, the warm bath, fomentations, fometimes heat itfelf, are ufeful for promoting it. It alfo comes on eafily after taking food, or indulging venery; the violent fenfation being then quieted, and the body itfelf fomewhat weakened. Cold produces a deep fleep of long continuance, not eafily difturbed, and often terminating in death. Laftly, There are certain fubftances which, when applied to the body, not only do not excite the nervous fyftem, but plainly lay us afleep, and render us unfit for fenfation; of this kind are thofe called *narcotics*, as opium and the like, among which alfo we may reckon wine taken in too great quantity. Laftly, Watching itfelf is often the caufe of fleep; becaufe while a man is awake he always more or lefs exercifes the organs of his body, by which the nervous influence is diminifhed, and thus the more violently the body is exercifed, in the fame proportion is the perfon under a neceffity of fleeping.

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Sleep is deficient in many difeafes; for there are few which do not excite pain, anxiety, or uneafinefs, fufficient to prevent the approach of fleep, or to difturb it. Fevers generally caufe thofe who labour under them to fleep ill; as well on account of the uneafinefs which accompanies this kind of difeafe, as by reafon of the impetus of the blood towards the head being frequently increafed; and likewife from the ftomach being difordered, loaded with meat, or diftended with drink. Hence alfo we may fee the reafon why many hypochondriac and hyfteric patients fleep fo ill; becaufe they have a bad digeftion, and their ftomach is difpofed to receive many though frequently flight diforders; the flighteft of which, however, is fufficient to deprive the patient of reft, provided the body be already irritable, and endowed with too great a fhare of mobility.

Want of fleep will hurt in difeafes as well as in health; and for the fame reafon; but in a greater degree, and more quickly, in the former than in the latter; and is therefore not only a very troublefome fymptom of itfelf, but often produces other very dangerous ones.

Too much fleep, on the other hand, produces many mifchiefs, rendering the whole body languid, torpid, and lazy; and it even almoft takes away the judgement. It alfo difturbs the circulation, and diminifhes moft of the fecretions and excretions. Hence plethora, fatnefs, flaccidity, and an inability for the common offices of life.—The caufes of this excefs are, either the ufual caufes of fleep above mentioned increafed beyond meafure, or fome fault in the brain, or a compreffion of it by an extravafation of the humours; or fometimes, as it would feem, from great debility produced by an unufual caufe, as in thofe who are recovering from typhous fevers and other difeafes. In thefe examples, however, this excefs of fleep is by no means hurtful; nor even, perhaps, in thofe cafes where an excefs of grief continued for a long time, or a great fright, have produced a furprifing and unexpected fomnolency. Laftly, Many people have accuftomed themfelves, and that not without a great deal of hurt to their conftitutions, to fleep too much. Nor are there examples wanting of fome who have paffed whole days, and even months, in fleep almoft uninterrupted.

With regard to the manner in which the circulation of the blood is performed, and the various principles of which it is compofed, fee the articles BLOOD, and ANATOMY. As for the diforders to which the blood and its circulation are fubject, it has been obferved, 95 Circulation.

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that in our younger years the veins are much more denſe, firm, and ſtrong, than the arteries; but the latter, by reaſon of the continual preſſure upon them, and the ſtrength which they exert, become daily more firm, hard, and ſtrong, until at laſt they equal or exceed the veins themſelves in ſtrength; and it is not uncommon in old men to find ſome part of the arteries converted into an horny ſubſtance, or even into a ſolid bone. Hence in the ſtate of infancy the greateſt part of the blood is contained in the arteries, and in old age in the veins; an affair indeed of no ſmall moment, as it ſhows the reaſon, in ſome meaſure, of the ſtate of increaſe and decreaſe of the body. Beſides, if any diſeaſe happens from too great a quantity of blood, it thence appears that it muſt ſhow itſelf in young ſubjects in the arteries, and in old ones in the veins; and this is the reaſon of many diſeaſes which accompany certain periods of life.

In moſt, if not in all ſpecies of animals, the arteries of the females are much more lax and capacious when compared with the veins, and the veins much leſs, than in the males of the ſame genus. The deſign of nature in this conformation, is probably that they may be the better able to nouriſh the fœtus in their womb. The ſame likewiſe ſeems to be the reaſon why women are more inclined to plethora than men; and to this greater capacity of the arteries and ſmallneſs of the veins are we to aſcribe that beauty and elegant ſhape of the arms in women, not disfigured or livid with veins as in men.

The blood is alſo diſtributed in various proportions to the different parts of the body, and that proportion too differs at different periods of our lives. At firſt a great quantity is ſent to the head, becauſe that part of the body is firſt to be evolved and fitted for its offices: but as ſoon as the parts begin to make a conſiderable reſiſtance to the efforts of the blood, and the veſſels cannot eaſily be further dilated, it is neceſſarily ſent off to other parts; by which means the reſt of the body increaſes in bulk, and becomes fitted for performing its proper functions. The effect of this change is alſo very ſoon obſerved, namely, when none of the blood paſſes through the navel, and of conſequence a greater quantity is ſent by the iliac arteries to the inferior extremities. Theſe, though ſo ſmall and ſlender in the fœtus, increaſe very ſuddenly; ſo that often in not many months the child can not only ſtand on its feet, but even walk tolerably well. And during the earlieſt periods of infancy, the inferior extremities grow more rapidly than any other part of the body.

96 Pulſation of the arteries.

Phyſicians are wont to judge of the ſtate of the circulation by the pulſe, which indeed is very various, as well with regard to its frequency, as to the ſtrength and equality of its ſtrokes and intervals.—Its common quickneſs in a healthy adult is about 70 ſtrokes in a minute. In a fœtus, perhaps, it is more than double; and in an infant a few months old, hardly leſs than 120. As we grow up, this quickneſs gradually diminiſhes; ſo that in extreme old age it ſometimes does not exceed 50, or is even ſlower. This rule, however, is not without exceptions: for many, eſpecially thoſe of an irritable habit, have the pulſe much quicker; while others, even in the vigour of their age, have their pulſe remarkably ſlow. It is for the moſt part ſomewhat quicker in women than in men.

The pulſe is alſo rendered quicker, both in a healthy and diſeaſed body, by the application of ſtimuli of many different kinds. Exerciſe eſpecially, by accelerating the return of the blood through the veins, increaſes the quickneſs of the pulſe to a ſurpriſing degree. Various kinds of irritations affecting the nervous ſyſtem, as intenſe thinking, paſſions of the mind, pain, heat, ſtimulating medicines, wine, ſpices, &c. likewiſe produce the ſame effect. The acrimony of the blood itſelf alſo is thought to quicken the pulſe.

When a perſon firſt awakes in the morning, the pulſe is ſlow, but becomes quicker by degrees on account of the many irritating matters applied to the body. Its quickneſs is increaſed after taking food, eſpecially of the animal kind, or ſuch as is hot or ſeaſoned with ſpices. In the evening a ſlight fever comes on, for which reſt and ſleep are the remedy. Theſe things, however, are ſcarcely to be obſerved in a healthy perſon, but are very evident in one that is feveriſh, eſpecially when the fever is a hectic.—Again, even debility itſelf often renders the pulſe quicker than uſual; becauſe the ventricle of the heart not being quite emptied, it is the ſooner dilated again, and of conſequence contracts the ſooner. For this reaſon a phyſician can never judge of the ſtrength of the circulation from the frequency of the pulſe.

Laſtly, In all fevers, however different from one another, the pulſe is found to be too quick, partly perhaps from debility, partly from the acrimony of the fluids, and partly from the repulſion of the blood from the ſurface of the body, and the accumulation of it in the large veſſels where it acts as a ſtimulus; though it muſt be owned, that a great deal of this is obſcure, if not totally unknown; nor in truth are we able to underſtand in what manner the *autocrateia* acts with regard to the frequency of the pulſe.

The pulſe is ſeldom obſerved too ſlow, unleſs when the mobility of the body is much diminiſhed, as in decrepid old age, or from a compreſſion or diſeaſe of the brain, as is exemplified in the ſecond ſtage of hydrocephalus; but a greater compreſſion of the brain uſually produces a ſtill more remarkable ſlowneſs of the pulſe, as in the third ſtage of hydrocephalus.—Sometimes alſo the pulſe is too ſlow in thoſe who are recovering from tedious fevers. But this is a matter of little moment, and ſeems to be owing to ſome kind of torpor. Indeed it has generally been conſidered as a mark of a thorough and complete ſolution of the fever; for it is commonly obſerved, that when this ſtate of the pulſe takes place, the patient ſeldom ſuffers a relapſe.

While the frequency of the pulſe continues the ſame, its ſtrokes may be either full, great, ſtrong, and hard; or ſoft, ſmall, and weak. A full, great, and ſtrong pulſe takes place when the ventricle ſtrongly and completely empties itſelf; throwing out a great quantity of blood into the arteries, which fully diſtends them and ſtimulates them to a ſtrong contraction. A pulſe of this kind is common in ſtrong healthy men, and is ſeldom to be accounted a ſymptom of diſeaſe. But if it be too ſtrong, and ſtrike the finger of the perſon who feels it violently and ſharply, it is called a *hard pulſe.* This hardneſs is produced by a ſudden and violent contraction of the heart and arteries, which diſtends even the remote branches, as thoſe of the wriſt, too ſuddenly and

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and fmartly, and excites them alfo to fudden and violent contractions.

A hard pulfe therefore denotes too great an action of the heart and arteries. It may arife from various caufes: in the firft place, from too great a tenfion of the veffels; for inftance, from their being too full, and by that means more prone to motion, and the more fit for receiving violent motions. It may arife alfo from too great a denfity and firmnefs of the folids; and hence it is moft frequent in cold countries, among ftrong robuft people, and fuch as are accuftomed to hard labour. It may likewife arife from various caufes irritating the whole nervous fyftem, or only the heart and arteries. Laftly, It accompanies many fevers, as well as moft inflammatory diforders, whether the inflammation arifes from a general ftimulus applied to the whole body, or from the irritation of particular parts, by degrees extended over the whole body. In fuch a ftate of the circulation, the patient frequently ftands in need of blood-letting, and almoft always bears it well.

A fmall, weak, and foft pulfe is generally owing to caufes oppofite to the former, and indicates a contrary ftate of the circulation and nervous fyftem. It frequently requires ftimulants; nor does it generally require blood-letting, or eafily bear it. Sometimes, however, a pulfe of this kind is obferved even in the cafe of a dangerous inflammation, of the ftomach for inftance, or inteftines. But in thefe and the like examples we ought to attend to the nature of the malady, much more than to the ftate of the pulfe.

The pulfe is faid to intermit, when the ftroke does not return after the ufual interval, and perhaps not till after twice, thrice, or four times the ufual fpace. A pulfe of this kind feems to be almoft natural and conftant in fome animals, and is common to fome men even in the moft perfect health; and if thefe happen to be feized with a fever, the pulfe fometimes becomes regular, nor can the difeafe be removed before the intermiffion has returned.

Moreover, in fome people, though their pulfe beats equally while in health, yet the flighteft illnefs makes it intermit; and in others, efpecially thofe who have a great deal of mobility in their conftitution, fuch as hypochondriac and hyfteric people, the intermiffion of the pulfe is felt, without applying the finger to the artery, merely by the uneafinefs which they perceive in their breafts during thofe intervals in which the pulfe is deficient. An intermittent pulfe likewife occurs in many difeafes of the breaft, efpecially when water is collected in it; and the like happens in the end of all difeafes, efpecially fevers, when the ftrength is nearly exhaufted, and death approaches, of which it is frequently the forerunner.

An intermitting pulfe therefore feems to arife from an unequal influx of the nervous power into the heart, or from the decay and exhauftion of the nervous power, by which means the heart is not able to contract till it has been diftended beyond its due pitch. Or laftly, It may arife from difeafes of the organ itfelf, or the neighbouring parts; from fwellings, water, &c. preffing upon them, and impeding the action of the heart: which indeed is a very dangerous diforder, and almoft always mortal.

Many other variations of the pulfe are enumerated by phyficians, but moft of them are uncertain, and not confirmed by experience. We fhall therefore now confider the motion of the blood, which may be either too great, too fmall, or irregular.

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A quick pulfe, *cæteris paribus*, produces a more rapid circulation, becaufe the fooner that the ventricle of the heart is emptied, the more quickly is the blood thrown into the arteries; and their actions muft anfwer to this ftronger ftimulus. Hence exercife, heat, ftimulants, plethora, every kind of irritation, paffions of the mind, and fever, increafe the circulation. The effect of this increafe is a diftention of the veffels, a ftimulus applied to the whole body, an increafe of heat, and often a debility. The fecretion of fweat is increafed while the other fecretions are diminifhed, and the various functions of the body impeded; thirft comes on, the appetite is loft, the fat confumed, and a difpofition to putrefcency introduced. Sometimes the fmaller veffels are burft; whence effufions of blood and hæmorrhages. But we are by no means to forget, that this violent motion of the blood, however hurtful it may feem, is among the beft remedies made ufe of by nature in curing many difeafes.

The motion of the blood is diminifhed, efpecially by debility, torpor, the want of irritation or of exercife: the fame thing happens to all the fluids, if there be any obftruction in the veffels, or any caufe by which their return is hindered or rendered more difficult. Thus, from the very weight of the blood itfelf, if a perfon has ftood long on his feet, the humours return more flowly from the inferior extremities. Any difeafe of the heart and arteries alfo, as an aneurifm, contraction, offification, muft neceffarily obftruct the circulation. The fame thing happens from obftructions of the veins, or interrupted refpiration, by which the paffage of the blood through the lungs to the left fide of the heart is impeded.

But, from whatever caufes this diminution of the circulation takes place, the bad confequences are perceived chiefly in the veins, becaufe in them the blood always moves more flowly than in the arteries. Hence varices, and congeftions of blood, efpecially in thofe parts of the body where the veins are deftitute of valves, and of confequence where the motion of the mufcles cannot affift the circulation. Hence alfo arife dropfies from an impeded or languid motion of the blood; becaufe the refiftance of the veins being increafed, the blood is received into them with the greater difficulty, and more of the thin humour is driven into the exhaling veffels, and by them depofited in fuch quantities as cannot be reabforbed by the lymphatics. Thefe difeafes, as well as all others proceeding from defects of the circulation, are alfo more difficult of cure than others, becaufe all the vital powers are weakened at the fame time.

Another diforder of the circulation is where the blood is carried to one part of the body in too great quantity, by which means the other parts are deprived of their due proportion. This irregular diftribution of the vital fluid frequently arifes from a ftimulus applied to the part itfelf, or to the brain, or at length acting on the mind, which, according to the laws of fympathy, produces a certain definite diftribution of the

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the blood. It arifes alfo not unfrequently from a fpafm taking place in fome other parts, which drives the blood out of its ordinary courfe.

In proportion to this irregularity of the circulation are the confequences; heat, fwelling, rednefs, inflammation, rupture of veffels, hæmorrhages, effufions, deftruction, corruption, and fuppuration of the cellular texture and adjoining parts, &c. Even this evil, however, nature often converts into an excellent remedy; and phyficians, following her fteps, frequently attempt to direct the diftribution of the blood in particular difeafes, well knowing that a change in the diftribution of the blood is frequently efficacious either for radically curing fome difeafes, or relieving their moft urgent fymptoms.

97 Palpitation.

Laftly, Some diforders in the motion of the heart itfelf, and thofe of no fmall confequence, remain yet to be taken notice of, namely, palpitation and fyncope. A palpitation is a violent and irregular action of the heart, fuch as for the moft part is perceived by the patient himfelf, and that not without a great deal of uneafinefs and oppreffion at his breaft; and it is alfo manifeft to the by-ftanders, if they apply their hands, or look at his naked breaft; the pulfe of the arteries in the mean time being weak, unequal, and intermittent. This is a fpafmodic diforder; and is induced by various caufes affecting either the nervous fyftem in general, or the heart in particular. Every difeafe of the organ itfelf, fuch as a conftriction of its valves and blood-veffels, an offification, enlargement, or polypus, hindering the free action of the heart, and evacuation of blood from it, are capable of exciting it to violent and unufual contractions. The fame effect will alfo follow plethora, or too violent an impulfe of the blood. The heart will likewife frequently palpitate from a violent excitement of the nervous fyftem, efpecially where the conftitution is endowed with a great deal of mobility. Hence palpitations arife from any affection of the mind, and in hyfteric women. Palpitation may likewife arife from an affection of the ftomach, occafioned by worms, a furfeit, flatus, or ftimulation by various acrid fubftances. It frequently alfo accompanies the gout when repelled, or even when a fit is coming on. Sometimes it arifes from debility, whatever may be the caufe; frequently from any difficulty in breathing; and many of thefe caufes may be joined at the fame time, or fome of them produce others.

Hence we may fee why the evil is fometimes flight and of fhort continuance; at other times altogether incurable, and certainly mortal in a longer or fhorter time; why it fometimes returns at intervals, often coming on and being increafed by every kind of irritation and exercife, and fometimes relieved or totally removed by ftimulants or exercife.

98 Syncope.

A fyncope takes place when the action of the heart, and along with it that of the arteries, is fuddenly and very much leffened; whence the animal powers, the fenfes, and voluntary motions, immediately ceafe. This may be produced by almoft all the caufes of palpitation; becaufe whatever can difturb and diforder the motion of the heart, may alfo weaken or fufpend it. The vitiated ftructure of the heart itfelf therefore, violent paffions of the mind, whether of the depreffing kind, or thofe which fuddenly and vehemently excite, various kinds of nervous difeafes, thofe of the ftomach, every kind of debility and evacuation, efpecially a great lofs of blood, exceffive and unremitting labour, long watching, heat, pain, many kinds of poifons, &c. produce fainting.

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Hence we fee, that whatever weakens the motion of the blood through the brain tends to produce fainting; and, on the contrary, whatever tends to augment that motion, alfo tends to refrefh, and to prevent the perfon from fainting. Hence alfo we fee how the mere pofture of the body may either bring on or keep off fainting, or remove it after it has already come on. We likewife fee how this diforder may fometimes be of little confequence and eafily removed; at others very dangerous, not only as a fymptom, but even of itfelf, as fometimes terminating in death; and laftly, how it may be ufed as a remedy by a fkilful phyfician, and artificially induced, either to free the patient from violent pain, or to ftop an immoderate effufion of blood fcarce to be reftrained by any other method.

99 Buff-coloured cruft on the blood.

With regard to the diforders of the blood itfelf, the glutinous part of it, or, more properly, its fibrine feparated from the red particles, produces that buff-coloured appearance often feen upon blood drawn from people afflicted with inflammatory diforders, and even fometimes when no fuch difeafes are prefent. This cruft indeed is nothing elfe than the fibrine of the blood taking longer time than ufual to coagulate, by which means the red particles have an opportunity of falling to the bottom. This indicates no lentor, denfity, thicknefs, or tenacity of the blood, as was formerly thought; but rather its thinnefs, or at leaft a lefs tendency in it to coagulate. It arifes for the moft part from a violent agitation and conquaffation of the blood within the body; and hence it accompanies many fevers, all inflammations, fometimes hæmorrhages, exanthemata, plethora, pain, and many irritations. It muft, however, be allowed, that in feveral of thefe difeafes it is rendered highly probable at leaft, from experiments apparently accurate, that the quantity of the fibrine of the blood is really increafed in the proportion which it bears to the other parts. This cruft, however, is not always to be accounted morbid, as it often happens to the moft healthy; and may even be produced or deftroyed by the flighteft caufes while the blood is running from the vein, fo that frequently we fhall fee a very thick and tenacious cruft on the blood flowing into one cup, while that which runs into another has little or none at all. In general, however, the appearance of this cruft fhows, that the patient will bear blood-letting well, though thofe have been in a great miftake who have directed this operation to be repeated till no more cruft appeared on the blood.

The coagulable part of the blood alfo frequently produces thofe maffes called *polypi*, which fometimes take place during life, but more frequently after death, in the large veffels near the heart, or even in the cavities of that organ. Similar maffes alfo are frequently formed in the uterus, and are called *moles*.

100 Plethora.

The quantity of blood contained in a healthy body is very various, and difficult to be afcertained. Many difeafes, however, may arife from its being either too fcanty or too abundant. Too great a quantity of blood is produced by the ufe of rich, nourifhing diet, ftrong drink, accompanied with a good digeftion; from a lazy, fedentary life, or much fleep, efpecially in

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in those who have been formerly accustomed to much exercise; with many other causes of the same kind. It renders the person dull and languid, and sometimes almost totally oppresses him; nor are those organs destined for moving the blood sufficient for driving forward such a load. The pulse sinks; and sometimes a syncope, vertigo, or palpitation takes place. More frequently, however, the vessels are too much distended, and ready to be thrown into violent and irregular motions. Hence a disposition to fevers, inflammations, an unequal distribution of the blood, unusual congestions, rupture of the vessels, and hæmorrhages. Besides this, in consequence of the close connection between the sanguiferous and the nervous system, a fulness of blood produces a disposition to spasm and other diseases of that kind.

Hence we may understand why a plethora is sometimes accompanied with a weak and sometimes with a strong and hard pulse, why it is the cause as well as a part of so many distempers, why it is the effect of a high state of health, &c.

101 Inanition.

The want of a due quantity of blood is no less pernicious than too great an abundance of it. It debilitates the person, and renders him unable to perform the proper duties of life; produces a languid circulation, syncope, spasms, and at last death itself. In a slighter degree of the disease the body is emaciated through want of nourishment, and its functions are vitiated in various ways. It may arise from want, bad food, or such as affords little nourishment: from bad digestion, or the chyle being hindered from passing into the blood: from fevers, or other diseases which exhaust the body and hinder nutrition: or lastly, from various evacuations, particularly of blood; and that the more especially if they are sudden, for in slow evacuations the vessels accommodate themselves surprisingly to the quantity left in them. Besides, if the body be slowly exhausted, the excretions are lessened by reason of the deficiency of the vital power; so that the unusual expence is easily compensated by the unusual retention. But if the evacuation happens to be very sudden and great, it may either prove mortal in a short time, or break the constitution to a degree beyond recovery.

102 Morbid thinness of the blood.

By a great and long-continued deficiency of blood the quality of it also is impaired; because the thin part of it is easily and soon made up; but the glutinous, and red part, not so easily. Hence the blood becomes thin, pale, scarcely capable of coagulation, or of affording a proper support to the body. Too great thinness of the blood also proceeds from using much drink, especially of the aqueous kind, slender and unnutritious diet, a bad digestion in the stomach; from diseases of the lungs and those organs which elaborate the red part; or from suppression of the usual evacuations of thin humours, as sweat or urine, induced by cold, a fault of the secreting organs, or from putrescency. But along with this, other disorders of the blood concur.

A too thin and watery blood makes the face pale, the body weak and languid. The solid parts become flaccid from want of nourishment, and having too great a quantity of water in their composition. It brings on hydropic effusions of water in all parts of the body, by reason of the increased exhalation of that thin fluid which moistens all the inward parts; partly by reason of the vessels being relaxed beyond their usual pitch, and not making a proper resistance. Besides, in this case, the lymphatics are so far from absorbing more than usual, that, partaking likewise of the general debility, they are scarcely fitted for performing their proper offices.

Nature, however, has taken care, by the most simple means, to provide against so many and so great evils; for neither does the blood so easily become thin as some have imagined, nor when this quality takes place does it want a proper remedy. For almost instantly, if the person be otherwise in health, the excretions of watery matters are greatly augmented, and the whole mass of blood in a short time becomes as thick as formerly.

103 Morbid thickness of the blood.

The opposite to this, namely, too great a thickness of the blood, though often spoken of by physicians, is very rarely if ever observed; and those fevers and inflammations which have been thought to arise from thence, are now found to originate from other causes. The following would seem to be the law of the human constitution. As soon as the blood has attained the due degree of thickness, or gone in the least beyond it, the excretions are either suppressed or diminished, the body attracts more moisture from the air, the person is thirsty, and drinks as much as is necessary for diluting the blood. But if water be wanting, and the person cannot satisfy his thirst, then the blood is so far from being thickened, that by reason of a putrescency begun or augmented, it is much dissolved, becomes acrid, and is with difficulty contained in the vessels.

104 Acrimony of the blood.

The acrimony of the fluids has afforded a large field for declamation to speculative physicians, and upon this slender foundation many perplexed and intricate theories have been built. It is certain indeed, that the blood in a state of health has some small share of acrimony; and this acrimony, from certain causes, may be a little increased so as to produce various diseases of a dangerous nature. This we are assured of from the increase of motion in the heart and arteries, and the similar augmentation of the action of the secretory organs, when certain acrid substances are taken inwardly. The same thing also appears from the unusual acrimony of the secreted fluids in such cases, by which the vessels are sometimes greatly stimulated, and sometimes even quite eroded. Very many acrid substances, however, are daily taken into the stomach; so that these must either be corrected in the *primæ viæ*, or changed by digestion before they pass into the blood; or at least by dilution with much water, or being blunted by an admixture with gluten, oil, or different gases, they must deposit much of their acrimony, and at last be thrown out of the body as noxious substances. Thus a vast quantity of salts, acid, alkaline, and neutral, may pass through the body, without in the least affecting the health; though these salts, if taken in very large quantity, undiluted, or not thrown out of the body, will do much hurt.

Moreover, even while life continues, putrefaction is going on, and produces much of that substance called *animal* salt; for into this a great part of our food is converted, and passes off by the urine. But if this putrescent disposition be too great, it will produce too large a quantity of animal salt; especially if much of any saline substance is otherwise thrown into the body without

Disorders of the Blood.

without proper dilution : and this kind of disease is well known to sailors who have been long at sea without having an opportunity of getting fresh provisions.

For this spontaneous putrescency, nature has suggested a proper remedy, namely, fresh meat, especially of the vegetable and acescent kind, and such as is much impregnated with acid, which it may impart to the body. But where this kind of food is wanting, the putrefaction goes on apace, and a very great thinness and acrimony of the juices take place; especially if there be also a scarcity of urine, or the excretions which ought to carry the putrid matters out of the body languish, either from cold, sloth, torpor, depressing passions of the mind, or from the constitution being broken by diseases; or lastly, from too great heat, which always favours putrefaction.

Besides, it would seem, that sometimes a disposition to putrefaction is much increased by the reception of a putrid ferment into the body; of which we have examples in some infectious fevers, where the contagion is very much assisted by heat, animal diet, certain kinds of salts, debility and nastiness.

Lastly, Any single part of the body may putrefy from various causes, as from inflammation, cold, &c. and thus may the whole body be infected; although for the most part the disease proves fatal before the corruption has spread over the whole body.

But when the mass of blood begins to putrefy greatly, it not only becomes very acrid, but thin also, so that it either will not coagulate at all, or shows only a slight and very loose crassamentum. Nay, even the red globules are broken down and destroyed; in which case it necessarily follows, that the blood must become very acrid, as well on account of the evolution of the salt, as by reason of the rancid and putrid gluten, which stimulates, and frequently even erodes, the vessels; producing spots, first red, then livid and black, tumors, and ulcers scarce possible to be cured, without first removing the putrescent disposition of the humours. From the same causes proceed hæmorrhages from every part of the body, hardly to be restrained; a most intolerable fetor of the breath and all the excrements; the highest debility and laxity of the solids; the putrefaction acting as a poison to the nervous system, and at length bringing on death.

An acrimony of the acid kind never takes place in the human blood, nor in any of the humours secreted from it; though one of them, namely the milk, turns acid spontaneously in a very short time after it is drawn from the breast. Neither does an alkaline acrimony seem ever to take place in the blood. Putrescency indeed tends this way, and at last terminates in it; but scarcely while the person lives, though the nature of the urine, even while recent, seems to be but little distant from that of an alkali.

Many kinds of acrimony may exist in the blood from too liberal an use of spices, wine, spirits, &c. but of these we know nothing certain. We well know, however, that the body is often infected with various kinds of morbid acrimony, which bring on many and dangerous diseases, as the small-pox, measles, cancers, lues venerea, &c. of which the origin and manner of acting are very little understood, though the effects are abundantly evident. In most cases, nature has taken no less care to provide against the *acrimony* than against the too great *viscidity* of the blood. Sometimes an antidote is afforded, either by the excitement of thirst, that the acrid substance may be diluted with plenty of drink; or by increasing the evacuations, that it may be thrown out of the body; or lastly, by exciting various motions and actions of the vital powers, by which it may be either subdued, changed, rendered innocent, or expelled from the body by new and unwonted passages.

Disorders of Respiration.

105 Respiration.

With regard to respiration, it may be obstructed from various causes seated either in the lungs themselves or the surrounding parts. But from whatever cause this obstruction may arise, it undoubtedly produces all those diseases which proceed from an interrupted circulation. The lungs themselves also being at length compressed, and not suffered to dilate sufficiently, cannot throw off the vapour which arises from them; and hence they are frequently oppressed with moisture. At the same time they are irritated, so that a greater quantity of mucus, and that of a thicker kind than usual, is secreted; by which means the passages through which the air enters them are stopped up, till a violent cough at length throws off the load.

The respiration is also subjected to some other disorders, as a cough and sneezing; which, though at first sight they may seem very dangerous, are not destitute of use, and may even be reckoned among the most salutary attempts of nature to relieve the patient. Often, however, they are attended with danger, or very great uneasiness; namely, when they are either too violent or exerted in vain. At any rate, it is necessary for a physician to know the nature, causes, and effects of these, that he may be enabled to promote them when necessary, to moderate them when too violent, and to stop them when noxious or of no use.

106 Cough.

A cough is a violent, frequently involuntary, and sonorous exspiration, suddenly expelling the air with great force through the glottis somewhat contracted. The convulsion of the muscles serving for exspiration, gives a great force to the air, while the contraction of the glottis produces the sound. It is often long continued, being repeated at certain intervals, during each of which the inspiration is imperfect and obstructed by reason of the contraction of the glottis. It is excited by any kind of acrid substance, either chemically or mechanically applied to those passages through which the air enters. These are lined with a membrane so exceedingly delicate and impatient of stimulus, that it cannot even bear the touch of the mildest substance, such as a small drop of water, without throwing the muscles serving for exspiration into a violent convulsion; the glottis at the same time contracting by means of the sympathy between it and the neighbouring parts. Thus the air is thrown out with such violence, that it drives the irritating substance along with it; and thus a cough becomes not only useful, but absolutely necessary for the preservation of life, as being able to free the lungs from every kind of irritating substance or foulness, which might soon bring on a suffocation. Hence a cough is almost an inseparable companion of every inflammation of the lungs, as well as every difficulty in respiration; and even frequently accompanies the entrance of the purest air when the trachea

Diſorders of Reſpiration. trachea and bronchiæ are excoriated, or become too ſenſible. Examples alſo are not wanting, where a violent and troubleſome cough has ariſen from an irritability of the nervous ſyſtem, or even of ſome particular part, of the ear, for inſtance, the ſtomach and inteſtines, the liver by inflammation, &c.

Coughing may alſo be voluntarily excited, and may then be managed at pleaſure. Even when involuntary, it may be moderated, or ſuppreſſed, by a contrary effort: though a violent fit of coughing cannot by any means be reſiſted. When it is once excited, the cough goes on till the irritating ſubſtance be expelled, or the ſenſe of irritation aboliſhed, or perhaps overcome by a more uneaſy ſenſation than even the cough itſelf; after which, the irritation again returning at a certain interval, the cough alſo returns. Hence we are taught a method of allaying and quieting this moſt troubleſome malady, though frequently it is not in our power to remove the cauſe of it altogether.

A very violent cough is often dangerous: For by the retention of the breath, and the ſtrong efforts made in coughing, a great quantity of blood is collected in the lungs, of which the veſſels are diſtended, and frequently broken; and hence there ſometimes happens a violent and even fatal hæmorrhage. More frequently, however, it is the cauſe of a ſlower, though equally fatal, diſeaſe. Nay, a frequent and troubleſome cough, without any great hæmorrhage, or even without any hæmorrhage at all, may injure the lungs to ſuch a degree, eſpecially if they be of a more tender ſtructure than uſual, as to lay the foundation of a phthiſis almoſt always incurable.

Again, by a long-continued and violent cough, the paſſage of the blood through the lungs being impeded, it muſt neceſſarily flow through the veins towards the head: hence redneſs and lividneſs in the countenance, hæmorrhages, palſies, apoplexies, and ſometimes fatal convulſions. Laſtly, by a violent cough the abdominal viſcera are compreſſed with remarkable violence; and if any part happens to be weaker than uſual, a hernia, prolapſus uteri, abortion, or ſimilar accidents, may happen.

Even when the cough is more gentle, if it happens to be importunate and frequent, although we have nothing of this kind to fear, yet the patient is by no means free from danger; as he is thereby agitated, fatigued, has his conſtitution broken, is deprived of reſt, has a fever brought upon him, his lungs are ſhaken and irritated, digeſtion and all the other functions are impeded, till at laſt he ſinks under a complication of maladies.

107 Sneezing. Sneezing is ſomewhat ſimilar to cough, as conſiſting of a very full inſpiration, to which ſucceeds a moſt violent exſpiration, by which the air is driven out through the noſtrils with immenſe violence, and ſweeps the paſſage through them as it goes out. It is a convulſion much more violent than a cough, and is beſides very difficult to be ſtopped when once a propenſity to it has taken place. As a cough proceeds from an irritation of the glottis, trachea, bronchia, and lungs, ſo ſneezing ariſes from an irritation of the membrane of the noſtrils, but rarely from ſympathy with any diſtant part. It is ſometimes of ſervice, as well as a cough; though it is alſo ſometimes prejudicial, for the reaſons which have been already aſſigned.

The laſt affections of which we ſhall here ſpeak, are thoſe ariſing from a bad digeſtion, diſordered motion of the inteſtines, and ſome of the principal ſecretions. Diſorders of Digeſtion.
The firſt of theſe are ſometimes very troubleſome, though ſeldom dangerous. The principal ſymptoms are oppreſſion, anxiety, pain at the ſtomach; eructations, 108
by reaſon of air extricated from the fermenting aliments, and irritating the ſtomach; nauſea and vomiting, from the irritation and diſtention of the ſame organ; the belly ſometimes too coſtive, and ſometimes too looſe; a defect of nouriſhment; a general debility; relaxation of the ſolid parts; too great thinneſs of the fluids; all the functions impeded; pain of the head; vertigo, ſyncope, aſthma, palpitation; great ſinking of the ſpirits, eſpecially if the patient has been of a peculiar conſtitution; ſometimes the gout, ſometimes a dropſy, or a ſlow fever which may prove fatal. Digeſtion.

109
The motion of the inteſtines may be either too great or too little; and hence proceeds either coſtiveneſs or looſeneſs. The former is frequently not to be accounted morbid; but, when it is, it may ariſe from the ſtructure of the inteſtines being injured, or from their being ſhut up or obſtructed by ſpaſm or otherwiſe, or from a deficiency of thoſe humours which moiſten the inteſtines; or it may ariſe from mere debility, from a palſy of the fibres, perhaps, or from a deficiency of the uſual ſtimulus, of the bile, for inſtance, or from too dry or ſlender a diet. Coſtiveneſs.

The conſequences of long-continued coſtiveneſs, are, firſt, an affection of the alimentary canal, and then of the whole body. The ſtomach is diſeaſed, and does not digeſt the aliments properly; the whole body is left deſtitute of its uſual ſtimulus; the blood is corrupted, perhaps from the reſorption of the putrid matter into it. The circulation through the abdominal viſcera is impeded; hence frequent and irregular congeſtions, varices of the veins, hæmorrhoids, &c. Nay, the inteſtines themſelves being overloaded, diſtended and irritated by an heavy, acrid, and putrid load of aliment or other matters, are excited to new and unuſual contractions, which, if they do not get the better of the obſtruction, bring on tormina, colic, or an iliac paſſion, inflammation and gangrene, fatal in a very ſhort time. 110

Looſeneſs, or diarrhœa, is a malady extremely common; being ſometimes a primary diſeaſe, and ſometimes only a ſymptom or an effect of others. Sometimes it is a ſalutary effort of nature, ſuch as the phyſician ought to imitate and bring on by art. It is alſo familiar to infants, and to people of a certain conſtitution; and to them coſtiveneſs is very prejudicial. It may ariſe, in the firſt place, from ſomething taken into the body, or generated in the inteſtines; from a fermentation and corruption of the maſs of aliments; from the bile being too abundant and acrid, or from blood or pus poured into the inteſtines; from the inteſtines themſelves being eroded, or deprived of their natural mucus; from the humours being driven from the ſurface of the body towards the inward parts, as by cold, eſpecially when applied to the feet; or from a general corruption of the whole body, as in the phthiſis, hectic, or putrid fever, eſpecially towards the end of theſe diſorders. In fevers it is ſometimes ſalutary, or even puts an end to the diſeaſe altogether, or Looſeneſs.

 at

Diſorders of the Alimentary Canal.

at leaſt renders it milder: more frequently, however, deriving its origin from putreſcency, it is of no ſervice, but rather exhauſts the ſtrength of the patient. A diarrhœa likewiſe, almoſt incurable, and often fatal in a ſhort time, frequently ariſes after the operation for the fiſtula in ano. Some have their inteſtines ſo extremely weak and moveable, that from the ſlighteſt cauſe, ſuch as catching cold, any violent commotion of the mind, &c. they are ſubject to a violent diarrhœa. Laſtly, whatever be its origin, if it has continued for a long time, the viſcera are rendered ſo weak and irritable, that the diſeaſe, though often removed, ſtill returns from the ſlighteſt cauſes, and even ſuch as are not eaſily diſcovered.

A diarrhœa proves very pernicious, by hindering digeſtion and the nouriſhment of the body; for the ſtomach is commonly affected, and the aliments paſs through the inteſtines ſo quickly, that they can neither be properly digeſted, nor are the lacteals able to abſorb the chyle from them as they go along. Such a violent evacuation is alſo hurtful by exhauſting the body, and carrying off a great quantity of the nutritious matter from the blood. Neither indeed, is it only the alimentary maſs which is thrown out ſooner than it ought to be; but at the ſame time, a great quantity of the fluids ſecreted in the inteſtines, ſo that the whole body quickly partakes of the debility.

Sometimes a violent and long-continued diarrhœa riſes to ſuch a height, that the aliment is diſcharged with little or no alteration. Sometimes alſo, though rarely, from a ſimilar cauſe, or from the obſtruction of the meſenteric glands, and its other paſſages into the blood, the chyle itſelf is thrown out like milk along with the excrements; and this diſeaſe is called the *fluxus cœliacus*.

111 Dyſentery.

A dyſentery is attended with very ſevere gripes in the belly, a frequent deſire of going to ſtool, and vain efforts, when nothing is excreted beſides the mucus of the inteſtines mixed with a little blood; it is alſo accompanied with exceſſive debility, and frequently with putreſcency and fever. It is thought to ariſe from the conſtriction of ſome part of the inteſtines, of the colon eſpecially: by which means the bowels, though ever ſo much irritated, can paſs nothing; neither can the diſeaſe be removed, until the belly has been well purged by proper medicines.

112 Teneſmus.

A teneſmus is a frequent and inſatiable propenſity to ſtool, without being able to paſs any thing, notwithſtanding the moſt violent efforts. It may be occaſioned by any kind of irritation, either of the rectum itſelf or of the neighbouring parts, by acrid ſubſtances taken into the body; by ſome of the ſtronger purges, eſpecially aloes, a ſubſtance very difficult of ſolution, which will paſs even to the rectum with very little alteration; by a violent and obſtinate diarrhœa, dyſentery, hæmorrhoids, worms, fiſtula, calculus, ulcer in the bladder, urethra, &c. It is often very pernicious, both from the exceſſive uneaſineſs it occaſions to the patient, and from its exhauſting his ſtrength, by the frequent and vain efforts bringing on a prolapſus ani, and communicating the violent irritation to the neighbouring parts, as the bladder, &c.

113 Nauſea and vomiting.

A nauſea and vomiting are diſorders very common, and owing to almoſt innumerable cauſes; not only to affections of the ſtomach itſelf, but alſo to affections and irritations of the remoteſt parts of the body which may act upon the ſtomach by ſympathy. Every irritation and diſtention of that viſcus therefore, a load of crude aliment, an obſtruction about the pylorus, all acrid ſubſtances taken into it, diſeaſes of the liver, inteſtines, kidneys, uterus, the head, the feet, the ſkin, or indeed the whole body, inflammation, the ſtone, king's evil, ſchirrus, apoplexy, compreſſion of the brain, fracture of the ſkull, vertigo, ſyncope, violent pain, the gout, eſpecially when repelled, fevers, paſſions of the mind, diſagreeable imaginations or diſcourſes, frequently induce nauſea and vomiting.

Theſe affections are often ſerviceable by freeing the ſtomach from ſomething with which it was overloaded; promoting ſpitting in ſome caſes where the lungs are overcharged with mucus, blood, pus, or water; producing ſweat, and a free and proper diſtribution of blood to the ſurface of the body; partly, perhaps, by the great ſtraining which accompanies vomiting, but rather by that wonderful ſympathy which takes place between the ſtomach and ſkin: and hence, in many diſeaſes, vomiting is a moſt excellent remedy. It is however in ſome caſes hurtful, if too violent or too frequently repeated, partly by debilitating and making the ſtomach more eaſily moved; and partly by fatiguing the patient with violent ſtrainings, which occaſion hernias, abortions, &c.

114 Iliac paſſion.

Sometimes we find the motion of the inteſtines totally inverted, from the anus to the mouth; a moſt dangerous diſtemper, which hath obtained the name of the *iliac paſſion*. It moſt frequently ariſes from ſome obſtruction in the alimentary canal hindering the deſcent of the excrements, as ſchirrus, ſpaſm, inflammation, &c.: though the moſt perfect iliac paſſion takes place without any obſtruction, ſo that clyſters will be vomited; and even after this has continued for ſeveral days, the patients have at length recovered.

A ſlighter degree of the iliac paſſion, namely the inverſion of the periſtaltic motion of the duodenum, always takes place in long-continued and violent vomiting, as in ſea-ſickneſs, or when a perſon has taken too large a doſe of an emetic; by which means a vaſt quantity of bile frequently aſcends into the ſtomach, and is diſcharged by vomiting.

115 Cholera.

An exceſſive vomiting with looſeneſs is called a *cholera*, when the matter diſcharged has a bilious appearance. It ariſes from a very great irritation of the alimentary canal without any obſtruction; and is for the moſt part occaſioned by too great a quantity, or from an acrimony of the bile, from whence it takes its name. It may originate from ſeveral cauſes, as too ſtrong a doſe of an emetic and cathartic medicine, eating too great a quantity of ſummer-fruits, &c. and is a very violent malady, often killing the patient in a few hours, unleſs proper remedies be applied in time.

116 Obſtructed perſpiration.

From a ſuppreſſion of any of the ſecretions, or a diſorder of any of the ſecretory organs, many miſchiefs may ariſe. A diminution of perſpiration produces plethora, laſſitude, languor, depreſſion of mind, bad digeſtion, loſs of appetite, and even a general corruption of the humours from the retention of ſuch a quantity of putreſcent matter.—The more ſuddenly the diminution or ſuppreſſion of the perſpiration takes place, Diſorders of Secretion.

place, the ſooner the miſchief is produced, and the greater it is; not only by retaining the matter which ought to be thrown out, but by repelling the humours from the ſurface of the body, and directing them to other parts; whence fevers, inflammations, congeſtions of the blood, &c. frequently take place.

Thus ſuppreſſion of perſpiration may ariſe from many different cauſes; as from cold ſuddenly applied to the body when very hot; ſometimes from very violent paſſions of the mind; or from ſpaſmodic diſeaſes, as the hyſterics, &c. It may be ſuppreſſed alſo by that kind of conſtriction of the veſſels of the ſkin which is produced by various kinds of fevers, the nature of which has hitherto been but little known.

117 Exceſſive perſpiration.

Exceſſive perſpiration or ſweating is injurious by debilitating the body, relaxing the ſkin, and expoſing the patient to all the evils which ariſe from catching cold. It may even be carried to ſuch a height as to produce fainting and death; though it muſt be owned that we cannot eaſily bring examples of people having, from this cauſe, their blood inſpiſſated, corrupted, or being thence made liable to inflammations and fevers.

118 Suppreſſion of urine.

A ſuppreſſion of urine is ſtill more dangerous than that of perſpiration, and unleſs relieved in a ſhort time will certainly prove fatal. This diſorder, which is called *iſchuria*, may ariſe from various diſeaſes of the kidneys, ureters, bladder, urethra, &c. Thus any obſtruction or irritation of one or other of the kidneys or ureters, by a ſtone, gravel, mucus, blood, inflammations, ſpaſm, ſuppuration, ſchirrus, ſwellings of the neighbouring parts, &c. may either prevent the urine from being ſecreted, or may give riſe to a ſcanty or depraved ſecretion, or, finally, may obſtruct its paſſage into the bladder after it is ſecreted.

The urine alſo, after it has entered the bladder, is there frequently ſuppreſſed, by reaſon of various diſorders to which that organ is liable, as an irritation or inflammation, ſpaſm, acrid ſubſtances injected, or ſympathy with the neighbouring parts; or by reaſon of the texture of the bladder itſelf being deſtroyed, or from a palſy, ſchirrus, ulcer, &c. in the bladder. Or, laſtly, the urine may be retained in the bladder from a general ſtupor, as from a diſeaſe of the brain, which happens in ſome fevers, when the patient is neither ſenſible of the uſual ſtimulus, nor even of one much greater, ſo that the fibres can ſcarcely be excited to contraction by any means whatever. This, in fevers, is always a bad ſign, and ſometimes even proves fatal.

A ſuppreſſion of urine for any length of time produces an immenſe diſtention of the bladder, oppreſſion, uneaſineſs, and pain, not only of the part itſelf, but of the ſurrounding ones, and even of the whole body; a ſpaſm, or inſuperable conſtriction of the ſphincter; an inflammation, gangrene, or laceration of the bladder itſelf; a violent irritation of the whole habit; then a nauſea, vomiting, vertigo, general ſtupor, and an impregnation of the whole maſs of blood with a humour of an urinous nature, which at laſt being poured out into various cavities of the body, eſpecially of the head, ſoon brings on a deep ſleep, convulſions, and death.

119 Dyſuria.

From the ſame cauſes, but acting with leſs force, proceeds that diſeaſe called a *dyſuria*, when the urine paſſes with difficulty and pain, and is frequently red, black, bloody, purulent, mucous, and ſandy; the reaſon of all which appearances is very much unknown.—The moſt frequent complaint, however, in making water, is where the patient has a continual and violent deſire of paſſing his urine, while at the ſame time only two or three drops can be paſſed at once, and that not without ſome pain. This may be occaſioned even in healthy people, by ſome acrid ſubſtance taken into the ſtomach; and is very common to old people, who are generally ſubject to diſorders of the kidneys and bladder. It ariſes alſo frequently from a ſtone irritating the bladder, or from an inflammation of it, or its being deprived of its mucus, or this laſt being ſomehow or other corrupted; or laſtly, from certain diſeaſes, or ſome particular ſtate of the neighbouring parts, as of the uterus, vagina, urethra, proſtate gland, &c.

120 Strangury.

121 Incontinence of urine.

Akin to the ſtrangury is an incontinence of urine, when the patient's water either comes away againſt his will, or altogether without his knowledge. This diſorder may ariſe from debility, palſy, an ulcer or wound, or any long-continued and violent irritation of the bladder, eſpecially of its ſphincter, as from a ſtone, a general palſy, or in females difficult labour, injuring the neighbouring parts.—This ſymptom occurs in a great number of diſeaſes, eſpecially in the hydrocephalus.—Sometimes the urine is expelled with violence, either by reaſon of univerſal ſpaſms, or by violent contractions of the muſcles of reſpiration, as in ſneezing, laughter, &c.

122 Urinary calculi.

Among the diſorders incident to the urine we may reckon the production of calculi, which frequently bring on the moſt excruciating and dangerous diſeaſes.—The urine, beſides the water and ſalts, contains no ſmall ſhare of the glutinous part of the blood already ſomewhat corrupted, and ſtill inclined to farther corruption. Hence the urine even of the moſt healthy people depoſits a ſediment after it has ſtood for ſome time; and though none of this ſediment be formed in a healthy body, yet if the ſmalleſt particle of foreign matter be introduced into the bladder, a cruſt ſoon gathers round it, and it is ſure to become the baſis of a concretion, which by degrees grows to a very great ſize. It is not unlikely, alſo, that ſome unknown fault of the fluids may contribute to the production of thoſe calculi, as the ſtone is well known to be an hereditary diſeaſe, and to be born with the patient. Calculous perſons alſo are commonly ſubject to complaints of the ſtomach, eſpecially to an acidity of it; and many have received no little relief from alkaleſcent or alkaline medicines.—From the ſame cauſes may calculi be formed in the kidneys; from which proceed a horrid train of ſymptoms deſcribed in the ſubſequent part of this treatiſe.

It is now found, by accurate experiments of the moſt able chemiſts, that urinary calculi do not, as was once ſuppoſed, conſiſt almoſt entirely of an earthy matter. Their principal conſtituent is a peculiar acid approaching more nearly to the phoſphoric found in the bones than to any other. But the acid of calculus being in ſome reſpects peculiar in its nature, has among modern chemiſts obtained a peculiar name, and been diſtinguiſhed by the appellation of the *lithic* or *uric acid*. It is highly probable that this acid preſent in the circulating maſs, is precipitated and diſengaged by the

Diſorder of the Glands. introduction of other acids, and thus thrown off in greater quantities by the kidneys. Thus, then, we can underſtand the influence of acids as tending to the generation of calculus, and of alkalies as tending to prevent it.

123 Schirrus. The laſt diſorder here to be taken notice of is a diſorder of the glands themſelves, owing to ſome kind of obſtruction, and is one of the moſt dreadful diſeaſes incident to human nature. Hence happens a great ſwelling and ſurpriſing hardneſs, not only without pain, but ſometimes even with a diminution of ſenſation in the part affected; and when the gland is thus affected, it is called a *ſchirrus*. Sometimes it remains in this ſtate for a long time; but ſooner or later produces the moſt excruciating torment. By degrees it is infected with a ſlow and malignant ſuppuration, degenerating into an horrid ulcer, conſuming not only the part itſelf, but eating away the neighbouring ones, and corrupting the whole body with the moſt acrid and incurable poiſon. This diſeaſe is called a *cancer*, of which the cauſes are very little known.

Verſatility of the Human Conſtitution. Of the organs in both ſexes concerned in the function of generation, and of that function as far as we yet know any thing reſpecting it, an account has already been given in ANATOMY; and after what has been ſaid of the different functions, and of the morbid affections, to which theſe are ſubjected, we may conclude our remarks on the theory of medicine, with mentioning the remarkable verſatility of the human conſtitution; which, more than that of any other animal, is capable of accommodating itſelf to every climate and to all kinds of diet. Hence we may conclude, that a large proportion of the diſeaſes to which we are ſubjected are produced by ourſelves.

PRACTICE of MEDICINE, or an Account of the principal Diſeaſes to which the Human Body is ſubjected.

124 General Arrangement of Diſeaſes. WE have already defined medicine to be the art of preventing, curing, and alleviating, thoſe diſeaſes to which mankind are ſubjected. While theſe affections, however, are in number almoſt infinite, each in its progreſs is ſubjected to almoſt endleſs varieties from differences in climate, conſtitution, treatment, and a variety of other particulars. Hence we may readily explain both the difficulty of diſtinguiſhing morbid affections from each other in actual practice, and the diverſity of names which have been affixed to them in the writings of ancient phyſicians. It may readily be ſuppoſed, that in this, as well as other ſubjects, there has been a gradual improvement from the progreſſive labours of induſtrious and ingenious men. And although much yet remains to be done in the proper arrangement and diſtinction of diſeaſes, or what has been called *methodical noſology*, yet there cannot be a doubt, that during the courſe of the 18th century, this ſubject has received very great improvements. For theſe, we are, in the firſt place, highly indebted to the labours of Franciſcus Boiſſier de Sauvages, an eminent profeſſor of medicine at Montpelier, who, following out an idea ſuggeſted by the ſagacious Dr Sydenham of England, firſt ſucceſsfully attempted to arrange diſeaſes, as botaniſts had done plants, into claſſes, orders, genera, and ſpecies. Since the publication of the *Noſologia Methodica* of Sauvages, this ſubject has been ſucceſsfully cultivated by ſeveral ingenious men, particularly by Sir Charles Linnæus of Upſal, to whoſe genius for arrangement every branch of natural hiſtory, but botany in particular, has been ſo highly indebted; by Rudolphus Auguſtus Vogel, an eminent profeſſor at Gottingen; and by John Baptiſt Sagar, a diſtinguiſhed phyſician at Iglaw in Moravia: But of all the ſyſtems of arrangement yet preſented to the medical world, that publiſhed by the late illuſtrious Dr William Cullen of Edinburgh, may juſtly be conſidered as the beſt. In treating, therefore, of the principal diſeaſes to which the human body is ſubjected, we ſhall follow his plan, endeavouring to deliver the beſt eſtabliſhed obſervations reſpecting the hiſtory, theory, and practice of each. In treating of particular genera of diſeaſe, although we follow the arrangement of Dr Cullen, yet for the ſatisfaction of the reader, we ſhall often point out the claſſes to which the ſame affection is referred by the other eminent writers whom we have mentioned. And on this account, it may not be improper briefly to enumerate the general claſſes to which each of them have referred the affections of the human body.

The Claſſes of Sauvages are,

1. Vitia.	6. Debilitates.
2. Febres.	7. Dolores.
3. Phlegmaſiæ.	8. Veſaniæ.
4. Spaſmi.	9. Fluxus.
5. Anhelationes.	10. Cachexiæ.

The Claſſes of Linnæus are,

1. Exanthematici.	7. Motorii.
2. Critici.	8. Suppreſſorii.
3. Phlogiſtici.	9. Evacuatorii.
4. Doloroſi.	10. Deformes.
5. Mentales.	11. Vitia.
6. Quietales.	

The Claſſes of Vogel are,

1. Febres.	7. Hyperæſtheſes.
2. Profluvia.	8. Cachexiæ.
3. Epiſcheſes.	9. Paranoiæ.
4. Dolores.	10. Vitia.
5. Spaſmi.	11. Deformitates.
6. Adynamiæ.	

The Claſſes of Sagar are,

1. Vitia.	8. Anhelationes.
2. Palgæ.	9. Debilitates.
3. Cachexiæ.	10. Exanthemata.
4. Dolores.	11. Phlegmaſiæ.
5. Fluxus.	12. Febres.
6. Suppreſſiones.	13. Veſaniæ.
7. Spaſmi.	

Beſides

General Arrangement of Diseases.

Besides these, two other systems have been presented to the public, which may be considered as deserving attention; those, viz. of the late learned Dr M'Bride of Dublin, and of the ingenious Dr Darwin of Derby.

The Classes and Orders of M'Bride.

Class I. *Universal Diseases.*

Or. 1. Fevers.
2. Inflammations.
3. Fluxes.
4. Painful diseases.
5. Spasmodic diseases.
6. Weaknesses or privation.
7. Asthmatic disorders.
8. Mental disorders.

Class II. *Local Diseases.*

Or. 1. Of the internal senses.
2. Of the external senses.
3. Of the appetites.
4. Of the secretions and excretions.
5. Impeding different actions.
6. Of the external habit.
7. Dislocations.
8. Solutions of continuity.

Class III. *Sexual Diseases.*

Or. 1. General proper to men.
2. Local proper to men.
3. General proper to women.
4. Local proper to women.

Class IV. *Infantile Diseases.*

Or. 1. General.
2. Local.

The Classes and Orders of Darwin.

Class I. *Diseases of Irritation.*

Or. 1. Increased irritation.
2. Decreased irritation.
3. Retrograde irritative motions.

Class II. *Diseases of Sensation.*

Or. 1. Increased sensation.
2. Decreased sensation.
3. Retrograde sensitive motions.

Class III. *Diseases of Volition.*

Or. 1. Increased volition.
2. Decreased volition.

Class IV. *Diseases of Association.*

Or. 1. Increased associated motions.
2. Decreased associated motions.
3. Retrograde associated motions.

After this short view of different classifications, we shall next present to our readers a more particular account of the arrangement of Dr Cullen; which, although it can by no means be represented as free from errors or imperfections, is yet in many respects the best that has hitherto been published.

General Arrangement of Diseases.

CULLEN'S *Arrangement.*

CLASS I. PYREXIÆ. A frequent pulse coming on after a horror; considerable heat; many of the functions injured; the strength of the limbs especially diminished.

Order I. FEBRES. Pyrexia without any primary local affection, following languor, lassitude, and other symptoms of debility.

Sect. I. *Intermittentes.* Fevers arising from the miasma of marshes; with an apyrexia, or at least a very evident remission; but the disease returns regularly, and for the most part with a horror or trembling.

Genus I. Tertiana. Similar paroxysms after an interval of about 48 hours, coming on most commonly at mid-day. A tertian hath either;

I. An apyrexia interposed.

1. Varying the duration of the paroxysms.

A, The tertian whose paroxysms are not extended beyond 12 hours.

B, The tertian with paroxysms extended beyond 12 hours.

2. Varying in the return of paroxysms.

C, The tertian returning every day with unequal paroxysms alternately similar to one another.

D, The tertian returning every third day with two paroxysms on the same day.

E, The tertian returning every day, with two paroxysms on every third day, and only one on the intermediate ones.

F, The tertian returning every day, with an evident remission interposed between the odd and the even days, but a less remarkable one between the even and the odd days.

3. Varying in its symptoms.

G, The tertian accompanied with a disposition to sleep.

H, Accompanied with spasms and convulsive motions.

I, Accompanied with an efflorescence on the skin.

K, with phlegmasia.

4. Varying in being complicated with other diseases.

5. Varying as to its origin.

II. With the interposition only of a remission between the paroxysms.

Genus II. Quartana. Similar paroxysms, with an interval of about 72 hours, coming on in the afternoon.

I. With the interposition of an apyrexia.

1. Varying in the type.

A, The quartan with single paroxysms, returnin every fourth day, none on the other days.

B, With two paroxysms every fourth day, and none on the other days.

C, With three paroxysms every fourth day, and none on the intermediate days.

D, Of the four days having only the third free from fever, with similar paroxysms every fourth day.

E, The quartan coming on every day, with similar paroxysms every fourth day.

2. Varying in its symptoms.

3. Varying in being complicated with other diseases.

II. With a remission only between the paroxysms.

Genus III. Quotidiana. Similar paroxysms with an

General Arrangement of Diseases.

an interval of about 24 hours, coming on commonly in the morning.

I. With the interposition of an apyrexia.

1. Varies in being solitary.

A, Universal.

B, Partial.

2. Complicated with other diseases.

II. With a remission only between the paroxysms.

Sect. II. *Continuæ.* Fevers without evident intermission, and not occasioned by marsh miasmata; but attended with exacerbations and remissions, though not always very remarkable.

Genus IV. Synocha. Great heat; a frequent, strong, and hard pulse; high-coloured urine; the functions of the sensorium a little disturbed.

Genus V. Typhus. A contagious disease; the heat not much above the natural; the pulse small, weak, and for the most part frequent; the urine little changed; the functions of the sensorium very much disturbed, and the strength greatly diminished.

The species are,

I. Typhus *petechialis.* Typhus for the most part with petechiæ.

Varying in degree. 1. Mild typhus. 2. Malignant typhus.

II. Typhus *icterodes.* Typhus with a yellowness of the skin.

Genus VI. Synochus. A contagious disease. A fever compounded of synocha and typhus; in the beginning a synocha, but towards the end a typhus.

Order II. Phlegmasiæ. A synocha fever, with inflammation or topical pain, the internal function of the parts being at the same time injured; the blood drawn and concreted exhibiting a white coriaceous surface.

Genus VII. Phlogosis. Pyrexia; redness, heat, and painful tension, of some external part.

The species are,

I. Phlogosis *(phlegmone)* of a vivid red colour; a swelling well defined, for the most part elevated to a point, and frequently degenerating into an abscess, with a beating or throbbing pain.

The variations are, 1. In the form. 2. In the situation.

II. Phlogosis *(erythema)* of a reddish colour, vanishing by pressure; of an unequal and creeping circumference, with scarce any swelling; ending in the scaling off of the cuticle, in pustules, or blisters.

The variations are, 1. In the degree of violence. 2. In the remote cause. 3. In being complicated with other diseases.

The consequences of a phlogosis are, an imposthume, gangrene, sphacelus.

Genus VIII. Ophthalmia. A redness and pain of the eye, with an inability to bear the light; for the most part with an effusion of tears.

The species and varieties of the ophthalmia are,

I. Idiopathic.

1. Ophthalmia (*membranarum*), in the tunica adnata, and the membranes lying under it, or the coats of the eye.

A, Varying in the degree of the external inflammation.

B, In the internal coats affected.

2. Ophthalmia (*tarsi*) of the eye-lids, with swelling, erosion, and glutinous exudation.

II. Symptomatic.

1. From a disease of the eye itself.

2. From diseases of other parts, or of the whole body.

Genus IX. Phrenitis. Violent pyrexia; pain of the head; redness of the face and eyes; inability to endure the light or any noise; watchfulness; a furious delirium, or typhomania.

I. Idiopathic.

II. Symptomatic.

Genus X. Cynanche. Pyrexia sometimes inclining to a typhus; difficulty of swallowing and breathing; with a sensation of narrowness in the fauces.

The species are,

I. Cynanche (*tonsillaris*) affecting the mucous membrane of the fauces, but especially the tonsils, with redness and swelling, accompanied with a synocha.

II. Cynanche (*maligna*) affecting the tonsils and mucous membrane of the fauces with swelling, redness, and mucous crusts of a whitish or ash-colour, creeping, and covering ulcers; with a typhous fever and exanthemata.

III. Cynanche (*trachealis*) attended with difficult respiration, noisy and hoarse inspiration, loud cough, without any apparent tumor in the fauces, somewhat difficult deglutition, and a synocha.

IV. Cynanche (*pharyngæa*) attended with redness in the bottom of the fauces, very difficult and painful deglutition, respiration sufficiently free, and a synocha.

V. Cynanche (*parotidæa*) with great swelling in the parotids and maxillary glands appearing on the outside: the respiration and deglutition but little injured; a synocha, for the most part mild.

Diseases of this genus are symptomatic, either from external or internal causes.

Genus XI. Pneumonia. Pyrexia, with a pain in some part of the thorax, difficult respiration, and cough. The species are,

I. Peripneumony, with a pulse not always hard, but sometimes soft; an obtuse pain of the breast; the respiration always difficult; sometimes the patient cannot breathe unless in an upright posture; the face swelled, and of a livid colour; the cough for the most part moist, frequently bloody.

1. Simple idiopathic peripneumonies.

Varying in degree.

2. Idiopathic peripneumonies complicated with fever.

3. Symptomatic peripneumonies.

II. Pleurisy, with a hard pulse; for the most part attended with a pungent pain of one side, augmented chiefly during the time of inspiration; an uneasiness when lying on the side; a most painful cough, dry in the beginning of the disease, afterwards moist, and frequently bloody.

1. Simple idiopathic pleurisies.

2. Pleurisies, complicated, (1.) With fever. (2.) With catarrh.

3. Symptomatic pleurisies.

4. False pleurisies.

The consequences of pleurisy are a vomica or empyema.

Genus

Genus XII. Carditis. Pyrexia; pain about the heart; anxiety; difficulty of breathing; cough; unequal pulse; palpitation of the heart, and fainting.

I. Idiopathic.

II. Symptomatic.

Genus XIII. Peritonitis. Pyrexia; pain of the belly, exasperated by an upright posture, without the proper signs of other abdominal phlegmasiæ.

I. Peritonitis *(propria)*, situated in the peritonæum, properly so called, surrounding the inside of the abdomen.

II. Peritonitis (*omentalis*), in the peritonæum extended through the omentum.

III. Peritonitis (*mesenterica*), in the peritonæum spread through the mesentery.

Genus XIV. Gastritis. Pyrexia inclining to a typhus; anxiety; pain and heat of the epigastrium, augmented when any thing is taken into the stomach; an inclination to vomit, and an immediate rejection of every thing swallowed; an hiccough.

I. Idiopathic.

1. From internal causes.

A, Gastritis (*phlegmonodæa*), attended with acute pain and violent pyrexia.

2. From external causes.

B, Gastritis (*erysipelatosa*), with a less violent fever and pain: an erysipelatous redness appearing on the fauces.

II. Symptomatic.

Genus XV. Enteritis. Pyrexia of a typhous nature; pungent pain of the belly, stretching and twisting about the navel; vomiting; the belly obstinately bound.

I. Idiopathic.

1. Enteritis (*phlegmonodæa*), with acute pain, violent fever, vomiting, and constipation of the belly.

2. Enteritis (*erysipelatosa*), with less acute fever and pain, without vomiting; but accompanied with a diarrhœa.

II. Symptomatic.

Genus XVI. Hepatitis. Pyrexia; tension and pain of the right hypochondrium; sometimes pungent like that of a pleurisy, but more frequently obtuse; a pain reaching to the clavicle and top of the right shoulder; a difficulty of lying on the left side; dyspnœa; dry cough, vomiting, and hiccough.

Genus XVII. Splenitis. Pyrexia; tension, heat, and swelling of the left hypochondrium, the pain increasing by pressure; without the signs of nephritis.

Genus XVIII. Nephritis. Pyrexia; pain in the region of the kidney, often following the course of the ureter: frequent discharge of urine, either thin and colourless, or very red; vomiting; stupor of the thigh; with a retraction or pain of the testicle of the same side. The species are,

I. Idiopathic. Spontaneous.

II. Symptomatic.

Genus XIX. Cystitis. Pyrexia; pain and swelling of the hypogastrium: frequent and painful discharge of urine, or ischuria; and tenesmus. The species are,

I. Those arising from internal causes.

II. Those from external causes.

Genus XX. Hysteritis. Pyrexia; heat, tension, swelling, and pain of the hypogastrium; the os uteri painful when touched; vomiting.

Genus XXI. Rheumatismus. A disease arising from an external and frequently very evident cause; pyrexia; pain about the joints, frequently following the course of the muscles; infesting the knees and other large joints rather than those of the feet or hands; increased by external heat.

The species are either idiopathic or symptomatic. The former varies in situation.

A, In the muscles of the loins

B, In the muscles of the coxendix.

C, In the muscles of the breast.

Genus XXII. Odontalgia; a rheumatism of the jaws from a caries of the teeth.

Genus XXIII. Podagra An hereditary disease, arising without any evident external cause, but for the most part preceded by an unusual affection of the stomach; pyrexia; pain of a joint for the most part of the great toe of the foot, at least infesting chiefly the wrists and ankles; returning by intervals; and often alternated with affections of the stomach and other internal parts.

I. Podagra (*regularis*), with a pretty violent inflammation of the joints remaining for some days, and by degrees going off with swelling, itching, and desquamation of the affected part.

II. Podagra (*atonica*), with an atony of the stomach, or some other internal part; and either without the usual inflammation of the joints, or only with slight and wandering pains; and frequently alternated with dyspepsia, or other symptoms of atony.

III. Podagra (*retrograda*), with the inflammation of the joints suddenly disappearing, and an atony of the stomach and other parts immediately following.

IV. Podagra (*aberrans*), with the inflammation of an internal part either preceding or not, and suddenly disappearing.

Genus XXIV. Arthropuosis. Deep, obtuse, and long-continued pains of the joints or muscular parts, frequently following contusions; with either no swelling, or a moderate and diffused one; no phlogosis; pyrexia, at first gentle, afterwards hectic, and at length an imposthume.

Order III. Exanthemata. Contagious diseases; affecting a person only once in his life; beginning with fever; after a certain time appear phlogoses, for the most part small and in considerable number, and dispersed over the skin.

Genus XXV. Erysipelas. A synocha of two or three days, for the most part attended with drowsiness, often with a delirium. In some parts of the skin, most frequently the face, appears a phlogosis. The species are,

I. Erysipelas (*vesiculosum*), with erythema, redness creeping, occupying a large space, and in some parts ending in large blisters.

II. Erysipelas (*phlyctænodes*), with an erythema formed of a number of papulæ, chiefly occupying the trunk of the body, ending in phlyctenæ or small blisters.

The disease is also symptomatic.

Genus XXVI. Pestis. An exceedingly contagious typhus, with the highest debility. On an uncertain day of the disease buboes and carbuncles break forth. It is various in degree, but the species are uncertain.

Genus

General Arrangement of Diseases.

Genus XXVII. Variola; a contagious synocha, with vomiting, and pain on pressing the epigastrium. On the third day begins, and on the fifth is finished, the eruption of inflammatory pustules, which suppurate in the space of eight days, and at last go off in crusts; frequently leaving depressed cicatrices or pockpits in the skin. The species are,

I. Variola (*discreta*), with few, distinct, turpid, pustules, having circular bases; the fever ceasing immediately after the eruption.

II. Variola (*confluens*), with numerous, confluent, irregularly shaped pustules, flaccid, and little elevated; the fever remaining after the eruption.

Genus XXVIII. Varicella. Synocha; papulæ breaking out after a short fever, similar to those of the small-pox, but hardly ever coming to suppuration; after a few days going off in small scales, without leaving any mark.

Genus XXIX. Rubeola. A contagious synocha, with sneezing, epiphora, and dry hoarse cough. On the fourth day, or a little later, break forth small, clustered, and scarcely elevated papulæ; after three days going off in very small branny scales.

I. Rubeola (*vulgaris*), with very small confluent corymbose papulæ, scarcely rising above the skin.

Varying,

1. In the symptoms being more severe, and the course of the disease less regular.

2. In being accompanied with a cynanche.

3. With a putrid diathesis.

II. Rubeola (*variolodes*), with distinct papulæ, raised above the skin.

Genus XXX. Miliaria. Synochus with anxiety, frequent sighing, unctuous sweat, and a sense of pricking as of pin points in the skin. On an uncertain day of the disease, break out red, small, distinct papulæ, spread over the whole body as well as the face; the apices of which, after one or two days, become very small white pustules, remaining for a short time.

Genus XXXI. Scarlatina. A contagious synocha. On the fourth day of the disease the face swells a little; at the same time an universal redness occupies the skin in large spots, at length running together; after three days going off in branny scales; frequently succeeded by an anasarca. The species are,

I. Scarlatina (*simplex*), not accompanied with cynanche.

II. Scarlatina (*cynanchica*), with an ulcerous cynanche.

Genus XXXII. Urticaria, A quotidian fever. On the second day of the disease, red spots resembling the stinging of nettles, almost vanishing during the day, but returning in the evening with the fever, and after a few days going off altogether in very small scales.

Genus XXXIII. Pemphigus. A contagious typhus. On the first, second, or third day of the disease, blisters break out in several parts of the body, of the bigness of a bean, remaining for many days, and at last pouring out a thin ichor.

Genus XXXIV. Aphtha. Synochus; the tongue somewhat swelled and of a livid colour, as well as the fauces; eschars first appearing in the fauces, but at length occupying the whole internal parts of the mouth, of a white colour, sometimes distinct, often running together; quickly growing again when taken off; and remaining for an uncertain time.

The species are, 1. Idiopathic. 2. Symptomatic.

Order IV. HÆMORRHAGIÆ. Pyrexia; with a discharge of blood, without any external violence: the blood drawn from a vein hath the same appearance as in phlegmasiæ.

Genus XXXV. Epistaxis. Pain or weight of the head, redness of the face; a discharge of blood from the nose.

I. Idiopathic.

Varying according to the time of life.

1. Epistaxis of young people, with symptoms of an arterial plethora.

2. Epistaxis of old people, with symptoms of a venous plethora.

II. Symptomatic.

1. From internal causes.

2. From external causes.

Genus XXXVI. Hæmoptysis. Redness of the cheeks; a sensation of uneasiness, or pain, and sometimes of heat in the breast; difficulty of breathing; tickling of the fauces; either a severe or less violent cough, bringing up florid and frequently frothy blood.

The idiopathic species are,

1. Hæmoptysis (*plethorica*), without any external violence, and without being preceded by any cough or suppression of any customary evacuation.

2. Hæmoptysis (*violenta*), from external violence applied.

3. Hæmoptysis (*phthisica*), after a long-continued cough, with a leanness and debility.

4. Hæmoptysis (*calculosa*), in which some calculous molecules, for the most part of a calcareous nature, are thrown up.

5. Hæmoptysis (*vicaria*), after the suppression of a customary evacuation.

Besides these, there are a number of symptomatic species mentioned by different authors. The consequence of an hæmoptysis is, a

Phthisis. A wasting and debility of the body, with a cough, hectic fever, and for the most part a purulent expectoration. The species are,

I. An incipient phthisis, without any expectoration of pus.

II. A confirmed phthisis, with an expectoration of pus.

Both species vary, 1. As to their remote cause. 2. As to the origin of the purulent matter.

Genus XXXVII. Hæmorrhois. Weight and pain of the head; vertigo; pain of the loins; pain of the anus; livid painful tubercles, from which for the most part blood flows out; which sometimes also drops out of the anus, without any apparent tumor. The species are,

1. Hæmorrhois (*tumens*), external from mariscæ.

Varying,

A, Bloody.

B, Mucous.

2. Hæmorrhois (*procidens*), external from a *procidentia ani*.

3. Hæmorrhois (*fluens*), internal, without any swelling, or *procidentia ani*.

4. Hæmorrhois

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4. Hæmorrhois (*cæca*), with pain and swelling of the anus, without any profusion of blood.

Genus XXXVIII. Menorrhagia. Pains of the back, belly, and loins, like those of child-birth; an unusually copious flux of the menses or blood from the vagina. The species are,

1. Menorrhagia (*rubra*), bloody in women neither with child nor in child-birth.

2. Menorrhagia (*abortus*), bloody in women with child.

3. Menorrhagia (*lochialis*), bloody in women after delivery.

4. Menorrhagia (*vitiorum*), bloody from some local disease.

5. Menorrhagia (*alba*), serous, without any local disease, in women not pregnant.

6. Menorrhagia (*Nabothi*), serous in women with child.

Order V. Profluvia. Pyrexia, with an increased excretion, naturally not bloody.

Genus XXXIX. Catarrhus. Pyrexia frequently contagious; an increased excretion of mucus, at least efforts to excrete it.

The species are,

1. From cold.

2. From contagion.

Genus XL. Dysenteria. Contagious pyrexia; frequent mucous or bloody stools, while the alvine fæces are for the most part retained; gripes; tenesmus.

Varying,

1. Accompanied with worms.

2. With the excretion of small fleshy or sebaceous bodies.

3. With an intermittent fever.

4. Without blood.

5. With a miliary fever.

Class II. NEUROSES. A præternatural affection of sense and motion, without an idiopathic pyrexia or any local affection.

Order I. Comata. A diminution of voluntary motion, with sleep, or a deprivation of the senses.

Genus XLI. Apoplexia. Almost all voluntary motion abolished, with sleep more or less profound; the motion of the heart and arteries remaining.

The idiopathic species are,

1. Apoplexia (*sanguinea*), with symptoms of universal plethora, especially of the head.

2. Apoplexia (*serosa*), with a leucophlegmatia over the whole body, especially in old people.

3. Apoplexia (*hydrocephalica*), coming on by degrees; affecting infants, or those below the age of puberty, first with lassitude, a slight fever and pain of the head, then slowness of the pulse, dilatation of the pupil of the eye, and drowsiness.

4. Apoplexia (*atrabiliaria*), taking place in those of a melancholic constitution.

5. Apoplexia (*traumatica*), from some external injury mechanically applied to the head.

6. Apoplexia (*venenata*), from powerful sedatives taken internally or applied externally.

7. Apoplexia (*mentalis*), from an affection or emotion of the mind.

8. Apoplexia (*cataleptica*), the muscles remaining contractile, by external motion of the limbs.

9. Apoplexia (*suffocata*), from some external suffocating power.

The apoplexy is frequently symptomatic.

1 Of an intermittent fever. 2 Continued fever. 3 Phlegmasia. 4 Exanthema. 5. Hysteria. 6 Epilepsia. 7 Podagra. 8 Worms. 9 Ischuria. 10 Scurvy.

Genus XLII. Paralysis. Only some of the voluntary motions impaired, frequently with sleep.

The idiopathic species are,

1. Paralysis (*partialis*) of some particular muscles only.

2. Paralysis (*hemiplegica*) of one side of the body. Varying according to the constitution of the body.

a, Hemiplegia in a plethoric habit.

b, In a leucophlegmatic habit.

3. Paralysis (*paraplegica*) of one half of the body taken transversely.

4. Paralysis (*venenata*) from sedative powers applied either internally or externally.

A symptom either of an Asthenia or Palsy is,

Tremor; an alternate motion of a limb by frequent strokes and intervals.

The species are, 1 Asthenic. 2 Paralytic. 3 Convulsive.

Order II. Adynamiæ. A diminution of the involuntary motions, whether vital or natural.

Genus XLIII. Syncope; a diminution, or even a total stoppage, of the motion of the heart for a short time.

I. Idiopathic.

1. Syncope (*cardiaca*), returning frequently without any manifest cause, with violent palpitations of the heart during the intervals.—From a fault of the heart or neighbouring vessels.

2. Syncope (*occasionalis*) arising from some evident cause.—From an affection of the whole system.

II. Symptomatic; of diseases either of the whole system, or of other parts besides the heart.

Genus XLIV. Dyspepsia. Anorexia, nausea, vomiting, inflation, eructation, rumination, cardialgia, gastrodynia, more or fewer of those symptoms at least concurring; for the most part with a constipation of the belly, and without any other disease either of the stomach itself or of other parts.

I. Idiopathic.

II. Symptomatic.

1. From a disease of the stomach itself.

2. From a disease of other parts, or of the whole body.

Genus XLV. Hypochondriasis. Dyspepsia, with languor, sadness and fear, without any adequate causes, in a melancholy temperament.

Genus XLVI. Chlorosis. Dyspepsia, or a desire of something not used as food; a pale or discoloured complexion; the veins not well filled: a soft tumor of the whole body; asthenia; palpitation; suppression of the menses.

Order III. Spasmi. Irregular motions of the muscles or muscular fibres.

Sect. I. *In the animal functions.*

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Genus XLVII. Tetanus. A ſpaſtic rigidity of almoſt the whole body.

Varying according to the remote cauſe, as it riſes either from ſomething internal, from cold, or from a wound. It varies likewiſe, from whatever cauſe it may ariſe, according to the part of the body affected.

Genus XLVIII. Triſmus. A ſpaſtic rigidity of the lower jaw.—The ſpecies are,

1. Triſmus (*naſcentium,*) attacking infants under two months old.

2. Triſmus (*traumaticus*), attacking people of all ages either from a wound or cold.

Genus XLIX. Convulſio.—An irregular clonic contraction of the muſcles without ſleep.

I. Idiopathic.

II. Symptomatic.

Genus L. Chorea, attacking thoſe who have not yet arrived at puberty, moſt commonly within the 10th or 14th year, with convulſive motions for the moſt part of one ſide in attempting the voluntary motion of the hands and arms, reſembling the geſticulations of mountebanks; in walking, rather dragging one of their feet than lifting it.

Genus LI. Raphania. A ſpaſtic contraction of the joints, with a convulſive agitation, and moſt violent periodical pain.

Genus LII. Epilepſia. A convulſion of the muſcles, with ſleep.

The idiopathic ſpecies are.

1. Epilepſia (*cerebralis*), ſuddenly attacking without any manifeſt cauſe, without any ſenſe of uneaſineſs preceding, excepting perhaps a ſlight vertigo or dimneſs of ſight.

2. Epilepſia (*ſympathica*), without any manifeſt cauſe, but preceded by the ſenſation of a kind of air riſing from a certain part of the body towards the head.

3. Epilepſia (*occaſionalis*), ariſing from a manifeſt irritation, and ceaſing on the removal of that irritation.

Varying according to the difference of the irritating matter. And thus it may ariſe,

From injuries of the head; pain; worms; poiſon; from the repulſion of the itch, or an effuſion of any other acrid humour; from crudities in the ſtomach; from paſſions of the mind; from an immoderate hæmorrhagy; or from debility.

Sect. II. *In the vital functions.*

In the action of the heart.

Genus LIII. Palpitatio. A violent and irregular motion of the heart.

In the action of the lungs.

Genus LIV. Aſthma. A difficulty of breathing returning by intervals, with a ſenſe of ſtraitneſs in the breaſt, and a noiſy reſpiration with hiſſing. In the beginning of the paroxyſm there is either no cough at all, or coughing is difficult; but towards the end the cough becomes free, frequently with a copious ſpitting of mucus.—The idiopathic ſpecies are,

1. Aſthma (*ſpontaneum*), without any manifeſt cauſe or other concomitant diſeaſe.

2. Aſthma (*exanthematicum*), from the repulſion of the itch or other acrid effuſion.

3. Aſthma (*plethoricum*), from the ſuppreſſion of ſome cuſtomary ſanguineous evacuation, or from a ſpontaneous plethora.

Genus LV. Dyſpnœa. A continual difficulty of breathing, without any ſenſe of ſtraitneſs, but rather of fullneſs and infarction in the breaſt; a frequent cough throughout the whole courſe of the diſeaſe.

The idiopathic ſpecies are,

1. Dyſpnœa (*catarrhalis*), with a frequent cough, bringing up plenty of viſcid mucus.

2. Dyſpnœa (*ſicca*), with a cough for the moſt part dry.

3. Dyſpnœa (*aërea*), increaſed by the leaſt change of weather.

4. Dyſpnœa (*terrea*), bringing up with the cough an earthy or calculous matter.

5. Dyſpnœa (*aquoſa*), with ſcanty urine and œdematous feet; without any fluctuation in the breaſt, or other ſigns of an hydrothorax.

6. Dyſpnœa (*pinguedinoſa*), in very fat people.

7. Dyſpnœa (*thoracica*), from an injury done to the parts ſurrounding the thorax, or from ſome malconformation of them.

8. Dyſpnœa (*extrinſeca*), from evident external cauſes.

The ſymptomatic ſpecies of dyſpnœa are conſequences,

1. Of diſeaſes of the heart or large veſſels.

2. Of a ſwelling in the abdomen.

3. Of various other diſeaſes.

Genus LVI. Pertuſſis. A contagious diſeaſe; convulſive ſtrangulating cough reiterated with noiſy inſpiration; frequent vomiting.

Sect. III. *In the natural functions.*

Genus LVII. Pyroſis. A burning pain in the epigaſtrium, with plenty of aqueous humour, for the moſt part inſipid, but ſometimes acrid, belched up.

Genus LVIII. Colica. Pain of the belly, eſpecially twiſting round the navel; vomiting; and a conſtipation.

The idiopathic ſpecies are,

1. Colica (*ſpaſmodica*), with retraction of the navel, and ſpaſms of the abdominal muſcles.

Varying, by reaſon of ſome ſymptoms ſuperadded. Hence,

a, Colica, with vomiting of excrements, or of matters injected by the anus.

b, Colica, with inflammation ſupervening.

2. Colica (*pictonum*), preceded by a ſenſe of weight or uneaſineſs in the belly, eſpecially about the navel; then comes on the colic pain, at firſt ſlight and interrupted, chiefly augmented after meals: at length more ſevere and almoſt continual, with pains of the arms and back, at laſt ending in a palſy.

Varying according to the nature of the remote cauſe; and hence,

a, From metallic poiſon.

b, From acids taken inwardly.

c, From cold.

d, From a contuſion of the back.

3. Colica (*ſtercorea*), in people ſubject to coſtiveneſs.

4. Colica (*accidentalis*), from acrid matter taken inwardly.

5. Colica (*meconialis*), in new-born children from a retention of the meconium.

6. Colica

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6. Colica (*callosa*), with a ſenſation of ſtricture in ſome part of the inteſtines, and frequently of a collection of flatus with ſome pain; which flatus alſo paſſing through the part where the ſtricture is felt, gradually vaniſhes; the belly ſlow, and at laſt paſſing only a few liquid fæces.

7. Colica (*calculoſa*), with a fixed hardneſs in ſome part of the abdomen, and calculi ſometimes paſſed by the anus.

Genus LIX. Cholera. A vomiting of bilious matter, and likewiſe a frequent excretion of the ſame by ſtool; anxiety; gripes; ſpaſms in the calves of the legs.

I. Idiopathic.

1. Cholera (*ſpontanea*), ariſing in a warm ſeaſon, without any manifeſt cauſe.

2. Cholera (*accidentalis*), from acrid matters taken inwardly.

II. Symptomatic.

Genus LX. Diarrhœa. Frequent ſtools; the diſeaſe not infectious; no primary pyrexia.

I. Idiopathic.

1. Diarrhœa (*crapuloſa*), in which the excrements are voided in greater quantity than naturally.

2. Diarrhœa (*bilioſa*), in which yellow fæces are voided in great quantity.

3. Diarrhœa (*mucoſa*) in which either from acrid ſubſtances taken inwardly, or from cold, eſpecially applied to the feet, a great quantity of mucus is voided.

4. Diarrhœa (*cœliaca*), in which a milky humour of the nature of chyle is diſcharged by ſtool.

5. Diarrhœa (*lienteria*), in which the aliments are diſcharged with little alteration ſoon after eating.

6. Diarrhœa (*hepatirrhœa*), in which a bloody ſerous matter is diſcharged without pain.

II. Symptomatic.

Genus LXI. Diabetes. A chronical profuſion of urine, for the moſt part preternatural, and in immoderate quantity.

I. Idiopathic.

1. Diabetes (*mellitus*), with urine of the ſmell, colour, and taſte of honey.

2. Diabetes (*inſipidus*), with limpid, but not ſweet, urine.

II. Symptomatic.

Genus LXII. Hyſteria. Rumbling of the bowels; a ſenſation as of a globe turning itſelf in the belly, aſcending to the ſtomach and fauces, and there threatening ſuffocation; ſleep; convulſions; a great quantity of limpid urine; the mind involuntarily fickle and mutable.

The following are by Sauvages reckoned diſtinct idiopathic ſpecies; but, by Dr Cullen, only varieties of the ſame ſpecies.

A, From a retention of the menſes.

B, From a menorrhagia cruenta.

C, From a menorrhagia ſeroſa, or fluor albus.

D, From an obſtruction of the viſcera.

E, From a fault of the ſtomach.

F, From too great ſalacity.

Genus LXIII. Hydrophobia. A diſlike and horror at any kind of drink, as occaſioning a convulſion of the pharynx; induced, for the moſt part, by the bite of a mad animal. The ſpecies are,

1. Hydrophobia (*rabioſa*), with a deſire of biting the byſtanders, occaſioned by the bite of a rabid animal.

II. Hydrophobia (*ſimplex*), without madneſs, or any deſire of biting.

Order IV. Vesaniæ. Diſorders of the judgement, without any pyrexia or coma.

Genus LXIV. Amentia; an imbecility of judgement, by which people either do not perceive, or do not remember, the relations of things. The ſpecies are,

I. Amentia (*congenita*), continuing from birth.

II. Amentia (*ſenilis*), from the diminution of the perceptions and memory through extreme old age.

III. Amentia (*acquiſita*), occurring in people formerly of a ſound mind, from evident external cauſes.

Genus LXV. Melancholia; a partial madneſs, without dyſpepſia.

Varying according to the different ſubjects concerning which the perſon raves; and thus it is,

1. With an imagination in the patient concerning his body being in a dangerous condition, from ſlight cauſes; or his affairs in a deſperate ſtate.

2. With an imagination concerning a proſperous ſtate of affairs.

3. With violent love, without ſatyriaſis or nymphomania.

4. With a ſuperſtitious fear of a future ſtate.

5. With an averſion from motion and all the offices of life.

6. With reſtleſſneſs, and an impatience of any ſituation whatever.

7. With a warineſs of life.

8. With a deception concerning the nature of the patient's ſpecies.

Dr Cullen thinks that there is no ſuch diſeaſe as that called *dæmonomania*, and that the diſeaſes mentioned by Sauvages under that title are either,

1. Species of melancholy or mania; or

2. Of ſome diſeaſe by the ſpectators falſely aſcribed to the influence of an evil ſpirit; or

3. Of a diſeaſe entirely feigned; or

4. Of a diſeaſe partly true and partly feigned.

Genus LXVI. Mania; univerſal madneſs.

1. Mania (*mentalis*), ariſing entirely from paſſions of the mind.

2. Mania (*corporea*), from an evident diſeaſe of the body.

Varying according to the different diſeaſe of the body.

3. Mania (*obſcura*), without any paſſion of mind or evident diſeaſe of the body preceding.

The ſymptomatic ſpecies of mania are,

1. Paraphroſyne from poiſons.

2. Paraphroſyne from paſſion.

3. Paraphroſyne febrilis.

Genus LXVII. Oneirodynia. A violent and troubleſome imagination in time of ſleep.

1. Oneirodynia (*activa*), exciting to walking and various motions.

2. Oneirodynia (*gravans*), from a ſenſe of ſome weight incumbent, and preſſing on the breaſt eſpecially.

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Class III. CACHEXIÆ; a depraved habit of the whole or greatest part of the body, without primary pyrexia or neurosis.

Order I. Marcores; emaciation of the whole body.

Genus LXVIII. Tabes. Leanness, asthenia, hectic fever. The species are,

1. Tabes (*purulenta*), from an external or internal ulcer, or from a vomica.

Varying in its situation: hence,

2. Tabes (*scrophulosa*), in scrophulous constitutions.

3. Tabes (*venenata*), from poison taken inwardly.

Genus LXIX. Atrophia. Leanness and asthenia, without hectic fever. The species are,

1. Atrophia (*inanitorum*), from too great evacuation.

2. Atrophia (*famelicorum*), from a want of nourishment.

3. Atrophia (*cacochymica*), from corrupted nourishment.

4. Atrophia (*debilium*), from the function of nutrition being depraved, without any extraordinary evacuation or cacochymia having preceded.

Order II. Intumescentiæ. An external swelling of the whole or greatest part of the body.

Sect. I. *Adiposæ*.

Genus LXX. Polysarcia; a troublesome swelling of the body from fat.

Sect. II. *Flatuosæ*.

Genus LXXI. Pneumatosis; a tense elastic swelling of the body, crackling under the hand. The species are,

1. Pneumatosis (*spontanea*), without any manifest cause.

2. Pneumatosis (*traumatica*), from a wound in the breast.

3. Pneumatosis (*veneneta*), from poison injected or applied.

4. Pneumatosis (*hysterica*), with hysteria.

Genus LXXII. Tympanites; a tense, elastic, sonorous swelling of the abdomen; costiveness; a decay of the other parts. The species are,

1. Tympanites (*intestinalis*), with a tumor of the abdomen frequently unequal, and with a frequent evacuation of air relieving the tension and pain.

2. Tympanites (*abdominalis*), with a more evident noise, a more equable tumor, and a less frequent emission of flatus, which also gives less relief.

Genus LXXIII. Physometra; a slight elastic swelling in the epigastrium, having the figure and situation of the uterus.

Sect. III. *Aquosæ* or *Dropsies*.

Genus LXXIV. Anasarca. A soft, inelastic swelling of the whole body, or some part of it. The species are,

1. Anasarca (*serosa*), from a retention of serum on account of the suppression of the usual evacuations, or from an increase of the serum on account of too great a quantity of water taken inwardly.

2. Anasarca (*oppilata*), from a compression of the veins.

3. Anasarca (*exanthematica*), arising after exanthemata, especially succeeding erysipelas.

4. Anasarca (*anæmia*), from the thinness of the blood produced by hæmorrhagy.

5. Anasarca (*debilium*), in weak people after long diseases, or from other causes.

Genus LXXV. Hydrocephalus. A soft inelastic swelling of the head, with the sutures of the cranium opened.

Genus LXXVI. Hydrorachitis. A soft, slender tumor above the vertebræ of the loins; the vertebræ gaping from each other.

Genus LXXVII. Hydrothorax. Dyspnœa; paleness of the face; œdematous swellings of the feet; scanty urine; difficult lying in a recumbent posture; a sudden and spontaneous starting out of sleep, with palpitation; water fluctuating in the breast.

Genus LXXVIII. Ascites. A tense, scarce elastic, but fluctuating swelling of the abdomen. The species are,

1. Ascites (*abdominalis*), with an equal swelling of the whole abdomen, and with a fluctuation sufficiently evident.

Varying according to the cause.

A, From an obstruction of the viscera.

B, From debility.

C, From a thinness of the blood.

2. Ascites (*saccatus*), with a swelling of the abdomen, in the beginning at least, partial, and with a less evident fluctuation.

Genus LXXIX. Hydrometra. A swelling of the hypogastrium in women, gradually increasing, keeping the shape of the uterus, yielding to pressure, and fluctuating; without ischuria or pregnancy.

Genus LXXX. Hydrocele. A swelling of the scrotum, not painful; increasing by degrees, soft, fluctuating, and pellucid.

Sect. IV. *Solidæ*.

Genus LXXXI. Physconia. A swelling chiefly occupying a certain part of the abdomen, gradually increasing, and neither sonorous nor fluctuating. The species are,

Physconia hepatica.
Physconia splenica.
Physconia renalis.
Physconia uterina.
Physconia ab ovario.
Physconia mesenterica.
Physconia intestinalis.
Physconia omentalis.
Physconia polysplachna.
Physconia visceralis.
Physconia externa lupialis.
Physconia externa schirrhodea.
Physconia externa hydatidosa.
Physconia ab adipe subcutaneo.
Physconia ab excrescentia.

Genus LXXXII. Rachitis. A large head, swelling most in the fore part, the ribs depressed; abdomen swelled, with a decay of the other parts.

Varying,

1. Simple, without any other disease.

2. Joined with other diseases.

Order III. Impetigines. Cachexies chiefly deforming the skin and external parts of the body.

Genus

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Genus LXXXIII. Scrophula. Swellings of the conglobate glands, especially in the neck; swelling of the upper lip and of the nose; the face florid, skin thin, abdomen swelled. The species are,

1. Scrophula (*vulgaris*), simple, external, and permanent.

2. Scrophula (*mesenterica*), simple, internal, with paleness of the face, want of appetite, swelling of the abdomen, and unusual fetor of the excrements.

3. Scrophula (*fugax*), most simple, appearing only about the neck; for the most part proceeding from the resorption of the matter of ulcers in the head.

4. Scrophula (*Americana*), joined with the yaws.

Genus LXXXIV. Syphilis. A contagious disease; ulcers of the tonsils, after impure venery, and a disorder of the genitals; clustered pimples of the skin, especially about the margin of the hair, ending in crusts and crusty ulcers; pains of the bones; exostoses.

Genus LXXXV. Scorbutus; in cold countries, attacking after putrescent diet, especially such as is salt and of the animal kind, where no supply of fresh vegetables is to be had; asthenia; stomacace; spots of different colours on the skin, for the most part livid, and appearing chiefly among the roots of the hair.

Varying in degree.

a, Scorbutus incipiens.
b, Scorbutus crescens.
c, Scorbutus inveteratus.

Varying also in symptoms.

d, Scorbutus lividus.
e, Scorbutus petechialis.
f, Scorbutus pallidus.
g, Scorbutus ruber.
h, Scorbutus calidus.

Genus LXXXVI. Elephantiasis; a contagious disease; thick, wrinkled, rough, unctuous skin, destitute of hairs, anæsthesia in the extremities, the face deformed with pimples, the voice hoarse and nasal.

Genus LXXXVII. Lepra; the skin rough, with white, branny, and chopped eschars, sometimes moist beneath, with itching.

Genus LXXXVIII. Frambœsia; swellings resembling fungi, or the fruit of the mulberry or raspberry, growing on various parts of the skin.

Genus LXXXIX. Trichoma; a contagious disease; the hairs thicker than usual, and twisted into inextricable knots and cords.

Genus XC. Icterus; yellowness of the skin and eyes; white fæces; urine of a dark red, tinging what is put into it of a yellow colour.

The idiopathic species are,

1. Icterus (*calculosus*), with acute pain in the epigastric region, increasing after meals; biliary concretions voided by stool.

2. Icterus (*spasmodicus*), without pain after spasmodic diseases and passions of the mind.

3. Icterus (*hepaticus*), without pain, after diseases of the liver.

4. Icterus (*gravidarum*), arising during the time of pregnancy, and going off after delivery.

5. Icterus (*infantum*), coming on in infants a few days after birth.

Class IV. LOCALES. An affection of some part, but not of the whole body.

Order I. Dysæsthesiæ. The senses depraved or destroyed, from a disease of the external organs.

Genus XCI. Caligo. The sight impaired or totally destroyed, on account of some opaque substance interposed between the objects and the retina, inherent in the eye itself or the eyelids. The species are,

1. Caligo (*lentis*), occasioned by an opaque spot behind the pupil.

2. Caligo (*corneæ*), from an opacity of the cornea.

3. Caligo (*pupillæ*), from an obstruction of the pupil.

Varying according to the different causes from which it proceeds.

4. Caligo (*humorum*), from a disease or defect of the aqueous humour.

Varying according to the different state of the humour.

5. Caligo (*palpebrarum*) from a disease inherent in the eyelids.

Varying according to the nature of the disease in the eyelids.

Genus XCII. Amaurosis. The sight diminished, or totally abolished, without any evident disease of the eye; the pupil for the most part remaining dilated and immoveable. The species are,

1. Amaurosis (*compressionis*), after the causes and attended with the symptoms of congestion in the brain.

Varying according to the nature of the remote cause.

2. Amaurosis (*atonica*), after the causes and accompanied with symptoms of debility.

3. Amaurosis (*spasmodica*), after the causes and with the signs of spasm.

4. Amaurosis (*venenata*), from poison taken into the body or applied outwardly to it.

Genus XCIII. Dysopia. A depravation of the sight, so that objects cannot be distinctly perceived, except at a certain distance, and in a certain situation.

The species are,

1. Dysopia (*tenebrarum*), in which objects are not seen unless they be placed in a strong light.

2. Dysopia (*luminis*), in which objects are not distinctly seen unless by a weak light.

3. Dysopia (*dissitorum*), in which distant objects are not perceived.

4. Dysopia (*proximorum*), in which the nearest objects are not perceived.

5. Dysopia (*lateralis*), in which objects are not perceived unless placed in an oblique posture.

Genus XCIV. Pseudoblepsis; when the sight is diseased in such a manner that the person imagines he sees things which really do not exist, or sees things which do exist after some other manner than they really are. The species are,

1. Pseudoblepsis (*imaginaria*), in which the person imagines he sees things which really do not exist.

Varying according to the nature of the imagination.

2. Pseudoblepsis (*mutans*), in which objects really existing appear somehow changed.

Varying

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Varying according to the change perceived in the objects, and according to the remote cause.

Genus XCV. Dysecoea. A diminution or total abolition of the sense of hearing. The species are,

1. Dysecoea (*organica*), from a disease in the organs transmitting sounds to the internal ear.

Varying according to the nature of the disease and of the part affected.

2. Dysecoea (*atonica*), without any evident disease of the organs transmitting the sounds.

Varying according to the nature of the cause.

Genus XCVI. Paracusis; a depravation of the hearing. The species are,

1. Paracusis (*imperfecta*), in which though sounds coming from external objects are heard, yet it is neither distinctly nor in the usual manner.

Varying,

a, With a dulness of hearing.

b, With a hearing too acute and sensible.

c, When a single external sound is doubled by some internal causes.

d, When the sounds which a person desires to hear are not perceived, unless some other violent sound is raised at the same time.

2. Paracusis (*imaginaria*), in which sounds not existing externally are excited from internal causes.

Varying according to the nature of the sound perceived, and according to the nature of the remote cause.

Genus XCVII. Anosmia; a diminution or abolition of the sense of smell. The species are,

1. Anosmia (*organica*), from a disease in the membrane lining the internal parts of the nostrils.

Varying according to the nature of the disease.

2. Anosmia (*atonica*), without any evident disease of the membrane of the nose.

Genus XCVIII. Agheustia; a diminution or abolition of the sense of taste.

1. Agheustia (*organica*), from a disease in the membrane of the tongue, keeping off from the nerves those substances which ought to produce taste.

2. Agheustia (*atonica*), without any evident disease of the tongue.

Genus XCIX. Anæsthesia; a diminution or abolition of the sense of feeling. The species from Sauvages, adopted by Dr Cullen, are,

1. Anæsthesia à spina bifida.
2. Anæsthesia plethorica.
3. Anæsthesia nascentium.
4. Anæsthesia melancholica.

Order II. Dysorexiæ; error or defect of appetite.

Sect. I. *Appetitus erronei.*

Genus C. Bulimia; a desire for food in greater quantities than can be digested.

The idiopathic species are,

1. Bulimia (*helluonum*), an unusual appetite for food, without any disease of the stomach.

2. Bulimia (*syncopalis*), a frequent desire of meat, on account of a sensation of hunger threatening syncope.

3. Bulimia (*emetica*), an appetite for a great quantity of meat, which is thrown up immediately after it is taken.

Genus CI. Polydipsia; an appetite for an unusual quantity of drink.

The polydipsia is almost always symptomatic, and varies only according to the nature of the disease which accompanies it.

Genus CII. Pica; a desire of swallowing substances not used as food.

Genus CIII. Satyriasis; an unbounded desire of venery in men. The species are,

1. Satyriasis (*juvenilis*), an unbounded desire of venery, the body at the same time being little disordered.

2. Satyriasis (*furens*), a vehement desire of venery with a great disorder of the body at the same time.

Genus CIV. Nymphomania; an unbounded desire of venery in women.

Varying in degree.

Genus CV. Nostalgia; a violent desire in those who are absent from their country of revisiting it.

1. Nostalgia (*simplex*), without any other disease.

2. Nostalgia (*complicata*), accompanied with other diseases.

Sect. II. *Appetitus deficientes.*

Genus CVI. Anorexia. Want of appetite for food. Always symptomatic.

1. Anorexia (*humoralis*), from some humour loading the stomach.

2. Anorexia (*atonica*), from the tone of the fibres of the stomach being lost.

Genus CVII. Adipsia; a want of desire for drink. Always a symptom of some disease affecting the sensorium commune.

Genus CVIII. Anaphrodisia; want of desire for, or impotence to, venery.

The true species are,

1. Anaphrodisia paralytica.
2. Anaphrodisia gonorrhoica.

The false ones are,

1. Anaphrodisia à mariscis.
2. Anaphrodisia ab urethræ vitio.

Order III. Dyscinesiæ. An impediment, or depravation of motion from a disorder of the organs.

Genus CIX. Aphonia; a total suppression of voice without coma or syncope. The species are,

1. Aphonia (*gutturalis*), from the fauces or glottis being swelled.

2. Aphonia (*trachealis*), from a compression of the trachea.

3. Aphonia (*atonica*), from the nerves of the larynx being cut.

Genus CX. Mutitas; a want of power to pronounce words. The species are,

1. Mutitas (*organica*), from the tongue being cut out or destroyed.

2. Mutitas (*atonica*), from injuries done to the nerves of the tongue.

3. Mutitas (*surdorum*), from people being born deaf, or the hearing being destroyed during childhood.

Genus CXI. Paraphonia; a depraved sound of the voice. The species are,

1. Paraphonia (*puberum*) in which, about the time of puberty, the voice from being acute and sweet, becomes more grave and harsh.

2. Paraphonia

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2. Paraphonia *(rauca)*, in which, by reason of the dryness or flaccid tumor of the fauces, the voice becomes rough and hoarse.

3. Paraphonia *(resonans)*, in which, by reason of an obstruction in the nostrils, the voice becomes hoarse, with a sound hissing through the nostrils.

4. Paraphonia *(palatina)*, in which, on account of a defect or division of the uvula, for the most part with an hare-lip, the voice becomes obscure, hoarse, and unpleasant.

5. Paraphonia *(clangens)*, in which the voice is changed to one acute, shrill, and small.

6. Paraphonia *(comatosa)*, in which, from a relaxation of the velum palati and glottis, a sound is produced during inspiration.

Genus CXII. Psellismus; a defect in the articulation of words. The species are,

1. Psellismus *(hæsitans)*, in which the words, especially the first ones of a discourse, are not easily pronounced, and not without a frequent repetition of the first syllable.

2. Psellismus *(ringens)*, in which the sound of the letter R is always aspirated, and, as it were, doubled.

3. Psellismus *(lallans)*, in which the sound of the letter L becomes more liquid, or is pronounced instead of R.

4. Psellismus *(emolliens)*, in which the hard letters are changed into the softer ones, and thus the letter S is much used.

5. Psellismus *(balbutiens)*, in which, by reason of the tongue being large, or swelled, the labial letters are better heard, and often pronounced instead of others.

6. Psellismus *(acheilos)*, in which the labial letters cannot be pronounced at all, or with difficulty.

7. Psellismus *(lagostomatum)*, in which, on account of the division of the palate, the guttural letters are less perfectly pronounced.

Genus CXIII. Strabismus; the optic axes of the eyes not converging. Ths species are,

1. Strabismus *(habitualis)*, from a bad custom of using only one eye.

2. Strabismus *(commodus)*, from the greater debility or mobility of one eye above the other; so that both eyes cannot be conveniently used.

3. Strabismus *(necessarius)*, from a change in the situation or shape of the parts of the eye.

Genus CXIV. Dysphagia; impeded deglutition, without phlegmasia or the respiration being affected.

Genus CXV. Contractura; a long-continued and rigid contraction of one or more limbs. The species, are,

1. Contractura *(primaria)*, from the muscles becoming contracted and rigid.

a, From the muscles becoming rigid by inflammation.

b, From muscles becoming rigid by spasm.

c, From muscles contracted by reason of their antagonists having become paralytic.

d, From muscles contracted by an irritating acrimony.

2. Contractura *(articularis)*, from stiff joints.

Order IV. Apocenoses. A flux either of blood or some other humour flowing more plentifully than usual, without pyrexia, or an increased impulse of fluids.

Genus CXVI. Profusio; a flux of blood.

Genus CXVII. Ephidrosis; a preternatural evacuation of sweat.

Symptomatic ephidroses vary according to the nature of the diseases which they accompany, the different nature of the sweat itself, and sometimes the different parts of the body which sweat most.

Genus CXVIII. Epiphora; a flux of the lachrymal humour.

Genus CXIX. Ptyalismus; a flux of saliva.

Genus CXX. Enuresis; an involuntary flux of urine without pain. The species are,

1. Enuresis *(atonica)*, after diseases injuring the sphincter of the bladder.

2. Enuresis *(irritata)*, from a compression or irritation of the bladder.

Genus CXXI. Gonorrhœa; a preternatural flux of humour from the urethra in men, with or without a desire of venery. The species are,

1. Gonorrhœa *(pura)*, in which, without any impure venery having preceded, a fluid resembling pus, without dysuria or propensity to venery, flows from the urethra.

2. Gonorrhœa *(impura)*, in which, after impure venery, a fluid like pus flows from the urethra with dysuria. The consequence of this is,

Gonorrhœa *(mucosa)*, in which after an impure gonorrhœa, a mucous humour flows from the urethra with little or no dysuria.

3. Gonorrhœa *(laxorum)*, in which an humour for the most part pellucid, without any erection of the penis, but with a propensity to venery, flows from the urethra while the person is awake.

4. Gonorrhœa *(dormientium)*, in which the seminal liquor is thrown out, with erection and desire of venery, in those who are asleep and have lascivious dreams.

Order V. Epischeses; suppressions of evacuations.

Genus CXXII. Obstipatio; the stools either suppressed, or slower than usual. The species are,

1. Obstipatio *(debilium)*, in lax, weak, and for the most part dyspeptic persons.

2. Obstipatio *(rigidorum)*, in people whose fibres are rigid, and frequently of an hypochondriac disposition.

3. Obstipatio *(obstructorum)*, with symptoms of the colica 1st, 2d, 4th, and 7th, above-mentioned.

Genus CXXIII. Ischuria; an absolute suppression of urine. The species are,

1. Ischuria *(renalis)*, coming after a disease of the kidneys, with pain, or troublesome sense of weight in the region of the kidneys, and without any swelling of the hypogastrium, or desire of making water.

2. Ischuria *(ureterica)*, coming after a disease of the kidneys, with a sense of pain or uneasiness in some part of the ureter, and without any tumor of the hypogastrium, or desire of making water.

3. Ischuria *(vesicalis)*, with a swelling of the hypogastrium, pain at the neck of the bladder, and a frequent stimulus to make water.

4. Ischuria *(urethralis)*, with a swelling of the hypogastrium, frequent stimulus to make water, and pain in some part of the urethra.

All these species are subdivided into many varieties, according to their different causes.

Genus CXXIV. Dysuria; a painful, and somehow impeded emission of urine. The species are,

1. Dysuria

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1. Dysuria (*ardens*), with heat of urine, without any manifest disorder of the bladder.

2. Dysuria (*spasmodica*), from a spasm communicated from the other parts to the bladder.

3. Dysuria (*compressionis*), from the neighbouring parts pressing upon the bladder.

4. Dysuria (*phlogistica*), from an inflammation of the neighbouring parts.

5. Dysuria (*irritata*), with signs of a stone in the bladder.

6. Dysuria (*mucosa*), with a copious excretion of mucus.

Genus CXXV. Dyspermatismus; a flow, impeded, and insufficient emission of semen in the venereal act. The species are,

1. Dyspermatismus (*urethralis*), from diseases of the urethra.

2. Dyspermatismus (*nodosus*), from knots on the corpora cavernosa penis.

3. Dyspermatismus (*præputialis*), from too narrow an orifice of the prepuce.

4. Dyspermatismus (*mucosus*), from mucus infarcting the urethra.

5. Dyspermatismus (*hypertonicus*), from too strong an erection of the penis.

6. Dyspermatismus (*epilepticus*), from a spasmodic epilepsy happening during the time of coition.

7. Dyspermatismus (*apractodes*), from an imbecility of the parts of generation.

8. Dyspermatismus (*refluus*), in which there is no emission of semen, because it returns from the urethra into the bladder.

Genus CXXVI. Amenorrhœa. The menses either flowing more sparingly than usual, or not at all, at their usual time, without pregnancy. The species are,

1. Amenorrhœa (*emansionis*), in those arrived at puberty, in whom, after the usual time, the menses have not yet made their appearance, and many different morbid affections have taken place.

2. Amenorrhœa (*suppressionis*), in adults, in whom the menses which had already begun to flow are suppressed.

3. Amenorrhœa (*difficilis*), in which the menses flow sparingly, and with difficulty.

Order VI. Tumores; an increased magnitude of any part without phlogosis.

Genus CXXVII. Aneurisma; a soft tumor, with pulsation, above an artery.

Genus CXXVIII. Varix; a soft tumor, without pulsation, above a vein.

Genus CXXIX. Ecchymoma; a diffused, little eminent, and livid tumor.

Genus CXXX. Schirrus; an hard tumor of some part, generally of a gland, without pain, and difficultly brought to suppuration.

Genus CXXXI. Cancer; a painful tumor of a schirrous nature, and degenerating into an ill-conditioned ulcer.

Genus CXXXII. Bubo; a suppurating tumor of a conglobate gland.

Genus CXXXIII. Sarcoma; a soft swelling, without pain.

Genus CXXXIV. Verruca; a harder scabrous swelling.

Genus CXXXV. Clavus; a hard, lamellated thickness of the skin.

Genus CXXXVI. Lupia. A moveable, soft tumor below the skin, without pain.

Genus CXXXVII. Ganglion. A hard moveable swelling, adhering to a tendon.

Genus CXXXVIII. Hydatis; a cuticular vesicle filled with aqueous humour.

Genus CXXXIX. Hydarthrus; a most painful swelling of the joints, chiefly of the knee, at first scarce elevated, of the same colour with the skin, diminishing the mobility.

Genus CXL. Exostosis; a hard tumor adhering to a bone.

Order VII. Ectopiæ; tumors occasioned by the removal of some part out of its proper situation.

Genus CXLI. Hernia; an ectopia of a soft part as yet covered with the skin and other integuments.

Genus CXLII. Prolapsus; a bare ectopia of some some soft part.

Genus CXLIII. Luxatio; the removal of a bone from its place in the joints.

Order VIII. Dialyses. A solution of continuity; manifest to the sight or touch.

Genus CXLIV. Vulnus; a recent and bloody solution of the unity of some soft part by the motion of some hard body.

Genus CXLV. Ulcus. A purulent or ichorous solution of a soft part.

Genus CXLVI. Herpes; a great number of phlyctenæ or small ulcers, gathering in clusters, creeping, and obstinate.

Genus CXLVII. Tinea; small ulcers among the roots of the hair of the head, pouring out a fluid which changes to a white friable scurf.

Genus CXLVIII. Psora. Itchy pustules and little ulcers of an infectious nature, chiefly infecting the hands.

Genus CXLIX. Fractura; bones broken into large fragments.

Genus CL. Caries; an ulceration of a bone.

Having thus presented to our readers Dr Cullen's general systematic view of all the diseases to which the human body is subjected, we come next to give a more particular account of the more important affections, treating of them in the order which Dr Cullen has arranged them.

Class I. PYREXIÆ, or the Febrile Diseases. 125

Order I. FEBRES, Or Fevers strictly so called.

Sauvag. Class II. *Vog.* Class I. *Sagar.* Class XII. Morbi Febriles Critici, *Lin.* Class II.

Sect. I. INTERMITTENTS.

Intermittentes of many authors; *Sauv.* Class II. Order III. *Lin.* Class II. Order II. *Vog.* Class I. Order I. *Sag.* Class XII. Order III.

The

Febres. The *remittentes* of others, *Sauv.* Claſs II. Order II. *Sag.* Claſs XII. Order II.

Exacerbantes, *Lin.* Claſs II. Order III.

Continuæ, *Vog.* Claſs I. Order II.

Genus I. TERTIANA; the Tertian Fever.

(*Tertiana*, Sauv. G. 88. Lin. 16. Hoffm. Stahl. Cleghorn. Senac.)

The *Genuine* Tertian.

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1. *Deſcription.* This diſeaſe, in its moſt regular form, conſiſts of repeated paroxyſms, returning every ſecond day, the patient during the intermediate period enjoying apparently a ſtate of good health. This is the moſt common form of ague, as it is commonly called in Britain. Each paroxyſm conſiſts of three parts, the cold, the hot, and the ſweating ſtages. The paroxyſm commonly begins with a remarkable ſhivering, increaſing frequently to a convulſive ſhaking of the limbs. The extremities are always cold, ſometimes remarkably ſo. The cold for the moſt part is firſt perceived about the lumbar regions, from thence aſcending along the ſpine it turns towards the pit of the ſtomach. Sometimes it begins in the firſt joint of the fingers and tip of the noſe. Sometimes it attacks only a particular part of the body, as one of the arms, the ſide of the head, &c. This cold is often preceded by a heavy and ſleepy torpor, languor, and laſſitude, which we are partly to aſcribe to real weakneſs and partly to mere languor. To theſe ſymptoms ſucceed yawning and ſtretching; after which the cold comes on as above deſcribed, not unfrequently with a pain of the back, and a troubleſome ſenſation of tenſion in the precordia and hypochondria. To this ſucceed nauſea and vomiting: and the more genuine the diſeaſe, the more certainly does the vomiting come on; by which a great deal of tough mucous matter, and ſometimes bilious ſtuff or indigeſted food, is evacuated during the firſt paroxyſm. In ſome there is only a violent ſtraining to vomit, without bringing up any thing: ſometimes, inſtead of theſe ſymptoms, a diarrhœa occurs; and this chiefly in weak, phlegmatic, and aged people, or where an indigeſted mucous ſaburra has long remained in the primæ viæ.

When theſe ſymptoms have continued for an hour or two, the cold begins to go off, and is ſucceeded by a laſſitude, languor, and flaccidity of the whole body, but chiefly in the limbs, with an uneaſy ſoreneſs as if the parts had been bruiſed; excepting in thoſe caſes where the nauſea continues for a longer time. After this languor, a heat comes on, the increaſe of which is generally ſlow, but ſometimes otherwiſe, with pain of the head, thirſt, and bitterneſs in the mouth. The pulſe is quick and unequal; ſometimes beating 130 ſtrokes in a minute. As ſoon as this heat has abated, a little moiſture or ſweat is obſerved to break forth; not always indeed in the firſt, but always in the ſucceeding paroxyſms, and the urine lets falls a quantity of lateritious ſediment. The whole paroxyſm is ſeldom over in leſs than ſix hours, more frequently eight, and in violent caſes it extends to 12 hours; but that which exceeds 12 hours is to be reckoned a ſpurious kind, and approaching to the nature of continued fevers. All theſe ſymptoms, however, are repeated every ſecond day, in ſuch a manner that the patient is quite free from fever for at leaſt 24 hours. The paroxyſms return much about the ſame time, though ſometimes a little ſooner or later. Tertiana.

2. *Cauſes of this diſeaſe, and perſons ſubject to it.* The genuine tertian attacks men rather than women, young people rather than old: the latter being more ſubject to anomalous tertians. It likewiſe ſeizes the luſty and active, rather than the lazy and indolent. Thoſe, however, who are apt to nauſeate their meat fall eaſily into a tertian fever. The cauſe, according to Dr Cullen, is the miaſma of marſhes, and that only. Other phyſicians have taken in many more cauſes, almoſt every thing indeed which debilitates the body: but the Doctor denies that any of theſe, though they may diſpoſe the body for receiving the diſeaſe, or many augment it, can by any means produce it without the concurrence of the marſh miaſma; and it cannot be denied, that it is a diſeaſe almoſt peculiar to marſhy ſituations. Thus we find it very frequent in the fenny counties of Britain, although in other parts of this iſland it may be conſidered as a very rare diſeaſe; nay, in many it may perhaps be ſaid that it never occurs. And it is alſo well known that intermittents have almoſt entirely diſappeared in many parts of Britain, in which they were very common before the marſhes of theſe places were drained.

3. *Prognoſis.* The genuine ſimple tertian, unleſs improper medicines be adminiſtered, is generally very eaſily cured; nay, the vulgar reckon it of ſuch a ſalutary nature, that after it they imagine a perſon becomes more ſtrong and healthy than before. Hippocrates has obſerved, that theſe fevers terminate of their own accord after ſeven or nine paroxyſms. Juncker tells us, that it frequently terminates before the ſeventh paroxyſm, but rarely before the fourth. He alſo denies that any thing critical is to be obſerved in its going off; but in this he differs from Vogel, who tells us, that the urine, for ſome days after the fever is quite gone off, appears ſlimy, and lets fall much ſediment. The latter alſo informs us, that beſides the common criſis by ſweat and urine, the tertian hath one peculiar to itſelf, namely, dry ſcabby ulcers breaking out upon the lips. Theſe ſometimes appear about the third or fourth paroxyſm; and then we may venture to foretel that the diſeaſe will go off ſpontaneouſly after the ſeventh. But though the diſeaſe be never dangerous, in cold climates at leaſt, when properly treated; yet the improper uſe of hot and ſtimulating medicines may change it into a continued fever, more or leſs dangerous according to the quantity of medicines taken and the conſtitution of the patient; in which caſe the prognoſis muſt be regulated by the particular ſymptoms which occur. In warm climates, however, the tertian fever may be conſidered as a much more alarming diſeaſe; and unleſs the moſt powerful remedies be employed, the patient is in danger of falling a victim to every paroxyſm.

A variety of theories have been propoſed for explaining the phenomena of this affection; but we may aſſert, that every thing hitherto ſaid upon the ſubject is highly unſatisfactory. For although it be now almoſt univerſally admitted, that this fever does ariſe from the effluvia of marſhes, yet in what manner the

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action of those effluvia induces fever, and particularly why this fever returns in regular paroxysms, are questions with regard to which we are still totally in the dark. Dr Cullen, with much ingenuity, attempted to prove, that the remote causes of this, as well as of other fevers, operate by inducing a state of debility; that this debility gives rise to spasm, which induces increased action, from which the phenomena are to be explained. But this theory is liable to no less numerous and unsurmountable objections than the exploded hypotheses which had before been proposed by others. For it is an undeniable truth, that debility often exists, even to the highest imaginable degree, without any fever; nay, that when fever has taken place, the debility is often much greater after it is entirely gone than at any period during its course. When spasm and increased action do take place, we have no reason to view them in any other light than merely as symptoms of the disease; and while they are often absent in this affection, they frequently occur in others where the sickness, anxiety, and other characterizing symptoms of fever are entirely absent: and, upon the whole, a probable or rational theory of intermittents, as well as of other fevers, still remains to be discovered.

Cure. The treatment of all genuine intermittents, whether *tertians*, quotidians, or quartans, being almost precisely the same, the general method of cure applicable to all of them may be here given, to which it will be easy to refer when we come to describe the others.

In treating intermittent fevers, physicians have formed indications of cure according to their different theories. The followers of Boerhaave, Stahl, &c. who imagined that the disease proceeded from a lentor or other disorders in the blood, always thought it necessary to correct and evacuate these peccant humours by emetics and purgatives, before they attempted to stop the disease by the Peruvian bark or any other medicine. Cinchona indeed, among some, seems to be held in very little estimation: since Vogel affirms, that this medicine, instead of deserving to have the preference of all other febrifuge medicines, ought rather to be ranked among the lowest of the whole; and for this reason he ascribes the cures, said to be obtained by the use of the Peruvian bark, entirely to nature.

According to Dr Cullen, the indications of cure in intermitting fevers may be reduced to the following:

1. In the time of intermission, to prevent the return of the paroxysms.

2. In the time of paroxysms, to conduct these in such a manner as to obtain a final solution of the disease.

3. To take off certain circumstances which might prevent the fulfilling of the two first indications.

The first indication may be answered in two ways: 1. By increasing the action of the heart and arteries some time before the period of accession, and supporting that increased action till the period of accession be over, and thus preventing the recurrence of that atony and spasm of the extreme vessels, which he thinks give occasion to the recurrence of paroxysms. 2. By supporting the tone of the vessels, and thereby preventing atony and the consequent spasm, without increasing the action of the heart and arteries, the recurrence of paroxysms may be prevented.

The action of the heart and arteries may be increased, 1. By various stimulant remedies internally given or externally applied, and that without exciting sweat. 2. By the same remedies, or by others, managed in such a manner as to excite sweating, and to support that sweating till the period of accession be for some time past. 3. By emetics, supporting for the same time the tone and action of the extreme vessels.

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The tone of the extreme vessels may be supported without increasing the action of the heart and arteries, by various tonic medicines; as, 1. Astringents alone. 2. Bitters alone. 3. Astringents and bitters conjoined. 4. Astringents and aromatics conjoined. 5. Certain metallic tonics; and, 6. Opiates. A good deal of exercise, and as full a diet as the condition of the patient's appetite and digestion allow, will be proper during the time of intermission, and may be considered as belonging to this head. Although many particulars in this plan of cure are deduced from Dr Cullen's theory, yet there can be no doubt that the object chiefly to be aimed at is to employ such remedies during the intermissions as will prevent a recurrence of the paroxysm. Of all the remedies hitherto employed with this intention, the most celebrated, perhaps the most certainly effectual, is the Peruvian bark; or, to speak more properly, the bark of the *Cinchona officinalis* of Linnæus. But it must be observed, that good effects are only to be expected from this medicine when employed in substance and in large quantity; and for its use the following rules or observations have been given:

1. The cinchona may with safety be employed at any period of intermitting fevers, providing that at the same time there be neither a phlogistic diathesis prevailing in the system, nor any considerable or fixed congestion present in the abdominal viscera.

2. The proper time for exhibiting the cinchona in intermittent fevers is during the time of intermission, and it is to be abstained from in the time of paroxysms.

3. In the case of genuine intermittents, while a due quantity of cinchona is employed, the exhibition of it ought to be brought as near to the time of accession as the condition of the patient's stomach will allow.

4. In all cases of intermittents, it is not sufficient that the recurrence of paroxysms be stopped for once by the use of the cinchona; a relapse is commonly to be expected, and should be prevented by the exhibition of the cinchona repeated at proper intervals.

The advantage of administering the medicine as early as possible, was fully ascertained by Dr Lind in the years 1765, 1766, and 1767, during an uncommon prevalence of intermittents. When the disease was stopped by the cinchona immediately after the first or second fit, which was the case with 200 of the Doctor's patients as well as himself, neither a jaundice nor dropsy ensued; whereas, when the cinchona could not be administered, on account of the imperfect intermission of the fever, or when the patient had neglected to take it, either a dropsy, jaundice, or constant headach, were the certain consequences, and the violence of the disease was in proportion to the number of the preceding fits, or to the continuance of the fever. By every paroxysm the dropsical swellings were visibly increased, and the colour of the skin rendered of a deeper yellow. When the fever continued a few days without intermission, the belly and legs generally swelled; a violent headach, likewise, and vertigo, for the most part distressed the patient;

Febres. patient; so that some, even after the fever had left them, were not able to walk across their chamber for a fortnight or three weeks. When the returns of the fever were regular and even, but slight, four or five fits of a simple tertian were sometimes followed by the most dangerous symptoms; especially in the year 1765, when these fevers raged with the greatest violence. If, as frequently happened, a dropsical patient relapsed into the intermittent, there was an absolute necessity for putting an immediate stop to it by the cinchona; and in upwards of 70 such patients, Dr Lind observed the most beneficial effects to accrue from this practice. Without regard to a cough, or any other chronical indisposition, he ordered it to be given in large doses.

Cinchona has been often observed to fail in removing intermittents, from not continuing the use of it for a sufficient length of time, from administering it in too small a dose, or from giving it in an improper form. It was a prevailing opinion, that an ounce, or an ounce and an half, taken during one intermission, was sufficient to prevent the return of another paroxysm. But this is not always the case; for a severe fit will often attack a patient who has taken such a quantity. When this happens, the patient ought to persevere during the following intermissions, with an increase of the dose, till five or six ounces at least have been taken. The medicine also ought not to be omitted as soon as one fit is stopped, but should be continued in a smaller dose, and after longer intervals, for at least ten days or a fortnight. Even for several months after the disease is entirely removed, it would be advisable to take a little occasionally in damp weather, or during an easterly wind, to prevent a relapse. Where the intervals between the fits are short, as in quotidians and double tertians, from one to two drams of it ought to be taken every two or three hours.

The form in which this medicine is administered is of some consequence. Mucilages and syrups have been recommended to conceal the taste of it; but, from various experiments, Dr Lind found nothing more effectual for this purpose than small beer or milk, especially the latter. A dram of bark mixed with two ounces of milk, and quickly drank, may easily be taken by a person of the most delicate taste, and by washing the mouth afterwards with milk, there will not remain the least flavour of the bark; but if the mixture be not drank immediately, the bark will impart a bitter taste to the milk. This medicine is commonly given in electuaries or boluses; but Dr Lind observes, that in these forms it proves much less efficacious than when administered in juleps or draughts, with the plentiful addition of wine or spirits. He has remarked, that six drams of powdered bark, given in a julep, consisting of one fourth or one third of brandy, is as effectual as an ounce of the powder in the form of an electuary, and proves less disagreeable to the stomach. For patients unaccustomed to wine or spirits, each draught should be warmed with spiritus ammoniæ, or tinct. myrrh. by both of which the efficacy of the bark is he thinks increased. Dr Lind is also fully convinced that wine or spirits improve the virtues of the bark much more than elixir vitrioli, tinct. rosar. or such other medicines as have been recommended by different physicians.

For those who nauseate cinchona from a weakness of the stomach or other cause, he advises it to be given in clysters, in which form it is, he tells us, as efficacious as when taken by the mouth. For this purpose the extract is most proper with the addition of a sufficient quantity of the tinctura thebaica, in order to its being longer retained. For children labouring under intermitting fevers, Dr Lind orders the spine of the back to be anointed, at the approach of the fit, with a liniment composed of equal parts of tinctura thebaica and liniment. sapon. which has often prevented it. If this should not produce the desired effect, he informs us that two or three tea-spoonfuls of syrup. è mecon. given in the hot fit, will generally mitigate the symptoms. But for the entire removal of the disease, after purging with magnesia alba, he prescribes a dram of the extract. cinchonæ with a few drops of tinct. thebaic. in a clyster, to be repeated every three hours for a child of about a year old. When the stomach is oppressed with phlegm, the magnesia frequently occasions vomiting, which should be promoted with warm water. The constant heaviness of the head occasioned by those fevers in such tender constitutions is best relieved by the application of a blister to the back. Tertiana.

Cinchona has also proved effectual for the cure of intermittents in children, even when externally applied, by putting the powder of it into a quilted waistcoat. Of its efficacy in this way several instances are related by Dr Samuel Pye in the second volume of Medical Observations and Inquiries. In short, so effectual was it found in removing these fevers when properly applied, that of between four and five hundred afflicted with them in the year 1765, Dr Lind lost only two, neither of whom had taken this medicine.

In all these cases, a vomit was administered whenever the patient complained of a sickness and retching to vomit, or was seized with a spontaneous vomiting; and cinchona was never given till this sickness was removed, or a purgative taken to clear more perfectly the whole alimentary canal. In those patients who were troubled with a cough, attended with a pain in the side affecting the breathing, when the pain was not relieved by warm fomentations, the balsamum anodynum, or by a blister, Dr Lind generally ordered a few ounces of blood to be taken away, and endeavoured to stop the fever as soon as possible by the administration of cinchona; having found that every return of the fever increased all such pains.—When the headach was very violent, and harassed the patient during the intermissions, the success of cinchona was rendered more complete by the application of a blister to the back.—A giddiness of the head, which is the symptom most commonly remaining after even a slight intermitting fever, was generally relieved by the sal C. C. and cinchona in wine. The former of these was administered in the following manner.

R. Aq. Alex. Simp. ℥vii.
Sal C. C. ʒss.
Syr. è Cort. Aurant. ℥i. M. f. julep. Cap. cochlear. ij. subindè.

If from the continuance of the fever the patient was distressed with a flatulence, a distention of the abdomen, and a swelling of the legs, a spoonful of tinctura sacra, with the addition of 30 drops of the spirit. lavend. compos. was ordered to be taken every night—A continuance

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continuance of cinchona, a change of air, and the cold bath, were often found requisite to prevent a relapse.

Such is the method of cure recommended by this experienced author, who has also discovered the efficacy and success of opium in intermitting fevers. He informs us, that he has prescribed an opiate to upwards of 300 patients labouring under this disease; and he observed, that, if taken during the intermission, it had not the least effect either in preventing or mitigating the succeeding paroxysm: when given in the cold fit, it once or twice seemed to remove it; but when given half an hour after the commencement of the hot fit, it generally gave immediate relief.—When given in the hot fit, the effects of opium are as follow: 1. It shortens and abates the fit; and this with more certainty than an ounce of cinchona is found to remove the disease. 2. It generally gives a sensible relief to the head, takes off the burning heat of the fever, and occasions a profuse sweat. This sweat is attended with an agreeable softness of the skin, instead of the burning sensation which affects patients sweating in the hot fit, and is always much more copious than in those who have not taken opium. 3. It often produces a soft and refreshing sleep to a patient tortured in the agonies of the fever, from which he awakes bathed in sweat, and in a great measure free from all complaints.

Dr Lind has always observed, that the effects of opium are more uniform and constant in intermitting fevers than in any other disease, and are then more quick and obvious than those of any other medicine. An opiate thus given soon after the commencement of the hot fit, by abating the violence and lessening the duration of the fever, preserves the constitution so entirely uninjured, that, since he used opium in agues, a dropsy or jaundice has seldom attacked any of his patients in those diseases. When opium did not immediately abate the symptoms of the fever, it never increased their violence. On the contrary, most patients reaped some benefit from an opiate given in the hot fit, and many of them bore a larger dose at that time than they could do at any other. He assures us, that even a delirium in the hot fit is not increased by opium, though opium will not remove it. Hence he thinks it probable, that many symptoms attending these fevers are spasmodic; but more especially the headach. However, if the patient be delirious in the fit, the administration of the opiate ought to be delayed until he recovers his senses, when it will be found greatly to relieve the weakness and faintness which commonly succeed the delirium. Dr Lind is of opinion, that opium in this disease is the best preparative for cinchona; as it not only produces a complete intermission, in which case alone that remedy can be safely administered; but occasions such a salutary and copious evacuation by sweat, as generally to render a much less quantity of cinchona requisite. He commonly prescribes the opiate in about two ounces of tinctura sacra, when the patient is costive, who is to take the cinchona immediately after the fit. By these means the paroxysm is shortened, and the intestines are cleansed, previous to the administration of cinchona; as the opiate doth not prevent, but only somewhat retards, the operation of the purgative. When a vomit is given immediately before the paroxysm, the administration of the opiate should be postponed till the hot fit be begun.

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In the administration of cinchona, care should be taken that it be of a good quality. And different opinions have been entertained with respect to the choice, even where there is no reason to believe that it has been adulterated by the mixture of other articles. For a long time, the preference was given to small quilled pieces of pale-coloured bark; but of late the red bark, which is generally in larger masses, of an apparently coarser texture, and evidently of a more resinous nature, has been highly celebrated by Dr Saunders and others. And in cases where it does not disagree with the stomach or excite looseness, it is admitted by the most accurate observers to be more powerful in preventing the return of intermittents. Whether the red bark be the product of a different species of the cinchona, or be obtained as well as the pale quilled bark from the cinchona officinalis, is not yet ascertained with sufficient accuracy. Cinchona of a yellow colour has lately been imported into Britain and highly extolled. Its botanical history is not ascertained. It contains more bitter extractive matter, and more tannin and gallic acid, than either the pale or red; but less gum than the pale, and less resin than the red. It seems to produce the same medical effects in smaller doses. And it has sometimes succeeded in the cure of intermittents where the pale and red cinchona have before been employed in vain.

A species of cinchona, distinguished by the title of *cinchona Jamaicensis*, has been discovered in Jamaica and other islands in the West Indies. A very accurate description of it has been given by Dr Wright of Jamaica in the Philosophical Transactions of London. The bark of this species also has been recommended in the cure of intermittents; but the advantages of it have not hitherto been sufficiently confirmed by experience.

The barks of various trees readily cultivated in Britain, particularly different species of the salix, the prunus, the fraxinus, and the quercus, have by some been represented as no less efficacious than the cinchona. But we may safely venture to assert, that although several of them may possess some power in stopping intermittents, yet that none hitherto tried can be considered as in any degree approaching to the cinchona in point of efficacy.

But although the Peruvian bark be the best cure for intermittents hitherto discovered, yet while it can by no means be represented as the only cure, it is very certain that other remedies have in different cases succeeded after the cinchona has failed. Cures have often been obtained by the use of different aromatics, bitters, and astringents. Many articles from the mineral kingdom also have been employed with advantage. And intermittents have unquestionably been in certain cases stopped by different preparations of iron, zinc, copper, lead, and mercury. But of all the articles of this nature, arsenic has of late been the most celebrated. Arsenic is on good grounds conjectured to be the basis of an article much employed in the cure of intermittents in some of the countries where they are most prevalent, and sold under the title of the *tasteless ague drop*. The great success attending the use of this article, led Dr Fowler, an ingenious physician of Stafford, to examine it with particular attention. And in a treatise which he has lately published, entitled *Medical Reports* on the effects of arsenic in the cure of agues, he has given a formula for an arsenical solution, Febres. solution, which he has found very succesful in affections of this kind, and which is probably very nearly the same with the tastelefs ague drop. Dr Fowler's mineral solution, as he styles it, is found by dissolving 64 grains of arsenic and as much fixed vegetable alkaline salt in a pound of distilled water. This solution is given in doses from three to 12 drops, varied according to the condition of the patient, and repeated two or three times a-day. And where the cinchona has failed in stopping intermittents, it seems to be one of the most powerful remedies yet discovered. But after all remedies prove ineffectual, intermittents are often stopped by change of season and of situation.

But besides the remedies employed in tertians and other intermittents, with the view of preventing the return of paroxysms, it is often also necessary to employ powerful articles with other intentions, particularly to mitigate and shorten the paroxysm when present; to obviate urgent symptoms, especially those of an inflammatory or putrid nature; and to obtain a complete apyrexia or intermission from fever after the paroxysm has ceased. With these intentions, recourse is not unfrequently had to emetics, laxatives, blood-letting, blisters, opium, diluents, or sudorifics, as the circumstances of the case may require.

127 The *Irregular* or *Spurious* TERTIAN.
Sp. I. var. 1. B.
Tertiana notha sive spuria, *Sauv.* sp. 2. *Sennert. Cleghorn. Hoffman.*

The characteristic marks of this fever are, that its paroxysms last longer than 12 hours, and consequently it inclines more to the quotidian or continued fever than the former. Its paroxysms have no stated hour of attacking. The cure, however, is precisely the same with that above described, observing the proper cautions already mentioned with regard to the use of the cinchona.

128 The *Double* TERTIAN. Sp. 1. var. 2. C.
Tertiana duplex, *Sauv.* sp. 13. *Vog.* G. 12. *Sennert. Cleghorn.*
Duplicata, *Lin.* 18.

The double tertian comes on every day; but differs from the quotidian in this, that its paroxysms do not answer to each other singly, but alternately. The first day, for instance, the fit will come on in the forenoon, in the second in the afternoon, the third in the forenoon, and the fourth in the afternoon.

Of these fevers we shall give the following description from Cleghorn's treatise on the diseases of Minorca: "They are called *double tertians* when there are two fits and two intervals within the time of each period. But commonly there is some difference between the two fits, either in respect of the hour they come at, the time of their duration, or the nature and violence of their concomitant symptoms. Some double tertians begin in this manner.—On the evening of Monday, for example, a slight fit comes on, and goes off early next morning; but on Tuesday, towards the middle of the day, a more severe paroxysm begins, and continues till night. Then there is an interval to Wednesday evening, when a slight fit commences a new period of the fever, which proceeds in the same manner as the first; so that according to the way Tertiana. physicians calculate the days of diseases, by beginning to reckon from the first hour of their invasion), both paroxysms happen on the odd days, while the greatest part of the even days is calm and undisturbed. But in most double tertians the patient has a fit every day of the disease; the severe one commonly appearing at noon upon the odd days, the slight one towards evening on the even days; though sometimes the worst of the two fits happen on the even days.

"There is a tertian fever sometimes to be met with, during each period of which there are three different fits, and as many intervals. For example, towards Monday noon the patient is seized with a paroxysm, which declines about five or six o'clock the same evening; a few hours after, another fit begins, and continues until morning: from which time there is an interval to Tuesday evening, when a third fit comes on, and lasts most part of the night. On Wednesday there are again two paroxysms, as on Monday, and on Thursday like that of Tuesday; and thus the fever goes on with a double fit on each of the odd days, and a single fit on the even days.

"In double tertians, that interval is the most considerable which follows the severe fit; for the slight fit oftener ends in a remission than intermission, and frequently lingers till the other approaches: Hence it is, that the night preceding the vehement fit is much more restless than that which comes after it, as has been observed by Hippocrates. In double tertians, the vehement fit often comes on a little earlier in each period, while the slight fit returns at the same hour, or perhaps later and later every second day: so that the motions of one have no influence on those of the other; from whence it appears, that each of these fits hath its own proper independent causes."

Duplicated TERTIAN. Sp. I. var. 2. D. 129
Tertiana duplicata, *Sauv.* sp. 14. *Jones. River.*

This hath two fits on the same day, with an intermediate day on which there are none. This also does not differ in any remarkable particular from those already described.

The *Triple* TERTIAN. Sp. I. var. 2. E. 130
Tertiana triplex, *Sauv.* sp. 15. *Cleghorn.*
Semitertiana, *Hoffman.*
Semitertiana primi ordinis, *Spig.*

This differs from the former in having a single and double fit alternately: thus, for instance, if there be two fits the first day, there is only one the second, two the third, one the fourth, &c. Its cure is the same as before.

The *Semi*-TERTIAN. Sp. I. var. 2. F. 131
Hemitritæus, *Cels.*
Semitertiana, *Cleghorn.*
Semitertiana secundi ordinis, *Spig.*
Amphimerina hemitritæus, *Sauv.* sp. 8.
Amphimerina pseudo-hemitritæus, *Sauv.* sp. 9.

The semitertian is described by Dr Cullen as having only an evident *remission* between its paroxysms; more remarkable between the odd and even day, but less so between the even and odd one. For this reason, he adds, that possibly some semitertians ought rather to

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to be classed among the remittents; and owns that it is difficult to settle the boundaries between them. But Cleghorn, whom he quotes, describes it in the following manner. "A fit begins on Monday noon, for example, and goes off the same night. On Tuesday afternoon a second fit comes on, and gradually increases till Wedenesday night, when it terminates. On Thursday morning there is such another interval as happened on Tuesday morning: But on Thursday afternoon another long fit like the preceding commences; and returning regularly every second day, leaves only a short interval of ten or twelve hours during the eight and forty.

Concerning the cure of these fevers Dr Cullen observes, that though no entire apyrexia occurs, cinchona may be given during the remissions: and it should be given even though the remissions be inconsiderable; if, from the known nature of the epidemic, intermissions or considerable remissions are not to be expected, and that great danger is apprehended from repeated exacerbations.

132 The *Sleepy* TERTIAN. Sp. I. var. 3. G.

Tertiana carotica, *Sauv.* sp. 10. *Werlhof.*
Tertiana hemiplegica, *Sauv.* sp. 20. *Werlhof.*
Quotidiana soporosa, *Sauv.* sp. 8. *Car. Pis.*
Febris caput impetens, *Sydenham*, ep. ad. R. Brady.

This, according to Vogel, is a most dangerous species, and very commonly fatal; for which reason he ranks it among those intermittents which he calls *malignant*. Sometimes he tells us the alarming symptom of a sleepiness comes on, not at the beginning of the disease, but will unexpectedly occur during the third, fourth, fifth, or sixth paroxysm. It commonly begins with the cold fit, and continues during the whole time of the paroxysm, and, becoming stronger at every succeeding one, at last terminates in a mortal apoplexy. Sometimes fevers of this kind rage epidemically. Vogel relates, that he saw a simple tertian changed into one of these dangerous fevers. The patient was a woman of a delicate constitution, and the symptom appeared in consequence of her being put in a violent passion: however, it occurred but once, and she recovered. Hoffman mentions a carus in a double tertian occurring seven times without proving mortal; though Vogel says, that the powers of nature are very seldom sufficient to conquer the disease.

In 1678, Dr Sydenham tells us that intermittents raged epidemically at London, where none had appeared before from 1664. Of them "it is to be noted (says he), that though quartans were most frequent formerly, yet now tertians or quotidians were most common, unless the latter be entitled double tertians; and likewise, that though these tertians sometimes began with chilness and shivering, which were succeeded first by heat, and soon after by sweat, and ended at length in a perfect intermission, returning again after a fixed time; yet they did not keep this order after the third or fourth fit, especially if the patient was confined to his bed and used hot cardiacs, which increase the disease. But afterwards this fever became so unusually violent, that only a remission happened in the place of an intermission; and approaching every day nearer the species of continued fevers, it seized the head, and proved fatal to abundance of persons."

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From this description of Sydenham's we may have an idea of the nature of the disease. As to its cure he strongly recommends cinchona; telling us, that, even in the *most continued* kind of intermittents, "the nearer the intermittent approaches to a continued fever, either spontaneously, or from using too hot a regimen, so much the more necessary is it to exhibit a larger quantity of the bark; and that he took advantage of a remission, though ever so small."

The *Spasmodic* or *Convulsive* TERTIAN. Sp. I. var. 3. H. 133

Tertiana asthmatica, *Sauv.* sp. 6. *Bonnet.*
Tertiana hysterica, *Sauv.* sp. 8. *Wedel.* A. N. C. Dec. I. A. II. obs. 193.
Hysteria febricosa, *Sauv.* G. 135. sp. 8. A. N. C. Dec. I. Ann. II.
Tertiana epileptica, *Sauv.* sp. 16. *Calder. Lautter.*
Quotidiana epileptica, *Sauv.* sp. 3. Edinb. Essays, vol. v. art. 49.
Ecclampsia febricosa, *Sauv.* G. 139. sp. 17.
Epilepsia febricosa, *Sauv.* G. 134. sp. 9.
Tertiana tetanodes Med. Beobacht I. Band.
Tetanus febricosus, *Sauv.* G. 122. sp. 10. *Stork*, Ann. Med. II.

Tertians of this kind occur with very different symptoms from those of the true ones, and sometimes even with those which are very extraordinary. In some they are attended with symptoms of asthma, in others with those of hysterics, in others with convulsions. Where the symptoms of asthma occur, the disease must be treated with diuretics and antispasmodics joined with cinchona. In the hysteric asthma the fit comes on with cold, yawning, cardialgia, terror and dejection of mind. The disease is to be removed by mild aperients and antihysterics joined with cinchona.

Of the convulsive tertian we have a most remarkable instance in the Edinburgh Medical Essays, vol. v. The patient was a farmer's son about 26 years of age, of a strong plethoric habit of body. He had laboured under an ague half-a-year, and had taken a great deal of Peruvian bark. While he was telling his case to the surgeon (Mr Baine of Pembroke), he was suddenly taken with a violent stamping of his feet; and the convulsions gradually ascended from the soles of the feet to his legs, thighs, belly, back, and shoulders. His head was then most violently convulsed, with a total deprivation of speech; but he had a most dismal vociferation, which might have been heard at a considerable distance, his abdomen and thorax working and heaving violently and unusually in the mean time. This fit having lasted half an hour, a profuse sweat broke out over all his body, which relieved him; and he then became capable of answering such questions as were put. These extraordinary fits, he said, had been occasioned by a fright, and his neighbours had concluded that he was bewitched. They returned sometimes twice a-day, and always at the times the ague used to return. During the paroxysm his pulse was very high and quick, his face much inflamed, and his eyes ready to start out of his head. After the

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134 The *Eruptive* TERTIAN. Sp. I. var. 3. I.
Tertiana petechialis, *Sauv.* sp. 3. *Donat. Lautter.*
Tertiana scorbutica, *Wedel.* A. N. C. Dec. I. A. II. obs. 193.
Tertiana urticata, *Sauv.* sp. 22. *Planchon.* Journ. de Med. 1765. *Cleghorn.*
Tertiana miliaris, *Sauv.* sp. 21. *Walthieri* de Med. Ger.

This species of tertian is accompanied with red or livid blotches on the skin, or an eruption like that occasioned by the stinging of nettles. In the latter case Dr Cleghorn says the disease is very dangerous; and as the former indicates an incipient dissolution and putrefaction of the blood, it must also be reckoned of very dangerous tendency.

135 The *Inflammatory* TERTIAN. Sp. I. var. 3. K.
Tertiana pleuritica, *Sauv.* sp. 4. *Vales. Lautt.*
Pleuritis periodica, *Sauv.* G. 103. sp. 14.
Tertiana arthritica, *Sauv.* sp. 5. *Morton. Lautt.*

Sauvages informs us, that he has seen a true and genuine pleurisy having all the pathognomic signs of the disease, but assuming the form of an intermittent; that is, the patient is one day affected with the pleurisy, and the next seemingly in perfect health. He also tells us, that in the month of May 1760 a tertian raged epidemically, which after the third fit imitated a pleurisy, the pain of the side and difficulty of breathing coming regularly on, and the fever from an intermittent becoming remittent; the blood had also the same appearance with that of pleuritic persons, and the distemper yielded to bleeding and gentle cathartics.—Morton also informs us, that he has observed similar disorders an hundred times, which were always certainly and safely cured by the Peruvian bark.

136 The TERTIAN *complicated* with other *Disorders.* Sp. I. var. 4.
Tertiana scorbutica, *Sauv.* sp. 9. *Etmuller. Timæus.*
Tertiana syphilitica, *Sauv.* sp. 17. *Deidier.*
Tertiana verminosa, *Sauv.* sp. 18. *Stisser.* in act. Helmstad. *Lancis.* de noxiis palud. *Pringle. Ramazzini. Van den Bosch.* de const. vermin.

The scorbutic tertian, according to Sauvages, is exceedingly anomalous, its periods being sometimes much anticipated, and sometimes much postponed. It is exceedingly obstinate, and will return if the body be not cleared of its scorbutic taint. The patient is affected with lancinating pains of a wandering nature. The urine lets fall a dusky red sediment, or a thick branny matter is copiously scattered up and down in it, seemingly tinged with blood. The usual symptoms of scurvy, viz. livid spots, and rotten fetid gums, also frequently occur. For this the Peruvian bark is very useful, both as a febrifuge and antiscorbutic.

A tertian accompanied with worms is taken notice of by Sir John Pringle in his treatise on the diseases of the army. The worms, he tells us, were of the round kind; and though we are by no means to reckon them the cause of the fever, they never failed to make it worse, occasioning obstinate gripings or sickness at stomach. In these cases stitches were frequent; but, being flatulent, were not often relieved by bleeding. The worms were discharged by vomiting as well as by stool. For discharging these worms, he commonly gave half a dram of rhubarb with 12 grains of calomel; without observing any inconvenience from such a large dose of mercury. Anthelmintics, which act slowly, had little chance of doing good; for though worms will sometimes lie long in the bowels without giving much uneasiness to a person otherwise well, yet in a fever, especially one of a putrid kind (to which his intermittents always seemed to incline), the worms being disturbed by the increase of heat, and the corruption of the humours in the *primæ viæ*, begin to move about, and struggle to get out. Lancisius, who makes this remark, adds, that upon opening the bodies of some who had died at Rome of fevers of this kind, wounds were found in the intestines made by the biting of the worms; nay, that some of them had even pierced through the coats of the guts, and lay in the cavity of the abdomen. Pringle never had any instance of this; but knew many cases in which the worms escaped by the patient's mouth, though there had been no previous retching to bring them up. One soldier was thrown into violent convulsions, but was cured by the above-mentioned powder.

The TERTIAN *varied* from its *Origin.* Sp. I. var. 5. 137
Tertiana accidentalis, *Sauv.* sp. 12. *Sydenham.*
Tertiana à scabie, *Sauv.* sp. 12. *Juncker,* tab. 80. *Hoffman,* II. p. 12.

The existence of fevers of this kind, as we have already observed, is denied by Dr Cullen; the accidental fever of Sauvages was said to arise from any slight error in the non-naturals, and consequently was very easily cured. That which arose from the repulsion of the itch, was cured as soon as the eruption returned.

The TERTIAN with only a *remission* between the fits. Sp. II. 138 Remittent tertian.
Tritæophya, *Sauv.* Gen. 85. *Sag.* p. 695.
Tritæus, *Lin.* 21.
Hemitritæa, *Lin.* 23.
Tertianæ remittentes et continuæ Auctorum.
Tertianæ subintrantes, proportionatæ, subcontinuæ, *Torti.*
Tertiana subcontinua, *Sauv.* sp. 19.
Quotidiana deceptiva, *Sauv.* sp. 2.
Amphimerina semiquintana, *Sauv.* sp. 24.
Tritæophya deceptiva, *Sauv.* sp. 10.
Causus *Hippocratis.*
Tritæophya causus, *Sauv.* sp. 2.
Febris ardens *Boerhaavii,* aph. 738.
Tertiana perniciosa, quæ simulata tertiani circuitus effigie lethalis, et mille accidentibus periculosissimis implicata, existit. *Lud. Mercatus.*
Tertiana pestilens, *P. Sal. Diversus.*

Tertiana

Febres.

Tertiana maligna peſtilens, *Riverii.*
Morbus Hungaricus. *Lang. Lemb. Sennert. Jordan.*
Languor Pannonicus, *Cober.*
Amphimerina Hungarica, *Sauv.* ſp. 10.
Hemitritæus peſtilens, *Schenck.* ex *Corn. Gamma.*
Febres peſtilentes Ægyptiorum, *Alpin.*
Febris tertiana epidemica, *Bartholin.*
Febres epidemicæ, autumni 1657 et 1658, *Willis.*
Febris ſyneches epidemica, ab anno 1658 ad 1664. et poſtea ab anno 1673 ad 1691, *Morton.*
Febres autumnales incipientes, *Sydenham.*
Affectus epidemicus Leidenſis, *Fr. Sylvii.*
Morbus epidemicus Leidenſis, 1669, *Fanois.*
Tertianæ pernicioſæ et peſtilentes, et febres caſtrenſes epidemicæ, *Lanciſi.*
Febres intermittentes anomalæ et mali moris, *Hoffman.*
Febris cholerica minus acuta, *Hoffman.*
Febris epidemica Leidenſis, anno 1719, *Koker* apud *Haller*, Diſp. tom. v.
Amphimerina paludoſa, *Sauv.* ſp. 19.
Febris paludum, *Pringle.*
Bononienſis conſtitutio hiemalis 1729, *Beccari* in A. N. C. vol. iii.
Amphimerina bilioſa, *Sauv.* ſp. 22.
Febris caſtrenſis, *Pringle.*
Febris putrida epidemica, *Huxham de aëre ad ann.* 1729.
Febris bilioſa Lauſanenſis, *Tiſſot.*
Tritæophya Wratiſlavienſis, *Sauv.* ſp. 3. Hahn. Epidemia verna Wratiſlav. in App. ad A. N. C. vol. x.
Tritæophya Americana, *Sauv.* ſp. 12.
Febris anomala Batava, *Grainger.*
Morbus Naronianus, *Pujati.*
Febris continua remittens, *Hillary's* diſeaſes of Barbadoes.
Febris remittens Indiæ Orientalis, *Lind.* diſſ. inaug. 1768.
Febris critica et febr. bilioſa æſtatis, *Rouppe.*
Febris remittens regionum calidarum, *Lind* on the diſeaſes of hot climates.

A. Tertiana cholerica ſive dyſenterica, *Tort.* Therap. Special. lib. iii. cap. 1. *Lautter.* Hiſt. Med. caſ. 6. 16. 17. 20. *Morton*, App. ad Exerc. II.

B. Tertiana ſubcruenta ſive atrabiliaris, *Tort.* ibid. Never ſeen by *Cleghorn.*

C. Tertiana cardiaca, *Tort.* ibid. *Lautter.* Hiſt. Med. caſ. 15. 16. 23.
Amphimerina cardiaca, *Sauv.* ſp. 5.
Tritæophya aſſodes, *Sauv.* ſp. 6.
Febris continua aſſodes, *Vog.* 27.

D. Tertiana diaphoretica, *Tort.* ibid.
Tritæophya typhodes, *Sauv.* ſp. 4.
Tritæophya elodes, *Sauv.* ſp. 5.
Febris continua elodes, *Vog.* 21.

E. Tertiana ſyncopalis, *Tort.* ibid. *Lautter.* caſ. 11. 12. 13. 15. 16.
Tritæophya ſyncopalis, *Sauv.* ſp. 1.
Amphimerina ſyncopalis, *Sauv.* ſp. 4.
Amphimerina humoroſa, *Sauv.* ſp. 6.
Febris continua ſyncopalis, *Vog.* 29.

F. Tertiana algida, *Tort.* ibid. *Lautter.* caſ. 13.
Amphimerina epiala, *Sauv.* ſp. 3.

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Amphimerina phricodes, *Sauv.* ſp. 7.
Tritæophya leipyria, *Sauv.* ſp. 9.
Tertiana leipyria, *Sauv.* ſp. 23. *Valcarenghi* Med. Ration. p. 18.
Febris continua epiala et leipyria, *Vog.* 19. et. 24.

G. Tertiana lethargica, *Tort.* ib.
Tritæophya carotica, *Sauv.* ſp. 7. *Lautter.* 1. 7. 14.
Tertiana apoplectica, *Morton.* Exerc. I. cap. ix. hiſt. 25.
Tertiana ſoporoſa, *Werlhof.* de febr. p. 6.
Febris epidemica Urbevetana, *Lanciſ.* de noxiis pal. effluv. I. II. c. 3.

The remittent fevers are much more dangerous than the true intermittents, as being generally attended with much greater debility of the nervous ſyſtem and tendency to putreſcency in the fluids than the latter. Sauvages divides his tritæophya, a remittent tertian into the following ſpecies:

139 1. *Tritæophya ſyncopalis*, or that attended with fainting. It begins like a tertian, with cold ſucceeded by heat and profuſe ſweating; but attended with much more dangerous ſymptoms, ſuch as cardialgia, enormous vomiting, great weakneſs, ſmall contracted pulſe, coldneſs of the extremities, and, unleſs timely aſſiſtance be given, kills during the ſecond or third paroxyſm.

140 2. The *cauſus*, or burning fever of Hippocrates, returns every third day without any new ſenſation of cold; and is attended with great thirſt, heat, but without diarrhœa or ſweat, and continues only for one week or two at the utmoſt. It attacks chiefly young people of a robuſt and bilious habit of body, who have been accuſtomed to much exerciſe, and expoſed to the ſun during the heats of ſummer, and have alſo uſed a phlogiſtic regimen. The tongue is dry, ſometimes black; the urine of a red or flame colour; together with pain of the head, anxiety, and ſometimes other ſymptoms ſtill more dangerous.

141 3. *Tritæophya Vratiſlavienſis*, was a peſtilential diſeaſe occaſioned by famine, during which the people fed on putrid aliments: the air was infected by the vaſt numbers of bodies of thoſe ſlain in battle, and the inhabitants were alſo dejected by reaſon of being deprived of their harveſt, and other calamities; to all which was added the continuance of a calm in the atmoſphere for a long time. It began with an acute fever, leipyria or coldneſs of the external parts and a ſenſation of burning heat inwardly; general weakneſs; pain of the head and præcordia; ſerous, or bilious diarrhœa; a delirium, in ſome furious, and accompanied with a dread of being expoſed to the air; on the ſecond day the thirſt was violent, attended with a bilious vomiting, as well as diarrhœa, tough viſcid ſpitting, fainting, burning heat in the bowels, the tongue dry and ſeeming as if burnt with a hot iron, a ſuppreſſion of the voice, anxiety, ſtupor, after which quickly followed convulſions and death. In ſome fevers leipyria came on with an exceeding great cold of the extremities, preſently followed by an intolerable heat of the viſcera, with ſymptomatic ſweats, violent diarrhœa, followed by a very itchy miliary eruption. On the fourth day came on copious ſweats, ſpaſms of the lower jaw, nauſea, involuntary paſſing of urine, ſlight delirium, a flux of ichorous matter from the noſtrils, an exceeding tough ſpitting, an epilepſy, and death. Profeſſor Hahn, who gives

Febres. gives the hiſtory of this diſeaſe, was himſelf attacked by it, and ſuffered in the following manner: On the firſt day was a violent feveriſh paroxyſm without rigor, a ſharp pain in the occiput, and immediately an inflammatory pain over the whole head; the feet were extremely cold, and the extremities rigid with ſpaſms. The pain continued to increaſe daily to ſuch a degree, that the contact of the air itſelf became at laſt intolerable; a dejection of mind and incredible weakneſs followed; he paſſed reſtleſs nights with continual ſweating, heavy and pained eyes, and an univerſal ſenſation of rheumatiſm over the whole body. On the third day the pains were aſſuaged, but he had a very bad night. On the fourth day all the ſymptoms were worſe, the feet quite chilled, the hands very red and agitated with convulſive motions; he was terrified with apprehenſions of death, and had a vomiting every now and then: this day ſponges dipped in cold water were applied over the whole body, and he uſed cold water for his drink. On the eighth day the pulſe was convulſive; and the pains were ſo violent that they made him cry out almoſt continually. On the ninth day he was delirious, and threw up ſome grumous blood. On the 11th his pulſe was more quiet, and he had a ſweat; a decoction of cinchona was given: his voice was broken, his ſpeech interrupted, and his teeth chattered upon one another. On the 12th his jaw was convulſed, he had a riſus ſardonicus, and deafneſs; after which the paroxyſms returned leſs frequently, and only towards night. On the 14th he had a chilling cold over the whole body, a cold ſweat; frequent lotions were applied, and all the ſymptoms became milder. On the 18th he had a quick delirium, but fainted as ſoon as taken out of bed; a ſenſation of hunger, followed by copious ſweats; profound ſleep; an averſion from noiſe; every thing appeared new and extraordinary. On the 36th a cholera; on the 48th a ſcaling off of the ſkin, and falling off of the nails. This epidemic carried off above 3000 people at Warſaw. Frequent lotion of the body either cold or tepid, watery glyſters, and the copious introduction of watery fluids under the form of drink, were of ſervice. But the moſt favourable criſis was under the form of ſome cutaneous eruption.

142 4. *Tritæophya typhodes*. The principal ſymptom of this fever was a continual ſweat with which the patients were almoſt always wet; with paroxyſms returning every third day. Sauvages tells us, that he had twice an opportunity of obſerving this fever; one was in the teacher of an academy, about 40 years of age, and of a melancholic temperament. He ſweated every ſecond night ſo plentifully, that he was obliged to change his linen nine times; and even on the intermediate days was never perfectly free of fever, and had his ſkin moiſtened with ſweat. The other was of a woman who went about in man's clothes, and was diſcovered only after her death. The diſeaſe began with a ſlight ſenſation of cold, after which ſhe ſweated for eight hours. It was attended with the higheſt debility, anxiety, and at the ſame time an inſatiable hunger.

143 5. *Tritæophya elodes*, was an inflammatory epidemic, but not contagious, terminating about the 14th or 21ſt day. The diſeaſe came on in the night-time, with diſturbed reſt, univerſal weakneſs, watchings, great heat and ſweat, redneſs of the face and almoſt of the whole body, ſparkling eyes, the tongue dry and white; a hard, tenſe, and turgid pulſe: about the third day a kind of frenzy frequently came on with the feveriſh paroxyſm, the forerunner of an univerſal miliary eruption; or, what was worſe, with purple ſpots ſo cloſe together, that they looked like an eryſipelas of the whole body. Sometimes bliſters of the ſize of ſmall pearls, filled with acrid ſerum, appeared on the neck, armpits, and trunk of the body, which were of all the ſymptoms the moſt dangerous. There was a variety of the diſeaſe, which Sauvages calls the *humoralis*, and in which the pulſe was ſoft and feeble, with greater weakneſs over the whole body, and the diſpoſition to ſleep more frequent than in the other; the eyes languid; the tongue very white, but not dry; and worms were ſometimes diſcharged.

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6. *Tritæophya aſſodes*. This ſpecies aroſe from a foulneſs of the primæ viæ, and the effluvia of waters in which hemp had been ſteeped. It began with rigor, followed by great heats, reſtleſſneſs, toſſing of the limbs, faintings, immoderate thirſt, dryneſs of tongue, delirium, and at length exceſſive watchings; theſe laſt, however, were leſs dangerous than vertigo or a comatoſe diſpoſition, which brought on convulſions or apoplexies. 144

7. *Tritæophya carotica*. This had exacerbations every other evening; and its diſtinguiſhing ſymptom was an exceſſive inclination to ſleep, preceded by a ſevere headach, and followed by delirium, and ſometimes convulſions; the tongue was black, and the patient inſenſible of thirſt after the delirium came on. In thoſe caſes where the diſeaſe proved fatal, a ſubſultus tendinum and other alarming ſymptoms, came on. 145

8. *Tritæophya leipyria* is only a variety of the tritæophya cauſus, already deſcribed. 146

9. *Tritæophya deceptiva*. This ſpecies at firſt aſſumes the appearance of a continued fever; but afterwards degenerates into a remittent, or even an intermittent. It is deſcribed by Sydenham, but attended with no remarkable ſymptoms. 147

10. The laſt of Sauvages's ſpecies of Tritæophya belonging to the remitting tertian is the *Americana*. This, according to Sauvages, is the ardent fever with which the Europeans are uſually ſeized on their firſt arrival in America, and generally carries off one half of them. Of this there are two varieties, the *very acute* and the *acute*. The very acute ends before the ſeventh day. It comes on a few days after the perſon's arrival, with loſs of appetite, with dyſpnœa and ſighing from weakneſs, headach, laſſitude, and pain of the loins: a pyrexia ſucceeds, with great thirſt, ſweat, and heat; the ſickneſs increaſes, nauſea comes on, with vomiting of porraceous bile; the tongue rough, the extremities often cold; watching, furious delirium; and the patient frequently dies on the third day. Copious ſweats, and a plentiful hemorrhagy from the noſe on the fifth day, but not ſooner, are ſerviceable; but a bilious diarrhœa is the beſt criſis of all. 148

The acute kind terminates moſt frequently on the ninth, but very rarely goes beyond the fifteenth day. Death frequently comes on between the fourth and ſeventh days. It begins with headach, pain in the loins, and ſometimes ſhivering; great laſſitude, dyſpnœa,

pnœa, thirſt; burning fever, increaſing every third day; inflation of the abdomen, pain at the pit of the ſtomach, nauſea, and bilious vomiting. Such is the ſtate of the diſeaſe within twenty-four hours. The eyes are red, and full of tears; the urine pellucid; there is a low delirium, and continual anxiety; the tongue is dry and red, and ſometimes, though rarely, black, which is a ſtill worſe ſign; the pulſe, formerly ſtrong and full, ſinks about the fourth day, and becomes tenſe and ſpaſmodic: if a carus then comes on, the patient dies the fifth or ſixth day; but if the pulſe keeps up, and no carus comes on, a criſis is to be expected by ſweat, by a copious hemorrhagy from the noſe, or, which is ſtill more ſafe, by a bilious diarrhœa, which is never ſalutary if it comes on before the fifth day.

To the remitting tertian alſo belong the following ſpecies mentioned by Sauvages, viz.

149 1. *Tertiana ſubcontinua.* This begins like a genuine tertian, and at firſt hath diſtinct paroxyſms; but theſe grow gradually more and more obſcure, the diſeaſe acquiring daily more of the appearance of continued fever, by which it is to be diſtinguiſhed from the other varieties of this ſpecies. It is not unfrequently joined with thoſe ſymptoms which attend the fatal fever already mentioned; as cardialgia, cholera, ſyncope, &c. but in a much leſs degree. The diſeaſe commonly begins with little or no ſenſe of cold, but rather a ſenſation of heat; when the tertian is doubled, it has firſt a ſlighter and then a more ſevere fit; and thus goes on with an exacerbation on the even days: and though it ſhould change from a double into a ſingle tertian, we are ſtill to ſuſpect it, if a weak fit is the forerunner of a very ſtrong one. This change of the tertian into a continued fever is alſo to be prognoſticated if a heat remarkable to the touch is perceived on the day of intermiſſion, together with ſome diſturbance of the pulſe, thirſt, and dryneſs of the tongue; all of which ſhow a tendency to inflammation: the ſame is foretold by the urine being in ſmall quantity, and very red, or of a ſaffron colour; alſo an ulcerous or aphthous inflammation of the throat, with difficulty of ſwallowing, or any very ſevere ſymptom coming on in the beginning of the diſeaſe, excepting only a delirium, which is eaſily removed.

150 2. *Quotidiana deceptiva.* This is a diſorder of an inflammatory kind, with a ſtrong tendency to putreſcency, and ſometimes aſſumes the form of a quotidian. In it the patient frequently complains of cold when he really is hot, and the remiſſion is very indiſtinct. The diſeaſe is known by the great languor of the patient and the foulneſs of his tongue.

151 3. *Amphimerina cardiaca* is an acute malignant fever, with daily exacerbations, attended with fainting and vomiting of green bile. Afterwards, the weakneſs increaſing, the patient's extremities grow cold, and a profuſe ſweat comes on, which is frequently ſucceeded by death on the fourth day. Another ſpecies reſembling this Sauvages calls the *ſyncopalis;* but the cardiaca differs from it in being attended with cardialgia.

152 4. *Amphimerina paludoſa.* This is the fever deſcribed by the Britiſh phyſicians under many different names, and appearing under various forms, according to the different conſtitutions of the patients. This fever in the Eaſt Indies, according to Dr Lind of Windſor, generally comes on ſuddenly, and begins with a ſenſe of debility and a very great lowneſs of ſpirits. Theſe ſymptoms, are attended with a greater or leſs degree of chillineſs, vertigo, nauſea, very acute pains in the head and loins, and a trembling of the hands; the countenance is pale, the ſkin commonly very dry and corrugated, the eyes dull and heavy, the pulſe quick and ſmall, the breath generally difficult, and interrupted with hiccough.

As the paroxyſm increaſes, the chillineſs now and then gives way to irregular heats, which ſoon become violent and permanent; the nauſea likewiſe increaſes; and in ſome there comes on a vomiting, in which they throw up a great deal of bile. Sometimes bile is likewiſe voided by ſtool. The ſkin grows red; the eyes appear ſmall, and ſometimes not a little inflamed. The pulſe becomes fuller, and the breath more difficult, attended with great reſtleſſneſs and a troubleſome thirſt; notwithſtanding which (ſo great is the nauſea) the patient cannot endure any kind of liquids. The tongue becomes foul, and the pain of the head and loins more violent; a delirium then follows; a ſlight moiſture appears on the face, and from thence ſpreads to the other parts; whilſt the violence of the other ſymptoms abates, and ſhows the beginning of a remiſſion, which is completed by plentiful ſweats.

On the fever's remitting, the pulſe returns almoſt to its natural ſtate; the pains of the head and loins ſtill continue, though ſomewhat leſs violent, as likewiſe the nauſea and want of appetite. When the diſeaſe gains ſtrength, the remiſſion is ſcarcely obvious, and is immediately followed by another paroxyſm; which begins, not indeed with ſo great a ſhivering, but is attended with a greater pain of the head, the greateſt anxiety, a heartburn, nauſea, vomiting, and bilious ſtools. The matter moſt commonly evacuated by vomit and ſtool is whitiſh like chalk and water, or curdled milk which is vomited by ſucking children, when the curd is much broke down. A heat, immoderate thirſt, and delirium, now come on. The tongue becomes more foul; the teeth and inſide of the lips are covered with a black cruſt; the breath grows hot and fetid: another remiſſion enſues, attended with a ſweat; but this remiſſion is both ſhorter and leſs obvious than the firſt.

This ſecond remiſſion is ſucceeded by a paroxyſm, in which the ſymptoms are far more violent than in the former; that which the patient diſcharges by vomiting and purging is more fetid; the mouth, teeth and inſide of the lips, are not only covered with a black cruſt, but the tongue becomes ſo dry and ſtiff, that the patient's voice can ſcarce be heard. Violent delirium, with reſtleſſneſs and anxiety, come on chiefly during the paroxyſm; nor do theſe ſymptoms abate till the fever remits, and the patient ſweats.

When the fever becomes ſo violent, during the third fit, as to end in death, which is often the caſe, ſome of the ſick have a coma; in others the delirium becomes more violent. The diſcharges now become more fetid, and have a cadaverous ſmell; the ſtools are involuntary; the pulſe is ſo quick, ſmall, and irregular, that it is ſcarce to be counted, or even felt; a cold ſweat is diffuſed over the whole body, eſpecially the head and neck: the face becomes Hippocratic and convulſed; the patient picks the bed-clothes; a ſubſultus tendinum comes on; the ſick lie conſtantly on their backs, and inſenſibly

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insensibly slide down to the foot of the bed; their extremities grow cold; they are then seized with convulsions, with which the scene closes.

In this fever, the urine, which at the beginning is pale, becomes of a deeper colour by degrees, but without depositing any sediment. There seldom or never appear any petechiæ, and the prickly heat which was before on the skin vanishes on the first appearance of the fever. But though these were the general symptoms of this disorder, they varied in the different subjects, and at different seasons of the same year. The pulse, for example, in some, was quick in the beginning of the disorder; in others, it varied with the other symptoms. The skin was generally dry in the beginning of the fit; but in some it was moist, and covered with sweat from the very beginning of the disease. In the month of September, when the disorder raged most, the remissions were very imperfect and obscure; but, on the return of winter and the healthy season, they became more regular, and the disease assumed the appearance of an intermitting fever, to such a degree as at length not to be distinguished from it. In some the remissions could scarce be perceived, and the fever continued for two weeks without any material change for the better or the worse. At this time numbers were seized with it. When the disorder continued for any time without a change, it generally ended in death; while the weather grew better, it sometimes, in the space of a few days, from a common fever became an intermitting one, and the patient recovered, unless his liver, which was sometimes the case, happened to be affected. The cure of an inflammation of the liver proved uncertain and tedious; as it was commonly followed by a colliquative diarrhœa, which generally endangered the patient's life.—Every succeeding paroxysm was observed to be more dangerous than the preceding; the third generally proved fatal; some died during the first. When this happened, the fever, in the language of the country, was called a *puca*, that is a strong fever.

This disease, according to Dr Lind of Haslar hospital, is the autumnal fever of all hot countries, the epidemic disease between the tropics, and the disease most fatal to Europeans in all hot and unhealthy climates. All authors agree that intermittents in general, but particularly this dangerous kind of them, are produced by heat and moisture, but particularly the evaporation of moisture from marshes. Dr Lind of Windsor remarks, that the European seamen are very subject to the fever above mentioned when they happen to arrive at Bengal in autumn. They are predisposed to it from the nature of their food, their confinement on board, the very great heats to which they are exposed during the voyage, and their lying for hours together exposed to the night colds.

Most of the meat used by the crews of those ships is salted, and often in a putrid state, without any fresh vegetables, they having only biscuits, and some other farinaceous matters. The quantity of the vinous or spirituous liquors allowed them is, in his opinion, by far too small to subdue the putrescent disposition of their animal-food. Their fluids consequently become, from day to day, more and more putrescent, and of course more apt to breed and contract this disorder. This disposition is likewise induced by their being stowed very close together, and that for a considerable length of time, and in a foul air, especially when the weather happens to be too stormy to permit the hatches and port-holes to be kept open.

Though the heats they endure in the voyage to India are less considerable than those of the country itself, yet they are too much for an European constitution to bear. The general heat at sea within the tropics is about 84° of Fahrenheit's thermometer, which is sufficient to relax them, and promote a corruption of their humours, especially when it coincides with the above causes. It likewise creates a languor and indolence, which alone are sufficient to increase that putrescence. These causes are apt to be considerably aggravated by the men's being often exposed, when on duty, for hours together, to rain, damp, and cold air; a circumstance which frequently happens to them when working their ships up the river Ganges in the night-time. Hence the perspiration is checked, and the excrementitious fluid which used to be discharged by the skin being retained in the body, contributes, he thinks, very much towards the predisposition to this disease.

But the most powerful of all the remote causes is justly thought to be the effluvia of marshes replete with putrid animal-substances. We have not, however, been able to determine from what kind of putrid animal-substances these effluvia derive their virus. For that every kind of putrefaction has not such an effect appears from this, that neither practical anatomists, nor those who by their trades are exposed to the putrid effluvia of animals, for instance such tanners and butchers as keep their shops and stalls very dirty, are more subject than others to putrid diseases. Nor are the ship-stewards and their servants, whose business it is to deliver out the provisions to the ships crews, and who spend the most of their time amongst the putrid and rancid effluvia of the places in which those provisions are kept, more subject to putrid fevers than their ship-mates. But whatever be in this, we are well assured that some particular putrid fermentations produce noxious vapours, which, united with those of marshes, render them more pernicious. Hence evidently proceeds the extreme unhealthfulness of a place called *Culpi*, on the eastern bank of the Ganges. The shores about it are full of mud, and the banks covered with trees. Opposite to the place where the ships lie there is a creek, and about a mile from its entrance stands the town of Culpi: the ships lie about a mile from the shore. None of the sailors on board the ships stationed at this place enjoyed their health. The burying ground also contributed not a little to spread the infection. The ground being marshy, the putrid water flowed from the old graves into the new ones, which infected the grave-diggers and those that attended the funerals; and from this cause many were suddenly seized while they were performing the last duty to their companions. This place has ever been remarkable for the unhealthfulness of its air. It was once customary to send some of the Company's servants here to receive the cargoes of the ships, and send them to Calcutta; but so many of them died on this duty, that the Company was at length obliged to dispense with it.

Hence it plainly appears, how apt putrid animal and vegetable substances are to render the effluvia of fenny

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fenny places more pernicious than they would otherwise be. The reason why great inundations of the Nile and Ganges are followed by a healthy season is, that by this means the putrid animal and vegetable substances dispersed over the contiguous countries are carried off into the sea.—The noxious vapours arising from fens spread but a little way. Dr Lind has often known ships crews at a very little distance from the shore quite free from this disorder. But although these marsh miasmata first bring on the disease, yet contagion particularly spreads it, and renders it more epidemic. Thus the Drake East Indiaman continued free from the disorder for two weeks together, when she had no communication with the other ships; but as soon as the disorder was brought on board, many were seized with it within a few days in such a manner as to leave no room to entertain the least doubt concerning its contagious nature.

Dr Lind of Haslar hospital has given a very curious and learned account of the appearance of this fever throughout the various parts of the globe. It was very common in England in the years 1765 and 1766, one obvious cause of which was the prevalence of the eastern wind. This wind in England is often said to bring with it a fog from the sea; but the truth of the matter is, that in many places of this island the east-wind frequently raises a copious vapour from water, mud, and all marshy or damp places. To this exhaling quality of the eastern wind Dr Lind has often been an eye-witness. When the wind changes to the east, the mud sometimes sends up a vapour as thick as smoke; and the doctor has observed two fish-ponds in his neighbourhood, one of fresh and the other of salt water, which on the approach of an easterly wind sometimes also emit a dense vapour, as from a pot of boiling water. In order to view this phenomenon distinctly, the person should stand at about 100 yards distance from the mud or ponds. If the sun shines when the wind changes to the east, he will observe a constant steam of vapours arising out of the ponds, from about five to ten yards in height, while the air about him remains serene. As the vapour or fog arising from other bodies glides along the surface of the earth, and is brought by the easterly wind to the ponds, he will still be able, for some time, to distinguish the vapours ascending perpendicularly out of the ponds from those which are carried in an horizontal direction by the wind; especially if the sun continues to shine, though faintly.

This evaporating quality of the east-wind seems to manifest itself also by its effects both on the thermometer and the human body; for a thermometer hung over a damp piece of ground during the fogs or exhalations arising from it, will often indicate a degree of cold below the freezing point. The chilliness of the body, so sensibly perceived when in this situation, seems to proceed from the same cause, and to produce nearly the same sensations, which the damp arising from the wet floor of a chamber communicates to those who happen to be in it.

Winds are not constant in their effects. As we have sometimes warm weather with a north-wind, and sometimes very little heat with one blowing from the south; so the fogs attending an east-wind are not constant, neither is the evaporation above mentioned at all times to be perceived. It is possible, however, that in all this there may be a deception; and that instead of supposing the quantity of vapours exhaled to be increased by an easterly wind, the coldness of that wind may only condense and render visible the vapours in the air at that time. But even this supposition is liable to great objections, as our coldest north-winds seldom or never produce such an effect, but on the contrary are attended with dry and serene weather.

Be this as it will, however, an east-wind is usually accompanied with a cold, damp, and unwholesome vapour, which is observed to affect the health both of animals and vegetables, and in many places to produce obstinate intermitting fevers, and also to occasion frequent relapses. In particular spots of the low damp island of Portsea, the ague frequently prevails during the autumnal season, and in some years is much more frequent and violent than in others. It is also observable, that this disease always attacks strangers, or those who have formerly lived on a drier soil, and in a more elevated situation, with greater severity than those who are natives of the island.

The year 1765 was remarkable, not only for the long continuance of the easterly winds, but for an excessive degree of heat, which produced a more violent and general appearance of those diseases than had been known for many years before. In the month of August the quicksilver in Fahrenheit's thermometer often rose to 82° in the middle of the day. This considerable addition of heat, together with the want of refreshing rains, greatly spread the fever, increased its violence, and even changed its form in many places. At Portsmouth, and throughout almost the whole island of Portsea, an alarming continual or remitting fever raged, which extended itself as far as Chichester. At the same time, the town of Gosport, though distant only one mile from Portsmouth, enjoyed an almost total exemption from sickness of every kind; whereas in the neighbouring villages and farm-houses, a mild regular tertian ague affected whole families. The violence of the fever, with its appearances in a continued, remitting, or intermitting form, marked in some measure the nature of the soil. In Portsmouth the symptoms were bad, worse at Kingston, and still more dangerous and violent at a place called *Half-way Houses*; a street so named, about half a mile from Portsmouth, where scarcely one in a family escaped this fever, which generally made its first attack with a delirium. In the large suburb of Portsmouth called the *Common*, it seemed to rage with more violence than in the town, some parts excepted; but even whole streets of this suburb, together with the houses in the dock-yard, escaped its attack.

The marines, who were three times a-week exercised early in the morning on South-sea beach, suffered much from the effect of the stagnant water in an adjoining morass. Half a dozen of them were frequently taken ill in their ranks when under arms; some being seized with such a giddiness of their head, that they could scarcely stand; while others fell down speechless, and upon recovering their senses complained of a violent headach. When such patients were received into the hospital, it was observed that some few had a regular ague, but that far the greater number laboured under a remitting fever, in which sometimes indeed there

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was no perceptible remiſſion for ſeveral days. A conſtant pain and giddineſs of the head were the moſt inſeparable and diſtreſſing ſymptoms of this diſeaſe. Some were delirious, and a few vomited up a quantity of bile; but in all the countenance was yellow. A long continuance of the fever produced a dropſy or jaundice, or both. Even a ſlight attack reduced the moſt robuſt conſtitution to a ſtate of extreme debility; and this weakneſs, together with the giddineſs, continued for a long time after the fever. A ſcabby eruption now and then made its appearance on the lips and the corners of the mouth: but dry itchy ſpots over the whole body, reſembling much the common itch, and ſeeming to partake of the nature of that diſeaſe, were more frequently obſerved in the patients at Portſmouth, where there was not the leaſt reaſon to ſuſpect any infection.

Such is the appearance of the remitting fever occaſioned by marſh miaſmata in England. In the Netherlands its ſymptoms are not much different. Dr Lind informs us, that at Middleburg, the capital of Weſt Zealand, a ſickneſs generally reigns towards the latter end of Auguſt, or the beginning of September, which is always moſt violent after hot ſummers. It commences after the rains which fall in the end of July; the ſooner it begins the longer it continues, and it is only checked by the coldneſs of the weather. Towards the end of Auguſt and beginning of September it is a continual burning fever, attended with a vomiting of bile, which is called the *gall-ſickneſs*. This fever, after continuing three or four days, intermits, and aſſumes the form of a double tertian; leaving the patient in a fortnight, or perhaps ſooner. Strangers that have been accuſtomed to breathe a dry pure air do not recover ſo quickly. Foreigners in indigent circumſtances, ſuch as the Scots and German ſoldiers, who are garriſoned in the adjacent places, are apt after thoſe fevers to have a ſwelling in their legs and a dropſy; of which many die.

Theſe diſeaſes, the doctor obſerves, are the ſame with the double tertians common within the tropics. Such as are ſeized with the gall-ſickneſs have at firſt ſome fluſhes of heat over the body, a loſs of appetite, a white foul tongue, a yellow tinct in the eyes, and a pale colour in the lips. Such as live well, drink wine, and have warm clothes and good lodgings, do not ſuffer ſo much during the ſickly ſeaſon as the poor people; however, theſe diſeaſes are not infectious, and ſeldom prove mortal to the natives.

Sir John Pringle obſerves, that the prevailing epidemic of autumn in all marſhy countries, is a fever of an intermitting nature, commonly of a tertian form, but of a bad kind; which, in the dampeſt places and worſt ſeaſons, appears as a double tertian, a remitting, or even an ardent fever. But however theſe fevers may vary in their appearance according to the conſtitution of the patient and other circumſtances, they are all of a ſimilar nature. For though, in the beginning of the epidemic, when the heat or rather the putrefaction in the air is the greateſt, they aſſume a continued or a remitting form, yet by the end of autumn they uſually terminate in regular intermittents.

In Zealand, where the air is more corrupted than in other parts of the Netherlands, this diſtemper is called the *gall-ſickneſs*; and indeed both the redundance and depravation of the bile is ſometimes ſo great, that it has been generally aſcribed to the corruption and overflowing of that humour. But though it cannot with juſtice be ſaid to originate from corrupted bile, it is certain that the diſeaſe may be continued, and the ſymptoms aggravated, by an increaſed ſecretion and putrefaction of the bile occaſioned by the fever. In proportion to the coolneſs of the ſeaſon, to the height and dryneſs of the ground, this diſtemper is milder, remits or intermits more freely, and removes further from the nature of a continued fever. The higher ranks of people in general are leaſt liable to the diſeaſes of the marſhes; for ſuch countries require dry houſes, apartments raiſed above the ground, moderate exerciſe, without labour in the ſun or evening damps, a juſt quantity of fermented liquors, plenty of vegetables, and freſh meats. Without ſuch helps, not only ſtrangers, but the natives themſelves, are ſickly, eſpecially after hot and cloſe ſummers. The hardieſt conſtitutions are very little excepted more than others; and hence the Britiſh in the Netherlands have always been liable to fevers.

By this diſtemper the Britiſh troops were haraſſed throughout the whole of the war from 1743 to 1747. It appeared in the month of Auguſt 1743; the paroxyſms came on in the evening, with great heat, thirſt, a violent headach, and often a delirium. Theſe ſymptoms laſted moſt of the night, but abated in the morning, with an imperfect ſweat, ſometimes with an hæmorhagy from the noſe or a looſeneſs. The ſtomach from the beginning was diſordered with a nauſea and ſenſe of oppreſſion, frequently with a bilious and offenſive vomiting. If evacuations were either neglected, or too ſparingly uſed, the patient fell into a continued fever, and ſometimes grew yellow as in a jaundice. When the ſeaſon was further advanced, this fever was attended with a cough, rheumatic pains, and ſizy blood. The officers being better accommodated than the common men, and the cavalry who had cloaks to keep them warm, were not ſo ſubject to it: and others who belonged to the army, but lay in quarters, were leaſt of all affected; and the leſs in proportion to their being little expoſed to heats, night-damps, and the other fatigues of the ſervice.

In this manner did the remitting fever infeſt the army for the remaining years of the war; and that exactly in proportion to their diſtance from the marſhy places, of which we have ſeveral notable inſtances in Pringle's obſervations. In Hungary the ſame diſeaſe appears with ſtill more violence, and is readily complicated with fevers of a truly peſtilential nature, by which means it becomes extremely dangerous. Hungary is acknowledged to be the moſt ſickly climate in Europe, and indeed as bad as any in the world. Here it was where the cruſaders in only marching through the country to invade Aſia, often loſt half their number by ſickneſs; and where the Auſtrians not long ſince buried, in a few years, above 40,000 of their beſt troops, who fell a ſacrifice to the malignant diſpoſition of the Hungarian air. The reaſon of this uncommon malignity is, that Hungary abounds with rivers, which, by often overflowing, leave that low flat country overſpread with lakes and ponds of ſtagnating water, and with large unwholeſome marſhes. So great is the impurity of theſe ſtagnated waters, that by them the rivers, even the Danube, whoſe courſe is ſlow, become in ſome places corrupted and offenſive. The air is moiſt, Febres. moist, and in summer quite sultry. In the nights of harvest, Kramer tells us, it was so very damp, that the Austrian soldiers could not secure themselves from the moisture even by a triple tent-covering. Here epidemical distempers begin constantly to rage during the hottest months of the year; which are July, August, and September: and these complaints, according to the observations of the physician above mentioned, are the same with those which are epidemic upon the coast of Guinea, and in the sickly climates of the East and West Indies, of which malignant fevers of the remitting and intermitting kind are the most common and dangerous.

The heat of the sun in Hungary is more intense than in any other country of Europe; and in proportion to the heat is the pestilential quality of the marshy exhalations. It is constantly observed, that the nearer any city or fort is to a morass or a large river with foul and oozy banks, the more unhealthy are the inhabitants. At such seasons and places, the air swarms with numberless insects and animalcules, a sure sign of its malignant disposition; and the hotter the summer, the more frequent and mortal are the diseases. In short, this country, on account of its unhealthiness, has been termed *the grave of the Germans;* and in Italy, the Campania of Rome is almost equally unhealthy. Lancisius, physician to Pope Clement XI. furnishes us with a very striking instance of the malignant quality of the air of Campania. Thirty gentlemen and ladies of the first rank in Rome having made an excursion, upon a party of pleasure, towards the mouth of the Tyber, the wind suddenly shifting, blew from the south over the putrid marshes, when 29 were immediately seized with a tertian fever, only one escaping.

The island of Sardinia is annually visited with an epidemical sickness, which rages from June to September, and is called by the natives the *intemperies.* In some years there is a want of rain for four or five months; and then it is that this sickness exerts its utmost violence, being always more fatal in some places than in others, and in particular to strangers. Of this the British had a severe proof in 1758.—Admiral Broderick, in the Prince ship of war, anchored in the bay of Oristagni, where 27 of his men, sent ashore on duty, were seized with the epidemical distemper of this island; twelve of them in particular, who had slept on shore, were brought on board delirious. All of them in general laboured under a low fever, attended with great oppression at the breast and at the pit of the stomach, a constant retching, and sometimes a vomiting of bile; upon which a delirium often ensued. These fevers changed into double tertians, and terminated in obstinate quartan agues. It is worthy of remark, that in this ship, which lay only two miles from the land, none were taken ill but such as had been on shore, of whom seven died. The prior of a convent, making a visit to the English officers, informed them, that the intemperies of the island was a remitting or intermitting fever, and that he himself had suffered several attacks of it. Sardinia was formerly so remarkable for its unwholesome air, that the Romans used to banish their criminals thither; and it is at present but thinly peopled, owing to the mortality occasioned by this annual sickness. For although it is about 140 miles long, and in several places 75 miles broad, yet it is computed that the whole number of its inhabitants does not exceed 250,000: an inconsiderable number, when compared with the inhabitants of the lesser, but comparatively more healthful, island of Corsica; though even there the French lost a number of their troops by intermitting and remitting fevers. In the island of Minorca, too, Dr Cleghorn informs us, that fevers of this kind prevail exceedingly; that their types are various, their symptoms violent, the intermissions fallacious, and that they frequently and suddenly prove fatal. It is more than probable, he adds, from the accounts of several physicians and travellers, that epidemical tertians are not wholly confined to the coasts and islands of the Mediterranean, but that they are equally frequent and destructive in many other parts of the globe; and perhaps may be deemed the anniversary autumnal distempers of most hot countries in the world. And though in the mild climate of Britain, a tertian may easily be cured when it is discovered; yet in warm climates, such is the rapid progress of the distemper, that it is necessary to know it in the very beginning, which is very difficult for those who have never seen any but the tertians usually met with in Britain.

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From Dr Cleghorn's account of Minorca, however, it doth not appear why that island should be so much infested with fevers of this kind, since it is far from being a marshy country; nay, on the contrary, is very dry. The south wind, he observes, is very unhealthy; and it is the prevalence of this wind which brings on the fever: but still the difficulty is not removed, because the sea air is so far from bringing on such dangerous diseases, that it is one of the greatest preservatives against them. As to the moisture which must necessarily accompany an insular situation, that cannot reasonably be admitted as a cause of this or any other disease. In the London Medical Observations we find a paper on a subject very similar to the present, namely, the mischiefs produced by lying in damp sheets, or being exposed to moist vapour. The author tells us, that he hardly knows a distemper the origin of which has not by some been ascribed to lying in a damp bed, or sitting in a wet room; and yet he does not know any one which will certainly be produced by these causes, and people frequently expose themselves to such causes without suffering any ill effects. "It must be owned indeed, (says he), that the vapours arising from the bilge-water of ships tend to produce a scurvy. The swampy plains also near the mouths of great rivers which are often overflowed, and low grounds which cannot readily be drained, and those tracts of land where the thickness and extent of the woods keep the ground moist and half putrid for want of ventilation, are destructive to the neighbouring inhabitants, by occasioning obstinate intermittents in the colder climates, and pestilential fevers in the hotter regions. But all this mischief arises not merely from moisture, but from an unventilated and putrid moisture; for the inoffensiveness of mere wetness, untainted with putridity, may be reasonably inferred from the following considerations. The air is often fully saturated with moisture; and yet neither is any epidemical distemper produced by it, nor are those remarkably aggravated with which the sick happen at that time to be afflicted. The air from rivers and from the sea is probably more replenished ed with vapours than inland countries cleared of their woods: yet the moſt celebrated of the ancient phyſicians recommended the bank of a running river for the ſituation of a houſe, on account of its peculiar healthfulneſs; and many invalids are ſent by the modern phyſicians to the ſea ſide, only for the benefit of the ſea air.

"Where the ſailors are cleanly, and not too much crowded, they are often as healthy during long voyages at ſea, as they would have been upon any part of the land. Venice is not obſerved to be leſs healthy than London or Paris.

"Thoſe who are much diſpoſed to ſweat, lie many hours in bedclothes impregnated probably with a leſs wholeſome moiſture than would have been left in the ſheets half-dried after waſhing; and there is no reaſon to think that any remarkable injury was done to the health by the continuance of ſuch ſweats almoſt every night for weeks, and for months, except what aroſe from the too great copiouſneſs of this evacuation.

"Children, and ſuch as are troubled with the ſtone, and thoſe who, from other infirmities or age, conſtantly wet their beds with their urine, do not appear to ſuffer in their health on this account.

"It is a common practice, in ſome diſorders, to go to bed with the legs or arms wrapped in linen cloths thoroughly ſoaked in Malvern water, ſo that the ſheets will be in many places as wet as they can be; and I have known theſe patients and their bedfellows receive no harm from a continuance of this practice for many months. Nor can it be ſaid that the Malvern water is more innocent than any other water might be, on account of any ingredients with which it is impregnated; for the Malvern water is purer than that of any other ſpring in England which I ever examined.

"The greateſt valetudinarians do not ſcruple to ſprinkle lavender-water upon their ſheets; and yet, when the ſpirit is flown off, there is left what is as truly water as if it had been taken from the river.

"Is it obſerved, that laundreſſes are peculiarly unhealthy above other women, though they live half their time in the midſt of wet linen, in an air fully ſaturated with vapours? Many other employments might be mentioned, the perſons occupied in which are conſtantly expoſed to wet floors or pavements, or to be ſurrounded with watery vapours, or to have their clothes often wet for many hours together.

"Is it the coldneſs of wet linen which is to be feared? But ſhirts and ſheets, colder than any unfrozen water can be, are ſafely worn and lain in by many perſons, who, during a hard froſt, neither warm their ſhirts nor their ſheets.—Or does the danger lie in the dampneſs? But then how comes it to paſs, that a warm or cold bath, and long-continued fomentations, can be uſed, without the deſtruction of thoſe who uſe them? Or is it from both together? Yet we have long heard of the thickneſs and continuance of the cold fogs in the ſeas north-weſt of England, but have never yet been told of any certain ill effect which they have upon thoſe that live in theſe countries."

With regard to the cauſes of fevers, however, Dr Lind is of opinion, that noxious vapours ariſing from the earth are for the moſt part to be blamed. Even in countries ſeemingly dry, and where violent rains are not frequent, he thinks that the air may load itſelf with putrid exhalations from the ground; and that, except in the burning deſerts of Arabia or Africa, people are nowhere exempt from diſeaſes occaſioned by putrid moiſture. In moſt of the hot countries, the pernicious effects of the putrid vapours are by no means equivocal. In Guinea, they ſeem to be more extraordinary than anywhere elſe in the world; neither indeed can it be ſuppoſed, that a hot and moiſt atmoſphere can be without putreſcency. It may in general be remarked, that in ſultry climates, or during hot weather, in all places ſubject to great rains, where the country is not cleared and cultivated, but is overrun with thickets, ſhrubs, or woods, eſpecially if there are marſhes or ſtagnating waters in the neighbourhood, ſickneſs may be dreaded, and particularly the remitting fever of which we now treat. The fens, even in different counties of England, are known to be very prejudicial to the health of thoſe who live near them, and ſtill more ſo to ſtrangers; but the woody and marſhy lands in hot countries are much more pernicious to the health of Europeans. In all thoſe unhealthy places, particularly during fogs or rains, a raw vapour, diſagreeable to the ſmell, ariſes from the earth, and eſpecially in the huts or houſes. But of all the vapours which infeſt the torrid zone, the moſt malignant and fatal are the *harmattans*: They are ſaid to ariſe from the conflux of ſeveral rivers in the king of *Dormeo's* dominions at Benin (the moſt unwholeſome part of Guinea), where travellers are obliged to be carried on men's backs for ſeveral days journey, through ſwampy grounds, and over marſhes, amidſt ſtinking ooze, and thickets of mangrove trees which are annually overflown. Theſe vapours come up the coaſt to a ſurpriſing diſtance, with the ſouth-eaſt and north-eaſt winds: and it has been obſerved, that in their progreſs they have often changed both the courſe of the winds and of the ſea-currents. The times of their appearance at Cape Coaſt are the months of December, January, or February. The north-eaſt and ſouth-eaſt winds are always unhealthy, but particularly ſo during the harmattan ſeaſon. In ſome years this vapour is ſcarcely perceptible; but in others it is thick, noxious, and deſtructive to the blacks as well as whites.—The mortality is in proportion to the denſity and duration of the fog. It has a raw putrid ſmell; and is ſometimes ſo thick, that a perſon or houſe cannot be diſcerned through it at the diſtance of 15 or 20 yards: and it continues ſo for 10 or 14 days; during which it opens the ſeams of ſhips, ſplits or opens the crevices of wood as if ſhrunk or dried with a great fire, and deſtroys both man and beaſt.—In the year 1754 or 1755, the mortality occaſioned in Guinea by this ſtinking fog was ſo great, that in ſeveral negro towns the living were ſcarce ſufficient to bury the dead.—Twenty women brought from Holland by a new governor to the Caſtle *del Mina*, periſhed, together with moſt of the men in the garriſon. The gates of Cape Coaſt caſtle were ſhut up for want of centinels to do duty; the blacks dying at this time as well as the white people. It is lucky that it is only in ſome years that *harmattans* are ſo very thick and noxious, otherwiſe that part of the country would be depopulated. It is obſerved that all fogs are extremely unhealthy in thoſe parts, particularly before and after the rainy ſeaſons; but the above account of the *harmattans* appeared ſo very extraordinary and incredible to ſome of Dr Lind's readers, that he thought proper to publiſh

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publish a further corroboration of the facts above mentioned. "A gentleman (says he), who had long resided at Cape Coast castle, informed me, that during the time of this fog, being in the upper chambers of the fort, the boards of the floor shrunk so much, that he could discern the candles burning in the apartments below him (there are no plaster ceilings used in those hot countries), and that he could then even distinguish what people were doing in the apartments below; the seams of the floor having opened above half an inch while the fog lasted, which afterwards, upon its being dispelled, became close and tight as before."

In Africa the rains and dews seem to be possessed of qualities almost equally pernicious with the fogs. This much is certain, that in Guinea, many of the principal negroes, and especially of the mulatto Portuguese, take the utmost precaution to avoid being wet with those rains, especially such as fall first. At the setting in of the rainy season, they generally shut themselves up in a close well-thatched hut, where they keep a constant fire, smoke tobacco, and drink brandy, as preservatives against the noxious quality of the air at that time. When wet by accident with the rain, they immediately plunge themselves into salt-water, if near it. Those natives generally bathe once a-day, but never in the fresh water rivers when they are overflown with the rains: at such times they prefer for that purpose the water of springs. The first rains which fall in Guinea are commonly supposed to be the most unhealthy. They have been known, in 48 hours, to render the leather of the shoes quite mouldy and rotten; they stain clothes more than any other rain; and soon after their commencement, even places formerly dry and parched swarm with frogs. At this time skins, part of the traffic of Senegal, quickly generate large worms; and it is remarked, that the fowls, which greedily prey on other insects, refuse to feed on these. It has been farther observed, that woollen cloths wet in those rains, and afterwards hung up to dry in the sun, have sometimes become full of maggots in a few hours.—It is also probable, that as in some of those countries the earth, for six or eight months of the year, receives no moisture from the heavens but what falls in dews, which every night renew the vegetation, the surface of the ground in many places becomes hard and incrustated with a dry scurf, which pens up the vapours below; until, by the continuance of the rains for some time, this crust is softened, and the long pent up vapours set free. That these dews do not penetrate deep into the earth is evident from the constant dryness and hardness of such spots of ground in those countries as are not covered with grass and other vegetables. Thus the large rivers in the dry season being confined within narrow bounds, leave a great part of their channel uncovered, which having its moisture totally exhaled, becomes a solid hard crust; but no sooner the rains fall, than by degrees this long parched up crust of earth and clay gradually softens, and the ground, which before had not the least smell, begins to emit a stench, which in four or five weeks becomes exceedingly noisome, at which time the sickness is generally most violent.

This sickness, however, is not different from the remitting fever which has been described under so many various forms and names. An inflammatory fever is seldom observed, during the season of sickness, in this part of the world; and we shall conclude our description of the *amphimerina paludosa* with some extracts from the surgeon's journal in a ship that sailed up the rivers of Guinea.

"On the 5th of April we sailed up the river of Gambia, and found all the English in the fort in perfect health. The surgeons of the factory informed me, that a relaxation of the stomach, and consequently a weakened digestion, seemed to bring on most of the diseases so fatal to Europeans in the sickly season. They were generally of a bilious nature, attended with a low fever, sometimes of a malignant, at other times of a remitting kind.—On the 12th of April, after sailing 30 miles up the river St Domingo, we came to Catchou, a town belonging to the Portuguese, in Lat. 20° N. In this town were only four white people, the governor, and three friars. The number of whites in the trading ships was 51. One morning, towards the latter end of April, a little rain fell. On the 13th of May there was a second shower, accompanied with a tornado. On the 18th of May it rained the whole day; and the rain continued, with but short intervals, until the beginning of October.

"In the month of June, almost two-thirds of the white people were taken ill. Their sickness could not be well characterised by any denomination commonly applied to fevers: it however approached nearest to what is called a *nervous fever*, as the pulse was always low, and the brain and nerves seemed principally affected. It had also a tendency to frequent remissions. It began sometimes with a vomiting, but oftener with a delirium. Its attack was commonly in the night; and the patients, being then delirious, were apt to run into the open air. I observed them frequently recover their senses for a short time, by means of the heavy rain which fell upon their naked bodies. But the delirium soon returned: they afterwards became comatose, their pulse sunk, and a train of nervous symptoms followed; their skin often became yellow; bilious vomitings and stools were frequent symptoms. The fever reduced the patient's strength so much, that it was generally six weeks or two months before he was able to walk abroad. A consuming flux, a jaundice, a dropsy, or obstructions in the bowels, were the consequences of it. Of 51 white men, being the companies of four ships which were at Catchou, one third died of the fever, and one-third more of the flux, and other diseases consequent upon it; and of these not one was taken ill till the rains began.

"I believe, on the whole face of the earth, there is hardly to be found a more unhealthy country than this during the rainy season: and the idea I then conceived of our white people was by making a comparison of their breathing such a noxious air, with a number of river-fish put into stagnating water; where, as the water corrupts, the fish grow less lively, they droop, pine away, and many die.

"Thus some persons became dull, inactive, or slightly delirious, at intervals; and, without being so much as confined to their beds, they expired in that delirious and comatose state in less than 48 hours, after being in apparent good health. The white people in general became yellow; their stomach could not receive much food without loathing and retchings. Indeed, it is no wonder that this sickness proved so fatal, that recoveries

ries from it were ſo tedious, and that they were attended with fluxes, dropſies, the jaundice, ague-cakes, and other dangerous chronical diſtempers. It ſeems more wonderful to me that any white people ever recover, while they continue to breathe ſo peſtiferous an air as that at Catchou during the rainy ſeaſon. We were, as I have already obſerved, 30 miles from the ſea, in a country altogether uncultivated, overflowed with water, ſurrounded with thick impenetrable woods, and overrun with ſlime. The air was vitiated, noiſome, and thick; inſomuch that the lighted torches or candles burnt dim, and ſeemed ready to be extinguiſhed: even the human voice loſt its natural tone. The ſmell of the ground and of the houſes was raw and offenſive; but the vapour ariſing from putrid water in the ditches was much worſe. All this, however, ſeemed tolerable, when compared with the infinite numbers of inſects ſwarming every where, both on the ground and in the air; which, as they ſeemed to be produced and cheriſhed by the putrefaction of the atmoſphere, ſo they contributed greatly to increaſe its impurity. The wild bees from the woods, together with millions of ants, overran and deſtroyed the furniture of the houſes; at the ſame time, ſwarms of cockroaches often darkened the air, and extinguiſhed even candles in their flight; but the greateſt plague was the muſquettoes and ſand-flies, whoſe inceſſant buzz and painful ſtings were more inſupportable than any ſymptom of the fever. Beſides all theſe, an incredible number of frogs on the banks of the river made ſuch a conſtant and diſagreeable croaking, that nothing but being accuſtomed to ſuch an hideous noiſe could permit the enjoyment of natural ſleep. In the beginning of October, as the rains abated, the weather became very hot; the woods were covered with abundance of dead frogs, and other vermin, left by the receſs of the river; all the mangroves and ſhrubs were likewiſe overſpread with ſtinking ſlime."

After ſo particular a deſcription of the remitting fever in many different parts of the world, we preſume it will be needleſs to take notice of any little varieties which may occur in the warm parts of America, as both the nature and cure of the diſtemper are radically the ſame: neither ſhall we lengthen out this article with further deſcriptions of remitting fevers from the works of foreign authors, as, from what we have already ſaid, their nature cannot eaſily be miſtaken.

Cure. The great difficulty in the cure of remitting fevers ariſes from their not being ſimple diſeaſes, but a complication of ſeveral. Fevers, properly ſpeaking, have but three or four different appearances which they can aſſume without a complication. One is, when they are attended with a phlogiſtic diatheſis: another is, when they aſſume the form of genuine intermittents; a third is, when they produce a great debility of the nervous ſyſtem; and the fourth is, when along with this debility there is alſo a rapid tendency to putrefaction. If, therefore, all theſe ſpecies happen to make an attack at once, the moſt dangerous fever we can imagine will be produced; and however contrary it may be to our theories to admit the poſſibility of ſuch an attack, the truth of the fact is too often confirmed by fatal experience. In the beginning of remittent fevers, for inſtance, the ſymptoms indicate a high degree of inflammation: but if the practitioner attempts to remove this inflammation by blood-letting or other evacuations, the pulſe ſinks irrecoverably, and the perſon dies with ſuch ſymptoms as ſhow that the nervous ſyſtem has been from the beginning greatly affected; at the ſame time the high ſtimulants and cordials, or cinchona, which would have conquered the nervous part of the diſeaſe, increaſe the inflammatory part of it to ſuch a degree, that, by a too early exhibition of them, the patient alſo dies, but after another manner.

In the remitting fever of the Eaſt Indies, Dr Lind of Windſor formed the following indications of cure. 1. To allay the violence of the fever. 2. To evacuate the putrid humours, and take great care to prevent the body from inclining to putrefaction. 3. To keep up the ſtrength of the patient as much as poſſible during the diſorder. 4. To loſe no time in preventing the return of the paroxyſms.

To allay the violence of the fever, every thing that can contribute to increaſe it ought to be carefully avoided or removed; ſuch as great heat, too ſtrong a light falling on the eyes, noiſe, and motion. If during the paroxyſm the head and loins be affected with violent pains, the pulſe be full and hard, and the heat intenſe, bleeding may be uſed, but with the greateſt caution: for, however uſeful this operation may be in cold climates, the ſucceſs of it in warm ones is ſo far from being certain, that the lives of the patients have been often very much endangered, nay even deſtroyed by it. Dr Badenoch, and the ſurgeon of the Ponſborne, endeavoured each of them to relieve two patients by blood-letting; and the conſequence was, that each of them loſt one patient. Dr Lind bled two patients; one of whom was Mr Richardſon, the firſt mate of the ſhip, who complained of a moſt violent pain in his head, with a full hard pulſe. About four or five ounces of blood were taken from him, by which he was greatly relieved: nor was the cure retarded by it; nay, the fever afterwards became leſs irregular. At the time the other patient was bled, the diſeaſe was exceedingly frequent and violent. He was ſo earneſt for bleeding, that he fired all the reſt with the ſame deſire, ſwearing, that by refuſing them this only remedy, every one of them would be ſent to their graves. To quiet them, therefore, and get quit of their importunities, the doctor complied with their requeſt, and took about five or ſix ounces from him who had been the firſt to require it. The conſequence was, that he immediately loſt his ſtrength; and in leſs than an hour, during which time he made his will, was carried off by the next fit. It is neceſſary, however, to obſerve, and indeed the doctor himſelf makes the obſervation, with regard to this patient, that he was bled at an improper time, namely, between the fits; whereas, had he been bled in the hot fit, it is poſſible he might have been relieved.

In ſupport of the advantages to be derived from bleeding under proper circumſtances, we have the authority both of Cleghorn and Pringle. As Dr Cleghorn practiſed in a very hot country, his obſervations muſt in the preſent caſe have greater weight than thoſe of Pringle, who practiſed in a colder one. The former acquaints us, that if he was called in early enough, unleſs there was a ſtrong contra-indication, he always uſed to take away ſome blood from people

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people of all ages; namely, from robust adults, 10 or 12 ounces; from others a smaller quantity, in proportion to their strength and years. And further, if a violent headach, obstinate delirium, and heat or pains of the bowels, were urgent, the bleeding was repeated within a day or two. By this seasonable evacuation, he found the vehemence of all the paroxysms somewhat diminished; the apyrexia became more complete; the operation of emetics and cathartics rendered safer and more successful; and the terrible symptoms which happened about the height of the distemper, such as raving *sopor*, difficulty of breathing, inflammations of the abdominal viscera, &c. were either prevented or mitigated. But if the fever had continued for some time before he was called, and the mass of blood appeared to be too much melted down or inclined to a putrid dissolution, he either abstained from bleeding entirely, or took away a very small quantity, though some urgent symptoms might seem to require a larger evacuation. As to the time of performing the operation, he acquaints us, that it is safe enough, except when the cold fit lasts or is soon expected, or while the skin is covered with critical sweats; and that he usually opened a vein in the beginning of the hot fit; by which means the sick were relieved, the immoderate heat of the body, which is often productive of fatal effects, was diminished, and the critical sweats brought on sooner and in greater abundance.

But though Dr Lind found venesection to be of such pernicious tendency in his patients, cooling acidulated liquors were of the utmost service, as they corrected the putrid humours, lessened the heat and thirst, and of course prevented the fever from arriving at so great an height as it would otherwise have done. Those cooling liquors are the best which are made up with some farinaceous substance, as they most easily unite with our fluids. Fossile acids too, and crystals of tartar, especially the latter, are of considerable use, not only in this, but in other fevers. The neutral salts, prepared with the juice of lemons, were likewise given with success during the heat of the fever. They lessen the nausea, the fits become more regular, and the remissions more full; and they are particularly grateful when given in a state of effervescence. The good effects of these draughts we are in a great measure to ascribe to the antiseptic quality of the fixed air extricated from them during the effervescence.

During the remission, it is proper to evacuate the putrid humours by small doses of ipecacuanha, or rather tartar emetic. The tartar emetic indeed appears to be endowed with some kind of febrifuge virtue, which Dr Cullen thinks is owing to its relaxing the febrile spasm taking place in the capillary vessels. But should there appear any symptoms of a topical inflammation in some of the abdominal viscera, a thing which never happens unless the disorder has been of some standing, vomiting is to be avoided, and we are to depend upon purgatives alone for the evacuation of the putrid bile. These are always useful in the cure of this disorder. But all acrid and strong purgatives are to be carefully avoided, and only the mild antiseptic ones made use of, such as crystals of tartar, or tamarinds made up with manna or with Glauber's salt.

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Though in these diseases there is a great quantity of putrescent bile collected in the body, yet it seems much more probable that this is the *effect* than the *cause* of the disorder; and therefore, though we carry off the quantity collected ever so often, more of the same kind will still be produced by the putrescent disposition of the other fluids, at the same time that the strength of the patient must necessarily be diminished by repeated evacuations, when it ought rather to be kept up by all possible means. We ought well to observe, however, that the mineral acids have not that property of sweetening putrid bile which the vegetable ones have; and therefore the same relief will not be given by them which might reasonably be expected from vinegar or lemon juice.

In order to keep up the strength of the patient, good food is absolutely necessary. Dr Lind allowed the sick small messes of panada made with boiled rice and barley mixed with currants or raisins and prunes, seasoned with sugar and a little wine, especially claret. During the paroxysms, they had gruel made of flour and rice, with sugar and the juice of acid fruit; and when the fit went off, a little wine was added to this mixture.

The shirts and bedding must be very often changed and well aired; their stools, and all filth and nastiness, are to be immediately removed; the places where they are lodged should be well aired and frequently sprinkled with vinegar; and, in the last place, the sick must be exceedingly well nursed. Blisters, according to Dr Lind, should never be used till the fever has been of long continuance, or the spirits and pulse of the patient have begun to flag. But here our author has implicitly followed Dr Huxham, whose theory concerning the use of blisters is now found to be erroneous. According to that celebrated author, blisters are capable of doing considerable hurt in all cases where there is a tendency to inflammation, by increasing the motion of the fluids and the oscillatory power of the vessels, both of which are already too great. They are also improper, according to him, where there is a considerable tendency of the fluids to putrefaction; because he supposes the salts of these flies to operate in the same manner with volatile alkalies, that is, by dissolving and putrefying the blood still farther. But Sir John Pringle has shown, that, in inflammatory fevers as well as those of the putrid kind, both blisters and volatile salts may be of service; the latter, particularly, he hath experimentally proved to be so far from promoting putrefaction, that they are exceedingly strong antiseptics.

In the East Indies, Dr Lind found it absolutely necessary to exhibit the Peruvian bark in large quantities, and as early as possible. By this method he not only secured the patient from the imminent danger of death to which he was exposed at every fit, but likewise conquered those obstructions which were apt to ensue in the abdominal viscera, and which are to be attributed to the continuance of the disorder, and not to the bark employed to cure it. He always gave the cinchona during the second remission, as all his care was during the first to cleanse the primæ viæ. He observes, however, that it is to no purpose to give the bark till the necessary purgations are over; but assures us, that it never fails, unless from the coming on of a vomiting

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or diarrhœa it cannot be taken in sufficient quantities before the return of a paroxyſm. To prevent the medicine from vomiting or purging, he mixed a few drops of liquid laudanum with every doſe of it. Half a dram was given every half hour in ſome convenient vehicle, beginning as ſoon as the fever had conſiderably abated, and the pulſe was returned nearly to its natural ſtate; both which generally happened before the ſweats were over. An ounce of the bark was ſometimes found too little to check the fever, but an ounce and a half never failed. It muſt be continued daily in ſmall doſes till the patient has recovered his ſtrength, and then a greater quantity muſt be given, eſpecially at the ſeaſon when the rivers overflow the country.

Dr Pringle found the autumnal remittents in the Netherlands complicated with a great many inflammatory ſymptoms; for which reaſon it was generally found neceſſary to open a vein in the beginning. The vernal and later autumnal remitting fevers are accompanied with pleuritic and rheumatic pains from the coldneſs of the weather, and on that account require more bleeding. A phyſician unacquainted with the nature of the diſeaſe, and attending chiefly to the paroxyſms and remiſſions, would be apt to omit this evacuation entirely, and give the cinchona too ſoon, which would bring on a continued inflammatory fever. In theſe countries a vein may be ſafely opened either during the remiſſion or in the height of a paroxyſm; and our author alſo found good effects reſulting from bleeding in the hot fits of the marſh fever, even after it had almoſt come to regular intermiſſions. After bleeding, a purgative was uſually exhibited, of which he gives us the following formula.

℞. Infuſi ſenæ commun. ℥iij.
Elect. Lenitiv. ℥ſs.
Nitr. pur. ʒi.
Tinct. ſen. ʒvi. M.

Of this only one half was taken at once; and if it did not operate twice in four hours, the remainder was then taken. This potion agreed with the ſtomach, purged plentifully, and therefore was a very uſeful compoſition. Next morning, when there was almoſt always ſome remiſſion, he gave one grain of emetic tartar rubbed with 12 grains of crabs-eyes, and repeated the doſe in two hours, if the firſt had little or no effect; or at any rate in four hours. This medicine was intended not only to vomit, but alſo to operate by ſtool, and excite a ſweat. If theſe evacuations were procured, the fever generally became eaſier, and was even ſometimes cured. This he prefers to the ipecacuanha, and therefore in the latter years of his practice diſuſed that root entirely. The ſame medicine was repeated next day or the day following; or if not, a laxative clyſter was thrown up: and this method was continued till the fever either went off altogether, or intermitted in ſuch a manner as to be cured by the cinchona.

A ſimilar method was followed by Dr Huck in the remitting fevers of the Weſt Indies and North America. In the beginning he let blood; and in the firſt remiſſion gave four or five grains of ipecacuanha, with from half a grain to two grains of emetic tartar. This powder he repeated in two hours, taking care that the patient ſhould not drink before the ſecond doſe; for then the medicine more readily paſſed into the bowels after it had operated by vomiting. If, after two hours more, the operation either way was ſmall, he gave a third doſe, which commonly had a good effect in opening the firſt paſſages; and then the fever either went quite off, or intermitted in ſuch a manner as to yield to the bark. On the continent, he found little difficulty after the intermiſſion; but in the Weſt Indies, unleſs he gave the cinchona upon the very firſt intermiſſion, though imperfect, the fever was apt to aſſume a continued and dangerous form.

In the remitting fevers of hot countries, however, it muſt be obſerved, that the lancet muſt in all caſes be much more ſparingly uſed than in ſimilar diſeaſes of the colder regions; and we muſt alſo be ſparing of veneſection in thoſe countries where the marſh effluvia are very ſtrong and prevail much. For this reaſon Dr Lind of Haſlar greatly condemns the practice of indiſcriminate bleeding when people firſt arrive in hot climates. The firſt diſeaſes indeed which occur in a voyage to the ſouthward are, for the moſt part, of an inflammatory nature, and owing to a ſudden tranſition from cold to hot weather. This occaſions a fullneſs and diſtenſion of the veſſels; whence all Europeans, on their firſt arrival under the tropic, bear evacuations much better than afterwards. The practice of indiſcriminately bleeding, however, a number of the ſhip's company when they firſt come into a warm latitude, is by no means found to anſwer the purpoſe of a preventive. In ſuch caſes, indeed, as plainly indicate a plethoric diſpoſition brought on by the heat, blood-letting is certainly uſeful. The ſigns of this are a pain and giddineſs in the head; a heavineſs and dulneſs of the eyes, which ſometimes appear ſlightly inflamed: there is alſo commonly a ſenſe of weight and fulneſs in the breaſt, the pulſe at the ſame time being quick and oppreſſed.

But the caſe is quite different after a longer continuance of ſultry weather, and when the conſtitution is in ſome meaſure habituated to the hot climate. For it is then obſerved, that the ſymptoms of inflammations in the bowels, even the moſt dangerous, are not near ſo ſevere in ſuch climates as in cold countries; nor can the patients bear ſuch large evacuations. The phyſician, however, muſt take care not to be miſled by the apparent mildneſs of the ſymptoms: for he will find, notwithſtanding ſuch deceitful appearances, that the inflammation makes a more rapid progreſs in hot countries than in cold, ſuppurations and mortifications being much more ſuddenly formed; and that in general all acute diſtempers come ſooner to a criſis in the warm than in colder regions. Hence it is an important rule of practice in thoſe climates, to ſeize the moſt early opportunity, in the commencement of all threatening inflammations, to make frequent though not copious evacuations by blood-letting. For by delay the inflammation quickly paſſes from its firſt to its laſt or fatal ſtage; at leaſt, an imperfect criſis in ſuch inflammatory fevers enſues, which fixes an obſtruction in the viſcera extremely difficult to remove.

It is indeed a general maxim with ſome phyſician in the Weſt Indies, that in moſt acute diſtempers bleeding in that country is prejudicial. This is founded upon a ſuppoſition that the craſſamentum of the blood is

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is thinned, and the ſolids greatly weakened, by the heat of the climate. It is therefore objected, that bleeding in ſuch an habit of body weakens the powers of nature, and withdraws the ſtrength which is requiſite to ſupport the patient until the criſis of the fever.

This reaſoning is partly juſt; but, like all general maxims, will admit of exceptions. Firſt, with regard to ſailors, it is to be remembered, that they are more expoſed to quick viciſſitudes of heat, cold, damps, and to various changes of the air and weather, than moſt of the other inhabitants of the Torrid Zone. Add to this, that their intemperance, and the exceſſes they are apt to fall into whenever it is in their power to commit them, render them more liable to inflammations than any other ſet of people. Hence their diſeaſes require more plentiful evacuations than the land-inhabitants of thoſe parts of the world, and generally they bear them better. But with regard to the natives of the country, or thoſe who have remained long there, it muſt be proper to bleed them very ſparingly, making allowance for the different ſeaſons of the year, the temperature of the air, and the ſituation of the places where they reſide. Thus, in ſome parts, even on the iſland of Jamaica, at particular ſeaſons, the weather is cool; wherefore, in theſe places, and at ſuch ſeaſons, the inhabitants having their fibres more rigid, and a firmer craſis of their blood, bear veneſection much better.

In cold countries the ſtate of the air greatly aſſiſts in reſtoring the impaired ſpring of the fibres; whereas every thing almoſt in warm weather, ſuch as heat, moiſture, &c. concur to relax and weaken the habit of body. Thus we may daily ſee perſons in Britain, after having ſuffered a moſt ſevere fit of ſickneſs, recover their ſtrength and ſpirits in a few days, and in a very ſhort time their natural conſtitution. But the caſe is very different in the ſultry regions of the Torrid Zone, or indeed in any part of the world where the heat of the ſeaſon cauſes the mercury to ſtand for any length of time at the 77th degree and upward of Fahrenheit's thermometer. During ſuch an exceſs of heat, debility after fevers is apt to remain with European conſtitutions for ſeveral months. In Jamaica, the convaleſcents are ſent to the cool ſummits of the mountains; but a retreat to a more northern climate is often abſolutely neceſſary to recover their wonted tone and vigour of body. It is a well-eſtabliſhed obſervation, that the negroes and aborigines of the Torrid Zone cannot bear plentiful evacuations by the lancet. They commonly mix the moſt ſtimulating poignant ſpices with their ordinary light food, and this is found by experience ſuitable to their conſtitutions.

As proper preventives for the dangerous fevers of which we are treating, Dr Lind on all occaſions recommends the avoiding of ſtagnant water, or putrid marſhes; the uſe of proper food, cleanlineſs, and ſobriety. Of the propriety of removing from the neighbourhood of thoſe places whoſe peſtilential effluvia produce the diſorders, we cannot poſſibly entertain a doubt; and of the efficacy of proper food in preventing putrid diſorders he gives a remarkable inſtance in the Sheerneſs man of war, bound to the Eaſt Indies. As they went out, the men being apprehenſive of ſickneſs in ſo long a voyage, petitioned the captain not to oblige them to take up their ſalt proviſions, but rather to permit them to live upon the other ſpecies of their allowance. It was therefore ordered, that they ſhould be ſerved with ſalt-meat only once a-week; and the conſequence was, that, after a paſſage of five months and one day, the ſhip arrived at the Cape of Good Hope without having a ſingle perſon ſick on board. As the uſe of Sutton's pipes had been then newly introduced into the king's ſhips, the captain was willing to aſcribe part of ſuch an uncommon healthfulneſs to their beneficial effects; but it was ſoon diſcovered, that, by the neglect of the carpenter, the cock of the pipes had all this while been kept ſhut. This ſhip remained in India ſome months, where none of the men, except the boats crew, had the benefit of going on ſhore; notwithſtanding which, the crew continued to enjoy the moſt perfect ſtate of health; they were, however, well ſupplied with freſh meat. On leaving India, knowing they were to ſtop at the Cape of Good Hope, and truſting to a quick paſſage, and the abundance of refreſhments to be had there, they ate their full allowance of ſalt meats, during a paſſage of only 10 weeks; and it is to be remarked the air-pipes were now opened. The effects of this was, that when they arrived at the Cape, 20 of them were afflicted in a moſt miſerable manner with ſcorbutic and other diſorders. Theſe, however, were ſpeedily recovered by the refreſhments they met with on ſhore. Being now thoroughly ſenſible of the beneficial effects of eating, in theſe ſouthern climates, as little ſalt meat as poſſible when at ſea, they unanimouſly agreed, in their voyage home from the Cape, to refrain from their too plentiful allowance of ſalt fleſh. And thus the Sheerneſs arrived at Spithead, with her full complement of 160 men in perfect health and with unbroken conſtitutions, having in this voyage of 14 months and 15 days buried but one man, who died in a mercurial ſalivation.

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Thus we ſee, that a free and pure air is not a ſufficient preſervative againſt a putreſcent ſtate of the fluids, without proper food; and, on the other hand, we have a very remarkable inſtance of the inefficacy of the moſt ſalutary food to prevent putrid diſeaſes, in a very noxious ſtate of the atmoſphere. In the year 1717, at the ſiege of Belgrade in Hungary, the fever of the country, and the flux, occaſioned a moſt extraordinary mortality among the troops. The dread of theſe diſeaſes cauſed every one, as may naturally be ſuppoſed, to have recourſe to different precautions for ſelf-preſervation. Prince Eugene, the commander in chief, had water and the proviſions for his table ſent him twice a-week from Vienna. The pure ſtream of the river Kahlenberg was regularly brought to him: he avoided all exceſſes, and lived regularly, or rather abſtemiouſly; refreſhed himſelf often by eating a cool melon; and mixed his uſual wine, which was Burgundy, with water. Yet, notwithſtanding his utmoſt care, he was ſeized with a dyſentery; which would have quickly put an end to his life, had not the ſpeedy concluſion of that campaign permitted him to make a quick retreat.

At this unhealthy ſeaſon, when hardly one imperial officer, much leſs their ſeveral domeſtics, eſcaped thoſe malignant diſeaſes, the renowned Count Bonneval and his

his numerous retinue continued in perfect health, to the ſurpriſe, or to uſe the words, of Dr Kramer, to the *envy*, of all who beheld them. The only precaution he uſed, was to take, two or three times a-day, a ſmall quantity of brandy in which the Peruvian bark was infuſed; and he obliged all his attendants and domeſtics to follow his example. It is no leſs remarkable that the count, placing his certain preſervation in the uſe of this ſingle medicine, lived for many years afterwards in the moſt unhealthy ſpots of Hungary, without any attack or apprehenſion of diſeaſe; and continued to enjoy a perfect ſtate of health during the hotteſt and moſt ſickly ſeaſons. And thus, with an unbroken and ſound conſtitution, which is ſeldom the caſe of thoſe who reſide long in ſuch climates, he lived to a great age. There is an inſtance produced by the ſame author, of a whole regiment in Italy having been preſerved by the uſe of cinchona from the attack of theſe malignant diſeaſes, viz. the flux, and *bilious* fever as it is frequently called, when the reſt of the Auſtrian army, not purſuing that method, became greatly annoyed with them.

The intemperance and irregular living of thoſe Europeans who viſit the hot climates is frequently accuſed as the cauſe of their deſtruction; but our author thinks, without ſufficient reaſon; for though intemperance will make the body more liable to receive ſuch diſeaſes, it will not bring them on. It muſt by no means, however, be imagined, that in thoſe climates Europeans may with impunity be guilty of exceſſes in eating or drinking: for the leaſt error in that way will often prove fatal by debilitating the body, whoſe utmoſt ſtrength in time of full health was perhaps ſcarce ſufficient to reſiſt the peſtilential miaſmata of the atmoſphere.

It appears, therefore, from the concurrent teſtimony of the moſt eminent phyſicians, that the moſt proper medicine to be uſed, either as a preventive or cure for remitting and intermitting diſorders, is the Peruvian bark, adminiſtered with proper precautions and after the *primæ viæ* have been evacuated of the putrid bilious matter collected in them. In thoſe ſpecies of *tritæophya*, &c. belonging to this claſs, enumerated by Sauvages, the ſame remedies only were uſeful; but in that peſtilential diſtemper which he calls *tritæophya Vratiſlavienſis*, he tells us, that waſhing the body with water ſometimes hot, ſometimes cold, watery clyſters, and plenty of aqueous drink, were likewiſe of uſe.

Genus II. QUARTANA; the Quartan Fever.

Quartana auctorum, *Sauv.* Gen. 89. *Lin.* 17. *Vog.* 3. *Sag.* 711. *Hoffm.* II. p. 23. *Junck.* tab. 81.

The *Genuine* Quartan, Sp. I. var. 1. A.

Quartana legitima, *Sauv.* ſp. 1. *Sydenham* de morb. acut. cap. v.

Deſcription. The genuine quartan, according to Juncker, keeps its form more exactly than other intermittents; ſcarcely coming on at any other time than four or five in the afternoon. The cold is leſs violent than in the tertian; but is very perceptible, though it doth not proceed to ſuch a height as to make the limbs ſhake; it continues for about two hours. It is preceded and accompanied by a languor both of body and mind. There is ſeldom any vomiting unleſs when the ſtomach is manifeſtly overloaded with aliment; neither is there any diarrhœa, but the belly in general is rather bound, not only on the days on which the paroxyſm takes place, but alſo on the intermediate ones. The heat, which ſlowly ſucceeds the cold, is leſs troubleſome to the patient by its violence than by the uneaſy dryneſs of the ſkin, which is ſcarcely ever moiſtened with ſweat. This heat rarely continues longer than four or five hours, unleſs perhaps at the firſt or ſecond paroxyſm. It is accompanied alſo with a giddineſs and dull pain of the head. On the termination of the paroxyſm, the patient returns to a middling ſtate of health, and continues in the ſame for the reſt of the intermediate days; only there remains ſomewhat of a loathing, and a deep-ſeated pain as if the perſon was all over bruiſed or broken, which kind of ſenſation the phyſicians are wont to call *oſteocopus*. The fit returns every fourth day, and that preciſely at the ſame hours, being rarely poſtponed.

Cauſes of, and perſons ſubject to, this diſorder. The ſame general cauſes concur in producing this as other intermittents, namely marſh miaſmata, and whatever can diſpoſe the body to be eaſily affected by them. Studious people, and thoſe of a melancholic turn, are ſaid to be particularly ſubject to quartans; but what are the immediate cauſes which produce a return of the fits every fourth day, inſtead of every day, or every third day, muſt probably lie for ever concealed, as depending upon the ſecret and inexplicable mechaniſm of the human body.

Prognoſis. A ſimple quartan, where there is no reaſon to dread any induration of the viſcera, may very certainly admit of a cure; and the prognoſis can never be unfavourable, unleſs in caſes of extreme weakneſs, or where the diſtemper hath been unſkilfully treated.

Cure. This does not in the leaſt differ from that which hath been fully laid down for the ſimple tertian, and which it is therefore needleſs to repeat here.

The *Duplicated* Quartan. Sp. I. var. 1. B.

Quartana duplicata, *Sauv.* ſp. 4. *Bonet.* 153

This is entirely ſimilar to the duplicated tertian already mentioned; proper allowance being made for the difference between the type of a tertian and quartan.

The *Triplicated* Quartan. Sp. I. var. 1. C.

Quartana triplicata, *Sauv.* ſp. 16. 154

This hath three paroxyſms every fourth day, while the intermediate days are entirely free from fever.

The *Double* Quartan. Sp. 1. var. 1. D.

Quartana duplex, *Sauv.* ſp. 3. *Vog.* ſp. 13. 155

In the double quartan, the fits come on every day except the third; but ſo that the firſt paroxyſm anſwers to the third, the ſecond to the fourth, and ſo on.

The *Triple* Quartan. Sp. I. var. 1. E.

Quartana triplex, *Sauv.* ſp. 5. *Vog.* ſp. 14. *Bartholin.* H. anat. c. 1. 95. 156

This comes on every day, but the quartan type is ſtill

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ftill preferved by the times of acceffion; that is, the time of the fourth paroxyfm's coming on anfwers to that of the firft, the fifth to the fecond, the fixth to the third, &c.

The QUARTAN, accompanied with *Symptoms* of other difeafes. Sp. I. var. 2.

157 Quartana cataleptica, *Sauv.* fp. 7. *Bonet.* polyalth. vol. i. p. 805.
Quartana comatofa, *Sauv.* fp. 15. *Werholf.* de febr. *C. Pifonis* Obferv. de morbis à colluvie ferof. obf. 166, 167, 168, 169, 171, 172, 173, 174.
Quartana epileptica, *Sauv.* fp. 8. *Scholzii* Conf. 379, 380.
Quartana hyfterica, *Sauv.* fp. 10. *Morton*, Pyret. exerc. 1. cap. ix. H. 10, 11.
Quartana nephralgica, *Sauv.* fp. 9.
Quartana metaftatica, *Sauv.* fp. 17.
Quartana amens, *Sauv.* fp. 12. *Sydenham* de morb. acut. cap. v.
Quartana fplenetica, *Sauv.* fp. 2. *Etmuller*, Coll. confult. caf. 25.

The QUARTAN *complicated* with other *Difeafes*. Sp. I. var. 3.

158 Quartana fyphilitica, *Sauv.* fp. 6. *Plateri*, obferv. L. III. p. 676. Edin. Eff. art. xlvii. obf. 8.
Quartana arthriticia, *Sauv.* fp. 11. *Mufgr. de Arthr.* fympt. cap. ix. H. 4. et 5.
Arthritis febrifequa, *Sauv.* fp. 10.
Arthritis febricofa, *Sauv.* fp. 10. *Werlhof.* de febr. *Cockburn* de morbis navigantium, obf. 19.
Quartana fcorbutica, *Sauv.* fp. 14. *Barthol.* de med. Dan. diff. iv. *Tim.* L. VIII. caf. 18.

The *Remitting* QUARTAN. Sp. II.

159 Tetartophya, *Sauv.* gen. 85. *Sag.* 699. *Lin.* 21.
Quartana remittens auctorum.

Var. 1. Tetartophya fimplex, *Sauv.* fp. 1.
2. Amphimerina femiquartana, *Sauv.* fp. 23.
3. Tetartophya femitertiana, *Sauv.* fp. 5.
4. Tetartophya maligna, *Sauv.* fp. 6. *Lautter.* Hift. med. caf. 21. *M. Donat.* L. III. cap. 14. ex *M. Gatenaria Horft.* L. I. obf. 15.
5. Tetartophya carotica, *Sauv.* fp. 4. *Werlhof.* de febr. *Bianchi* Hift. hep. pars III. conft. ann. 1718, p. 751.
6. Tetartophya fplenalgica, *Sauv.* fp. 2.
7. Tetartophya hepatalgica, *Sauv.* 3. *Car. Pif.* in prefat. p. 33.
8. Amphimerina fpafmodica, *Sauv.* fp. 16.

To the tertian or quartan fevers alfo belong the *Erraticæ* of authors. As all thofe above mentioned differ only in the flight circumftance of the type from the intermitting and remitting tertians already defcribed at length, it is unneceffary here to take up time in defcribing every minute circumftance related by phyficians concerning them, efpecially as it could contribute nothing towards the laying down a better method of cure than what hath been already fuggefted.

Quotidiana.

GENUS III. QUOTIDIANA; the QUOTIDIAN FEVER.

Quotidiana auctorum, *Sauv.* gen. 86. *Lin.* 15. *Vog.* I. *Hoffm.* II. 33. *Junck.* tab. 79.

The *Genuine* QUOTIDIAN. Sp. I. var. 1. A.

Quotidiana fimplex, *Sauv.* fp. 1. 160
Quotidiana legitima, *Sennert.* de febr. cap. 18.

Defcription. This kind of fever generally comes on about fix or feven o'clock in the morning, beginning with a confiderable degree of cold and fhivering, which lafts for about an hour; and is often accompanied with vomiting or fpontaneous diarrhœa, or both. It is fucceeded by a pretty ftrong heat, accompanied with thirft, reftleffnefs, and pain of the head. When the heat abates a little, a fpontaneous fweat commonly follows, and the whole paroxyfm rarely exceeds fix hours. It returns, however, every day almoft always at the fame hour, unlefs it be evidently difturbed.

Caufes of, and perfons fubject to, the difeafe. The fame general caufes are to be affigned for the quotidian as for other intermittents. This kind occurs but rarely; and is faid to attack people of a phlegmatic temperament rather than any other: alfo old people rather than young, and women rather than men.

The prognofis and method of cure are not different from thofe of tertians and quartans.

The *Partial* QUOTIDIAN. Sp. I. var. 1. B.

Quotidiana partialis, *Sauv.* fp. 16. *Cnoffel*, E. N. C. D. I. A. III. obf. 205. Edin. Med. Eff. vol. i. art. 31. vol. ii. art. 16. 161
Quotidiana cephalalgica, *Sauv.* fp. 6. *Mort.* pyretol. exerc. i. hift. 27. *Van Swieten in Boerh.* p. 534.
Cephalalgia intermittens, *Sauv.* fp. 7.
Cephalæa febricofa, *Sauv.* fp. 4.
Quotidiana ophthalmica, *Morton*, ibid. hift. 17. *Van Swieten*, ibid.
Ophthalmia febricofa, *Sauv.* fp. 23.

Thefe diftempers attack only fome particular part of the body, as the head, the eye, arm, &c. producing periodical affections of thofe parts returning once in 24 hours; they are to be cured by cinchona, as other intermittents. They are known to belong to this clafs, by the evident intermiffion of the pain or other affection of the part. The *quotidiana hysterica*, *Sauv.* fp. 3. *quotidiana catarrhalis*, *Sauv.* fp. 9. and *quotidiana ftranguriofa*, *Sauv.* fp. 11. feem to be fymptomatic diforders.

The *Remitting* QUOTIDIAN. Sp. II.

Amphimerina, *Sauv.* gen. 84. *Lin.* 20. 162
Quotidiana continua, *Vog.* 15.
Quotidianæ remittentes et continuæ auctorum.
Amphimerina latica, *Sauv.* fp. 1.
Febris continua lymphatica, *Etmuller*, Coll. conf. caf. 32. *River.* Obf. cent. 1. obf. 57.
Amphimerina fingultuofa, *Sauv.* fp. 14.
Febris continua Lyngodes, *Vog.* 26.

Concerning thefe alfo nothing remains neceffary to be mentioned in this place, having already fo fully difcuffed the remitting fevers in all the different parts of the

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Sect. II. CONTINUED FEVERS.

Continuæ, *Sauv.* clafs ii. ord. 1. *Vog.* clafs i. ord. 2. *Sag.* 666. *Boerh.* 727.
Continentes, *Lin.* clafs ii. ord. 1. *Stahl.* Caf. mag. 35. Caf. min. 87. *Junck.* 58. *Sennert.* de febr. L. ii. cap. 2. et 10.

Genus IV. SYNOCHA.

163 Synocha, *Sauv.* gen. 80. *Lin.* 12. *Junck.* 58.
Synocha, five febris acuta fanguinea, *Hoffm.* II. 105.
Synochus, *Vog.* 16.
Continua non putris, *Boerh.* 720.
Ephemera, *Sauv.* g. 79. *Boerh.* 728. *Junc.* 57.
Diaria, *Lin.* 11.
Febris inflammatoria auctorum.

Defcription. The moft fimple kind of fynocha is the ephemera or diary fever. It begins without any fenfation of cold or fhivering, unlefs there be fome internal inflammation, or the fmall-pox or meafles happen to be prefent. A continual heat without any intermiffion conftitutes the effence of this difeafe. The heat, however, is more tolerable than in the fynocha properly fo called. In fome, the pains of the head are pungent and throbbing, anfwering to the pulfations of the arteries; but in others they are dull and heavy. The face is red and bloated; and there is a remarkable laffitude of the limbs, with a ftrong, full, and frequent pulfe. The urine is red, and depofits a fediment almoft of the colour of orange-peel; and in the very firft day of the difeafe, figns of concoction (according to the Hippocratic phrafe) appear. The fever commonly goes off with a gentle fweat; but fometimes, though more rarely, with a hemorrhagy by the nofe. Its fhorteft period is 24 hours; but if it goes beyond the fourth day, it is then a *fynocha* properly fo called.

The fimple fynocha, according to Vogel, begins with cold and fhivering, fucceeded by vehement heat, rednefs, and drynefs of the fkin. The face, efpecially, is very red, and the thirft intenfe. The head is either pained or heavy. The patient either doth not fleep at all, or is difturbed with dreams. A moift fweat then breaks out all over the fkin. The pulfe is full, quick, and frequent; the judgement is fometimes a little difturbed; young people are apt to be terrified with imaginations; and they for the moft part incline to fleep: the refpiration is difficult, and the belly coftive; at the fame time that a tenfive kind of laffitude is perceived over the whole body. A complete crifis takes place either on the fourth or at the fartheft on the eleventh day. The characteriftic marks of the fimple fynocha, therefore, are, A rednefs of the face, moifture of the fkin, a ftrong and frequent pulfe.

Caufes of, and perfons fubject to, this difeafe. As we have already remarked of intermittents, fo muft we alfo now remark of continued fevers, that it is impoffible to difcover thofe minute caufes which occafion the difference of type betwixt one inflammatory fever and another, though moft authors pretend to enumerate thefe with great certainty. Thus Juncker tells us, that the caufe of the fimple ephemera is plethora, together with any immoderate agitation and commotion of the fluids while in that ftate. Vogel reckons among the caufes of his *febris diaria*, paffions of the mind, pain, want, expofure to the fun, &c.; a repulfion or abforption of certain humours; wounds, fractures, luxations, &c.; fo that in general we may reckon every thing tending to increafe the action of the arterial fyftem to be in certain circumftances a caufe of inflammatory fever.—Hence we find thofe are moft fubject to the fynocha whofe conftitution is either naturally robuft, or who are expofed to thofe caufes which tend to produce an increafed action of the arterial fyftem; fuch as hard labour, high living, &c. Synocha.

Prognofis. The moft fimple kind of fynocha, that is, the ephemera or diary fever, is commonly cured without the affiftance of medicine, and therefore the prognofis is for the moft part favourable: yet, if it be improperly treated by heating medicines, it may eafily be converted into the other kind; or, if there be a putrid difpofition of the fluids, into a fever of a very dangerous nature. The fame thing is to be underftood even of the moft violent kind; for fimple inflammatory fevers are not dangerous unlefs complicated with an affection of fome particular part, as the pleura, ftomach, &c.

Cure. Dr Cullen objects to the plan of thofe who are for leaving the cure of continued fevers to the operations of nature; becaufe thefe operations are neither certain in themfelves, nor are they fo well underftood as to enable us to regulate them properly; and it is likewife poffible to fuperfede them by art. The plan therefore on which he proceeds is, to form his indications of cure upon the means of obviating the tendency to death in fevers; and thefe he reduces to three. 1. To moderate the violence of re-action.—2. To remove or obviate the caufes of debility; and, 3. To obviate or correct the tendency of the fluids to putrefaction.

The *firft* indication may be anfwered, 1. By all thofe means which diminifh the action of the heart and arteries. 2. By thofe which take off the fpafm of the extreme veffels, which, according to his theory, is the chief caufe of violent re-action.

I. The action of the heart and arteries may be diminifhed, 1. By avoiding or moderating thofe irritations which, in one degree or other, are almoft conftantly applied to the body. 2. By the ufe of certain fedative powers. 3. By diminifhing the tenfion or tone of the arterial fyftem.

[1.] The irritations above-mentioned are the impreffions made upon our fenfes, the exercife of the body and mind, and the taking in of aliments. The avoiding of thefe as much as poffible, or the moderating their force, makes what is properly called the *antiphlogiftic regimen*, proper to be employed in *almoft* every continued fever. This regimen is to be directed in the following manner.

1. Impreffions on the external fenfes, as ftimulant to the fyftem, and a chief fupport of its activity, fhould be avoided as much as poffible; efpecially fuch as are of a ftronger kind, and which give pain and uneafinefs. No impreffion is to be more carefully guarded againft than that of external heat; and at the

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ſame time every other means of increaſing the heat of the body is to be ſhunned. Both theſe precautions are to be taken as ſoon as a hot ſtage is fully formed, and to be attended to during its continuance, except in certain caſes, where a determination to ſweating is neceſſary, or where the ſtimulant effects of heat may be compenſated by circumſtances which determine it to produce a relaxation and revulſion.

2. All motion of the body is to be avoided as much as poſſible, and that poſture only choſen which employs the feweſt muſcles, and keeps none of then long in a ſtate of contraction. Speaking, as it accelerates reſpiration, is particularly to be avoided. It muſt alſo be obſerved, that every motion of the body is more ſtimulant in proportion as the patient is weaker.

3. The exerciſe of the mind is alſo to be avoided, as being a ſtimulus to the body; but here an exception is to be made in the caſe of a delirium coming on, when the preſenting of accuſtomed objects may divert the irregular train of ideas then ariſing in the mind.

4. The preſence of recent aliment in the ſtomach proves always a ſtimulus to the ſyſtem, and ought therefore to be as moderate as poſſible. A total abſtinence for ſome time may be of ſervice; but as this cannot be long continued with ſafety, we muſt avoid the ſtimulus of aliment by chooſing that kind which gives the leaſt. Alimentary matters are alſo to be accounted more ſtimulant in proportion to their alkaleſcent qualities; and this leads us to avoid all animal, and uſe only vegetable food. For the ſame reaſon, aromatic and ſpirituous liquors are to be avoided; and in anſwering the preſent indication, we muſt abſtain from all fermented liquors except thoſe of the loweſt quality. Other ſtimuli are, the ſenſation of thirſt, crudities or corrupted humours in the ſtomach, a preternatural retention of the fæces in the inteſtines, and a general acrimony of all the humours, which is in moſt fevers to be ſuſpected. Theſe are to be removed by ſuch methods as the urgency of the ſymptoms require, by diluting liquors, vomiting, the uſe of acids, laxative clyſters, and large quantities of antiſeptic drinks.

[2.] The ſecond method of moderating the violence of reaction is by the employment of certain ſedative powers, with a view to diminiſh the activity of the whole body, and particularly that of the ſanguiferous ſyſtem. The firſt of theſe to be mentioned is the application of cold. Heat is the chief ſupport of the activity of the animal-ſyſtem; and the ſyſtem is therefore provided with a power of generating heat: but at the ſame time we may obſerve, that this would go to exceſs, were it not conſtantly moderated by a cooler temperature in the ſurrounding atmoſphere. When, therefore, the generating power of heat in the ſyſtem is increaſed, as is commonly the caſe in fevers, it is neceſſary not only to avoid all further means of increaſing it, but alſo to apply air of a cooler temperature; or at leaſt to apply it more entirely and freely than in a ſtate of health. This is ſhown, from ſome late obſervations, to be a very powerful means of moderating the violence of re-action: but what is the mode of its operation, to what circumſtances of fever it particularly applies, or what limitations it requires, are not yet fully aſcertained.

Another ſedative power very frequently employed in fevers, is that of certain medicines known in the materia medica by the name of *refrigerants*. The chief of theſe are acids of all kinds when ſufficiently diluted, and which are, in ſeveral reſpects, remedies adapted to continued fevers. Thoſe eſpecially in uſe are the ſulphuric and vegetable; and on many accounts the latter are to be preferred. Another ſet of refrigerants are the neutral ſalts formed of the ſulphuric, nitrous or vegetable acids, with alkalies either fixed or volatile. All theſe neutrals, while they are diſſolved in water, generate cold; but as that cold ceaſes ſoon after the diſſolution is finiſhed, and as the ſalts are generally exhibited in a diſſolved ſtate, their refrigerant power in the animal body does not all depend upon their power of generating cold with water. Nitre is the refrigerant chiefly employed; but all the others, compounded as above mentioned, partake more or leſs of the ſame quality. Beſides theſe neutrals, ſome metallic ſalts have alſo been employed in fevers, particularly the acetite of lead: but the refrigerant powers of this ſalt are by no means aſcertained, and its deleterious qualities are too well known to admit of its being freely uſed.

[3.] The third general method of diminiſhing the reaction, is by leſſening the tenſion, tone, and activity of the ſanguiferous ſyſtem. As the activity of the ſyſtem in a great meaſure depends upon the tone, and this again upon the tenſion, of the veſſels, given to them by the quantity of fluids they contain, it is evident, that the diminution of the quantity of theſe muſt diminiſh the activity of the ſanguiferous ſyſtem. The moſt efficacious means of diminiſhing the quantity of fluids is by the evacuations of blood-letting and purging. The former is evidently one of the moſt powerful means of diminiſhing the activity of the whole body, and eſpecially of the ſanguiferous ſyſtem; and it muſt therefore be the moſt effectual means of moderating the reaction in fevers. When the violence of reaction, and its conſtant attendant a phlogiſtic diatheſis, are ſufficiently evident; when theſe conſtitute the principal part of the diſeaſe, and may be expected to continue through the whole of it, as in the caſes of ſynocha; then blood-letting is the principal remedy, and may be employed as far as the ſymptoms of the diſeaſe may ſeem to require, and the conſtitution of the patient will bear. It muſt, however, be remarked, that a greater evacuation than is neceſſary may occaſion a ſlower recovery, and render the perſon more liable to a relapſe, or bring on other diſeaſes. It is alſo to be obſerved, that this evacuation is the more effectual, as the blood is more ſuddenly drawn off, and as the body is at the ſame time more free from all irritation, and therefore when it is in a poſture in which the feweſt muſcles are in action.

With regard to purging, when we conſider the quantity of fluids conſtantly preſent in the cavity of the inteſtines, and the quantity which may be drawn off from the innumerable excretories that open into this cavity, it will be obvious, that a very great evacuation may be made in this way; and if this be done by a ſtimulus that is not at the ſame time communicated to the reſt of the body, it may, by emptying both the cavity of the inteſtines and the arteries which furniſh

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furnish the excretions poured into it, induce a considerable relaxation in the whole system; and is therefore suited to moderate the violence of reaction in fevers. But it is to be observed, that as the fluid drawn from the excretories opening into the intestines is not all drawn immediately from the arteries, and as what is even more immediately drawn from these is drawn off slowly; so the evacuation will not, in proportion to its quantity, occasion such a sudden depletion of the red vessels as blood-letting does; and therefore cannot act so powerfully in taking off the phlogistic diathesis of the system.

At the same time this evacuation may induce a considerable degree of debility; and therefore, in those cases in which a dangerous state of debility is likely to occur, purging is to be employed with a great deal of caution; and this caution is more difficult to be observed than in the case of blood letting: and it is further to be noticed, that as purging takes off in some measure the determination of the blood to the vessels on the surface of the body, it seems to be less adapted to the cure of fevers.

II. The other method of moderating the violence of reaction in fevers is by the exhibition of those remedies suited to take off the spasm of the extreme vessels, supposed to be the irritation which chiefly supports the reaction. The means to be employed for this purpose are either internal or external.

First, The internal means are, 1. Those which determine the force of the circulation to the extreme vessels on the surface of the body, and by restoring the tone and activity of these vessels, overcome the spasm on their extremities. 2. Those medicines which have the power of taking off spasm in any part of the system, and which are known under the title of ANTISPASMODICS.

(1.) Those remedies which are fit to determine to the surface of the body are, 1. Diluents. 2. Neutral salts. 3. Sudorifics. 4. Emetics.

1. Water enters, in a large proportion, into the composition of all the animal fluids, and a large quantity of it is always diffused through the whole of the common mass. In a sound state, the fluidity of the whole mass depends upon the quantity of water present in it. Water therefore is the proper diluent of our mass of blood, and other fluids are diluent only in proportion to the quantity of water they contain.

In a healthy state, also the fulness of the extreme vessels and the quantity of excretion are in proportion to the quantity of water present in the body. But in fever, though the excretions be in some measure interrupted, they continue in such quantity as to exhale the more fluid parts of the blood; and, while a portion of them is at the same time necessarily retained in the larger vessels, the smaller, and the extreme vessels, both from the deficiency of fluid and their own contracted state, are less filled, and therefore allowed to remain in that condition. To remedy this contracted state, nothing is more necessary than a large supply of water or watery fluids taken in by drinking or otherwise; for as any superfluous quantity of water is forced off by the several excretories, such a force applied may be a means of dilating the extreme vessels, and of overcoming the spasm affecting their extremities. Accordingly, the throwing in a large quantity of watery fluids, has been, at all times, a remedy much employed in fevers; and in no instance more remarkably than by the Spanish and Italian physicians, in the use of what they call the *diæta aquea*. This practice consists in taking away every other kind of aliment and drink, and in giving, in divided portions, every day for several days together, six or eight pounds of plain water, generally cold, but sometimes warm. This, however, is to be done only after the disease has continued for some time, and at least for a week.

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2. A second mean of determining to the surface of the body, is by the use of neutral salts. These neutrals, in a certain dose, taken into the stomach, produce soon after a sense of heat upon the surface of the body; and, if the body be covered close and kept warm, a sweat is readily brought out. The same medicines taken during the cold stage of a fever, very often put an end to it, and bring on the hot one; and they are also remarkable for stopping the vomiting which so frequently attends the cold stage of fevers. All this shows, that neutral salts have a power of determining the blood to the surface of the body, and may therefore be of use in taking off the spasm which subsists there in fevers. The neutral most commonly employed in fevers, is that formed of an alkali with the native acid of vegetables. But all the other neutrals have more or less of the same virtue; and perhaps some of them, particularly the ammoniacal salts, possess it in a stronger degree. As cold water taken into the stomach often shows the same diaphoretic effects with the neutral salts, it is probable that the effect of the latter depends upon their refrigerant powers.

3. A third method of determining to the surface of the body, and taking off the spasm subsisting there, is by the use of sudorifics and by sweating. The propriety of this practice has been much disputed; and many specious arguments may be adduced both for and against it. In its favour may be urged, 1. That in healthy persons, in every case of increased action of the heart and arteries, a sweating takes place, and is, seemingly, the means of preventing the bad effects of such increased action. 2. That, in fevers, their most usual solution and termination is by spontaneous sweating. 3. That, even when excited by art, it has been found useful at certain periods, and in certain species of fever.—On the other hand, it may be urged against the practice of sweating, 1. That in fevers, as a spontaneous sweating does not immediately come on, there are some circumstances different from those in the state of health, and which may render it doubtful whether the sweating can be safely excited by art. 2. That in many cases the practice has been attended with bad consequences. The means commonly employed have a tendency to produce an inflammatory diathesis; which, if not taken off by the sweat succeeding, must be increased with much danger. Thus sweating employed to prevent the accessions of intermitting fevers has often changed them into a continued form, which is always dangerous. 3. The utility of the practice is doubtful; as sweating, when it happens, does not always give a final termination, as must be manifest in the case of intermittents, and in many continued fevers which are sometimes in the beginning attended with sweatings which do not prove final; and, on the contrary, whether they be sponta-

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neous or excited by art, they ſeem often to aggravate the diſeaſe.

From theſe conſiderations, it is doubtful if the practice of ſweating can be admitted very generally; but, at the ſame time, it is alſo very doubtful if the failure of the practice, or the miſchiefs ſaid to ariſe from it, have not been owing to the improper conduct of the practitioner. With reſpect to the laſt, it is almoſt agreed among phyſicians, 1. That ſweating has been generally hurtful when excited by ſtimulant, heating, and inflammatory medicines. 2. That it has been hurtful when excited by much external heat, and continued with a great increaſe of the heat of the body. 3. That it is always hurtful when it does not relieve; and rather increaſes the frequency and hardneſs of the pulſe, the anxiety and difficulty of breathing, the headach, and delirium. 4. That it is always hurtful if it be urged when the ſweat is not fluid, and when it is partial and on the ſuperior parts of the body only.

In theſe caſes, it is probable, that either an inflammatory diatheſis is produced, which increaſes the ſpaſm on the extreme veſſels; or that, from other cauſes, the ſpaſm is too much fixed to yield eaſily to the increaſed action of the heart and arteries: and upon either ſuppoſition it muſt be obvious, that urging the ſweat may produce determinations to ſome of the internal parts, with very great danger.

Notwithſtanding theſe doubts, however, it ſtill remains true, 1. That ſweating has been often uſeful in preventing the acceſſions of fevers when they have been certainly foreſeen, and a proper conduct employed. 2. That even after fevers have in ſome meaſure come on, ſweating has interrupted their progreſs when properly employed, either at the very beginning of the diſeaſe, or during its approach and gradual formation. 3. That even after pyrexiæ have continued for ſome time, ſweating has been ſucceſsfully employed in curing them, as is particularly exemplified in the caſe of a rheumatiſm. 4. That certain fevers produced by a very powerful ſedative contagion, have been generally treated moſt ſucceſsfully by ſweating.

Theſe inſtances are in favour of ſweating, but give no general rule; and it muſt be left to farther experience to determine how far any general rule can be eſtabliſhed in this matter. In the mean time, if the practice of ſweating is to be attempted, the following rules may be laid down for the conduct of it: 1. That a ſweat ſhould be excited without the uſe of ſtimulant inflammatory medicines. 2. That it ſhould be excited with as little external heat, and with as little increaſe of the heat of the body, as poſſible. 3. That, when excited, it ſhould be continued for a due length of time; not leſs than 12 hours, and ſometimes for 24 or 48 hours; always, however, ſuppoſing that it proceeds without the dangerous circumſtances already mentioned. 4. That for ſome part of the time, and as long as the perſon can eaſily bear, it ſhould be carried on without admitting of ſleep. 5. That it ſhould be rendered univerſal over the whole body; and therefore particularly that care ſhould be taken to bring the ſweating to the lower extremities. 6. That the practice ſhould be rendered ſafer by moderate purging excited at the ſame time. 7. That it ſhould not be ſuddenly checked by cold anyhow applied to the body.

When attention is to be given to theſe rules, the ſweating may be excited, 1. By warm bathing, or a fomentation of the lower extremities. 2. By frequent draughts of tepid liquors, chiefly water, rendered more grateful by the addition of a light aromatic, or more powerful by that of a ſmall quantity of wine. 3. By giving ſome doſes of neutral ſalts. 4. Moſt effectually, and perhaps moſt ſafely, by a large doſe of an opiate, joined with a portion of neutral ſalts, and of an emetic.

The fourth mean of determining to the ſurface of the body, and thereby taking off the ſpaſm affecting the extreme veſſels, is by the uſe of emetics. Theſe, particularly of the antimonial kind, have been employed in the cure of fevers ever ſince the introduction of chemical medicines; but though of late their uſe has become very general, their efficacy is ſtill diſputed, and their manner of operating is differently explained.

Vomiting is in many reſpects uſeful in fevers; as it evacuates the contents of the ſtomach, as it emulges the biliary and pancreatic ducts, and evacuates the contents of the duodenum, and perhaps alſo of a large portion of the inteſtines; as it agitates the whole of the abdominal viſcera, it expedes the circulation in them, and promotes their ſeveral ſecretions; and, laſtly, as it agitates alſo the viſcera of the thorax, it has like effects there.

It is not to this cauſe, however, that we are to impute the effect vomiting has in determining to the ſurface of the body. This muſt be attributed to the particular operation of emetics upon the muſcular fibres of the ſtomach, whereby they excite the action of the extreme arteries on the ſurface of the body, and by this means effectually determine the blood to theſe veſſels, remove the atony, and take off the ſpaſm affecting them. For this purpoſe they are exhibited in two different ways; that is, either in ſuch doſes as may excite full and repeated vomitings, or in ſuch doſes as may excite ſickneſs and nauſea only, with little or no vomiting at all.

Full vomiting is well ſuited to determine to the ſurface of the body, and thereby to obviate the atony and ſpaſm which lay the foundation of fever. Thus, vomiting excited a little before the expected acceſſion of the paroxyſm of an intermittent, has been found to prevent the paroxyſm altogether. It has been obſerved alſo, that when contagion has been applied to a perſon, and firſt diſcovers its operation, an emetic given has prevented the fever which might otherwiſe have been expected.

Theſe are the advantages to be obtained by exciting vomiting at the firſt approach of fevers, or of the paroxyſm of fevers; and they may alſo be applied after fevers are formed, to take off, perhaps entirely, the atony and ſpaſm, or at leaſt to moderate theſe, ſo that the fever may proceed more gently and ſafely. It is ſeldom, however, that vomiting is found to produce a final ſolution of fevers; and after they are once formed, it is commonly neceſſary to repeat the vomiting ſeveral times; but this is attended with inconveniency, and ſometimes with diſadvantage. The operation of

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full vomiting is tranſitory, and the exerciſe of vomiting is a debilitating power; and therefore, when the vomiting does not remove the atony and ſpaſm very entirely, it may give occaſion to their recurrence with greater force. For theſe reaſons, after fevers are fully formed, ſome phyſicians have thought proper to employ emetics in nauſeating doſes only. Theſe are capable of exciting the action of the extreme veſſels, and their operation is more permanent. At the ſame time they often ſhow their power by exciting ſome degree of ſweat, and their operation is rendered more ſafe by their commonly producing ſome evacuation by ſtool. But nauſea continued for any great length of time, is to moſt patients a ſenſation highly diſtreſſing, and almoſt inſufferable.

The emetics chiefly in uſe at preſent are, ipecacuanha and antimony. The former may be employed for determining to the ſurface of the body: but, even in very ſmall doſes, it ſo readily excites vomiting, that it is with difficulty employed for the purpoſe of nauſeating only; and in whatever manner employed, there is reaſon to ſuſpect that its effects are leſs permanent, and leſs powerfully communicated from the ſtomach to the reſt of the ſyſtem, than thoſe of antimony. This laſt is therefore generally preferred; and its preparations, ſeemingly various, may all be reduced to two heads; one comprehending thoſe in which the reguline part is in a condition to be acted upon by acids, and therefore on meeting with acids in the ſtomach it becomes active; and another, comprehending thoſe preparations in which the reguline part is already joined with an acid, rendering it active. Of each kind there are great numbers, but not differing eſſentially from one another; the two moſt worthy of notice are, the *calx nitrata antimonii*, and *emetic tartar*, or *tartrite of antimony*, of the Edinburgh Diſpenſatory. Both theſe are very efficacious medicines; but the latter ſeems preferable, becauſe its doſe is capable of being better aſcertained; though the former, on account of its ſlower operation, may have ſome advantages, and in certain caſes be more efficacious as a purgative and ſudorific.

The *calx nitrata antimonii*, when firſt introduced into the pharmacopœia of the Edinburgh college was ſuppoſed to be very nearly, if not preciſely, the ſame with a medicine which has of late been highly celebrated in the cure of fevers, Dr James's powder. But from more accurate obſervations, there is now reaſon to believe that the pulvis antimonialis of the London Pharmacopœia, formed by the calcination of antimony with hartſhorn, approaches more nearly to that celebrated arcanum. But at any rate, the calx antimonii nitrata, the pulvis antimonialis, and James's powder, are probably not eſſentially different from each other. The two latter, however, have the moſt near reſemblance; and accordingly the Edinburgh college, in their Pharmacopœia, have introduced an article under the title of *antimonium calcareo-phoſphoratum*, which they conſider as ſo much ſimilar to James's powder, that they have uſed as a ſynonyme for it, the title of *pulvis Jacobi*.

The time moſt proper for exhibiting theſe medicines is a little before the acceſſion, when that can be certainly known. In continued fevers the exacerbations are not always very obſervable; but there is reaſon to believe, that one commonly happens about noon or ſoon after it; and that theſe, therefore, are the moſt proper times for exhibiting emetics.

With reſpect to the manner of adminiſtration, that of the *calx nitrata* is ſimple, as the whole of what is thought a proper doſe may be given at once; and no more can be properly given till the next acceſſion. The adminiſtration of the emetic tartar is different. It is to be given in ſmall doſes, not ſufficient to excite vomiting; and theſe doſes are to be repeated after ſhort intervals for ſeveral times, till ſickneſs, nauſea, and ſome, though not much, vomiting come on. The difference of adminiſtration muſt depend upon the doſe, and the length of the interval at which it is given. If it be intended that the medicine ſhould certainly operate by ſtool, the doſes are made ſmall, and the intervals long. On the contrary, when vomiting is proper, or when much purging ought to be avoided, and therefore ſome vomiting muſt be admitted, the doſes are made larger, and the intervals ſhorter. With reſpect to both kinds of preparations, the repetition is to be made at the times of acceſſion, but not very often: for if the firſt exhibitions, duly managed, have little effect, it is ſeldom that the after exhibitions have much; and it ſometimes happens that the repeated vomiting, and eſpecially repeated purging, does harm by weakening the patient.

(2.) The other ſet of internal medicines which are ſuppoſed uſeful in taking off the ſpaſm of the extreme veſſels, are thoſe named *antiſpaſmodics*. But whatever may be the virtues of ſome of them in this way, ſuch is their power of ſtimulating at the ſame time, that very few of them can with ſafety be adminiſtered in fevers of an inflammatory nature. Almoſt the only one which can with ſafety be exhibited in theſe caſes is camphor; and the operations of this are by no means well aſcertained. Dr Huxham mentions it as a corrector of the acrimony of cantharides; and aſſures us, that it very effectually promotes a diaphoreſis. But from the remarks of other practitioners, we have no juſt reaſon to ſuppoſe that it acts perceptibly in a doſe of five or ſix grains, though in 15 or 20 it produces a particular kind of intoxication.

Secondly, The external means ſuited to take off the ſpaſm of the extreme veſſels, are bliſtering and warm bathing.

1. What are the effects of bliſtering ſo frequently employed in fevers, is not yet agreed among phyſicians. Dr Cullen is of opinion, that the ſmall quantity of cantharides abſorbed from a bliſtering plaſter, is not ſufficient to change the conſiſtence of the maſs of blood; and therefore, that ſuch a quantity can neither do good by reſolving phlogiſtic lentor if it exiſts, nor do harm by increaſing the diſſolution of the blood ariſing from a putrid tendency in it. The effects of cantharides upon the fluids, therefore, may be entirely neglected. The inflammation produced by the application of cantharides to the ſkin, affords a certain proof of their ſtimulant power: but in many perſons the effect of that ſtimulus is not conſiderable; in many it is not communicated to the whole ſyſtem; and even when it does take place in the whole ſyſtem, it ſeems to be taken off very entirely by the effuſion and evacuation of ſerum from the bliſtered part. It may be concluded, therefore, that neither much good is to be expected, nor

nor much harm to be apprehended, from the ſtimulant power of bliſtering; and the certainty of this concluſion is eſtabliſhed by the great benefit ariſing from the proper practice of bliſtering in inflammatory diſeaſes. Much has been imputed to the evacuation made by bliſtering; but it is never ſo conſiderable as to affect the whole ſyſtem; and therefore can neither, by a ſudden depletion, relax the ſanguiferous ſyſtem, nor by any revulſion affect the general diſtribution of the fluids. The evacuation, however, is ſo conſiderable as to affect the neighbouring veſſels; and the manifeſt utility of bliſtering near the part affected in inflammatory diſeaſes leads us to think, that bliſtering, by deriving to the ſkin, and producing an effuſion there, relaxes the ſpaſm of the deeper ſeated veſſels. It is in this manner, moſt probably, that the tumor of a joint, from an effuſion into the cellular texture under the ſkin, takes off the rheumatic pain formerly affecting that joint. Analogous to this, probably, is the good effect of bliſtering in continued fevers, ariſing from the relaxation of the ſpaſm of the extreme veſſels by a communication of the bliſtered part with the reſt of the ſkin. A bliſter may be employed at any period in continued fevers; but it will be of moſt advantage in the advanced ſtate of ſuch fevers, when, the reaction being weaker, all ambiguity from the ſtimulating power of bliſtering is removed, and when it may beſt concur with other circumſtances tending to a final ſolution of the ſpaſm.

From this view of the matter, it will appear, that the part of the body to which bliſters ought to be applied is indifferent, except upon the ſuſpicion of topical affection, when the bliſtering is to be made as near as poſſible to the part affected. Whether ſinapiſms and other *rubefacientia* act in a manner analogous to what has been ſuppoſed of bliſtering may be doubtful; but their effects in rheumatiſm and other inflammatory diſeaſes render it probable.

2. The other external means of taking off the ſpaſm of the extreme veſſels is warm bathing. This was frequently, and in different circumſtances, employed by the ancients; but has, till very lately, been neglected by modern phyſicians. As the heat of the bath ſtimulates the extreme veſſels, and, with the concurrence of moiſture, alſo relaxes them, it ſeems to be a ſafe ſtimulus, and well ſuited to take off the ſpaſm affecting theſe veſſels. It may be applied to the whole body by immerſion; but this is in many reſpects inconvenient. From extenſive experience it appears, that moſt of the purpoſes of warm bathing can be obtained by a fomentation of the legs and feet, if properly adminiſtered, and continued for a due length of time, not leſs than an hour. The marks of the good effects of ſuch a fomentation are, the patient's bearing it eaſily, its relieving delirium, and inducing ſleep.

164 Genus V. TYPHUS; the *Typhous Fever.*

Typhus, *Sauv.* gen. 82. *Sag.* 677.

165 I. Typhus mitior, or the *Slow Nervous Fever.* Sp. I. var. 1.

Febris maligna hectica convulſiva, ſive lues νευρωδης, *Willis*, de morb. convulſiv. cap. 8.

Febris peſtilens, *Fracaſtor.* de morb. contag. l. ii. cap. 4.

Febris peſtilens ſine charactere veneni, *Foreſt*, l. vi. obſ. 26.

Febris hectica peſtilens, *Foreſt*, l. vi. obſ. 32.

Febris nova ann. 1685, *Sydenham*, Sched. monitor.

Febris putrida nervoſa, *Wintringh.* Com. Noſolog. ad ann. 1720, 1721.

Febris lenta nervoſa, *Huxham* on fevers, chap. 8.

Febris contagioſa, *Lind* on fevers and infection, *paſſim.*

Typhus nervoſus, *Sauv.* ſp. 2.

Typhus comatoſus, *Sauv.* ſp. 3.

Tritæophya typhodes Mangeti, *Sauv.* ſp. 11. *Raym. Fort.* de febribus.

Deſcription. Of all the deſcriptions we have of the nervous fever, that of Dr Huxham is perhaps the beſt. According to him, the patient at firſt grows ſomewhat liſtleſs, and feels ſlight chills and ſhudders, with uncertain fluſhes of heat, and a kind of wearineſs all over, like what is felt after great fatigue. This is always attended with a ſort of heavineſs and dejection of ſpirit, and more or leſs of a load, pain, or giddineſs of the head; a nauſea and diſreliſh of every thing ſoon follows, without any conſiderable thirſt, but frequently with retching to vomit, though little but inſipid phlegm is brought up. Though a kind of lucid interval of ſeveral hours ſometimes intervenes, yet the ſymptoms return with aggravation, eſpecially towards night; the head grows more giddy or heavy; the heat greater; the pulſe quicker, but weak; with an oppreſſive kind of breathing. A great torpor, or obtuſe pain and coldneſs, affects the hinder part of the head frequently, and oftentimes a heavy pain is felt on the top all along the *coronary ſuture*; this, and that of the back part of the head, generally attend nervous fevers, and are commonly ſucceeded by ſome degree of a delirium. In this condition the patient often continues for five or ſix days, with a heavy, pale, ſunk countenance; ſeemingly not very ſick, and yet far from being well; reſtleſs, anxious, and commonly quite void of ſleep, though ſometimes very drowſy and heavy; but although he appears to thoſe about him actually to ſleep, he is utterly inſenſible of it. The pulſe during all this time is quick, weak, and unequal; ſometimes fluttering, and ſometimes for a few moments ſlow; nay, even intermitting, and then, with a ſudden fluſh in the face, immediately very quick, and perhaps ſoon after ſurpriſingly calm and equal; and thus alternately. The heats and chills are as uncertain and unequal; ſometimes a ſudden colour and glow ariſe in the cheeks, while the tip of the noſe and ears is cold, and the forehead at the ſame time in a cold dewy ſweat. Nay, it is very common, that a high colour and heat appear in the face, when the extremities are quite cold. The urine is commonly pale, and often limpid; frequently of a whey colour, or like vapid ſmall beer, in which there is either no manner of ſediment, or a kind of looſe matter like bran irregularly ſcattered up and down in it. The tongue at the beginning is ſeldom or never dry or diſcoloured, but ſometimes covered with a thin whitiſh mucus: at length, indeed, it often appears very dry, red, and chapped, or of the colour of pomegranate rind; but this chiefly at the cloſe of the diſeaſe: yet, however dry the tongue and lips ſeem, the patient ſeldom complains of thirſt, though ſometimes of a heat in the tongue. About the ſeventh or eighth day, the giddineſs,

giddineſs, pain, or heavineſs of the head become much greater, with a conſtant noiſe in it, or *tinnitus aurium;* which is very diſturbing to the ſick, and frequently brings on a delirium. The load on the præcordia, anxiety and faintneſs, grow much more urgent; and patients often fall into an actual deliquium, eſpecially if they attempt to ſit up; cold ſweats ſuddenly come out on the forehead, and on the backs of the hands (though at the ſame time there be too much heat in the cheeks and palms), and as ſuddenly go off. If the urine now grow more pale and limpid, a delirium is certainly to be expected, with univerſal tremors and *ſubſultus tendinum;* the delirium is ſeldom violent, but as it were a confuſion of thought and action, muttering continually and faltering in their ſpeech. Sometimes they awake only in a hurry and confuſion, and preſently recollect themſelves, but forthwith fall into a muttering dozy ſtate again. The tongue grows often very dry at the height, eſpecially in its middle part, with a yellowiſh liſt on each ſide, and trembles greatly when the ſick attempts to put it out. Frequently profuſe ſweats pour forth all at once, about the ninth, tenth, or eleventh day, commonly coldiſh and clammy on the extremities; oftentimes very thin ſtools are diſcharged, and then nature ſinks apace; the extremities grow cold, the nails pale or livid; the pulſe may be ſaid to tremble and flutter, rather than to beat, the vibrations being ſo exceedingly weak and quick that they can ſcarce be diſtinguiſhed; though ſometimes they creep on ſurpriſingly ſlow, and very frequently intermit. The ſick become quite inſenſible and ſtupid, ſcarce affected with the loudeſt noiſe or the ſtrongeſt light; though, at the beginning, ſtrangely ſuſceptible of the impreſſions of either. The delirium now ends in a profound coma, and that ſoon in death. The ſtools, urine, and tears, run off involuntarily, and denounce a ſpeedy diſſolution, as the tremblings and twitchings of the nerves and tendons are preludes to a general convulſion, which at once ſnaps the thread of life. In one or other of theſe ways are the ſick carried off, after having languiſhed for 14, 18, or 20 days; nay, ſometimes much longer. Moſt patients grow deaf and ſtupid towards the end of this diſeaſe (ſome extremely deaf), though too quick and apprehenſive at the beginning; inſomuch that the leaſt noiſe or light greatly offended them. Many from their immoderate fears ſeem to hurry themſelves out of life, where little danger is apparent at the beginning: nay, ſome will not allow themſelves to ſleep, from a vain fear of dozing quite away; and others from the vaſt hurry, anxiety, and confuſion of which they are ſenſible either during ſleep or at their waking.

Cauſes of, and perſons ſubject to, this diſorder. The nervous fever is moſt frequently the conſequence of contagion. It moſt commonly attacks perſons of weak nerves, a lax habit of body, and a poor thin blood; thoſe who have ſuffered great evacuations, a long dejection of ſpirits, immoderate watchings, ſtudies, fatigue, &c.; alſo thoſe who have uſed much crude unwholeſome food, vapid impure drinks, or who have been confined long in damp foul air; who have broken the vigour of their conſtitutions by ſalivations, too frequent purging, immoderate venery, &c. Hence we ſee how the diſeaſe is connected with an extreme debility of the nervous ſyſtem; for when people are prepared for this fever by having their nerves already weakened, the contagious particles immediately attack the nervous ſyſtem, without ſo much affecting the ſtate of the blood or juices, though the latter are greatly affected in the putrid malignant fevers.

Prognoſis. In nervous fevers, the prognoſis is very much the ſame with that of the putrid malignant kind. And although death be not ſo frequent as in that modification of fever, yet it may juſtly be conſidered as a very fatal diſeaſe.

Cure. As this fever is produced by contagion affecting the nervous ſyſtem of a perſon already debilitated, and thus producing weakneſs in an extreme degree, we have now occaſion to conſider Dr Cullen's *two indications* of cure omitted under the *Synocha;* namely, to remove the cauſe and obviate the effects of debility, and to correct the putreſcent tendency of the fluids; for though, in the beginning of nervous fevers, the tendency to putrefaction be not remarkable, it becomes exceedingly great towards their concluſion.

[1.] In anſwering the firſt indication, Dr Cullen obſerves, that moſt of the ſedative powers inducing debility ceaſe to act ſoon after they have been firſt applied; and therefore the removing them is not an object of the preſent indication. There is only one which may be ſuppoſed to continue to act for a long time, and that is the contagion applied; but we know nothing in the nature of contagion that can lead us to any meaſures for removing or correcting it. We know only its effects as a ſedative power inducing debility, or as a ferment inducing a tendency to putrefaction in the fluids, the former of which at preſent falls under our conſideration.—The debility induced in fevers by contagion, or other cauſes, appears eſpecially in the weaker energy of the brain; but in what this conſiſts, or how it may be reſtored, we do not well know; but as nature, ſeemingly for this purpoſe, excites the motion of the heart and arteries, we muſt aſcribe the continuance of the debility to the weaker reaction of the ſanguiferous ſyſtem: the means, therefore, which we employ for obviating debility, are immediately directed to ſupport and increaſe the action of the heart and arteries; and the remedies employed are tonics or ſtimulants.

In contagious diſeaſes we know, both from the effects which appear, and from diſſections, that the tone of the heart and arteries is conſiderably diminiſhed; and that tonic remedies are therefore properly indicated. We are to conſider theſe remedies as of two kinds; 1. The power of cold; 2. That of tonic medicines.

The power of cold as a tonic in fevers may be employed in two ways: either as thrown into the ſtomach, or as applied to the ſurface of the body. As we have already obſerved that the power of cold may be communicated from any one part to every other part of the ſyſtem, ſo it will be readily allowed that the ſtomach is a part as fit as any other for this communication, and that cold drink taken into the ſtomach may prove an uſeful tonic in fevers. This the experience of all ages has confirmed; but at the ſame time it has been frequently obſerved, that, in certain circumſtances, cold drink taken into the ſtomach has proved very hurtful; and therefore that its uſe in fevers requires ſome limitations.

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tations. What thefe limitations fhould be, and what are all the circumftances which may forbid the ufe of cold drink, it is difficult to determine; but it feems clearly forbidden in all cafes where a phlogiftic diathefis prevails in the fyftem, and more efpecially when there are topical affections of an inflammatory nature.

The other method of employing cold as a tonic, is by applying it to the furface of the body, as a refrigerant power fit to moderate the violence of reaction; but probably it may here alfo be confidered properly as a tonic, and ufeful in cafes of debility.—Not only cool air, but cold water alfo may be applied to the furface of the body as a tonic. The ancients frequently applied it with advantage to particular parts as a tonic; but it is a difcovery of modern times, that, in the cafe of putrid fevers attended with much debility, the body may be wafhed all over with cold water. This was firft practifed at Breflaw in Silefia, as appears from a differtation under the title of *Epidemia Verna, quæ Wratiflaviam anno* 1737 *afflixit*, to be found in the *Acta Nat. Curiof.* vol. x. And from other writers it appears, that the practice has paffed into fome of the neighbouring countries. But in Britain the ufe of cold water externally applied has of late been more extenfively introduced than into any other country of Europe. For this we are chiefly indebted to the late ingenious Dr Currie of Liverpool. He has recommended the dafhing cold water over the whole furface of the body, as a means not only of obviating heat, delirium, and other fymptoms moft urgent; but of putting an immediate ftop to the difeafe. And there can be no doubt that the practice has often been attended with the moft falutary confequences. But it is by no means fo generally advantageous as Dr Currie and fome others are inclined to believe. It is in but very rare inftances that an artificial termination of fever can thus be obtained; and even as obviating fymptoms, it is not unfrequently attended with bad confequences. It can never be employed with fafety unlefs where the heat is very urgent. And perhaps all the advantages of cold immerfion may be obtained merely from cold wafhing, a practice now very common in Britain.

The medicines which have been employed in fevers as tonics are various. If the acetite of lead hath been found ufeful, it is probably as a tonic rather than as a refrigerant; and the *ens veneris*, or other preparations of iron which have been employed, can act as tonics only. The preparations of copper, from their effects in epilepfy, are prefumed to poffefs a tonic power; but whether their ufe in fevers be founded on their tonic or emetic powers, is uncertain. And upon the whole there may no doubt occur fome inftances of fevers being cured by tonics taken from the foffil kingdom; but the vegetable tonics are the moft efficacious, and among thefe the cinchona certainly holds the firft place.

The cinchona has commonly been confidered as a fpecific, or a remedy of which the operation was not underftood. We muft obferve, however, that, as in many cafes the effects of the bark are perceived foon after its being taken into the ftomach, and before it can poffibly be conveyed to the mafs of blood, we may conclude, that its effects do not arife from its operating on the fluids; and muft therefore depend upon its acting on the nerves of the ftomach, and being thereby communicated to the reft of the nervous fyftem. This operation feems to be a tonic power, the bark being a remedy in many cafes of debility, particularly in gangrene; and if its operation may be explained from its poffeffing a tonic power, we may eafily perceive why it is improper when a phlogiftic diathefis prevails; and from the fame view we can afcertain in what cafes of continued fever it may be admitted. Thefe cafes are either where confiderable remiffions have appeared, when it may be employed to prevent the return of exacerbations, on the fame footing as it is ufed in intermitting fevers; or in the advanced ftate of fevers, when all fufpicion of an inflammatory condition is removed, and a general debility prevails in the fyftem; and its being then employed is fufficiently agreeable to the prefent practice.

Another fet of medicines to be employed for obviating debility and its effects, are the direct ftimulants. Thefe, in fome meafure, increafe the tone of the moving fibres; but are different from the tonics, as they more directly excite and increafe the action of the heart and arteries. This mode of operation renders their ufe ambiguous; and when an inflammatory diathefis is prefent, the effects of the ftimulants may be very hurtful; but it is ftill probable, that in the advanced ftate of thefe fevers, when debility prevails, they may be ufeful.

Of all the ftimulants which may be properly employed, wine feems to be the moft eligible. It has the advantage of being grateful to the palate and ftomach, and of having its ftimulant parts fo much diluted, that it can be conveniently given in fmall dofes; and therefore it may be employed with fufficient fafety.—It may be fufpected that wine has an operation analogous to that of opium; and on good grounds. But we can diftinctly remark its ftimulant power only; which renders its effects in the phrenetic delirium manifeftly hurtful; and in the mild delirium depending on debility, as remarkably ufeful.

[2.] We muft now proceed to the other indication of cure, namely, to correct or obviate the tendency in the fluids to putrefaction. This may be done, 1. By avoiding any new application of putrid or putrefcent matter. 2. By evacuating the putrid or putrefcent matter already prefent in the body. 3. By correcting the putrid or putrefcent matter remaining in the body by diluents and antifeptics. 4. By fupporting the tone of the veffels, and thereby refifting further putrefaction, or obviating its effects. 5. By moderating the violence of reaction, confidered as a means of increafing putrefaction.

The further application of putrid or putrefcent matter may be avoided, 1. By removing the patient from places filled with corrupted air. 2. By preventing the accumulation of the patient's own effluvia, by a conftant ventilation, and by a frequent change of bedclothes and body linen. 3. By the careful and fpeedy removal of all excremental matters from the patient's chamber. 4. By avoiding animal food.

The putrid or putrefcent matter already prefent in the body, may be evacuated partly by frequent evacuations of the contents of the inteftines; and more effectually ftill by fupporting the excretions of perfpiration

ration and urine by the plentiful ufe of diluents. That which remains in the body may be rendered more mild and innocent by the ufe of diluents, or may be corrected by the ufe of antifeptics. Thefe laft are of many and various kinds; but which of them are conveniently applicable, or more particularly fuited to the cafe of fevers, is not well afcertained. Thofe moft certainly applicable and ufeful are acefcent aliments, particularly fruits, acids of all kinds, and neutral falts.

The progrefs of putrefaction may be confiderably retarded, and its effects obviated, by fupporting the tone of the veffels; and this may be done by tonic medicines, of which the chief are cold, and the Peruvian bark, as already mentioned. The violence of reaction increafing the tendency to putrefaction, may be moderated by the means already mentioned under *Synocha*.

Thefe are the proper indications to be obferved in the cure of the flow nervous fever; and they are chiefly fulfilled by cleanlinefs, cool air, and diluents; which, perhaps upon the whole are more ufeful in fevers, than all other practices put together. Dr Huxham obferves, that evacuations (efpecially bleeding), are improper even at the beginning. Even a common purgative given at this time hath been followed by furprifing languors, fyncope, and a train of other ill fymptoms. It may, however, fometimes be neceffary to cleanfe the ftomach and primæ viæ by a gentle emetic, or a mild laxative. Indeed, where naufea, ficknefs and load at ftomach are urgent, as is frequently the cafe in the beginning of this fever, a vomit is neceffary. Clyfters of milk, fugar, and falt, may be injected with fafety and advantage every fecond or third day, if nature wants to be prompted to ftool. The temperate, cordial, diaphoretic medicines, are certainly, according to our author, moft proper in thefe fevers; and a well-regulated, fupporting, diluting diet is neceffary. The latter of itfelf, judicioufly managed, will go a great way in the cure, efpecially if affifted by well-timed and well-applied blifters, and a due care to keep the patient as quiet as poffible both in body and mind. But it fhould be noted, that ftrong opiates are commonly very pernicious, however much the want of fleep and reftleffnefs may feem to demand them. Mild diaphoretics, fuch as neutral draughts or elixir paregoricum, have much better effects; which, by raifing a gentle eafy fweat, or at leaft a plentiful perfpiration, calm the hurry of the fpirits, and a refrefhing fleep enfues. Where the confufion and dejection of fpirits are very confiderable, blifters have been advifed to be applied to the neck, occiput, or behind the ears; and during all this a free ufe of thin wine whey, fome pleafant ptifan or gruel, with a little pure wine, muft be directed. Indeed the patients, in this cafe fhould drink frequently: though fuch quantities may not be neceffary as in the ardent or even putrid malignant fevers; yet they fhould be fufficient to carry on the work of dilution, fupport the fweats, and fupply the blood with frefh and wholefome fluids, in place of that noxious matter which is continually paffing off. In this view alfo a thin chicken-broth is of fervice, both as food and phyfic, efpecially towards the decline of the difeafe; and for the fame reafon thin jellies of hartfhorn, fago, and panada, are ufeful, adding a little wine to them, and the juice of orange or lemon.

It is obfervable, that the fick are never fo eafy as when they are in a gentle fweat; for this foon removes the hurry of fpirits, exacerbations of heat, &c. But profufe fweats fhould never be encouraged, much lefs induced, by very ftrong heating medicines, efpecially in the beginning or advance of the fever; for they too much exhauft the vital powers, and are followed by a vaft dejection of fpirits, tremors, ftartings of the tendons, and fometimes end in rigors, cold clammy fweats, fyncope, or a comatofe difpofition. Sometimes irregular partial heats and flufhes fucceed, with great anxiety, reftleffnefs, delirium, difficulty of breathing, and a vaft load and oppreffion in the præcordia, fo as to incline the lefs cautious obferver to think there may be fomething pneumonic in it; but even here we muft beware of bleeding, as the pulfe will be found very fmall and unequal, though very quick. Nor is bleeding contraindicated only by the weaknefs and fluttering of the pulfe, but alfo by the pale, limpid, and watery urine which is commonly attendant. Thefe fymptoms denote the load, anxiety, and oppreffion on the præcordia to proceed from an affection of the nervous fyftem, and not from a pneumonic obftruction or inflammation. The breathing in this cafe, though thick and laborious, is not hot, but a kind of fighing or fobbing refpiration, nor is there often any kind of cough concomitant; fo that it has been conjectured to proceed from fome fpafm on the vitals. Here therefore the nervous cordial medicines are indicated, and blifters to the thighs, legs, or arms.

The above-mentioned difficulty of breathing, anxiety, and oppreffion, many times precede a miliary eruption, which often appears on the feventh, ninth, or eleventh day of the fever, and fometimes later. Indeed great anxiety and oppreffion on the præcordia always precede puftular eruptions of any kind in all forts of fevers. This eruption fhould be promoted by foft eafy cordials and proper diluents; to which fhould be fometimes added fome gentle aromatics. Thefe tend to calm the univerfal uneafinefs commonly complained of, and alfo very effectually promote a diaphorefis, with which the miliary eruptions freely and eafily advance. But however advantageous thefe commonly are, profufe fweats are feldom or never fo, even though attended with a very large eruption. Two or three crops of thefe miliary puftules have been known to fucceed one another, following profufe fweats, not only without advantage, but with great detriment to the patients, as they were thereby reduced to an extreme degree of weaknefs; fo that they may juftly be reckoned fymptomatic rather than any thing elfe, and the confequent eruption is often merely the fymptom of a fymptom.

In thefe profufe colliquative fweatings a little generous red wine (diluted fomewhat, if neceffary) may be given with the greateft advantage; as it prefently moderates the fweats, fupports the patient, and keeps up the miliary papulæ if they happen at attend. Towards the decline of the fever alfo, where the fweats are abundant and weakening, fmall dofes of the tincture of cinchona with faffron and fnakeroot may be given with the greateft advantage, frequently interpofing a dofe of rhubarb to carry off the putrid colluvies in the firft paffages; which withal makes the remiffions or intermiffions that often happen in the decline of nervous

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fevers more diſtinct and manifeſt, and gives a fairer opportunity of throwing in the bark; for in the proper exhibition of this medicine we are to place our chief hope of curing both the nervous and putrid malignant fevers.

166 II. Typhus gravior, or the *putrid*, *peſtilential*, or *malignant* FEVER. Sp. I. var. 2.

Febris peſtilens, *P. Sal. Diverſ.* de febre peſtilenti.

Febris peſtilens Ægyptiorum, *Alpin.* de med. Ægypt. l. i. cap. 14.

Typhus Ægyptiacus, *Sauv.* ſp. 6.

Febris peſtilens maligna, *Sennert.* de febribus, l. iv. cap. 10.

Febris maligna peſtilens, *River*, l. xvii. ſect. iii. cap. 1.

Febris peſtilens maligna, ann. 1643, *Willis*, de febribus, cap. 14.

Typhus carcerum, *Sauv.* ſp. 1.

Febris nautica peſtilentialis, *Huxham* de aëre ad. ann. 1740.

Miliaris nautica, *Sauv.* ſp. g.

Febris putrida contagioſa in carceribus genita, *Huxham* de aëre ad ann. 1742.

Miliaris purpurata, *Sauv.* ſp. h.

Febris carcerum et noſocomiorum. *Pringle*, Diſeaſes of the army, p. 294. *Van Swieten*, Maladies des armés, p. 136.

Typhus caſtrenſis, *Sauv.* ſp. 5.

Febris caſtrenſis, quam vulgò cephalalgiam epidemicam vocant, *Henr. Maii* et *A. Ph. Koph.* Diſſ. apud *Hallerum*, tom. v.

Febris Hungarica ſive caſtrenſis, *Juncker*, 74. et *plurium auctorum*.

Febris caſtrenſis Gallorum in Bohemiâ, ann. 1742, *Scrinci.* Diſſ. apud *Haller.* tom v.

Febris petechialis, *Sennert.* l. iv. cap. 13. *River.* prax. l. xvii. ſect. iii. cap. 1. *Hoffm.* ii. p. 84. *Juncker*, 73. *Huxham* on fevers, chap. 8. *Ludwig.* Inſt. med. clin. N° 146. *Schreiber* von erkentneſs, und cur der Krank heiten. p. 126. *Monro*, Diſeaſes of military hoſpitals, p. 1.

Febris catarrhalis maligna petechizans, *Juncker*, 72. *Hoffm.* ii. 75. *Eller* de cogn. et cur. morb. ſect. vi.

Febris quæ lenticulas, puncticula, aut peticulas vocant, *Fracaſtorius* de morb. contag. lib. ii. cap. 6.

Febris peticularis Tridenti, ann. 1591. *Roboretus* de febr. peticul.

Febris petechialis epidemica Coloniæ, ann. 1672. *Donckers*, Idia febris petechialis.

Febris petechialis epidemica Poſonii, 1683, *C. F. Loeu* in App. ad A. N. C. vol. ii.

Febris petechialis epidemica Mutinæ, 1692. *Ramazzini.* Conſt. Mutinenſis, oper. p. 177.

Febris maligna petechizans, ann. 1698. *Hoffm.* ii. p. 80.

Febris petechialis Wratiſlaviæ, ann. 1699. *Helwich*, Ephem. Germ. D. III. A. VII. et VIII. obſ. 132. p. 616.

Febris epidemica Lipſiæ, 1718. *M. Adolph.* A. N. C. III. obſ. 131. p. 296.

Febris endemica et epidemica Corcagienſis, ann. 1708, 1718, et ſeq. *Rogers*, Eſſay on Epidemic diſeaſes.

Typhus.

Febris continua epidemica Corcagienſis, ann. 1719. et ſeq. *M. O'Connel*, Obſ. de morbis.

Febris petechialis epidemica Cremonæ, 1734. *Valcharenghi* Med. ration. ſect. 3.

Febris petechizans Petropoli, 1735. *Weitbrecht.* Diſſ. apud Haller. tom. v.

Febris petechialis, ann. 1740, 1741, in Haſſia, *Ritter.* A. N. C. vol. vii. obſ. 4.

Febris maligna petechialis Rintelli, 1741. *Furſtenau*, A. N. C. vol. vii. obſ. 5.

Febris petechialis epidemica Sileſiæ, 1741, et ſeq. *Bandhorſt.* Diſſ. apud *Haller.* tom. v.

Febris petechialis epidemica Viennæ, 1757. *Haſenohrl.* Hiſt. med. cap. 2.

Febris petechialis epidemica Lipſiæ, 1757. *Ludwig.* Adverſar. tom. i. pars 1.

Febris petechialis epidemica variis Germaniæ locis ab ann. 1755 ad 1761. *Strack* de morbo cum petechiis.

Deſcription. This diſeaſe has been ſuppoſed to differ from the former in degree only; and there are many circumſtances which would lead us to conclude, that both frequently originate from a contagion preciſely of the ſame nature. In the ſame manner we ſee, during different ſeaſons, and in different circumſtances, various degrees of malignity in ſmallpox. Though every inſtance of the diſeaſe depends on the introduction of a peculiar and ſpecific contagion into the body, yet this contagion in particular epidemics evidently poſſeſſes peculiar malignancy. The ſame is probably the caſe with the typhoid fever: But whether this obſervation be well founded or not, there cannot be a doubt that the typhus gravior or putrid fever is a diſeaſe of the moſt dangerous nature, as, beſides the extreme debility of the nervous ſyſtem, there is a rapid tendency of the fluids to putrefaction, which ſometimes cuts off the patient in a few days, nay, in the warm climates, in 12 or 14 hours; or if the patient recovers, he is for a long time, even in this country, in an exceedingly weak ſtate, and requires many weeks to recover his former health.

The putrid fevers, according to Huxham, make their attack with much more violence than the ſlow nervous ones; the rigors are ſometimes very great, though ſometimes ſcarce felt; the heats much ſharper and permanent; yet, at firſt, ſudden, tranſient, and remittent: the pulſe more tenſe and hard, but commonly quick and ſmall; though ſometimes ſlow, and ſeemingly regular for a time, and then fluttering and unequal. The headach, nauſea, and vomiting, are much more conſiderable even from the beginning. Sometimes a ſevere fixed pain is felt in one or both temples, or over one or both eyebrows; frequently in the bottom of the orbits of the eyes. The eyes always appear very dull, heavy, ſometimes yellowiſh, and very often a little inflamed. The countenance ſeems bloated, and more dead-coloured than uſual. Commonly the temporal arteries throb much, and a tinnitus aurium is very troubleſome: a ſtrong vibration alſo of the carotid arteries frequently takes place in the advance of the fever, though the pulſe at the wriſt may be ſmall, nay even ſlow: this is a certain ſign of an impending delirium, Febres. rium, and generally proceeds from ſome conſiderable obſtructions in the brain.

The proſtration of ſpirits, weakneſs, and faintneſs, are often ſurpriſingly great and ſudden, though no inordinate evacuation happens; and this too ſometimes when the pulſe ſeems tolerably ſtrong. The reſpiration is moſt commonly laborious, and interrupted with a kind of ſighing or ſobbing, and the breath is hot and offenſive.

Few or none of theſe fevers are without pain in the back and loins; always an univerſal wearineſs or ſoreneſs is felt, and often much pain in the limbs. Sometimes a great heat, load, and pain, affect the pit of the ſtomach, with perpetual vomiting of porraceous or black bile, and a moſt troubleſome ſingultus; the matter diſcharged is frequently of a very nauſeous ſmell. The tongue, though only white at the beginning, grows daily more dark and dry; ſometimes of a ſhining livid colour, with a kind of dark bubble at top; ſometimes exceeding black; and ſo continues for many days together; nor is the tinct to be got off many times for ſeveral days, even after a favourable criſis: at the height of the diſeaſe, it generally becomes very dry, ſtiff, and black, or of a dark pomegranate colour. Hence the ſpeech is very inarticulate, and ſcarce intelligible. The thirſt in the increaſe of the fever is commonly very great, ſometimes unquenchable; and yet no kind of drink pleaſes, but all ſeem bitter and mawkiſh; at other times, however, no thirſt is complained of, though the mouth and tongue are exceedingly foul and dry; this is always a dangerous ſymptom, and ends in a frenzy or coma. The lips and teeth, eſpecially near the height, are covered with a very black tenacious ſordes. At the commencement of the fever, the urine is often crude, pale, and vapid, but grows much higher coloured in the advance, and frequently reſembles a ſtrong lixivium, or citrine urine, tinged with a ſmall quantity of blood; it is without the leaſt ſediment or cloud, and ſo continues for many days together: by degrees it grows darker, like dead ſtrong high-coloured beer, and ſmells very rank and offenſive. In petechial fevers, the urine has often been ſeen almoſt black and very *fetid*. The ſtools, eſpecially near the height, or in the decline of the fever, are for the moſt part intolerably fetid, green, livid, or black, frequently with ſevere gripes and blood. When they are more yellow or brown, the leſs is the danger; but the higheſt when they run off inſenſibly, whatever their colour may be. It is likewiſe a very bad ſymptom when the belly continues tenſe, ſwollen, and hard, after profuſe ſtools; for this is generally the conſequence of an inflammation or mortification of the inteſtines. A gentle diarrhœa is often very beneficial, and ſometimes ſeems to be the only way which nature takes to carry off the morbific matter.

Sometimes black, livid, dun, or greeniſh ſpots appear on different parts of the ſkin, particularly on the breaſt, which always indicate a high degree of malignity; but the more florid the ſpots are, the leſs danger is to be feared. It is alſo a good ſign when the black or violet petechiæ become of a brighter colour. The large, black, or livid ſpots, are almoſt always attended with profuſe hæmorrhagies; and the ſmall, duſky, brown ſpots, like freckles, are not much leſs dangerous than the livid or black; though they are ſeldom accompanied with fluxes of blood: exceſſively profuſe, cold, clammy ſweats are often concomitant, by which alſo they ſometimes vaniſh, though without any advantage to the patient. The eruption of the petechiæ is uncertain; ſometimes they appear on the fourth or fifth day, though ſometimes not till the eleventh, or even later. The *vibices*, or large dark, blue, or greeniſh marks, ſeldom appear till very near the fatal period. Frequently alſo we meet with an efflorеſcence like the meaſles in malignant fevers, but of a much more dull and livid hue; in which the ſkin, eſpecially on the breaſt, appears as it were marbled or variegated. This in general is an ill ſymptom, and is often attended with fatal conſequences.

Typhus. Sometimes about the 11th or 14th day, on the occurrence of profuſe ſweats, the petechiæ diſappear, and vaſt quantities of white miliary puſtules break out. This is ſeldom found of any conſiderable advantage; but an itching, ſmarting, red raſh, commonly gives great relief; and ſo do the large, fretting, watery bladders, which many times riſe upon the back, breaſt, ſhoulders, &c. A ſcabby eruption likewiſe about the lips and noſe is one of the ſalutary ſymptoms; and the more hot and angry it is, ſo much the better. But of much more uncertain and dangerous event are the brown-coloured aphthæ; nor are thoſe that are exceeding white and thick, like lard, of a very promiſing aſpect. They are ſoon ſucceeded by great difficulty of ſwallowing, pain and ulceration of the fauces, œſophagus, &c. and with an inceſſant ſingultus: the whole *primæ viæ* become at laſt affected; a bloody dyſentery comes on, followed by a ſphacelation of the inteſtines; as is evident from the black, ſanious, and bloody ſtools, extremely fetid and infectious. Vibices, or large, black, and bluiſh marks reſembling bruiſes, are frequently ſeen towards the cloſe of the fever; and, when attended with lividity and coldneſs of the extremities, are certain tokens of approaching death. In ſome caſes, the blackneſs has been known to reach almoſt to the elbows, and the hands have been dead-cold for a day or two before the death of the patient.

Such are the general appearances of the putrid malignant fever in this country, among thoſe who enjoy a free air, and are not crowded together, or expoſed to the cauſes of infection: but, in jails, hoſpitals, or other places where the ſick are crowded, and in ſome meaſure deprived of the benefit of the free air, the ſymptoms are, if poſſible, more terrible. Sir John Pringle, who had many opportunities of obſerving it, tells us, that the jail or hoſpital fever, in the beginning, is not eaſy to be diſtinguiſhed from a common fever. The firſt ſymptoms are ſlight interchanges of heat and cold, a trembling of the hands, ſometimes a ſenſe of numbneſs in the arms, weakneſs of the limbs, loſs of appetite; and the diſorder increaſing towards night, the body grows hot, the ſleep is interrupted, and not refreſhing. With theſe ſymptoms, for the moſt part, there is ſome pain or confuſion in the head; the pulſe at firſt is a little quicker than natural, and the patients find themſelves too much indiſpoſed to go about buſineſs, though too well to be wholly confined. When the fever advances, the above-mentioned ſymptoms are in a higher degree; and in particular the patient

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patient complains of a laſſitude, nauſea, pains in his back, a more conſtant pain and confuſion in his head, attended with an uncommon dejection of ſpirits. At this time the pulſe is never ſunk, but beats quick, and often varies in the ſame day both as to ſtrength and fulneſs. It is little affected by bleeding, if a moderate quantity of blood be taken away; but if the evacuation be large, and eſpecially if it be repeated, to anſwer a falſe indication of inflammation, the pulſe, increaſing in frequency, is apt to ſink in force, and often irrecoverably, whilſt the patient becomes delirious. But we muſt obſerve, that, in every caſe, independent of evacuations, the pulſe ſooner or later ſinks, and then gives certain evidence of the nature of the diſeaſe. The appearance of the blood is various; for though it be commonly little altered, yet ſometimes it will be ſizy, not only on the firſt attack, but after the fever is formed. The worſt appearance is when the craſſamentum is diſſolved; though this does not happen till the advanced ſtate of the fever: indeed this ſeems not eaſy to be aſcertained, as blood has been ſo ſeldom taken away at that time. The urine is alſo various. Sometimes it is of a reddiſh or flame colour, which it preſerves a long time; but it is oftener pale, and changes from time to time in colour as well as crudity, being ſometimes clear, ſometimes clouded: towards the end, upon a favourable criſis, it becomes thick, but does not always depoſit a ſediment. If the ſick lie warm, and have had no preceding flux, the belly is generally bound; but when they lie cold, as they often do in field-hoſpitals, the pores of the ſkin being ſhut, a diarrhœa is a common ſymptom, but is not critical. In the worſt caſes, a flux appears in the laſt ſtage; then the ſtools are involuntary, colliquative, ichorous, or bloody, and have a cadaverous ſmell; the effects of a mortification of the bowels, and the ſign of approaching death. When the hoſpitals are filled with dyſenteric patients, ſome of the nurſes will be infected with the flux only, and others with this fever, ending in theſe bloody and gangrenous ſtools.

In the beginning the heat is moderate; and even in the advanced ſtate, on firſt touching the ſkin, it ſeems inconſiderable: but upon feeling the pulſe for ſome time, we are ſenſible of an uncommon heat (the *calor mordicans*, as it has been called), leaving an unpleaſant ſenſation on the fingers for a few minutes. A day or two before death, if care be not taken, the extremities become cold, and the pulſe is then hardly to be felt. The ſkin is generally dry and parched; though ſometimes there are longer or ſhorter ſweats, eſpecially in the beginning. Such as are produced by medicine are of no uſe, except on the firſt attack, at which time they will often remove the fever; and natural ſweats are never critical till the diſtemper begins to decline. Theſe laſt are rarely profuſe, but gentle, continued, and equally diffuſed over the body: ſometimes the diſeaſe will terminate by an almoſt imperceptible moiſture of the ſkin; the ſweats are uſually fetid, and offenſive even to the patient himſelf.

The tongue is commonly dry; and, without conſtant care of the nurſe, becomes hard and brown, with deep chops: but this ſymptom is common to moſt fevers. At other times, though rarely, the tongue is ſoft and moiſt to the laſt, but with a mixture of a greeniſh or yellowiſh colour. The thirſt is ſometimes great, but more frequently moderate. In the advanced ſtate, the breath is offenſive, and a blackiſh furring gathers about the roots of the teeth.

Some are never delirious, but all lie under a ſtupor or confuſion; few retain their ſenſes till death: many loſe them early, and from two cauſes; either from immoderate bleeding, or the premature uſe of warm and ſpirituous medicines. They rarely ſleep; and, unleſs delirious, have more of a dejected and thoughtful look than what is commonly ſeen in other fevers. The face is late in acquiring either a ghaſtly or a very morbid appearance; yet the eyes are always muddy, and generally the white is of a reddiſh caſt as if inflamed. The confuſion of head commonly riſes to a delirium, eſpecially at night; but, unleſs by an unſeaſonable hot regimen, it ſeldom turns to rage, or to thoſe high flights of imagination common in other fevers. When the delirium comes to that height, the face is fluſhed, the eyes red, the voice is quick, and the patient ſtruggles to get up. But when that ſymptom is owing to large evacuations, or only to the advanced ſtate of the diſeaſe, the face appears meagre; the eye-lids in ſlumbers are only half ſhut; and the voice, which is commonly low and ſlow, ſinks to a degree ſcarce to be heard. From the beginning there is generally a great dejection and failure of ſtrength. A tremor of the hands is more common than a ſtarting of the tendons; and if the ſubſultus occurs, it is in a leſſer degree than in many other fevers. In every ſtage of the diſeaſe, as the pulſe ſinks, the delirium and tremors increaſe; and in proportion as the pulſe riſes, the head and ſpirits are relieved. Sometimes in the beginning, but for the moſt part in the advanced ſtate, the patient grows dull of hearing, and at laſt almoſt deaf. When the fever is protracted, with a ſlow and low voice, the ſick have a particular craving for ſomething cordial, and nothing is ſo cordial or ſo acceptable as wine. They long for no food, yet willingly take a little panada if wine be added. But ſuch as are delirious, with a quick voice, wild looks, a ſubſultus tendinum, or violent actions, though their pulſe be ſunk, yet bear neither hot medicines, wine, nor the common cordials.

Vomiting, and complaints of a load and ſickneſs at ſtomach, though uſual ſymptoms, are not eſſential to the diſeaſe; nor are pleuritic ſtitches, difficulty in breathing, or flying pains, to be referred ſo much to it as to the conſtitution of the patient, or to a preceding cold.

A petechial effloreſcence is a frequent, though not an inſeparable, attendant of this fever. It ſometimes appears of a brighter or paler red, at other times of a livid colour, but never riſes above the ſkin. The ſpots are ſmall; but generally ſo confluent, that at a little diſtance the ſkin appears only ſomewhat redder than ordinary, as if the colour was uniform; but upon a nearer inſpection interſtices are ſeen. For the moſt part this eruption is ſo little conſpicuous, that unleſs it be looked for attentively, it may eſcape notice. The ſpots appear thickeſt on the back and breaſt, leſs on the legs and arms, and Sir John Pringle never remembers to have ſeen any on the face. As to the time of their appearance, he agrees entirely with Dr Huxham. Theſe ſpots are never critical, nor are they reckoned among the mortal ſymptoms; but only concur with other ſigns to aſcertain the nature of the diſeaſe. The nearer they

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they approach to purple, the more they are to be dreaded. In a few cafes, inftead of fpots, purple ftreaks and blotches were obferved. Sometimes the petechiæ did not appear till after death; and there was one cafe in which, after bleeding, the petechiæ were feen only on the arm below the ligature, and nowhere elfe on the fkin.

The hofpital fever, though accounted one of the continued kind, yet has generally fome exacerbation at night, with a remiffion and often partial fweats in the day; and after a long continuance it is apt to change into a hectic, or an intermitting form. The length of the difeafe is uncertain. Sometimes it was terminated, either in death or recovery, in feven days after the patient took to his bed; but in the hofpitals it generally continued from 14 to 20, and fome died or recovered after four weeks. From the time of the finking of the pulfe until death or a favourable crifis, there is perhaps lefs change to be feen from day to day in this than in moft other fevers. When its courfe is long, it fometimes terminates in fuppurations of the parotid or axillary glands; and when thefe do not appear, it is probable that the fever is kept up by the formation of fome internal abfcefs. The parotid glands themfelves do not fuppurate, but only fome of the lymphatic glands that lie over them. Sir John Pringle obferved one inftance of a fwelling of this kind on both fides, without any previous indifpofition, when the perfon, not fufpecting the caufe, and applying difcutient cataplafms, was, upon the tumor fubfiding, feized with the hofpital-fever. Many patients after the crifis of this fever complain of a pain in the limbs and want of reft; and almoft all of them mention great weaknefs, confufion in their head, vertigo, and a noife in their ears.

Ten of the bodies of thofe who died of this diftemper in Houghton's regiment were opened. In fome, all the cavities were examined; in others, only the brain and the bowels. In fome of them, the brain appeared to be fuppurated. The firft of this kind Sir John Pringle met with at Ghent; but the man being brought into the hofpital from the barracks no earlier than two days before he died, he could only conjecture from the fymptoms and the imperfect accounts he had of him, that his death was owing to a fever of this kind, after lingering near a mouth in it. About three ounces of purulent matter were found in the ventricles of the brain, and the whole cortical and medullary fubftance was uncommonly flaccid and tender; nay, fome of the fame kind of matter was found in the fubftance of the upper part of the cerebellum: yet this perfon, with fome ftupor and deafnefs, had his fenfes till the night before he died; fo far, at leaft, that he anfwered diftinctly when roufed and fpoken to; but about that time the mufcles of his face began to be convulfed. Of two other inftances of men who undoubtedly died of this fever, in one the cerebrum was fuppurated, in the other the cerebellum. In the former cafe, the patient was under a ftupor, with deafnefs from the beginning; but was never delirious, nor altogether infenfible. His pulfe funk early; and about ten days before his death his head began to fwell, and continued very large till within two days before he died, when it fubfided a little. For feveral days before his end, he would tafte nothing but cold water, and during his illnefs he lay conftantly upon one fide. The head being opened, an abfcefs as large as an egg was found in the fubftance of the forepart of the right hemifphere of the brain, full of thin matter like whey. At that time five more, ill of the fame fever, had the like fwelling of their heads, but recovered. In the other cafe, the abfcefs in the cerebellum was about the fize of a fmall pigeon's egg, and contained alfo a thin ichorous matter; nor had this patient ever been fo thoroughly infenfible as not to anfwer reafonably when fpoken to. Two days before he died his urine turned pale.

Thefe fuppurations, however, were not conftant; for another who died about the fame time, and had been ill about the fame number of days with the like fymptoms, the pale water excepted, had no abfcefs either in the brain or cerebellum. Two were opened afterwards, in whom the cortical fubftance of the brain had an inflammatory appearance, but no fuppuration. In one of them the large inteftines were corrupted: that man went off with a loofenefs; and juft before he died, an ichorous matter was difcharged from his nofe. In the military hofpital at Ipfwich, one who unexpectedly died of this fever after having been feemingly in a fair way of recovery, had no fuppuration in his brain; but in another, who died after an abfcefs in both orbits, the brain was found flaccid, and about two ounces of a thin ferum in the ventricles.

Caufes of, and perfons fubject to, this diforder. The caufe of this fever, as well as that of the flow-nervous fever, is an infection or contagion from fome difeafed animal-body, or from corrupted vegetables; and therefore is very little, if at all, different from thofe peftilential diforders which have arifen after battles, where great numbers of dead bodies were allowed to lie above ground, and infect the air with their effluvia. This is confirmed by an obfervation of Foreftus, who was eyewitnefs to a diftemper of this kind (which indeed he calls a *plague*) owing to the fame caufe, attended with buboes and a high degree of contagion. The fame author alfo gives an account of a malignant fever breaking out at Egmont in North-Holland, occafioned by the rotting of a whale which had been left on the fhore. We have a like obfervation of a fever affecting the crew of a French fhip, by the putrefaction of fome cattle which they had killed on the ifland of Nevis in the Weft Indies. Thefe men were feized with a pain in their head and loins, great weaknefs, and a diforder of the ftomach, accompanied with fever. Some had carbuncles; and on others purple fpots appeared after death.

Galen affigns two caufes for peftilential fevers: 1. The great heat of the weather, when the humours happen to be in a more putrefcent ftate than ufual. 2. A putrid ftate of the air, arifing either from a multitude of dead bodies left unburied, as after a battle, or from the evaporation of corrupted lakes and marfhes.

One of the moft remarkable difeafes incident to an army is related by Diodorus, as breaking out among the Carthaginians at the fiege of Syracufe. That author not only relates fome of its moft diftinguifhing fymptoms, but reafons well about its caufe. He obferves, that pains in the back and eruptions (φλυκταιναι) were common; that fome had bloody ftools; that others were feized with a delirium, fo as to run about and beat all that came in their way; that the phyficians

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cians knew no cure; and that it was the more fatal as the sick were abandoned by every body on account of the contagion. As to the cause, the author takes notice of the multitude of people confined within a narrow compass; of the situation of the camp in low and wet ground; of the scorching heats in the middle of the day, succeeded by the cold and damp air from the marshes in the night-time; to these he adds, the putrid steams arising first from the marshes, and afterwards from the bodies of those who lay unburied.—This distemper seems to have been a compound of the marsh and pestilential fever.

Forestus remarks, that, from the putrefaction of the water only, the city of Delft, where he practised, was scarce ten years together free from the plague or some pestilential distemper. He adds, that the magistrates, upon his representation of the cause, erected a wind-mill for moving and refreshing the water. At that time Holland was much more subject to inundations and the stagnation of water than at present. In 1694, a fever broke out at Rochfort in France, which, on account of the uncommon symptoms and great mortality, was at first believed to be the plague. But M. Chirac, who was sent by the court to inquire into its nature, found the cause to arise from some marshes that had been made by an inundation of the sea; and observed, that the corrupted steams, which smelled like gun-powder, were carried to the town by the wind, which had long blown from that quarter. About two-thirds of those who were taken ill died. In such as were opened, the brain was found either inflamed or loaded with blood; the fibres of the body were uncommonly tender; and the bowels had either suppurated or were mortified.

It is needless to mention more instances of pestilential fevers being brought on by the steams of corrupted substances, whether animal or vegetable. In general it may be remarked, that the putrefaction of these substances in a dry air is more apt to bring on a fever of the continued form; but in a moist air has a greater tendency to produce remitting fevers. But it must also be observed, that, even in cases where the most malignant fevers prevail, all persons are not equally disposed to receive the infection, though equally exposed to it with others. Some, through mere vigour of body and mind, cannot be infected with the most contagious diseases; while, on the other hand, those whose bodies are debilitated by a former disease, by study, low diet, or want, or those who have laboured under any of the depressing passions of the mind for some time, seldom or never escape. Men, therefore, who have been weakened by accidents (as those who have undergone a mercurial salivation) are very apt to fall into this distemper. Those who are taken into crowded hospitals, ill of the smallpox, however good the sort may be, fall readily into this fever, and run a greater risk of dying of it than others. The second fever is attended with double danger, seeing the patient has been so much weakened by the first. A sure sign of the corruption of the air in an hospital is when many of the nurses fall sick.

Prognosis. In these fevers we cannot draw a prognostic from any symptom by itself; and perhaps all of them together are more fallible than in others. Generally the following are good: To have little delirium; the strength little impaired; turbid urine in the decline of the disease; and at that time a gentle sweat or moisture diffused over the body, or even the skin soft and the tongue moist; or to have some loose stools succeeded by a diaphoresis; the pulse to rise by wine or cordials, with an abatement of the stupor, tremor, and other affections of the brain. Deafness is rather a good sign. A sediment in the urine, without other changes for the better, is no sure sign of recovery; and some have recovered in whose urine there was no sediment.—The bad signs are, a subsultus tendinum; the eyes much inflamed and staring; the speech quick, and the sound of the voice altered; a high delirium; perpetual watchfulness; constant sickness at the stomach, and vomitings; frequent stools, with a sinking pulse, and the disorder of the head increased; coldness of the extremities, and a tremulous motion of the tongue. It is observed to be among the worst signs when the patient complains of blindness; when he swallows with difficulty, or cannot put out his tongue when desired to do it; when he can lie on his back only, and pulls up his knees; or when insensible he endeavours to uncover his breast, or makes frequent attempts to get out of bed without assigning any reason. If to any of these are added ichorous, cadaverous, and involuntary stools, it is a sign of a mortification of the bowels and approaching death. It will not seem strange to find most of these prognostics common to the advanced state of other fevers, when we consider, that from whatever cause fevers begin, by a long continuance the humours are corrupted, and the brain and nerves affected much in the same manner as in those which arise from infection.

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Prevention and cure. As distempers of the putrid kind never arise without an infection received from some quarter or other, the methods of prevention must evidently be reduced to two general heads. 1. To avoid receiving the infection into the body; and, 2. To put the body in such a situation as may enable it to resist the infection when received. On both these methods scarce any writer hath equalled Dr Lind of Haslar, whose opinions and directions therefore we shall give pretty fully.

As putrid diseases are very common and violent in the hot countries, it is very necessary for Europeans who visit these climates to be well informed, in the first place, of the signs of an unhealthy country, that they may be upon their guard as soon as they enter any foreign region. These signs are by this author enumerated as follows.

1. A sudden and great alteration in the air, at sunset, from intolerable heat to a chilling cold. This is perceived as soon as the sun is down, and is for the most part accompanied with a very heavy dew: it shows an unhealthy swampy soil, the nature of which is such, that no sooner the sun-beams are withdrawn, than the vapours emitted from it render the air damp, raw, and chilling, in the most sultry climates; so that even under the equator, in some unhealthy places, the night-air is very cold to an European constitution.

2. Thick noisome fogs, chiefly after sunset, arising from the valleys, and particularly from the mud, slime, or other impurities. In hot countries, the smell of these

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3. Numerous swarms of flies, gnats, and other insects which attend stagnated air and unhealthy places covered with wood.

4. When all butchers meat soon corrupts, and in a few hours becomes full of maggots; when metals are quickly corroded on being exposed to the air; and when a corpse becomes intolerably offensive in less than six hours; these are proofs of a close, hot, and unwholesome country. And in such places, during excessive heats and great calms, it is not altogether uncommon for Europeans, especially such as are of a gross habit of body, to be seized at once with the most alarming and fatal symptoms of what is called the *yellow fever*, without even any previous complaint of sickness or other symptoms of the disease. There has first been perceived an uneasy itching sensation, commonly in the legs; and upon pulling down the stockings, streams of thin dissolved blood followed, a ghastly yellow colour quickly diffused itself over the whole body, and the patient has been carried off in less than forty-eight hours.

5. A sort of sandy soil, commonly a small, loose, white sand, as that at Pensacola, Whydah, and the island of Bonavista, which is found by experience to be injurious to health. The pestiferous vapour arising, during the summer months and in the heat of the day, from such a sandy soil, is best characterized by its effects in the extensive deserts of Asia and Africa. It there constitutes what is called the *Samiel-wind*; a blast which, in the parched desert, proves instantly fatal both to man and beast; but when it passes over a soil well covered with grass and vegetables, has its effects greatly mitigated; it is, however, even then, productive of sickness: thus the southerly winds, while they blow from the deserts of Libya during the summer, at Algiers, Tunis, and Tripoli, produce an unhealthy season; and at Madras the winds, which, in the months of April and May, pass over a large tract of sand, are always hot, disagreeable, and unwholesome.

During these land-winds, sudden gusts of a more hot and suffocating nature are often observed to come from these sands once or twice, or even more frequently, in a day, which seem to be this vapour in a purer form. These gusts pass very quickly, and affect persons who happen to stand with their faces towards them in the same manner as the hot air which issues from a burning furnace, or from a heated oven, and obliges them immediately to turn away from it in order to recover breath. The effect of this hot suffocating blast or vapour on the human body, even when mitigated by passing through a moist atmosphere, is the same as that of intense cold; it shuts up every pore of the skin, and entirely stops the perspiration of such as are exposed to it. These blasts come only in the daytime, and always from the deserts. Water is the only known corrector or antidote against them: hence, coarse thick clothes, kept constantly wet, and hung up at the windows or doors, greatly mitigate their violence. A house so built as to have no windows or doors towards the deserts, is an excellent protection against their pernicious effects. The hot land-winds constantly blow at Madras and other places on the coast of Coromandel, at that season, from midnight till noon; the sea-breezes then begin, which relieve the difficulty in breathing, and the obstructed perspiration, which the former occasioned. Typhus.

That the heat of these land-winds, as also of the sudden gusts which accompany them, proceed from large tracts of sand heated by the sun, is evident from the increased heat and suffocating quality of those winds, in proportion as the day advances, and as the heat of the season is increased. The opposite winds, blowing from each side of the Balagate mountains, are a farther proof of this. These mountains, running from north to south, divide the hither Peninsula of India into two equal parts, and separate what is called the *Malabar* from the *Coromandel* coast. To the former they are very near, but at a great distance from the latter. The winds blowing from those hills are on the Malabar coast always remarkably cool; but on the coast of Coromandel, in the months of April, May, June, and July, are extremely hot and suffocating, as they pass over a large tract of intermediate sand, heated during those months by an almost vertical sun. Hence the Malabar coast is always covered with an agreeable verdure; whereas the Coromandel coast, during the continuance of these hot winds, seems a barren wilderness, nothing appearing green except the trees. On the contrary, the winds that pass over these sands, after being wet with the rains, are the coldest which blow at Madras. Bottles of liquor inclosed in bags of coarse cloth, kept constantly wet, and suspended in the shade, where those hot winds may have access to them, become as cold as if they had been immersed in a solution of nitre; an effect owing undoubtedly to the constant evaporation of water from the surface.

It is an observation of the natives on the coast of Coromandel, which is confirmed by the experience of many Europeans, that the longer the hot land-winds blow, the healthier are the ensuing months; these winds, as they express it, purifying the air. Are not the winds therefore the cause why the air on the coast of Coromandel, except during their continuance, is more healthy than in other parts of India where these winds do not blow? Does not this also suggest a very probable reason, why the plague in Egypt generally ceases in the beginning of June; the periodical hot winds which come from the deserts of Nubia and Ethiopia having then rendered the air of Egypt pure and wholesome? Many have ascribed that effect to the north winds; as the plague not only ceases when they blow, but all infected goods, household-furniture, and wearing apparel, are then said to become entirely free from the contagion: these, however, cannot be the cause, as the most destructive plague is abated in its violence, if not wholly eradicated, before they set in. With equal propriety we may reject the opinion that the overflowing of the Nile is productive of that salutary effect, as the plague generally ceases before the increase of that river is perceptible.

Thus the plague, the greatest calamity which can afflict mankind, seems to be destroyed by those hot winds, which are otherwise so pernicious to animal and vegetable life. And although, during the continuance of these winds, the most fruitful fields wear the

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the aſpect of a parched deſert, yet no ſooner the rains fall, but vegetation is reſtored, the plants revive, and a beautiful verdure is again ſpread over the face of the country.

Having thus given an account of the ſigns of an unhealthy country, Dr Lind next proceeds to mention ſuch employments as are particularly dangerous to Europeans on their firſt arrival. One of theſe is the cutting down of trees, ſhrubs, &c. or *clearing the ground*, as it is called. Of the unhealthineſs of this employment he gives two inſtances. At the concluſion of the late peace, the captain of a ſhip of war went on ſhore at the iſland of Dominica, with 12 of his men, to cut down the wood, and to clear a piece of ground which he intended to have purchaſed: but, in a few days, ſickneſs obliged him to deſiſt from this dangerous work; the captain and 11 of his men being ſeized with violent fevers, which terminated in obſtinate intermittents, and of which ſeveral died. The ſurvivors ſuffered ſo much in their conſtitutions, that, even after they came to England, the return of an eaſt-wind was apt to bring on a violent fit of the ague. The Ludlow-Caſtle, a ſhip of war of 40 guns, in a voyage to the coaſt of Guinea, alſo loſt 25 of her men at Sierra Leona, who were employed in cutting down wood for the ſhip. This is an occupation which has often proved deſtructive to Europeans in thoſe climates, and in which they ought never to be employed, eſpecially during the rainy ſeaſon; there being numberleſs inſtances of white perſons, when cutting down the woods at that ſeaſon, who have been taken ill in the morning, and dead before night.

Another evil, leſs known, and leſs ſuſpected, but no leſs dangerous, is the ſending Europeans in open boats after ſunſet, where the ſoil is ſwampy, or where there are great night-fogs. The ſingle duty alone of fetching freſh-killed butchers meat at night for the uſe of our ſhips companies in the Eaſt and Weſt Indies, has deſtroyed every year ſeveral thouſand ſeamen. In thoſe parts of the world, butchers meat muſt be brought on board at night immediately after it is killed, otherwiſe it will not be fit for uſe the next day; but a contract made with the natives to ſend it on board at that time, which might be done for a trifling ſum, would be the means of preſerving many uſeful lives. During the ſickly ſeaſon at Batavia, a boat belonging to the Medway, which attended on ſhore every night, was three times ſucceſſively manned, not one having ſurvived that ſervice. They were all taken ill in the night, when on ſhore, or when returning on board; ſo that at length the officers were obliged to employ none but the natives on that buſineſs. Great numbers of men have periſhed from being employed in this manner at Bengal, where the European ſhips often anchor in the moſt unhealthy ſpots of the river; and even when the great night-fogs ariſe, after the rainy ſeaſon, the men are often obliged to perform ſuch night-ſervices in boats. Now ſince it is ſo dangerous for Europeans in unhealthy countries, particularly during a ſeaſon of ſickneſs, to be expoſed in an open boat to the foggy night-air, it muſt appear that ſending them unſheltered, in open boats, far up rivers, in unhealthy ſouthern climates, for the ſake of wood, water, trade, or other purpoſes, muſt be attended with the moſt deſtructive and fatal conſequences.

Burying the dead in ſwampy countries is another occupation which has proved fatal to many, and which ought to be entruſted to negroes or the natives of the country. The effluvia from the ground when newly opened, whether from graves or ditches, are far more dangerous than from the ſame ſwampy ſoil when the ſurface is undiſturbed; nay, in ſome places, it has been found almoſt certain death for an European to dig a grave, unleſs long ſeaſoned to the country. In ſuch a place, the attendance of friends at funerals ought to be diſpenſed with.

In all caſes where it is practicable, the ſhips which viſit theſe unhealthy countries ſhould anchor at as great a diſtance as poſſible from ſhore; or if obliged to anchor near marſhy grounds or ſwamps, eſpecially during ſummer or in hot weather, and when the wind blows directly from thence, the gun-ports which would admit the noxious land-breeze ought to be kept ſhut, eſpecially at night. Or if the ſhip rides with her head to the wind, a thick ſail ought to be put upon the fore-maſt, along which the ſmoke from the fire-place might be made conſtantly to play and aſcend. If the ſail ſhould occaſion a little ſmoke between decks, this inconvenience will be ſufficiently compenſated by its keeping off the direct ſtream of the ſwampy ſhore effluvia; which now being obliged to form a curve before they reach the more diſtant parts of the veſſel, muſt needs be greatly diverted and ſcattered.

The beſt preſervative againſt the miſchievous impreſſions of a putrid fog, or of a marſhy exhalation, is a cloſe, ſheltered, and covered place; ſuch as the lower apartments in a ſhip, or a houſe in which there are no doors or windows facing the ſwamps. If in ſuch places a fire be kept either at the doors and other inlets to a houſe, or in the chambers, as is practiſed in ſome unhealthy countries during the rainy or foggy ſeaſon, it will prove an excellent and effectual protection againſt the injuries of a bad air. On board of ſhips alſo fires may be made at the hatchways; and of the good effects of this we have the following example. When the Edgar, a ſhip of war of 60 guns, was upon the coaſt of Guinea in the year 1768, her men were very ſickly, and many of them died: however it was obſerved, that in a ſloop of war, which was conſtantly in company with her, few were taken ill, and not one died during the whole voyage. This could be aſcribed to no other cauſe, but that in the ſloop the fire-place for cooking victuals was on the ſame level with the deck where the men lay; and every morning when the fire was lighted, eſpecially when there was but little wind, the ſmoke from the cook-room ſpread itſelf all over the ſhip, and particularly over thoſe parts where the men lay; but from the conſtruction of the fire-place of the Edgar, no ſmoke from it ever came between her decks.

Perſons on board any ſhip whatever, are much more ſafe, and their ſituation is much preferable to that of thoſe who make diſtant inland excurſions in ſmall boats upon the rivers, and who are for the moſt part ignorant of the cauſe of thoſe maladies which deſtroy them. The intolerable heat at noon often obliges ſuch perſons to go in a manner half naked; while a free and plentiful perſpiration iſſues from every pore. A near approach to putrid ſwamps at this time is apt to produce an immediate ſickneſs, vomiting, and afterwards

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Where such exposure becomes unavoidable, the only method is to defend the body as much as possible against the pernicious miasmata with which the air abounds.—All those who are employed in cutting down woods, or in other laborious and dangerous services in hot climates, during the heat of the day, ought to have their heads covered with a bladder dipt in vinegar, and to wash their mouths often with the same liquor; never to swallow their spittle, but rather to chew a little rhubarb or some other bitter, and spit it out frequently; to stop their nostrils with a small bit of linen or tow dipped in camphorated vinegar; and to infuse some Peruvian bark, garlic, and rhubarb, in brandy, of which a dram is to be taken, either by itself or diluted with water, morning and evening.

In the evening before sunset they should leave off work, and not return to their labour in the morning till the sun has dispersed the unwholesome dews and vapours. Those who must of necessity remain on shore, and sleep in dangerous places, should take care not to sleep upon the ground exposed to the dews, but in hammocks in a close tent, standing upon a dry sand, gravel, or chalk, near the sea shore, and where there is no subterraneous water for at least four feet below the surface of the ground. The door of this tent should be made to open towards the sea; and the back part of it, which receives the land breeze, must be well secured by double canvas, or covered with branches of trees. But in such circumstances, a hut, when it can be procured, is preferable to a tent, especially if it be well thatched, so as to prove a defence both against the excessive heat of the sun by day, and the noxious dews which fall at night. Here the men may be enjoined to smoke tobacco. When the air is thick, moist, and chill, the earth being overspread with cold dew, a constant fire must be kept in and about the tent or hut, as the most excellent means of purifying such unwholesome air, and of preserving the health of those who either sleeping or waking are exposed to its influence. The centinels who guard the water-casks, ought likewise at such a time to have a fire burning near them. All old and forsaken habitations, natural caves and grottos in the earth, where the men may be induced to take up their abode, must before their admission be perfectly dried and purified with sufficient fires. Fire and smoke are undoubtedly the great purifiers of all tainted and unwholesome air, and the most excellent preservatives against its noxious influence. It is the custom of the negroes in Guinea, and also of some Indians (who both sleep for the most part on the ground), to have a fire, producing a little smoke, constantly burning in their huts where they sleep. This not only corrects the moisture of the night, but also, by occasioning more smoke than heat, renders the damp from the earth less noxious; of which Dr Lind gives the following remarkable instance. Typhus. A Guinea ship being up one of the rivers for the sake of trade, it was found to be very dangerous to sleep on shore; without which their trade could not be so conveniently carried on. First the captain, then the mate, and two or three of the seamen, were taken ill; each of them the morning after they had lain on shore. By these accidents the men were greatly intimidated from lying ashore; till the surgeon boldly offered to try the experiment on himself. Next morning when he waked, he found himself seized, as the rest, with a giddiness and pain in the head, He immediately acquainted one of the negroes with his condition, who carried him to his hut, and set him down in the smoke of it; when his shiverings and giddiness soon left him. He then took a dram of the bark bitter; and found himself greatly relieved, especially by breathing some time in the smoke.—Thus instructed by the negro, he ordered a large fire to dry the hut he slept in; and afterwards had every night a small fire sufficient to raise a gentle smoke, without occasioning a troublesome heat: and by this means he and several others, using the same precautions, slept many nights on shore without any inconvenience.

Fire and smoke indeed are found to be certain correctors, or rather destroyers, of infection in all cases, whether arising from the noxious effluvia of marshes, or from the contagion of diseased bodies. Even those most extraordinary and fatal damps called *harmattans*, are unable to resist the salutary effects of smoke. In other cases, Dr Lind remarks, that, under some circumstances, the source of an infection in a sick chamber or any other place, may be removed or destroyed by accidental means, for which we cannot account, and which we often cannot ascertain. But it oftener happens, that it is very difficultly rooted out; and that exact cleanliness, with the benefit of a pure air, often proves insufficient to remove the evil. Smoke, however, has never been known to fail. It is not to be doubted, that, excepting the true plague, there has been an infection fully as pestilential and as mortal in some ships as in any other place whatever; yet it has never been heard, that any ship, after having been carefully smoked, did not immediately become healthy: and if afterwards they turned sickly, it was easy to trace that sickness from other infected ships, jails, and the like places.

There are three methods practised for purifying vessels after the men have been removed out of them. The first is by burning of tobacco. A quantity of tobacco is spread on several fires, made with such old pieces of rope as are called *junk*. These are dispersed into different places of the ship, and their heat and smoke afterwards closely confined below for a considerable time.—The second method is by charcoal fires strewed with brimstone. The heat and steam of these burning materials must also be long and close shut up: but, although this fume, properly applied, has been found by experience to purify most effectually tainted apartments, ships, clothes, &c. yet there are some kinds of vermin which it will not destroy, particularly lice. The third method of purification is performed by the addition of arsenic to the materials of the second process,

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ceſs in the following manner. After carefully ſtopping up all the openings and every ſmall crevice of the ſhip (as was alſo neceſſary in the preceding proceſſes), a number of iron pots, properly ſecured, are to be placed in the *hold*, *orlope*, *gun-deck*, &c. Each of theſe is to contain a layer of charcoal at the bottom, then a layer of brimſtone, and ſo alternately three or four layers of each, upon which the arſenic is to be ſprinkled, and on the top of it ſome oakum dipped in tar is to be laid to ſerve as a match. The men, upon ſetting fire to the oakum, muſt ſpeedily leave the place, ſhutting cloſe the hatchway by which they came up.

From the known and experienced efficacy of theſe proceſſes, it appears, that fire and ſmoke are powerful agents for annihilating infection; and, it may be preſumed, even the plague itſelf. This is in ſome meaſure agreeable to what we learn from the ancient records of phyſic. But the prepoſterous uſe, or rather abuſe, of fire on ſuch occaſions, has cauſed its effects to be diſregarded by ſome, and to be ſuſpected of miſchief by others. The modern practice of burning large fires in the open air, in the ſtreets, and about the walls of towns infected with the plague or other contagion, is founded on principles groundleſs and erroneous; and has therefore been found by experience not only unſucceſsful, but hurtful. But though this muſt be allowed, it does not thence by any means follow, that when once a houſe hath been infected, and the patients removed from it, the doors and windows at the ſame time being ſhut, that ſuch fires will then prove hurtful; or that, by this method of purification, all the ſeeds of contagion may not be effectually deſtroyed. Whenever, therefore, perſons die of a ſpotted fever, a malignant ſore throat, the ſmall-pox, or any diſtemper found to be communicable from the ſick to the ſound, the corpſe ought quickly after death to be removed into another room; that in which the perſon died ſhould be well aired, by having the windows opened, till a charcoal fire be kindled, with ſome rolls of ſulphur upon it; after which, both doors and windows ſhould be kept ſhut for a conſiderable time, not leſs than eight or ten hours, till the room be thoroughly ſmoked. In ſeveral ſhips, where there are the faireſt opportunities of trying and judging things of this nature, the contagion of the ſmall-pox has been entirely ſtopped by wood-fires, ſprinkled with brimſtone, kept burning and cloſely confined in the infected place. In a word, a judicious and proper application of fire and ſmoke is a powerful agent for the deſtruction and utter extinction of the moſt malignant ſources of diſeaſe; and they are beſides great purifiers of all bad and tainted air.

Next to the ſmoke of wood for purifying a tainted air, that of gun-powder is to be eſteemed the beſt; and it has this further good property, that it is entirely inoffenſive to the lungs. The caſcarilla-bark, when burning, gives a moſt agreeable ſcent to the chamber of the ſick; thus it is at leaſt an elegant preſervative, and may prevent bad ſmells from taking effect. The ſteam of camphorated vinegar, warmed, is ſtill more powerful for this purpoſe. But, beſides correcting the ill quality of the air, and purifying the chamber, another good effect is produced from ſuch ſteams and ſmoke as are inoffenſive to the lungs. As ſoon as the vapour becomes denſe, the nurſes and patients become deſirous of the admiſſion of freſh air by the door or windows. Now it is certain, that the air in the chambers of the ſick cannot be too often changed, provided the patient be well covered, and the curtains of his bed, if neceſſary, be drawn cloſe. No argument is ſo forcible to obviate the danger of foul air in a room or ward (occaſioned by the obſtinacy of nurſes or relations), as ordering it to be frequently fumigated or ſmoked: A practice more frequent in other countries than in this, but of great benefit to the ſick.

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Laſtly, with regard to the method of purifying goods, moveables, clothes, &c. which are ſuppoſed to harbour infection, it muſt be obſerved, that the uſual cuſtom of only unpacking and expoſing ſuch materials to the open air, is in many inſtances inſufficient to deſtroy the latent ſeeds of diſeaſe. It is certain indeed, that in moſt caſes the contagious particles are more readily and fatally communicated from the clothes of a ſick perſon than from his body. The ſpreading abroad, therefore, of contaminated clothes to dry or to be aired, without a previous fumigation of them, may be of dangerous and fatal conſequence. All ſuch ſuſpected ſubſtances ſhould be firſt fumigated in a cloſe place, and in the ſame manner as an infected chamber, after which they may be ſpread abroad and expoſed to the air. In infectious diſeaſes, eſpecially fevers, the linen of the ſick, or ſuch clothes about them as will admit of being waſhed, ought never at firſt to be put in warm water, as it is dangerous to receive the ſteam that may hence ariſe. It is neceſſary to ſteep them firſt either in cold water or in cold ſoap-lees for ſeveral hours, that the filth may be waſhed off.

But although the deſtruction of contagion by ſmoke is unqueſtionably a very important practice, yet it cannot now be ſaid, that it is the moſt powerful agent for this purpoſe. By the ingenious obſervations and experiments of M. Morveau in France, and of Dr Smyth Carmichael in England, it is now aſcertained, that we poſſeſs ſtill more powerful means of deſtroying contagions, either in the muriatic or nitrous acid gas. The former may eaſily be detached from common ſea ſalt, and the latter from nitre, by means of the ſulphuric acid. Rooms may, with the utmoſt ſafety and eaſe, be filled with theſe fumes, although the ſick be not removed from them. But for diſinfecting a room, ward, or ſhip, when empty, the moſt powerful article yet diſcovered is the oxygenated muriatic acid gas, detached from a mixture of manganeſe and ſea ſalt, by means of the ſulphuric acid.

We muſt now proceed to give an account of the method of cure, after theſe means of preventing the infection from being received into the body have either been neglected or proved ineffectual. Here it is of the utmoſt importance to take the diſeaſe in the very beginning, before it has time to corrupt the fluids to ſuch a degree as to endanger life. In ſlight degrees of infection, a vomit properly adminiſtered, eſpecially if ſucceeded by a bliſter, never fails to remove the diſorder, and prevent the fever which would otherwiſe unavoidably follow. Of this Dr Lind gives the following inſtances. A lady afflicted with the bilious cholic, had intolerably fetid diſcharges of corrupted matters upwards and downwards. A gentlewoman, only in paſſing the room, was immediately ſeized with a retching and ſickneſs, which continued 24 hours. The nurſe who attended was ſuddenly ſeized

zed with a giddineſs and vomiting from the bad ſmell, which, as ſhe expreſſed it, reached into her ſtomach. The vomiting became more ſevere at night, accompanied with a purging and frequent ſhiverings. By means of an emetic both evacuations were ſtopped: notwithſtanding which, for ſome days afterwards, ſhe continued to have frequent tremors, and a violent headach, with a low irregular pulſe; and did not recover ſo ſoon as the patient.

Such ſlight degrees of infection have been often obſerved to be derived from patients of a groſs habit of body, when labouring under inflammatory diſtempers, and even other complaints. A man was ſent to Haſlar Hoſpital, ſuppoſed to have a fever. He was furiouſly delirious, with a quick full pulſe. Notwithſtanding plentiful evacuations, this delirium continued for two months with ſhort intervals: when the caſe was found to be plainly maniacal. A nurſe, upon raiſing this perſon up in her arms, perceived an intolerably bad ſmall, and was inſtantly ſeized with ſhiverings, ſickneſs, and headach. Finding herſelf very ill, ſhe took a vomit in ſix hours afterwards, and paſſed the night in profuſe ſweats by means of a ſudorific draught. Next morning the violence of the headach was but little abated; upon every attempt to move, ſhe complained of a burning heat and pain in her forehead, and became giddy. Her inclination to drink was frequent, and her pulſe low and quick. A bliſter was immediately applied to the back; as ſoon as the bliſter took effect, the headach and thirſt entirely left her, and the pulſe was calm. Next day ſhe aroſe and was well.

Many ſimilar inſtances of infection have been obſerved from putting the dead into their coffins. In particular, one man, from performing that duty to his meſſmate, was ſo ill, even after the operation of the vomit, as to require a bliſter, In the courſe of one week two nurſes were infected by a perſon in the ſmall-pox. Both were ſeized in like manner with ſhiverings, ſickneſs, and headach; the one upon receiving the patient's breath, the other upon making his bed. In one, a pain darted into her breaſt; in the other, into the breaſt and in the ſmall of the back. The complaints of the former were ſpeedily removed by a vomit, though ſhe continued to have irregular returns of ſhiverings for three days afterwards. But in the latter, though the headach, ſickneſs, and rigors, were greatly abated by the vomit, yet a conſtant heat and thirſt, with a low pulſe, and a violent pain in the breaſt, indicated the neceſſity of applying a bliſter to the affected parts, which next morning removed all her complaints.

A perſon is often immediately ſenſible of his having received infection from the firſt attack: they generally compare the firſt impreſſion to an earthy, diſagreeable ſmell, reaching down, as they expreſs it, into their ſtomach, as from a grave newly opened, but not quite ſo raw as the cadaverous ſtench; and the effects of it, ſhivering and ſickneſs, are inſtantaneous. It is a ſmell difficult to deſcribe; but it is well known to the nurſes and attendants about the ſick, as it uſually accompanies fevers of extreme malignity, and, with the peculiar diſcharges from the bliſtered parts, may the reckoned among the moſt conſtant ſymptoms of a bad fever. Some compare the ſmell to that of rotten ſtraw.

It often reſembles the diſagreeable ſmell of a perſon labouring under the confluent ſmall-pox at their turn, though not ſo ſtrong. One perſon, on receiving the infection, was ſenſible of ſomething like an electric ſhock through his body. But many are not ſenſible of any effect from infection at firſt; and an infection from a fever will ſometimes continue for many days, nay weeks, diſcovering itſelf chiefly by irregular ſhiverings, ſometimes ſo ſevere as to oblige the patients to have recourſe to their beds once or twice a-day; ſometimes every other day. Among a number thus affected, it alſo appears, that ſuch as are put into unſeaſoned chambers, or have ſat down on the cold ground, lain in raw damp apartments, &c. are immediately ſeized with a ſickneſs at ſtomach, ſometimes with a dangerous purging, and often with fevers accompanied with bad ſymptoms, which others have entirely eſcaped.

It now remains to conſider the proper method of curing putrid fevers, on the ſuppoſition that the infection has been allowed to operate till the blood becomes radically tainted, and of conſequence the nervous ſyſtem affected to ſuch a degree, that its power cannot be reſtored by any of the ſimple practices above mentioned. Here all authors agree, that a change of air, when it can be effected, is highly advantageous, and often contributes more towards the removing of the diſeaſe than all the medicines that can be exhibited. The utility of this change will appear from what has been formerly ſaid; and we ſhall only further mention one inſtance from Dr Lind, in which the effects of bad air appear to a degree almoſt incredible. "It is remarkable (ſays he), that, in the laſt war, the Engliſh ſhips which touched at Batavia ſuffered more by the malignant and fatal diſeaſes of that climate, than they did in any other part of India, if we except a fatal ſcurvy which once raged in that fleet at ſea. Soon after the capture of Manilla, the Falmouth, a ſhip of 50 guns, went to Batavia, where ſhe remained from the latter end of July to the latter end of January; during which time ſhe buried 100 ſoldiers of the 79th regiment and 75 of the ſhip's company; not one perſon in the ſhip having eſcaped a fit of ſickneſs, except her commander Captain Brereton. The Panther, a ſhip of 60 guns, was there in the years 1762 and 1764; and both times during the rainy ſeaſon. In the former of theſe years, ſhe buried 70 of her men; and 92 of them were very ill when ſhe left the place. In the year 1764, during a ſhort ſtay, 25 of her men died. The Medway, which was in company with her, loſt alſo a great number of men. Nor was the ſickneſs at that time confined to the ſhips: the whole city afforded a ſcene of diſeaſe and death: ſtreets crowded with funerals, bells tolling from morning to night, and horſes jaded with dragging the dead in herſes to their graves. At that time a ſlight cut of the ſkin, the leaſt ſcratch of a nail, or the moſt inconſiderable wound, turned quickly to a ſpreading putrid ulcer, which in 24 hours conſumed the fleſh even to the bone. This fact is ſo extraordinary, that upon a ſingle teſtimony, credit would hardly be given to it; yet on board the Medway and Panther they had the moſt fatal experience of it, and ſuffered much from it."

But where a change of air is impracticable or ineffectual, and where the fever has already made ſome progreſs, Sir John Pringle generally took away ſome blood if the pulſe was full. When the ſymptoms run high,

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high, a plentiful evacuation of that kind ſeemed indicated; yet it was obſerved, that large bleedings generally did harm, by ſinking the pulſe, and affecting the head. Nor was a moderate bleeding to be repeated without caution; even thoſe whoſe blood was ſizy, unleſs their lungs were inflamed, were the worſe for a ſecond bleeding. If the head only ſuffered, it was much ſafer to uſe leeches than to open a vein in the arm; but in the delirium with a ſunk pulſe, even leeches were hurtful. Many recovered without letting blood, but few who loſt much of it.

Emetics alſo muſt be uſed with caution; for though they may be of ſervice by way of prevention, yet in the advanced ſtate of the diſeaſe, when the patient has all along complained of a ſickneſs at ſtomach, they are evidently unſafe. Here the antiſeptic quality of fixed air is of much uſe, and the neutral draughts given in the act of effervefcence are generally attended with happy effects. Nay, clyſters of fixed air itſelf have been found very ſerviceable. Even in very bad ſtages of the diſtemper, where a putrid and colliquative looſeneſs has taken place, clyſters of fixed air have been known to alleviate the ſymptoms. We muſt not, however, put too much confidence in medicines of this kind. Mild tonic cordials, eſpecially wine and cinchona, are the only reſources in theſe diſorders. Concerning the former, Sir John Pringle obſerves, in the low ſtate of theſe fevers, and in great ſinkings, which either come after unſeaſonable bleedings or long want of nouriſhment, it was a moſt grateful and efficacious cordial, to which nothing was comparable. The common men had an allowance, from a quarter to half a pint in a day, of a ſtrong kind, made into whey, or added to the panada which was their ordinary food. But to others out of the hoſpital, he uſually preſcribed Rheniſh or a ſmall French wine, whereof ſome conſumed near a quart per day, and part of that undiluted. Nay, ſo great was the virtue of wine in this ſtage of the fever, that ſeveral were known to recover from the loweſt condition, when, refuſing the bark on account of its taſte, they took nothing but a little panada with wine, and a volatile diaphoretic mixture, every two or three hours by turns. Perhaps there is no rule more neceſſary in this ſtate, than not to let the patient when low remain long without taking ſomething cordial and nouriſhing; as many have been obſerved paſt recovery, by being ſuffered to paſs a whole night without any ſupport about the time of the criſis. In the advanced ſtate of this fever the ſick are remarkably low; and therefore Hoffman adviſes in ſuch caſes, that they ſhould be conſtantly kept in bed, and not permitted even to ſit up in it. In the laſt ſtage of this fever, as well as in that of the ſea-ſcurvy, it would ſeem that the force of the heart was too ſmall to convey the blood to the brain, except when the body is in a horizontal poſture.

But, however neceſſary wine and cinchona may be in the low ſtage of this fever, we muſt remember, that theſe remedies are to be adminiſtered only as antiſeptics and ſupporters of the *vis vitæ*, without aiming at thoroughly raiſing the pulſe or relieving the head, or at forcing a ſweat by them, before nature points that way, and which Sir John Pringle ſeldom obſerved before the 14th day.

In the low ſtate of the hoſpital fever, a ſtupor was a conſtant attendant, which was very apt, in the evening, to change to a ſlight delirium. If this was all, nothing was done. But if the delirium increaſed upon uſing wine, if the eyes looked wild, or the voice became quick, there was reaſon to apprehend a phrenitis; and accordingly it was obſerved, that at ſuch times all internal heating medicines aggravated the ſymptoms; and in theſe caſes, bliſters were of the greateſt ſervice. Fomentations of vinegar and warm water for the feet, Sir John Pringle is of opinion, would anſwer better than either ſinapiſms or bliſters, provided they were long enough and often enough applied. In the inflammatory fevers, he has known theſe ſomentations have little effect for the firſt hour, and yet ſucceed afterwards. For internal medicine, cinchona was omitted for ſome time, but the patient was continued with an acidulated drink, viz. barley-water and vinegar; and treated alſo with camphire, *pulvis contrayervæ compoſitus*, and nitre, as was uſual in the beginning of the fever. If the delirium was of the low kind, a decoction of cinchona and wine were the only remedies; for in no inſtance was the delirium perfectly removed till the time of the criſis. It muſt alſo be obſerved, that a delirium may ariſe in putrid fevers from two oppoſite errors; one from large and repeated bleedings, and the other from wine and the cordial medicines being taken too early. It appears, therefore, how nice the principles are that regard the cure; as neither a hot nor a cool regimen will anſwer with every patient, or in every ſtate of the diſeaſe.

If a diarrhœa came on in the decline of the fever, it was moderated, but not ſuppreſſed, by adding an opiate to the uſual medicines. For though the looſeneſs may be conſidered as critical; yet as the ſick were too low to bear evacuations, there was a neceſſity for reſtraining it in ſome meaſure; and it has often been obſerved, that when it has been treated in this manner, about the uſual time of the criſis, the patient has fallen into a gentle ſweat, which has carried off the diſeaſe. In the worſt caſes of this fever, and eſpecially when it coincides with the dyſentery, the ſtools are frequently bloody; in which dangerous ſtate, if any thing could be done, it was attempted by medicines of the ſame kind. In proportion to the putrid nature of the ſtools, opiates and aſtringents were uſed with the greater caution.

If the diſeaſe terminate in a ſuppuration upon one of the parotid glands, the abſceſs was opened without waiting for a fluctuation, which might never happen; the pus being often here ſo viſcid, that after it was ripe the part felt nearly as hard as if the ſuppuration had not begun.

Almoſt every patient, after the fever, complained of want of reſt, frequently of a vertigo or confuſion of the head, of a continuation of the deafneſs, or of other ſymptoms commonly called *nervous*. An opiate was then given at night; and in the day ſome ſtrengthening medicines, ſuch as cinchona and the ſulphuric acid. In theſe caſes, the bark was found not only to be the beſt ſtrengthener, but the ſureſt preſervative againſt a return of the diſeaſe. For this laſt intention the convaleſcent was ordered about three drams a-day for ſix or ſeven days together; and afterwards, if he remained longer in the hoſpital, ſome ſmaller quantity daily. But if there was any appearance of a hec-

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tic fever from an inward abſceſs, the caſe was treated accordingly. Upon comparing ſome of the remaining ſymptoms of thoſe who recovered, with the condition of the brain in thoſe who died and were opened, Sir John Pringle was induced to think, that ſome part even of that ſubſtance might ſuppurate, and yet the perſon recover.

Sometimes the patient falls into an irregular intermittent; which, if not of a hectic nature from an internal abſceſs, may proceed from neglecting to clear the *primæ viæ*. For it is eaſy to conceive, that after a long fever of ſuch a putrid nature, often attended with languor of the bowels, the fæces may be ſo much accumulated, and ſo corrupted, as to occaſion new diſorders. In ſuch caſes, after proper evacuation by a purge, cinchona was almoſt an infallible remedy.

The Yellow Fever.

Typhus cum flavedine cutis.
Typhus icteroides, *Sauv.* ſp. 7.
167 *Febris flava Indiæ Occidentalis, Warren.* Malignant Fever of Barbadoes, *Hillary's* Diſeaſes of Barbadoes. *Lining* on the Yellow Fever of South Carolina, Edin. Phyſ. and Liter. Eſſays, vol. ii. *M'Kittrick* de Febre Flavâ Indiæ Occidentalis, Edin. 1766.

Deſcription. This is one of the moſt fatal diſeaſes to which the inhabitants of warm climates are ſubject, and is the ſame with that called, from one of its worſt ſymptoms, the *black vomit*, which is ſo terribly deſtructive in ſome of the warm parts of America, particularly at Carthagena; and which of late has proved ſo fatal in Philadelphia, New York, and the Britiſh Weſt India iſlands, as deſcribed by Drs Ruſh, Chiſholm, Clerk, and other late writers. This, though by ſome conſidered as a new diſeaſe, is evidently from the ſame contagion which has produced fatal fevers on many former occaſions.

The yellow or putrid bilious fever has been in particular minutely deſcribed by Dr Hillary. It moſt commonly ſeizes the patient at firſt with a faintneſs, then with a ſickneſs at ſtomach, accompanied in general with a giddineſs of the head; and ſoon after with a ſlight chilneſs and horror, very rarely with a rigor. Theſe ſymptoms are ſoon followed by a violent heat and high fever, attended with acute darting pains in the head and back. A fluſhing in the face, with an inflamed redneſs and a burning heat in the eyes, great anxiety and oppreſſion about the præcordia, are the pathognomonic ſigns of the diſtemper, eſpecially when attended with ſickneſs at ſtomach, violent retchings, and bilious yellow vomitings, with frequent ſighing. The pulſe is now generally very quick, high, ſoft, and ſometimes throbbing, but never hard: in ſome it is very quick, ſoft, low, and oppreſſed; the reſpiration quick, full, and ſometimes difficult; the ſkin very hot, and ſometimes dry, though more frequently moiſt. Blood taken from the patient, even at the very beginning of the diſeaſe, is often of an exceeding florid red colour, without the leaſt appearance of ſize; and the craſſamentum, when it has ſtood till it is cold, will ſcarce cohere, but fluctuates; the ſerum is often yellow.

Moſt of the above-mentioned ſymptoms continually increaſe, and are much aggravated: the retching and vomiting become almoſt inceſſant; the anxiety great, and ſighing frequent; great reſtleſſneſs; continual toſſing; no eaſe in any poſture; little ſleep, and that diſturbed and uneaſy, and without any refreſhment to the ſick. When they are fainting, they turn yellow about the face and neck, inſtead of turning pale; and as the fainting goes off, they recover their natural colour. Theſe ſymptoms generally continue to the third day, though ſometimes not longer than the firſt or ſecond; in others to the end of the fourth: the firſt ſhows the greater diſſolution of the blood, and the greater malignity of the diſeaſe; the laſt, the contrary; which the improper manner of treating the diſeaſe ſometimes haſtens and increaſes, or the proper method retards. This may be called the firſt ſtadium of the diſeaſe, and generally ends on the third day.

Blood taken from the ſick on the ſecond or third day, is much more diſſolved, the ſerum more yellow, and the craſſamentum florid, looſe, ſcarcely cohering, but undulates like ſizy water when ſhaken, and ſometimes has dark blackiſh ſpots on its ſurface, ſhowing a ſtrong gangreneſcent diatheſis.

About the third day, the pulſe, which was quick and full before, now generally ſinks greatly, and becomes very low: though ſometimes it remains very quick, yet in others it is not much quicker than when the patient was in health, but is always low; the vomiting becomes almoſt inceſſant if not ſo before, and the matter thrown up is black; the patient then becomes comatoſe, with interrupted delirium. The thirſt in ſome is very great, in others but little; the pulſe ſtill low and quick, attended with cold clammy ſweats, and ſometimes with deliquium. The eyes, which were inflamed and red before, and began to be of a more duſkiſh colour, now turn yellow; and this yellowneſs alſo ſoon after appears round the mouth, eyes, temples, and neck, and in a ſhort time diffuſes itſelf all over the body. But this yellowneſs is ſo far from being always an encouraging prognoſtic, as ſome would have it, that it moſt commonly proves a mortal ſymptom. Sometimes indeed, though ſeldom, this ſuffuſion of bile upon the ſurface has proved critical; but then it did not come on till the eighth or ninth day, nor appear till the coma and all the other bad ſymptoms began to abate; and then in proportion as the yellowneſs increaſes, all the bad ſymptoms decreaſe. But the caſe is moſt commonly quite the reverſe; eſpecially when the yellowneſs comes ſoon on: and then it uſhers in the moſt fatal ſymptoms of the diſeaſe, viz. a deep coma, a low, vermicular, and intermitting pulſe, great hæmorrhages from various parts of the body, a delirium with laborious and interrupted reſpiration, great anxiety, deep ſighing, reſtleſſneſs, a ſubſultus tendinum, coldneſs of the extreme parts firſt, and then all over the body, a faltering of the ſpeech, tremors, and convulſions, which are ſoon after followed by death. So that from the firſt appearance of the yellowneſs we may ſay the patient is in the laſt ſtage of the diſeaſe, whether it terminates in death or recovery.

It has been obſerved, that, in ſome ſtrong ſanguine conſtitutions, when the patients have not been bled to a ſufficient quantity in the beginning of the diſeaſe, the pulſe has continued full, ſtrong, and rapid, but never hard; the face fluſhed, eyes inflamed; the tongue dry, with great thirſt and heat, till the ſecond or laſt ſtage of the fever is come on, when the pulſe has

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fuddenly funk, and death foon after enfued. Yet in others, who feemed to be of a plethoric habit, the tongue has been moift all along, though they have been delirious moft of the time, and the heat of their fkin and the ftrength and quicknefs of their pulfe have continued, after the firft ftage of the difeafe was over, pretty near to that of their natural ftate in health, till within a few hours of death; and when they have had a coma on them, one who is not well acquainted with the nature of this difeafe would, from the pulfe, heat, breathing, and other fymptoms, have taken them to be in a natural fleep. Others, when the pulfe has begun to fink, and the fatal period feemed to be juft approaching, to the great furprife of all prefent have recovered their fenfes, fat up and talked pretty cheerfully for an hour or two, and in the midft of this feeming fecurity have been fuddenly feized with convulfions which carried them off immediately.

In the latter ftage of this fever, the blood is fo attenuated and diffolved, that we frequently fee it flowing not only out of the nofe and mouth, but from the eyes, and even through the pores of the fkin; great quantities alfo of black, half-baked, or half-mortified blood, are frequently voided both by vomiting and by ftool, with great quantities of yellow and blackifh putrid bile by the fame paffages; and the urine, which was before of a high icteritious colour, is now almoft black, and is frequently mixed with a confiderable quantity of half-diffolved blood. The pulfe, which was much funk before, now becomes very low, unequal, and intermitting; the breathing difficult and laborious; and the anxiety inexpreffible; an oppreffion with a burning heat about the præcordia comes on, though the extremities are cold, and often covered with cold clammy fweats: a conftant delirium follows; and then a total lofs of the outward fenfes as well as the judgement, with livid fpots in many parts of the body, efpecially about the præcordia; and fometimes gangrenes in other parts of the body, which are very foon fucceeded by death.

In a fhort time after death, the body appears much more full of livid, large, mortified fpots, particularly about the præcordia and hypochondres, efpecially the right; which parts feem, even from the firft feizure, to be the principal feat of this terrible difeafe; and, upon opening the bodies of thofe who die of it, we generally find the gall-bladder and biliary ducts turgid, and filled with a putrid blackifh bile; and the liver, ftomach, and adjoining parts, full of livid or blackifh mortified fpots; and the whole corpfe foon putrefies after death, and can be kept but a few hours above ground.

Dr Lind is of opinion, that the remarkable diffolution of the blood, the violent hæmorrhages, black vomit, and the other fymptoms which characterize the yellow fever, are only accidental appearances in the common fever of the Weft Indies; that they are to be efteemed merely as adventitious, in the fame manner as purple fpots and bloody urine are in the fmallpox, or as an hiccough in the dyfentery: like thefe they only appear when the difeafe is attended with a high degree of malignity, and therefore always indicate great danger. This opinion, he thinks, is confirmed by an obfervation of Dr Wind's, that in 1750 the crew of a Dutch fhip of war were diftreffed by the yellow fever, accompanied with the black vomit; but when the fhip left the harbour, and changed the noxious land air for one more healthy, the fever continued, but was not accompanied with the black vomit.

Difeafes fimilar to this fever, Dr Lind informs us, may arife in any part of the world where the air is intenfely hot and unwholefome; and therefore he treats as chimerical the notion of its being imported from one part of the world to another. An example of this happened at Cadiz in Spain, in the months of September and October 1764, when exceffive heat, and want of rain for fome months, gave rife to violent, epidemic, bilious diforders, refembling thofe of the Weft Indies, of which 100 perfons often died in a day. At this time the winds blew principally from the fouth, and after funfet there fell an unufual and very heavy dew. But his opinion on this fubject is liable to ftrong objections. And however the difeafe may originate, yet the late introduction of it from Spain into the fortrefs of Gibraltar, from which, by proper attention, it had been excluded in former epidemics, demonftrates the contagious nature of this fever beyond all poffibility of doubt.

It has been a matter of much difpute, whether the yellow fever is of an infectious nature or not. Some time ago it became an object of confideration before the Right Hon. the Lords Commiffioners of Trade and Plantations, where it was urged among other reafons, for not removing the feat of government and juftice in the ifland of Jamaica from Spanifh Town to Kingfton, that there was danger from Greenwich hofpital, fituated near Kingfton, of an infection from the yellow fever being frequently communicated to that town. On this affair a phyfician was confulted, who had long practifed in that ifland, and who gave it as his opinion, that from the yellow fever in that ifland there was no infection. This was the opinion not only of that gentleman, but of many others who had an opportunity of being well acquainted with this fever in Jamaica. But this opinion probably only arofe from thefe practitioners having confounded the ordinary remittent fever of the Weft Indies, which is often accompanied with bilious fymptoms, and is from thence often denominated the yellow fever, with the typhus icteroides, a difeafe effentially different from the bilious remittent which often prevails both in the Weft and Eaft Indies. Dr Lind gives a remarkable inftance of its being of an infectious nature.—A gentleman dying at Barbadoes of a yellow fever, his wearing apparel and linen, packed up in a cheft, were fent to his friends at Philadelphia; where, upon opening the cheft, the family was taken ill; and the clothes being unluckily hung abroad to be aired, they prefently diffufed the contagion of the yellow fever over the whole town, by which 200 perfons died.

In the defcription of the fame fever by Dr Lining, as it appeared in South Carolina, there are feveral particulars confiderably different from that by Dr Hillary. According to the former, people complained for a day or two before the attack, of a headach, pain in the loins and extremities, efpecially in the knees and calves of the legs, lofs of appetite, debility, and a fpontaneous laffitude. Some, however, were feized fuddenly, without any fuch previous fymptoms. After a chillinefs and horror, with which this difeafe generally invades, a fever fucceeded. The pulfe was very frequent, till near the termination of the fever, and was generally full,

full, hard, and consequently strong: in some, it was small and hard; in others, soft and small; but in all those cases, it frequently varied in its fulness and hardness. Towards the termination of the fever, the pulse became smaller, harder, and less frequent. In some there was a remarkable throbbing in the carotids and in the hypochondria; in the latter of which it was sometimes so great, that it caused a constant tremulous motion of the abdomen. The heat generally did not exceed 102 degrees of Fahrenheit's thermometer; in some it was less; it varied frequently, and was commonly nearly equal in all parts, the heat about the præcordia being seldom more intense than in the extremities when these were kept covered. On the first day of the disease, some had frequent returns of a sense of chilliness, though there was not any abatement of the heat. In a few, there happened so great a remission of the heat for some hours, when at the same time the pulse was soft and less frequent, and the skin so moist, that one from these circumstances might reasonably have hoped that the fever would only prove a remittent or intermittent. About the end of the second day, the heat began to abate. The skin was sometimes (though rarely) dry; but oftener, and indeed generally, it was moist, and disposed to sweat. On the first day, the sweating was commonly profuse and general; on the second day, it was more moderate: but on both these, there happened frequent and short remissions of the sweatings; at which times the febrile heat increased, and the patient became more uneasy. On the third day, the disposition to sweat was so much abated, that the skin was generally dry; only the forehead and backs of the hands continued moist. The respiration was by no means frequent or difficult; but was soon accelerated by motion, or the fatigue of drinking a cup of any liquid. The tongue was moist, rough, and white, even to its tip and edges. On the second day, its middle in some was brown. On the third day, the whiteness and roughness of the tongue began to abate. The thirst in very few was great. A nausea, vomiting, or frequent retchings to vomit, especially after the exhibition of either medicines or food, came on generally the third day, as the fever began to lessen; or rather as the fulness of the pulse, heat, and disposition to sweat, began to abate. Some indeed, but very few, on the first day, had a vomiting, either bilious or phlegmatic. Very few complained of anxiety or oppression about the præcordia or hypochondria, nor was there any tension or hardness about the latter. On the first day they generally dozed much, but were afterwards very watchful. Restlessness and almost continual jactations came on the second day. A great despondency attended the sick, and the strength was much prostrated from the first attack. The pain in the head, loins, &c. of which they had complained before the attack, was much increased, and in some the pain in the forehead was very acute and darting; but those pains went generally off the second day. The face was flushed; and the eyes were hot, inflamed, and unable to bear much light. On the first day, many of them at times were a little delirious, but afterwards not until the recess of the fever. The blood drawn by venesection had not any inflammatory crust; in warm weather, it was florid like arterial blood, and continued in one soft homogeneous-like mass, without any separation of the serum after it was cold. When there was any separation, the crassamentum was of a very lax texture. The stools, after the first day, were fetid, inclined to a black colour, and were very rarely bilious, soft, or liquid, excepting when forced by art; for an obstinate costiveness attended the febrile state. The urine was discharged in a large quantity, was pale, sometimes limpid, and rarely of a higher than a straw colour, except when the weather was very warm, and then it was more saturated, of a deep colour, and discharged in smaller quantities. It had a large cloud, except when it was very pale or limpid; but more generally it had a copious white sediment, even on the first day of the fever. On the second day, the urine continued to be discharged very copiously; in some it was then turbid, and deposited a more copious sediment than on the first day; this sediment was sometimes of a brownish colour; in which case it was generally followed by bloody urine, either about the end of the second or beginning of the third day.—The colour and quantity of the urine, discharged in equal times, were remarkably variable, being now limpid, then of a deeper colour; now discharged in a larger, then in a smaller quantity; which could not be ascribed to any change made either in the quantity or quality of the drink.

The fever accompanied with those symptoms terminated on the third day, or generally in less than 72 hours from the first attack, not by any assimilation or coction and excretion of the morbid matter: for if by the latter, there would have been some critical discharge by sweat, urine, stool, or otherwise, none of which happened; and if by the former, nothing then would have remained but great debility. This fever, however, did not terminate in either of these salutary ways, excepting in some, who were happy enough to have the disease conquered in the beginning by proper evacuations, and by keeping up a plentiful sweat, till the total solution of the fever, by proper mild diaphoretics and diluents. But in those who had not that good fortune, however tranquil things might appear, yet the face of affairs was quickly changed: for this period was soon succeeded by the second *stadium*; a state, though without any fever, much more terrible than the first: the symptoms in which were the following. The pulse, immediately after the recess of the fever, was very little more frequent than in health, but hard and small. However, though it continued small, it became, soon afterwards, slower and very soft; and this softness of the pulse remained as long as the pulse could be felt. In many, in this stage of the disease, the pulse gradually subsided, until it became scarce perceptible; and this, notwithstanding all the means used to support and fill it; and when this was the case, the icteritious-like suffusion, the vomiting, delirium, restlessness, &c. increased to a great degree. In some, the pulse, after being exceedingly small and scarce perceptible, recovered considerably its fulness; but that favourable appearance was generally of but short continuance. The heat did not exceed the natural animal heat; and when the pulse subsided, the skin became cold, and the face, breast, and extremities acquired somewhat of a livid colour. The skin was dry when the weather was cold, but was moist and clammy when the weather was hot. The respiration was

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was natural, or rather ſlow. The tongue was moiſt, and much cleaner than in the former ſtage; its tip and edges, as alſo the gums and lips, were of a more florid red colour than uſual. Very few complained of thirſt, though they had a great deſire for cold liquors. The vomiting or retching to vomit increaſed, and in ſome was ſo conſtant that neither medicines nor aliment of any kind were retained. Some vomited blood; others only what was laſt exhibited mixed with phlegm; and others again had what is called the black vomit. The retching to vomit continued a longer or ſhorter time according to the ſtate of the pulſe; for as that became fuller, and the heat greater, the retching to vomit abated, and *è contra*. The inquietude was very obſtinate; and when they dozed, their ſlumbers were but ſhort and unrefreſhing. There were ſome who were drowſy; but theſe always awaked, after the ſhorteſt ſlumbers, with a great dejection of ſpirits and ſtrength. The jactations or reſtleſſneſs were ſurpriſing: it was frequently ſcarce poſſible to keep the patients in bed; though, at the ſame time, they did not complain of any anxiety or uneaſineſs; but if aſked how they did? the reply was, *Very well*. The debility was ſo great, that, if the patient was raiſed erect in the bed, or, in ſome, if the head was only raiſed from the pillow, while a cup of drink was given, the pulſe ſunk immediately, and became ſometimes ſo ſmall, that it could ſcarce be felt; at this time, they became cold, as in a horripilatio, but without the anſerine-like ſkin: their lips and ſkin, eſpecially about the neck, face, and extremities, together with their nails, acquired a livid colour. The delirium returned and increaſed; it was generally conſtant in thoſe whoſe pulſe was ſmall and ſubſiding. The inflammation of the tunica conjunctiva or white of the eyes increaſed much, but without pain. A yellowneſs in the white of the eyes, if it did not appear before in the febrile ſtate, became now very obſervable, and that icteritious tinct was ſoon diffuſed over the whole ſurface of the body, and was continually acquiring a deeper ſaffron-like colour. In ſome, indeed, no yellowneſs was obſervable, excepting in the white of the eyes, until a little before death, when it increaſed very quickly, eſpecially about the breaſt and neck. There were many ſmall ſpecks, not raiſed above the ſkin, which appeared very thick in the breaſt and neck, but leſs ſo in the extremities, and were of a ſcarlet, purple, or livid colour. In women the menſtrua flowed, and ſometimes exceſſively, though not at their regular period.

There was ſuch a putrid diſſolution of the blood in this ſtadium of the diſeaſe, that, there were hæmorrhages from the noſe, mouth, ears, eyes, and from the parts which were bliſtered with cantharides. Nay, in the years 1739 and 1745, there were one or two inſtances of an hæmorrhage from the ſkin, without any apparent puncture or loſs of any part of the ſcarf-ſkin.

An obſtinate coſtiveneſs continued in ſome; in others, the ſtools were frequent and looſe; in ſome they were black, liquid, large, and greatly fatiguing; in others, when the ſtools were moderate, even though they were black, they gave great relief; in others, again, the ſtools nearly reſembled tar in ſmoothneſs, tenacity, colour, and conſiſtence.

The urine was diſcharged in a large quantity, in proportion to the drink retained by the patient: it was pale if the patient was not yellow; but if yellow, then it was of a deep ſaffron-colour: in either caſe, it had a ſediment, or at leaſt a large cloud, which remained at the bottom of the glaſs; in ſome, it was very turbid; in others it was bloody: and the quantity of blood diſcharged with the urine bore always ſome proportion to the ſtate of the pulſe; when that became fuller, the quantity of blood in the urine was diminiſhed; when the pulſe ſubſided, the bloody urine increaſed, and even returned after it had ceaſed ſome days, ſoon after the pulſe became ſmaller. This ſtage of the diſeaſe continued ſometimes ſeven or eight days before the patient died.

When this ſtadium of the diſeaſe terminated in health, it was by a receſs or abatement of the vomiting, hæmorrhages, delirium, inquietude, jactations, and icteritious-like ſuffuſion of the ſkin and white of the eyes; while, at the ſame time, the pulſe became fuller, and the patient gained ſtrength, but very ſlowly. But when it terminated in death, thoſe ſymptoms not only continued, but ſooner or later increaſed in violence, and were ſucceeded with the following, which may be termed the third *ſtadium* of the diſeaſe, which quickly ended in death. The pulſe, though ſoft, became exceedingly ſmall and unequal; the extremities grew cold, clammy, and livid; the face and lips, in ſome, were fluſhed; in others, they were of a livid colour; the livid ſpecks increaſed ſo faſt, that in ſome the whole breaſt and neck appeared livid; the heart palpitated ſtrongly; the heat about the præcordia increaſed much; the reſpiration became difficult, with frequent ſighing; the patient now became anxious, and extremely reſtleſs; the ſweat flowed from the face, neck, and breaſt; blood flowed from the mouth, or noſe, or ears, and in ſome from all thoſe parts at once; the deglutition became difficult; the hiccoughs and ſubſultus tendinum came on, and were frequent; the patients trifled with their fingers, and picked the naps of the bedclothes; they grew comatoſe, or were conſtantly delirious. In this terrible ſtate, ſome continued eight, ten, or twelve hours before they died, even after they had been ſo long ſpeechleſs, and without any perceptible pulſation of the arteries at the wriſts; whereas, in all other acute diſeaſes, after the pulſe in the wriſts ceaſes, death follows almoſt immediately. When the diſeaſe was very acute, violent convulſions ſeized the unhappy patient, and quickly brought this ſtadium to its fatal end. After death, the livid blotches increaſed faſt, eſpecially about the face, breaſt, and neck, and the putrefaction began very early, or rather increaſed very quickly.

Such was the progreſs of this terrible diſeaſe through its ſeveral ſtadia. But in hot weather, and when the ſymptoms in the firſt ſtage were very violent, it paſſed through thoſe ſtages with ſuch precipitation that there was but little opportunity of diſtinguiſhing its different ſtadia, the whole tragedy having been finiſhed in leſs than 48 hours. It was remarkable, that, 1. The infection was increaſed by warm and leſſened by cold weather. 2. The ſymptoms in the ſeveral ſtadium were more or leſs violent, according to the heat or coolneſs of the weather. In hot days, the ſymptoms were not only more violent, but in thoſe who ſeemed in moderate weather to be on the recovery, or at leaſt in no danger, the ſymptoms were all ſo greatly heightened,

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when the weather grew confiderably warmer, as frequently to become fatal. In cool days, the fymptoms were not only milder, but many who were apparently in great danger in hot days were faved from the very jaws of death by the weather becoming happily cooler. 3. The difeafe was generally more fatal to thofe who lay in fmall chambers not conveniently fituated for the admiffion of frefh air, to thofe of an athletic and full habit, to ftrangers who were natives of a cold climate, to thofe who had the greateft dread of it, and to thofe who before the attack of the difeafe had overheated themfelves by exercife in the fun, or by exceffive drinking of ftrong liquors; either of which indeed feemed to render the body more fufceptible of the infection. Laftly, The difeafe proved moft certainly fatal to valetudinarians, or to thofe who had been weakened by any previous difeafe.

Caufes of, and perfons fubject to, this difeafe. The yellow fever attacks principally Europeans, efpecially thofe who have but lately arrived in the hot climates. Negroes are entirely exempt from it, though the mulattoes and tawnies are as liable to be feized with it as the whites themfelves. The caufe of the difeafe feems to be a particular kind of contagion; but Dr Lind feems to be of opinion, that the immediate caufe of the fymptoms is a difpofition in the glutinous part of the blood to feparate from the others, and to become putrefcent. In fome perfons who have been bled in the yellow fever, the blood has been obferved very vifcid; the craffamentum covered with a yellow gluten half an inch in thicknefs, and impenetrable to the finger unlefs cut by the nail; the ferum being at the fame time of the confiftence of a thin fyrup, and of a deep yellow tinct. This ferum tafted bitter, and refembled a compofition of foot. The appearances on diffection, with his conclufions from them, we fhall give in his own words: "In a man who died on the eleventh day of a yellow fever, whofe body emitted no bad fmell 36 hours after death, and was ftill yellow, I found all the bowels of the abdomen found; the liver and fpleen were remarkably fo; as alfo the ftomach and inteftines. There was no fuffufion of the bile either in the inteftines or ftomach. The gall-bladder, of the natural fize, contained the ufual quantity of bile, fomewhat thicker than common, and grumous (B).

"Upon examining further, this difeafe was found to have lain wholly on the left fide, where, within the breaft, was found near a quart of yellowifh water, in which were many large flakes of yellowifh gluten, appearing, by comparifon, precifely the fame with the thick pellicle which had covered the blood taken from his arm. Thefe flakes bore in feveral places a refemblance to a membranous fubftance beginning to be converted into a purulent jelly. The pleura, both on its infide and outfide, as alfo its continuation, the inverting membrane of the lungs, were covered with cakes of this gluten, hanging in fome places loofely, in others adhering more ftrongly: and all in different ftates of yellow or purulent corruption. The right cavity of the breaft, and all the other parts of his body, were found entirely free from difeafe.

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"His complaints had been chiefly in his breaft; and a fmall quantity of blood, taken from him two days before his death, was covered with an impenetrable, yellow, thick gluten; the red portion below it being quite loofe.

"In thofe fevers, I have alfo feen (fays Dr Lind) the difeafe entirely confined to the heart and pericardium. In one who died on the tenth day of the fever, without having been yellow, a quantity of pus and purulent crufts were found mixed with the water of the pericardium. The heart in different places was excoriated; and, together with the infide of the pericardium, was lined with a thick membranous cake, fimilar to that already mentioned on the lungs and pleura. In fome places this cake had a purulent, in others a gelatinous appearance, exactly refembling the coagulum of the blood. His complaints had been, a great oppreffion on the breaft, and an extreme difficulty of breathing. In a third perfon, who died on the thirteenth day of the fever, above two quarts of pus and purulent jelly were found in the cavity of the belly. The fource of fuch an extraordinary quantity of matter was not from any preceding inflammation, nor any impofthume, that we could difcover; but from innumerable ulcerations on the furface of the inteftines, omentum, mefentery, and peritoneum. Neither did thofe ulcerations (or excoriations, as they rather appeared in feveral places) feem to be the primary fountains of the matter, but to have been occafioned by its acrimony.

"This purulent appearance feems to arife merely from an extravafation of one of the component parts of the blood, the gluten or fibrine as it is now called. Blood taken from perfons in a fever, and frequently even from perfons in perfect health, after ftanding in a clean veffel for a fhort time, commonly feparates into three diftinct portions; viz. the ferum, or water of the blood, the red concreted mafs, and a vifcid pellicle termed the *fize*, which fpreads itfelf on the top of the red concretion. Some time ago, when making experiments with the blood taken from perfons in the fcurvy, I was furprifed to find it often covered with that fizy cruft. This induced me to extend my experiments to large quantities of blood from different fubjects, which I had opportunities of infpecting at once in fo large an hofpital. For this purpofe I one morning ordered ten patients in the fcurvy to be bled, taking two ounces from each. A larger quantity was taken, for its infpection, from two men in health. That day I had occafion to prefcribe bleeding to a woman in labour, two hours before her delivery; to a girl of fixteen years of age afflicted with a lunacy proceeding from the chlorofis; to three patients in the rheumatifm; and to a perfon labouring under an obftruction of the liver.

"From a nice comparifon, and an examination of the blood in thefe cafes, I found in general, that the more

(B) In others who died in this yellow ftate, the bile in the gall-bladder was found of a thick ropy confiftence like pitch, but the liver never appeared in the leaft affected. Dr Lind at firft in feveral bodies opened the head only; but afterwards judged that all the cavities ought to be infpected.

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more ſize there was on the top, and the thicker and more viſcid this white pellicle ſhowed itſelf, the concretion below it was of a more looſe coherence. This was not ſo obſervable when only ſome ſlight white ſtreaks appeared on the top. But when much ſize had ſeparated itſelf, the red maſs became very ſoft at the bottom of the veſſel, and leſs compact in its different parts, in proportion to their diſtance from the ſurface, towards which this whitiſh portion had aſcended.

"From this and from other experiments it appears, that this cruſt or pellicle is the natural gluten which becomes ſtrongly diſpoſed, in certain circumſtances and diſeaſes, to ſeparate itſelf. And whereas the ſerum and red concretion are eaſily incorporated together, it will be found, that this glue, after its ſeparation, becomes immiſcible with either. We have, by gentle drying, converted it into a perfectly tough elaſtic membrane; and, by the means of a ſmall portion of the red maſs being left adhering to it, into a ſubſtance reſembling muſcular fleſh; and it is capable of undergoing various changes into corruption, in the ſame manner as either of theſe.

"Now, I can ſee no reaſon why this gluten, in its morbid ſtate, may not ſeparate itſelf from the circulating blood, and be depoſited in the cavities of the body, as readily as the ſerum does in dropſies; the former having always a leſs diſpoſition than the latter to incorporate with the maſs.

"In diſſecting perſons who died of fevers in London and Minorca, and where no infection was ſuſpected, appearances ſimilar to theſe have alſo fallen under the inſpection of thoſe accurate anatomiſts Drs Hunter and Cleghorn. Hence it may be preſumed very difficult to diſtinguiſh fevers that are produced by infection, from ſome others. I cannot, however, be induced to think, as thoſe gentlemen ſeem to do, that theſe preternatural ſubſtances which were found in the cavities of the body are the conſequence, but rather that they are the cauſe, of the inflammation and excoriations. I believe theſe ſubſtances to be at firſt diſeaſed extravaſated gluten, and conjecture their different ſtates greatly to depend upon the different times at which they were depoſited.

"I have remarked, in a variety of dead bodies, three different kinds of extravaſation; theſe occurred in ſuch as had died of the ſcurvy, of conſumption, and of fevers. In the former of thoſe diſeaſes, red coagulated blood is found extravaſated in almoſt all parts of the body, not only into the tela celluloſa, but into the bellies of the muſcles, particularly of the legs and thighs, which often become quite ſtuffed and even diſtorted with large grumous maſſes. The inteſtines and meſentery are often ſpotted alſo with extravaſated blood; and I have ſeen large ecchymoſes on the ſtomach. Thoſe appearances at firſt ſight reſembled ſo many diſtinct mortifications; and by this appearance ſome anatomiſts have been deceived; but, upon a nice examination, the texture of the parts is found to be ſound and firm. There is likewiſe, in that diſeaſe, ſometimes, an extravaſation of water, chiefly collected in the tela celluloſa.

"But as, in the limbs of ſcorbutic perſons, it is extremely difficult to make a good diſſection by reaſon of ſuch quantities of extravaſated blood that everywhere obſtruct the operator; ſo, on the contrary, the lower extremities of thoſe who have died conſumptive, with ſwelled legs, are, of all ſubjects, in the beſt ſtate to afford a ſatisfactory view of the muſcles. The water encloſed in their legs having inſinuated itſelf, by paſſing the tela celluloſa, into the ſpaces between the muſcles, the muſcles are eaſily ſeparated from each other; and their ſeveral origins and inſertions may be diſtinctly traced by means of their having been cleanſed and waſhed by the water in the inveſting cellular membrane. Thus there are extravaſations of three ſorts; viz. Firſt, The grumous maſs in the ſcurvy; and this I have often remarked where no ſerum was obſerved. Secondly, The ſerum alone in anaſarcous ſwellings. The third and laſt is what was taken notice of in thoſe who died of fevers, being the gluten of the blood, accompanied for the moſt part with ſome ſerum; both of them altogether confined to the large cavities of the body.

"I conjecture, that in thoſe fevers there is always an ulcerous or purulent diſpoſition in the blood; and that the gluten is greatly diſeaſed. I have frequently ſeen it have a true purulent appearance ſoon after it was drawn off, when the patient ſeemed not very ill.

"And I further conjecture, that the miſchief often lies within the breaſt; as alſo that the great benefit derived from the very early application of bliſters, in a great meaſure flows from ſo many ulcerations and vents being timely provided for the free diſcharge of thoſe purulent and tainted particles from the body.

"If an infection depends, as many have imagined, on the admiſſion of certain foreign particles into the blood, this gluten ſeems to be primarily affected by it; and a diſcharge of this, by waſhing thoſe particles out of the body, tends in a great meaſure to remove that diſeaſe.

"It is an obſervation of the beſt practical writers, that iſſues and ſetons are moſt excellent preſervatives againſt receiving an infection, even that of the plague itſelf. And indeed a ſuppuration and plentiful diſcharge from a proper ulcer, whether produced by nature or by art, ſeems to open a channel the beſt appropriated for an exit out of the body to ſome of the moſt malignant poiſons. Thus the moſt favourable criſis in the plague, and in moſt peſtilential fevers, happens when nature excites tumors kindly ſuppurating in the groin or armpits, by whoſe beneficial and plentiful diſcharge the deadly poiſon is expelled from the conſtitution.

"I have obſerved it to be amongſt the moſt certain characteriſtics of the worſt fevers, that the bliſters either do not riſe and fill, or diſcharge ſuch yellow, greeniſh, fetid, and highly offenſive ſtuff, that even experienced nurſes could give a pretty certain conjecture from the bliſters of the different degrees of malignity in the fever. We have more than once endeavoured to conceal the bad ſtate of ſome patients in the hoſpital; but a diſcovery was always made of their condition in the waſhhouſe, from the linen ſent there ſtained with the diſcharges from the bliſtered parts. And indeed a careful inſpection of the ſtate and diſcharge from the bliſters, together with their effects, furniſhes us, in thoſe diſeaſes, with ſome of the moſt certain diagnoſtics of their nature, and prognoſtics of their event."

Prognoſis. This diſtemper, where it attacks with violence,

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violence, is generally fatal; the prognosis therefore must be commonly unfavourable, and always uncertain; neither can any thing more be said on this subject, than that an abatement of the symptoms already enumerated affords a favourable prognostic, and an increase of them the contrary.

Cure. The cure of this terrible disease, according to Dr Hilary, is very easy and simple. His indications are, 1. To moderate the too great and rapid motion of the fluids, and abate the too great heat and violence of the fever in the two first days of the disease, as much and as safely as we can. 2. To evacuate and carry out of the body as much of the putrid bile and other humours, and as expeditiously and safely as possible. 3. To put a stop to the putrescent disposition of the fluids, and to prevent the gangrenes from coming on, by suitable antiseptics.

The first indication is answered by bleeding, which, in the first stage of this fever, is sometimes absolutely necessary in some degree: the quantity to be taken away must be determined by the age and strength of the patients, the degree of plethora, fulness of the pulse, &c. When called at the beginning, he orders 12, 14, 16, 18, or 20 ounces of blood to be taken away on the first or second day; and if the patient's pulse rise after the first bleeding, or if the fever still continue high and the pulse full, he repeats the bleeding once on the days above mentioned. But bleeding a third time is seldom or never required; neither is bleeding on the third day almost ever necessary; and when it is performed on that day, it ought to be done with the greatest caution and judgement: neither should a vein be opened after the third day in this fever, unless some very extraordinary symptoms and circumstances require it; which seldom or never happen. On that day, indeed, the pulse generally sinks, and the blood is in such a dissolved state, that bleeding must be accounted highly pernicious. Nevertheless, it is indispensably necessary in the beginning of the distemper; and if omitted at that time, the violent heat and motion of the blood increase the putrescence of the humours to such a degree as to bring on the fatal consequences much sooner than would otherwise have happened. If blood-letting be thus advised by Dr Hilary, it has been still more strongly recommended by Dr Rush, who, in his first publication on the subject of the dreadful yellow fever which proved so fatal at Philadelphia, represented it as an almost infallible remedy for the disease. But the observations and experience of others have by no means confirmed the practice which he recommended.

After bleeding, we come to the second indication of cure, namely, to evacuate as much of the bilious and putrid humours as soon and as safely as we can. The great irritation of the stomach, by the putrid bilious humours constantly attending this fever, with almost continual retchings and violent vomitings, seem to indicate the giving of an emetic: but the stomach is always observed to be so violently stimulated and irritated, and most commonly inflamed, by the acrimony of the putrescent bile, that any emetic, even the most mild and gentle, given in the smallest dose, brings on an incessant vomiting, which continues, in spite of all remedies, till a mortification and death ensue. Instead of this, it is proper to give large draughts of warm water, which, without any additional stimulus to the stomach, evacuates its acrid and putrid contents, commonly with great relief to the patient: the warm water also acts as an emollient fotus to the inflamed coats of the stomach; and thus abates the inflammation, and prevents gangrene and mortification from coming on.

After the patient has by this means vomited seven or eight times, or oftener, and discharged a great quantity of yellow and blackish bilious matter, a grain or a grain and a half of thebaic extract is given, in order to procure some respite from the violent retching, vomiting, and anxiety. The person is desired to take nothing into his stomach for two hours after this, by which means it is seldom or never rejected; and thus all the symptoms are considerably abated, the retching and vomiting either totally cease or are very much lessened, so that medicines may now be exhibited which the stomach would not have retained before. These are cooling acid juleps, or other antiseptic remedies; but neither nitre nor any of its preparations will commonly be found to stay on the stomach, nor, according to Dr Hilary, are the nitrous medicines, or even the common antiemetic draughts, proper to be given in this disease, even though they should agree with the stomach, on account of their attenuating property.

If the patient has not a stool or two after drinking the warm water and vomiting, it is necessary to give a gentle purging clyster; and when six or eight hours rest have been obtained, a gentle antiphlogistic and antiseptic purge, in order to evacuate by stool as much of the bilious matter as we possibly can. Or if the patient has a purging before, which sometimes though very rarely happens, a dose of toasted rhubarb is given, and an antiseptic anodyne after it has operated, to abate and check the too great purging, but not to stop it, as this evacuation has been always observed to be of service, provided it be not very violent.

After this indication is completely answered, the next is to exhibit such proper antiseptic medicines as may stop the putrescent disposition of the fluids. Here the cinchona would seem to be the most proper remedy; but unluckily the stomachs of the patients in this disease are so much irritated, and so apt to reject every thing, that it cannot be retained in any form whatever. In this case Dr Percival recommends columbo root, the infusion of which is found to be a powerful antiemetic and antiputrescent medicine, and might perhaps so far alter the state of the stomach as to make it bear the bark. Dr Hillary, however, who was ignorant of the virtues of columbo, substituted the *radix serpentariæ Virginianæ* with success. A slight infusion of this root not only sat easily on the stomach of the patients, but moderately raised the pulse and fever, both of which are now too-low. The following receipt was found the most agreeable and efficacious.

℞ Rad. serpent. Virginian. ℥ij.
Croc. Ang. ʒ ss. M. et infunde vase clauso in aq. bul. q. per horam unam ut col. ℥vj. Adde aq. menth. simp. ℥ij. Vin. Maderiens. ℥iv. Syr. croc. vel syr. è mecon. ℥i. Elix. vitriol. acid. q. s. ad grat. acid. sap. Exhibe cochlearia duo vel tria singulis horis vel bihoris, vel sæpius pro re nata.

By the use of this medicine, and soft light nourishment taken in small quantities, the pulse is usually kept up

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At the ſame time that the ſtrength of the patient is kept up by the medicines above mentioned, or by others ſimilar, he gave repeated gentle purgatives every ſecond or third day, and ſometimes, when the ſymptoms were very urgent, every day, for four or five days ſucceſſively. But if proper methods be taken in the beginning of the diſeaſe, it is ſeldom that ſuch a repetition of purging is neceſſary.

Dr Hilary's plan of treating the yellow fever is, in our opinion, as judicious as any that has yet been propoſed. But, among the late writers, ſome have recommended mercury, particularly under the form of calomel, as the moſt efficacious remedy which can be employed. In ſome caſes it has certainly been given to an almoſt incredible extent, in a very ſhort time, without exciting either purging or ſalivation. And it cannot be denied, that patients have not unfrequently recovered under the uſe of it. But calomel can no more be reckoned an infallible remedy for this diſeaſe than blood-letting.

Since the introduction of cold affuſion, in the cure of typhus fevers, by Dr Currie, it has been imagined by ſome, that this practice would afford a very efficacious remedy in the typhus icteroides, as well as in the typhus mitior. But experience has not yet confirmed the utility of this practice.

Some have ſuggeſted the internal uſe of the oxygenated muriatic acid, properly diluted, as an article from which great benefit may be expected in the yellow fever. This practice deſerves, we think, a fair trial: but the utility of it ſtill remains to be determined by experience.

To the genus of *typhus* alſo belong all thoſe fevers attended with very profuſe and debilitating ſweats, and which have ſometimes, not without good reaſon, been accounted plagues; ſuch as the Engliſh ſweating-ſickneſs, Miliaris ſudatoria, *Sauv.* ſp. 5. Ephemera ſudatoria, *Sauv.* ſp. 7. Ephemera Britannica, *Caius de ephem. Britan.*

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Genus VI. SYNOCHUS.

Synochus, *Sauv.* gen. 81. *Lin.* 13.
Lenta, *Lin.* 14.
Phrenitis, *Vog.* 18.
Febris continua putrida, *Boerh.* 730.

This is a contagious diſtemper, being a complication of a ſynocha and typhus; for the deſcription and cure of which, we muſt of conſequence refer to what hath been already ſaid concerning theſe diſeaſes.

The *Hectic* Fever.

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Hectica, *Sauv.* gen. 83. *Lin.* 24. *Vog.* 80. *Sag.* 684.

This diſeaſe is reckoned by Dr Cullen to be merely ſymptomatic; as indeed ſeems very probable, ſince it generally accompanies abſorption of pus into the blood from internal ſuppurations, or indeed from ſuch as are external, provided they be very large or of a bad kind.

Deſcription. The beſt, perhaps the only proper, deſcription of this diſorder we have is that by Dr Heberden. According to him, the appearance of the hectic fever is not unlike that of the genuine intermittent; from which, however, the diſeaſe is very different in its nature, while at the ſame time it is much more dangerous. In the true intermittent, the three ſtages of cold, heat, and ſweat, are far more diſtinctly marked, the whole fit is much longer, the period which it obſerves is more conſtant and regular, and the intermiſſions are more perfect, than in the hectic fever. For in the latter, even during the cleareſt remiſſion, there is uſually a feveriſh quickneſs perceptible in the pulſe, which ſeldom fails to exceed the utmoſt limit of a healthy one by at leaſt 10 ſtrokes in a minute.

The chilneſs of the hectic fever is ſometimes ſucceeded by heat, and ſometimes immediately by a ſweat without any intermediate ſtate of heat. The heat will ſometimes come on without any remarkable chilneſs preceding; and the chilneſs has been obſerved to go off without being followed either by heat or ſweat. The duration of theſe ſtages is ſeldom the ſame for three fits together; and as it is not uncommon for one of them to be wanting, the length of the whole fit muſt vary much more than in the true intermittent; but in general it is much ſhorter.

A patient ſubjected to hectic fever is little or nothing relieved by the occurrence of the ſweat; but is often as anxious and reſtleſs under it as during the chilneſs or heat. When the ſweat is over, the fever will ſometimes continue; and in the middle of the fever the chilneſs will return; which is a moſt certain mark of this diſeaſe.

The hectic fever will return with great exactneſs, like an intermittent, for two or perhaps three fits; but Dr Heberden informs us, that he does not remember ever to have known it keep the ſame period for four fits ſucceſſively. The paroxyſm will now and then keep off for 10 or 12 days; and at other times, eſpecially when the patient is very ill, it will return ſo frequently on the ſame day, that the chilneſs of a new fit will follow immediately the ſweat of the former. It is not unuſual to have many threatenings of a ſhivering in the ſame day; and ſome degree of drowſineſs is apt to attend the ceſſation of a fit.

The urine in a true intermittent is clear during the fits and turbid during the intervals; but in the hectic fever it is liable to all kinds of irregularity. It will be equally clear or turbid in both ſtages; or turbid in the fits and clear in the intervals; and ſometimes it will be, as in a true intermittent, clear during the fever, and thick at the going off.

Hectic patients often complain of pains like thoſe of the rheumatiſm, which either affect by turns almoſt every

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every part of the body, or elſe return conſtantly to the ſame part; which is often at a great diſtance from the ſeat of the principal diſorder, and, as far as is known, without any peculiar connection with it. Thoſe pains are ſo violent in ſome patients, as to require a large quantity of opium. As far as Dr Heberden has obſerved, they are moſt common where the hectic ariſes from ſome ulcer open to the external air, as in cancers of the face, breaſt, &c. Joined with this fever, and ariſing probably from one common cauſe, he has been ſurpriſed to ſee ſwellings of the limbs, neck, or trunk of the body, riſe up almoſt in an inſtant, as if the part was all at once grown fatter. Theſe ſwellings are not painful, hard, or diſcoloured, and they continue for ſeveral hours.

Dr Heberden has ſeen this fever attack thoſe who ſeemed in tolerable health, in a ſudden and violent manner, like a common inflammatory one; and like that, alſo, in a very ſhort time bring them into imminent danger of their lives; after which it has begun to abate, and to afford hopes of a perfect recovery. But though the danger might be over for the preſent, and but little of a fever remain; yet that little has ſoon demonſtrated, that it was kept up by ſome great miſchief within, and, proving unconquerable by any remedies, has gradually undermined the health of the patient, and never ceaſed except with his life. This manner of its beginning, however, is a rare occurrence. It much oftener diſſembles its ſtrength at firſt; and creeps on ſo ſlowly, that the ſubjects of it, though they be not perfectly well, yet for ſome months hardly think themſelves ill; complaining only of being ſooner tired with exerciſe than uſual, of want of appetite, and of falling away. But gentle as the ſymptoms may ſeem, if the pulſe be quicker than ordinary, ſo as to have the artery to beat 90 times and perhaps 120 times in a minute, there is the greateſt reaſon to be apprehenſive of the event. In no diſorder, perhaps, is the pulſe of more uſe to guide our judgement than in the hectic fever: yet even here we muſt be upon our guard, and not truſt entirely to this criterion; for one in about twenty patients, with all the worſt ſigns of decay from ſome incurable cauſe, which irreſiſtibly goes on to deſtroy his life, will ſhow not the ſmalleſt degree of quickneſs, nor any other irregularity of the pulſe, to the day of his death.

Cauſes, &c. This fever will ſupervene whenever there is a great collection of matter formed in any part of the body; but it more particularly attends upon the inflammation of a ſcirrhous gland, and even upon one that is ſlight and only juſt beginning; the fever growing worſe in proportion as the gland becomes more inflamed, ulcered, or gangrenous. And ſuch is the lingering nature of thoſe glandular diſorders, that the firſt of thoſe ſtages will continue for many months, and the ſecond for ſome years.

If this ſcirrhous inflammation be external, or in the lungs, or ſome of the abdominal viſcera, where the diſturbance of their functions plainly points out the ſeat of the diſorder, no doubt can be entertained concerning the cauſe of the fever. But if the part affected be not obvious to the ſenſes, and its preciſe functions be not known, the hectic, which is there only part of the train of another diſeaſe, may be miſtaken for the primary or only affection.

Hectica.

Lying-in-women, on account of the violence ſuſtained in delivery, generally die when affected with this fever. Women of the age of near 50 and upwards are particularly liable to it. For, upon the ceſſation of their natural diſcharge, the glands of the breaſts, ovaries, or womb, too commonly begin to grow ſcirrhous, and proceed to be cancerous. Not only theſe, but the glandular parts of all the abdominal viſcera, are diſpoſed to be affected at this particular time, and to become the ſeats of incurable diſorders.

The injuries done to the ſtomach and liver by hard drinking are attended with ſimilar ſymptoms, and terminate in the ſame manner.

Dr Heberden obſerves, that the ſlighteſt wound by a fine-pointed inſtrument is known upon ſome occaſions to bring on the greateſt diſturbances, and the moſt alarming ſymptoms, nay even death itſelf. For not only the wounded part will ſwell and be painful, but by turns almoſt every part of the body; and very diſtant parts have been known to come even to ſuppuration. Theſe ſymptoms are conſtantly accompanied with this irregular intermittent, which laſts as long as any of them remain.

Prognoſis. This anomalous fever is never leſs dangerous than when it originates from a kindly ſuppuration, into which all the diſeaſed parts are melted down, and for which there is a proper outlet.

The ſymptoms and danger from ſome ſmall punctures, with their concomitant fever, moſt frequently give way in a few days; though in ſome perſons they have continued for two or three months, and in others have proved fatal.

The inflammation of internal ſcirrhous glands, or of thoſe in the breaſts, ſometimes goes off, and the fever, which depended upon it, ceaſes; but it much oftener happens, that it proceeds to cancerous and gangrenous ulcers, and terminates only in death. Death is alſo, almoſt univerſally, the conſequence of hectic fever from tubercles of the lungs, which have in general at leaſt been conſidered as glandular bodies in a ſcirrhous ſtate.

Cure. It is not to be expected that the ſame remedies will in every caſe be adapted to a fever which, ariſing from very different cauſes, is attended with ſuch a variety of ſymptoms. A mixture of aſſafœtida and opium has in ſome perſons ſeemed ſingularly ſerviceable in this fever, when brought on by a ſmall wound; but in moſt other caſes the principal if not the ſole attention of the phyſician muſt be employed in relieving the ſymptoms, by tempering the heat, by preventing both coſtiveneſs and purging, by procuring ſleep, and by checking the ſweats. If, at the ſame time, continues Dr Heberden, he put the body into as good general health as may be, by air, exerciſe, and a proper courſe of mild diet, he can perhaps do nothing better than to leave all the reſt to nature. In ſome few fortunate patients, nature appears to have ſuch reſources, as may afford reaſon for entertaining hopes of cure, even in very bad caſes. For ſome have recovered from this fever attended with every ſymptom of an abdominal viſcus incurably diſeaſed, after all probable methods of relief from art had been tried in vain, and after the fleſh and ſtrength were ſo exhauſted as to leave ſcarce any hopes from nature. In thoſe deplorable

Phlegmasiæ.

ble circumstances, there has arisen a swelling not far from the probable seat of the disorder, and yet without any discoverable communication with it. This swelling has come to an abscess; in consequence of which the pulse has soon returned to its natural state, as have also the appetite, flesh, and strength. What nature has performed in those rare cases, Dr Heberden acquaints us, he has often endeavoured to imitate, by making issues or applying blisters near the seat of the disease; but he cannot say with the same success.

It seems at present, Dr Heberden observes, to be the opinion of many practitioners, that gangrenes will be stopped, and suppuration become more kindly, by the use of Peruvian bark; and therefore this remedy is always either advised or permitted in the irregular fever joined with suppurations and gangrenes. But he affirms he does not remember ever to have seen any good effect from cinchona in this fever unattended with an apparent ulcer; and even in gangrenes it so often fails, that in successful cases, where it has been administered, there must be room for suspicion that the success was owing to another cause. Dr Heberden acknowledges at the same time, that he never saw any harm from cinchona, in these, or indeed in any other cases, except a slight temporary purging or sickness, where it has happened to disagree with the stomach, or where the latter has been loaded by taking the medicine too fast, especially in dry boluses wrapped in wafer-paper.

In hectic illnesses, where all other means have proved ineffectual, a journey to Bath is usually proposed by the friends, and wished for by the sick; but Dr Heberden justly observes, that, besides the fatigue and many inconveniences of a journey to a dying person, the Bath waters are peculiarly hurtful in this fever, which they never fail to increase, and thereby aggravate the sufferings and hasten the death of the patient.

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Order II. PHLEGMASIÆ.

Phlegmasiæ membranosæ et parenchymatosæ, *Sauv.* Class III. Ord. I. II. *Sag.* 605.
Morbi febriles phlogistici, *Lin.* Class III.
Febres continuæ compositæ inflammatoriæ, *Vog.*
Morbi acuti febriles, *Boerh.* 770.
Febres inflammatoriæ, *Hoffm.* II. 105. *Junck.* 61.

The phlegmasiæ, or topical inflammations, are a very numerous assemblage of diseases. Their great characteristics are, the general symptoms of fever, and a topical inflammation, attended with the lesion of some important function. In most instances, when blood is drawn, it is found upon coagulation to be covered with a buffy coat. Under this order, many important genera are comprehended, each requiring a separate consideration.

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Genus VII. PHLOGOSIS.

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Sp. I. Phlogosis phlegmone.

Phlegmone auctorum, *Sauv.* gen. 15. *Lin.* 39. *Vog.* 351.
Inflammatio, *Lin.* 231. *Boerh.* 370. *Junck.* 20.

This disease is a synocha fever, accompanied with an inflammation of some particular part either external or internal, and consequently it varies very much in its form and the degree of danger attending it, according to the situation and functions of the part affected with topical inflammation. To this species, therefore, belong the following diseases:

Phlogosis.

Furunculus, *Sauv.* gen. 18. *Vog.* 352.
Terminthus, *Vog.* 381.
Pupula, *Lin.* 275. *Sauv.* p. 6.
Varus, *Vog.* 436. *Lin.* 269. *Sauv.* p. 7.
Bacchia, *Lin.* 270.
Gutta rosea, *Sauv.* gen. 4.
Gutta rosacea, *Vog.* 437.
Hordeolum, *Sauv.* gen. 27. *Lin.* 276. *Vog.* 434.
Otalgia, *Sauv.* gen. 197. *Lin.* 44. *Vog.* 148.
Dolor otalgicus, *Hoffm.* II. 336.
Parulis, *Vog.* 362.
Mastodynia, *Sauv.* gen. 210. *Vog.* 153.
Paronychia, *Sauv.* gen. 21. *Lin.* 258. *Vog.* 345.
Arthrocace, *Sauv.* gen. 78. *Lin.* 256.
  Pædarthrocace, *Vog.* 419.
  Spina ventosa, *Boerh.* 526.
Phimosis, *Sauv.* gen. 22. *Lin.* 297. *Vog.* 348.
  Paraphimosis, *Vog.* 349.

For the cure of inflammations, Dr Cullen lays down the following indications. 1. To remove the remote causes when they are evident and continue to operate. 2. To take off the phlogistic diathesis affecting the whole system, or the particular part. 3. To take off the spasm of the particular part, by remedies applied to the whole system, or to the part itself.

The means of removing the remote causes will readily occur, from considering the particular nature and circumstances of the different kinds. Acrid matters must be removed, or their action must be prevented, by the application of demulcents. Compressing and overstretching powers must be taken away; and from their several circumstances, the means of doing so will be obvious.

The means of taking off the phlogistic diathesis of the system are the same with those already mentioned under the cure for synocha. The means of taking off the spasm also from the particular part, are much the same with those already mentioned. Only it is to be remembered, that topical bleedings, such as cupping with scarifications, applying leeches, &c. are in this case much more indicated; and that some of the other remedies are to be directed more particularly to the part affected, as shall be more fully considered when we treat of those diseases attended with particular inflammations.

When a tendency to suppuration is perceived, the proper indication is to promote the production of perfect pus as much as possible. For this purpose various remedies, supposed to possess a specific power, have been proposed: but it does not appear that any of them are possessed of a virtue of this kind; and, in Dr Cullen's opinion, all that can be done is to favour the suppuration by such applications as may support a moderate heat in the part, by some tenacity confine the perspiration, and by an emollient quality may weaken the cohesion of the teguments, and favour their erosion. As all abscesses are occasioned by the effusion of fluids, and as in the case of certain effusions a suppuration becomes

comes not only unavoidable but deſirable, it may be ſuppoſed that moſt of the means of procuring a reſolution, by diminiſhing the force of circulation, &c. ought to be avoided. But as we obſerve on the one hand, that a certain degree of increaſed impetus, or of the original ſymptoms of inflammation, is neceſſary to produce a proper ſuppuration; ſo it is then eſpecially neceſſary to avoid thoſe means of reſolution which may diminiſh too much the force of circulation. And on the other hand, as the impetus of the blood, when violent, is found to prevent the proper ſuppuration; ſo, in ſuch caſes, though a tendency to ſuppuration may have begun, it may be proper to continue thoſe means of reſolution which moderate the force of the circulation. With reſpect to the opening of abſceſſes when completely formed, ſee the article SURGERY.

When an inflammation has taken a tendency to gangrene, that event is to be prevented by every poſſible means; and theſe muſt be different according to the nature of the ſeveral cauſes: but after a gangrene has in ſome degree taken place, it can be cured only by the ſeparation of the dead from the living parts. This in certain circumſtances can be performed, and moſt properly, by the knife. In other caſes it can be done by exciting a ſuppuratory inflammation on the verge of the living part, whereby its coheſion with the dead part may be everywhere broken off, ſo that the latter may fall off by itſelf. While this is doing, it is proper to prevent the further putrefaction of the part, and its ſpreading wider. For this purpoſe various antiſeptic applications have been propoſed: but Dr Cullen is of opinion, that while the teguments are entire, theſe applications can hardly have any effect; and therefore, that the fundamental procedure muſt be to ſcarify the part ſo as to reach the living ſubſtance, and, by the wounds made there, to excite the ſuppuration required. By the ſame inciſions alſo we give acceſs to antiſeptics, which may both prevent the progreſs of the putrefaction in the dead, and excite the inflammation neceſſary on the verge of the living parts.

When the gangrene proceeds from loſs of tone, and when this, communicated to the neighbouring parts, prevents that inflammation which, as we have ſaid, is requiſite to the ſeparation of the dead parts from the living, it will be neceſſary to obviate this loſs of tone by tonic medicines given internally; and for this purpoſe cinchona has been found to be moſt effectual. But when the gangrene ariſes from the violence of inflammation, the bark may not only fail of proving a remedy, but may do harm: for its power as a tonic is eſpecially ſuited to thoſe caſes of gangrene which proceed from an original loſs of tone, as in the caſe of palſy and œdema; or in thoſe caſes where a loſs of tone takes place after the original inflammatory ſymptoms are removed.

On the other hand, Mr Bell is of opinion, that inciſions made with a view to admit the operation of antiſeptic remedies in gangrenes, as well as the remedies themſelves, muſt be pernicious from the irritation they occaſion, and from the danger of wounding blood-veſſels, nerves, or tendons, and alſo by allowing a free paſſage for the putreſcent fluids into the parts not yet affected. And unleſs they be carried ſo deep as to reach the ſound parts, applications of the antiſeptic kind can never have any effect in anſwering the purpoſe for which they were intended. The ſame author alſo remarks, that all the advantages commonly obſerved from the great number of applications recommended for gangrene, are obtained with more eaſe, and generally too with more certainty, from the uſe of ſome gentle ſtimulating embrocation; which, by exciting a ſlight irritation upon the ſurface, eſpecially when aſſiſted by a free uſe of cinchona, produces for the moſt part ſuch a degree of inflammation as is wiſhed for. With this view he has frequently known a weak ſolution of ſal ammoniac, a dram of the ſalt to two ounces of vinegar and ſix of water, form a mixture of very proper ſtrength for every purpoſe of this kind. But the degree of ſtimulus can eaſily be either increaſed or diminiſhed according to circumſtances, by uſing a larger or ſmaller proportion of the ſalt.

Whenever, either by the means recommended, or by a natural exertion of the ſyſtem, a ſlight inflammation appears between the diſeaſed and ſound parts, we may in general, with tolerable certainty, expect, that in due time the parts will be ſeparated; and when a full ſuppuration is once fairly eſtabliſhed, there can be little doubt that the mortified parts will be ſoon and eaſily removed.

A complete ſeparation being effected, the ſore is to be treated in the manner deſcribed under the article SURGERY; with a proper attention, at the ſame time, to the ſupport of the general ſyſtem by the continuance of nouriſhing diet, and cinchona with ſuch quantities of wine as may ſeem neceſſary.

With regard to the bark, however, it is proper to take notice of another caſe of mortification in which it is likewiſe unſucceſsful, as well as in that attended with a high degree of inflammation; and that is, in thoſe mortifications of the toes and feet, common in old people, or which ariſe from any cauſe increaſing the rigidity of the veſſels to ſuch a degree as to prevent the motion of the fluids through them. In this caſe Mr Pott has diſcovered, that all kinds of warm applications are very unſucceſsful; but by the free uſe of opium, together with ſedatives and relaxants externally applied, he has frequently ſeen the tumefaction of the feet and ankles ſubſide, the ſkin recover its natural colour, and all the mortified parts ſeparate in a very ſhort time, leaving a clean ſore. But as to ſcarifications, or any other attempt to ſeparate artificially the mortified from the ſound parts, he thinks them very prejudicial, by giving pain; which is generally of itſelf violent in this diſeaſe, and which ſeems to have a great ſhare in producing the other evils.

The other terminations of inflammation either do not admit of any treatment except that of preventing them by reſolution, or properly belong to the article SURGERY.

Sp. II. PHLOGOSIS ERYTHEMA. 173

Erythema, *Sauv.* gen. 11.
  Eryſipelas auctorum, *Vog.* 343.
  Hieropyr. *Vog.* 344.
Anthrax, *Sauv.* gen. 19. *Lin.* 272. *Vog.* 353.
  Carbo et carbunculus auctorum.
  Erythema gangrænoſum, *Sauv.* ſp. 7.
Erythema à frigore.
  Erythema pernio, *Sauv.* ſp. 4.
  Pernio, *Lin.* 259. *Vog.* 350.

Erythema

Phlegmasiæ.

Erythema ambustio, *Sauv.* sp. 2.
Erysipelas ambustio, *Sauv.* sp. 4.
Combustura, *Lin.* 245.
Combustio, *Boerh.* 476.
Encausis, *Vog.* 347.
Erythema ab acri alieno applicato.
Erysipelas Sinense, *Sauv.* sp. 7.
Erythema ab acri inquilino.
Erythema intertrigo, *Sauv.* sp. 5.
Intertrigo, *Lin.* 247. *Vog.* 502.
Erythema à compressione.
Erythema paratrima, *Sauv.* sp. 6.
Erythema à punctura, *Sauv.* sp. 9.
Erysipelas à vespis, *Sauv.* sp. 19.
Psydracia à vespis, *Sauv.* sp. 2.
Erythema cum phlegmone.
Erysipelas phlegmonodes auctorum.
Erythema cum œdemate.
Erysipelas symptomaticum, *Sauv.* sp. 6.

The word *erythema* does not apply to any primary disease, but to a great number of those cutaneous inflammations denominated by another general term, viz. the *erysipelas*, or "St Anthony's fire;" and which being commonly symptomatic of some other inflammation or disorder, are to be removed only by removing the primary disease: the erythema is found scarcely to bear any kind of warm application to itself; and is very apt, if treated as a primary disease, to terminate in a gangrene of the part affected, or some other disorder still more dangerous. The difference between the *phlegmon* or preceding species, and *erythema*, according to Dr Cullen, is, that, in the former, the inflammation seems particularly to affect the vessels on the internal surface of the skin, communicating with the lax adjacent cellular texture; whence a more copious effusion, and that too of serum convertible into pus, takes place. In the erythema the affection is of the vessels on the external surface of the skin communicating with the *rete mucosum*. This affection does not admit of any effusion but what separates the cuticle, and gives occasion to the formation of a blister, while the smaller size of the vessels admits only of the effusion of a thin fluid very seldom convertible into pus. For the cure of the fever attended with erythema or *erysipelas*, see below; and for the external treatment of erythema, see SURGERY.

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GENUS VIII. OPHTHALMIA.

Inflammation of the EYES.

Ophthalmia, *Sauv.* gen. 196. *Lin.* 43. *Vog.* 341. *Sag.* 231. *Junck.* 24.
Chemosis, *Vog.* 46.
Ophthalmites, *Vog.* 47.
Inflammatio oculorum, *Hoffm.* II. 165.
Ophthalmia taraxis, *Sauv.* sp. 1.
Ophthalmia humida, *Sauv.* sp. 8.
Ophthalmia chemosis, *Sauv.* sp. 12.
Ophthalmia erysipelatosa, *Sauv.* sp. 7.
Ophthalmia pustulosa, *Sauv.* sp. 6.
Ophthalmia phlyctænodes, *Sauv.* sp. 21.
Ophthalmia choroeidea, *Sauv.* sp. 13.
Ophthalmia tenebricosa, *Sauv.* sp. 10.
Ophthalmia trachoma, *Sauv.* sp. 4.
Ophthalmia sicca, *Sauv.* sp. 5.
Ophthalmia angularis, *Sauv.* sp. 14.
Ophthalmia tuberculosa, *Sauv.* sp. 3.
Ophthalmia trichiasis, *Sauv.* sp. 2.
Ophthalmia cancrosa, *Sauv.* sp. 15.
Ophthalmia à synechiâ, *Sauv.* sp. 16.
Ophthalmia à lagophthalmo, *Sauv.* sp. 17.
Ophthalmia ab elcomate, *Sauv.* sp. 18.
Ophthalmia ab ungue, *Sauv.* sp. 19.
Ophthalmia à corneæ fistulâ, *Sauv.* sp. 20.
Ophthalmia uveæ, *Sauv.* sp. 22.
Ophthalmia metastatica, *Sauv.* sp. 24.
Ophthalmia scrophulosa, *Sauv.* sp. 9.
Ophthalmia siphylitica, *Sauv.* sp. 11.
Ophthalmia febricosa, *Sauv.* sp. 23.

Ophthalmia.

From reading this long list of distinctions which authors have invented in the opththalmia, it is evident, that by far the greatest part of them are symptomatic, or merely the consequences of other disorders present in the habit; and therefore the remedies must be directed towards the removal of these primary disorders; and when they are gone the ophthalmia will be removed of course. Dr Cullen observes, that the inflammation of the eye may be considered as of two kinds; according as it is seated in the membranes of the ball of the eye, when it is named *ophthalmia membranarum;* or as it is seated in the sebaceous glands placed in the tarsus, or edges of the eyelids, in which case it may be termed *ophthalmia tarsi.* These two kinds are very frequently connected together, as the one may excite the other; but they are still to be distinguished according as the one or the other may happen to be the primary affection.

1. The inflammation of the *membranes* of the eye affects especially, and most frequently, the adnata, and appears in a turgescence of its vessels; so that the red vessels which are naturally there, become not only increased in size, but many more appear than in a natural state. This turgescence of the vessels is attended with pain, especially upon the motion of the ball of the eye; and this irritation, like every other, applied to the surface of the eye, produces an effusion of tears from the lachrymal gland.

The inflammation commonly, and chiefly, affects the adnata spread on the anterior part of the bulb of the eye; but usually spreads also along the continuation of the adnata on the inside of the palpebræ; and as that is extended on the tarsus palpebrarum, the excretories of the sebaceous glands opening there are also frequently affected. When the affection of the adnata is considerable, it may be communicated to the subjacent membranes of the eye, and even to the retina itself; which thereby acquires so great sensibility, that every impression of light becomes painful. The inflammation of the membranes of the eye is in different degrees, according as the adnata is more or less affected, or according as the inflammation is either of the adnata alone, or of the subjacent membranes also; and upon these differences, different species have been established; but they seem all to differ only in degree, and are to be cured by the same remedies more or less employed.

The proximate cause of ophthalmia is not different from that of inflammation in general; and the different circumstances of ophthalmia may be explained by by the difference of its remote causes, and by the different parts of the eye which it happens to affect; as may be understood from what has been already said. We shall therefore proceed to give an account of the method of cure.

The great objects to be aimed at in the treatment of ophthalmia, are, in the first place, the resolution of the inflammation which has already taken place; and, secondly, the removal of those consequences which frequently arise from the inflammation, especially if it have been of long standing. But besides these, while it has appeared from former observation, that there is a peculiar disposition to the disease, practices may often be successfully employed to combat this disposition, and thus prevent the return of the affection.

The ophthalmia membranarum requires the remedies proper for inflammation in general; and when the deeper-seated membranes are affected, and especially when a pyrexia is present, large general bleedings may be necessary. But this last is seldom requisite, and, for the most part, the ophthalmia is an affection merely local, accompanied with little or no pyrexia. General bleedings therefore have little effect upon it, and the cure is chiefly to be obtained by topical bleedings, that is, blood drawn from the vessels near the inflamed part; and opening the jugular vein, or the temporal artery, may be considered as in some measure of this kind. It is commonly sufficient to apply a number of leeches round the eye; but it is perhaps still better to draw blood by cupping and scarifying from the temples. In many cases, the most effectual remedy is to scarify the internal surface of the inferior eyelid, and to cut the turgid vessels upon the adnata itself.

Besides bloodletting, purging, as a remedy suited to inflammation in general, has been considered as peculiarly adapted to inflammation in any part of the head, and therefore to ophthalmia; and it is sometimes useful: but, for the reasons given before with respect to general bleeding, purging in the case of ophthalmia does not prove useful in any proportion to the evacuation excited.—For relaxing the spasm in the part, and taking off the determination of the fluids to it, blistering near the part has commonly been found useful. When the inflammation does not yield to the application of blisters after topical bleeding, great benefit is often obtained by supporting a discharge from the blistered part, under the form of an issue, by which means a more permanent determination of blood from the part is obtained.

It is probably also on the same principle that the good effects obtained from the use of errhine medicines in obstinate cases of ophthalmia are to be accounted for. By these errhines, in particular, which occasion and support for some time a great discharge from the nose, great benefit has often been obtained. The powder of asarabacca, or the infusion of hippocastanum, snuffed up the nose at bedtime in proper doses, are often productive of the best effects, when many other remedies have been tried in vain.

Ophthalmia, as an external inflammation, admits of topical applications. All those, however, which increase the heat and relax the vessels of the part, prove hurtful; and the admission of cool air to the eye, and the application of cooling and astringent medicines, which at the same time do not produce irritation, prove useful. Of all these the solution of acetite of lead, assiduously applied, is perhaps the best. In the cure of this distemper, indeed, all irritation must carefully be avoided, particularly that of light; and the only certain means of doing this is by keeping the patient in a very dark chamber.

2. In the *ophthalmia tarsi*, the same medicines may be necessary, as have been already recommended for the ophthalmia membranarum. However, as the ophthalmia tarsi may often depend upon an acrimony deposited in the sebaceous glands of the part, so it may require various internal remedies according to the variety of the acrimony in fault; for which we must refer to the consideration of scrophula, siphylis, or other diseases with which this ophthalmia may be connected; and where these shall not be evident, certain remedies more generally adapted to the evacuation of acrimony, such as mercury, may be employed. In the ophthalmia tarsi, it almost constantly happens that some ulcerations are formed on the tarsus. These require the application of mercury and copper, which alone may sometimes cure the whole affection; and they may be useful even when the disease depends upon a fault of the whole system.

Both in the ophthalmia membranarum, and in the ophthalmia tarsi, it is necessary to obviate that gluing together of the eyelids which commonly happens in sleep; and which may be done by insinuating a little of any mild unctuous medicine between the eyelids before the patient shall go to sleep.

The slighter kinds of inflammations from the dust or the sun, may be removed by fomenting with warm milk and water, adding a small portion of brandy; and by anointing the borders of the eyelids with *unguentum tutiæ*, or the like, at night, especially when those parts are excoriated and sore. But in bad cases, after the inflammation has yielded a little to evacuations, the *cataplasma aluminis* of the London Pharmacopœia spread on lint, and applied at bedtime, has been found the best external remedy. Before the use of the latter, the solution of sulphate of zinc is prescribed with advantage; and in violent pains it is of service to foment frequently with a decoction of white poppy-heads. One of the most common and most disagreeable consequences of ophthalmia, is an offuscation of the cornea, so far obstructing the passage of light as to diminish or prevent vision. This is sometimes so considerable as to admit of removal by operation: but in slighter cases it may often be removed by the application of different gentle escharotics; and in this way, without the least danger of any inconvenience, good effects are often obtained, from gently introducing into the eye at bedtime a powder consisting of equal parts of supertartrite of potash and sugar, reduced together to a fine powder.

Where there is a disposition to frequent returns of this affection, cinchona is often employed with success in combating it: But nothing in general answers better than frequent and regular cold bathing of the eyes.

Besides the various species of ophthalmia which were before known in Britain, another has lately been introduced, that contagious ophthalmia, viz. with which the British

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British troops were affected in Egypt, and which they have imported into this island on their return from thence.

Of this affection many interesting accounts have been published. Perhaps the best is an elaborate treatise by Mr Edmonston, who has had many opportunities of witnessing the affection, and extensive practice in the treatment of the disease, both in Egypt and in Britain. To his work therefore we may refer those who wish for the most full information respecting it. We shall only observe, that now, no doubt can be entertained respecting the contagious nature of the disease; and that therefore the first great object necessary in the treatment is the complete separation of the diseased from the sound.

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Genus IX. PHRENITIS.

Phrensy, or *Inflammation of the Brain*.

Phrenitis, *Sauv.* gen. 101. *Lin.* 25. *Sag.* gen. 301. *Boerh.* 771. *Hoffm.* II. 131. *Junck.* 63.
Phrenismus, *Vog.* 45.
Cephalitis, *Sauv.* gen. 109. *Sag.* gen. 310.
Sphacelismus, *Lin.* 32.
Phrenitis vera, *Sauv.* sp. 1. *Boerh.* 771.
Phrenitis idiopathica, *Junck.* 63.
Cephalalgia inflammatoria, *Sauv.* sp. 9.
Cephalitis spontanea, *Sauv.* sp. 3.
Cephalitis siriasis, *Sauv.* sp. 4.
Siriasis, *Vog.* 34.
Cephalitis Littriana, *Sauv.* sp. 5.

Dr Cullen observes, that the true phrenitis, or inflammation of the membranes or substance of the brain, is very rare as an original disease: but, as a symptom of others, much more frequent; of which the following kinds are enumerated by different authors:

Phrenitis synochi pleuriticæ, *Sauv.* sp. 2.
Phrenitis synochi sanguineæ, *Sauv.* sp. 4.
Phrenitis calentura, *Sauv.* sp. 11.
Phrenitis Indica, *Sauv.* sp. 12.
Cephalitis Ægyptiaca, *Sauv.* sp. 1.
Cephalitis epidemica anno 1510, *Sauv.* sp. 6.
Cephalitis verminosa, *Sauv.* sp. 7.
Cephalitis cerebelli, *Sauv.* sp. 8.
Phrenitis miliaris, *Sauv.* sp. 3.
Phrenitis variolosa, *Sauv.* sp. 5.
Phrenitis morbillosa, *Sauv.* sp. 6.
Phrenitis à plicâ, *Sauv.* sp. 8.
Phrenitis aphrodisiaca, *Sauv.* sp. 9.
Phrenitis à tarantismo, *Sauv.* sp. 14.
Phrenitis hydrophobica, *Sauv.* sp. 15.
Phrenitis à dolore, *Sauv.* sp. 13.
Cephalitis traumatica, *Sauv.* sp. 2.

Description. The signs of an impending phrenitis are, immoderate and continual watchings; or if any sleep be obtained, it is disturbed with dreams, and gives no refreshment; acute and lasting pains, especially in the hind part of the head and neck; little thirst; a great and slow respiration, as if proceeding from the bottom of the breast; the pulse sometimes small and slow, sometimes quick and frequent; a suppression of urine; and forgetfulness. The distemper when present may be known by the following signs: The veins of the head swell, and the temporal arteries throb much; the eyes are fixed, sparkle, and have a fierce aspect; the speech is incoherent, and the patient behaves very roughly to the bystanders, with furious attempts to get out of bed, not indeed continually, but returning as it were by paroxysms; the tongue is dry, rough, yellow, or black; there is a coldness of the external parts; a proneness to anger; chattering of the teeth; a trembling of the hands, with which the sick seem to be gathering something, and actually do gather the naps off the bed-clothes.

Phrenitis.

Causes of, and persons subject to, this disorder. People of a hot and bilious habit of body, and such as are of a passionate disposition, are apt to be affected with phrenitis. In the same danger are those who make much use of spices, or are given to hot and spirituous liquors; who have been exposed more than usual to the sun, or obliged to undergo immoderate studies or watchings; who are subject to headachs, or in whom some customary hemorrhages have been stopped; or the disease may arise from some injury offered to the head externally. Sir John Pringle observes, that the phrenitis, when considered as an original disease, is apt to attack soldiers in the summer-season when they are exposed to the heat of the sun, and especially when asleep and in liquor. A symptomatic phrenitis is also more frequent in the army than elsewhere, on account of the violence done to all fevers when the sick are carried in waggons from the camp to an hospital, where the very noise or light alone would be sufficient, with more delicate natures, to raise a phrensy. From these and similar causes, a state of active inflammation, affecting some parts within the cranium, is produced: and there can be no doubt, that from this all the symptoms of the disease arise, and particularly that peculiar delirium which characterizes it. But in what manner local diseases, even of the brain itself, produce affections of the mind, we are still totally in the dark.

Prognosis. Every kind of phrenitis, whether idiopathic or symptomatic, is attended with a high degree of danger; and, unless removed before the fourth day, a gangrene or sphacelus of the meninges readily takes place, and the patient dies delirious. The following are the most fatal symptoms: A continual and furious delirium, with watching; thin watery urine, white fæces, the urine and stools running off involuntarily, or a total suppression of these excretions; a ready disposition to become stupid, or to faint; trembling, rigor, chattering of the teeth, convulsions, hiccough, coldness of the extremities, trembling of the tongue, shrill voice, a sudden cessation of pain, with apparent tranquillity. The following are favourable: Sweats, apparently critical, breaking out; a seeming effort of nature to terminate the disease by a diarrhœa; a large hemorrhagy from the nose; swellings of the glands behind the ears; hæmorrhoids.

Cure. From what has been said of the theory of this disease, the cure must entirely depend on obtaining a resolution of the inflammation. The objects chiefly to be aimed at with this view are, 1. The removal of such exciting causes as continue to operate. 2. The diminution of the momentum of the blood in the circulating system in general. 3. The diminution of impetus at the brain in particular: and, 4. The avoiding

Phlegmasiæ. ing circumſtances which tend either to accelerate the motion of the blood or to give determination to the head.

Different practices may be uſed with theſe intentions; but the moſt powerful remedies are to be immediately employed. Large and repeated bleedings are eſpecially neceſſary; and theſe too taken from veſſels as near as poſſible to the part affected. The opening the temporal artery has been recommended, and with ſome reaſon: but as the practice is attended with inconveniences, perhaps the opening of the jugular veins may in general prove more effectual; with which, however, may be joined the drawing of blood from the temples by cupping and ſcarifying. It is alſo probable, that purging may be of more uſe in this than in ſome other inflammatory affections, as it may operate by revulſion. For the ſame purpoſe of revulſion, warm pediluvia are a remedy, but rather ambiguous. The taking off the force of the blood in the veſſels of the head by an erect poſture is generally uſeful. Bliſtering is alſo uſeful, but chiefly when applied near to the part affected. In ſhort, every part of the antiphlogiſtic regimen is here neceſſary, and particularly the admiſſion of cold air. Even cold ſubſtances applied to the head have been found uſeful; and the application of ſuch refrigerants as vinegar is certainly proper. Opiates are thought to be hurtful in every inflammatory ſtate of the brain. On the whole, however, it muſt be remarked, that practitioners are very uncertain with regard to the means proper to be uſed in this diſeaſe; and the more ſo, that the ſymptoms by which the diſeaſe is commonly judged to be preſent, appear ſometimes without any internal inflammation; and on the other hand, diſſections have ſhown that the brain has been inflamed, where few of the peculiar ſymptoms of inflammation had appeared before death.

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Genus X. CYNANCHE.

Cynanche, *Sauv.* gen. 110. *Lin.* 33. *Sag.* gen. 300.
Angina, *Vog.* 49. *Hoffm.* II. 125. *Junck.* 30.
Angina inflammatoria, *Boerh.* 798.

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Sp. I. Cynanche tonsillaris.
The *Inflammatory Quinsy*.

Cynanche tonſillaris, *Sauv.* ſp. 1.
Angina inflammatoria, ſp. 5. *Boerh.* 805.

Deſcription. This is an inflammation of the mucous membrane of the fauces, affecting principally that congeries of mucous follicles which forms the tonſils; and from thence ſpreading along the velum and uvula, ſo as frequently to affect every part of the mucous membrane. The diſeaſe appears by ſome tumour and redneſs of the parts; is attended with a painful and difficult deglutition; a troubleſome clammineſs of the mouth and throat; a frequent but difficult excretion of mucus; and the whole is accompanied with pyrexia. The inflammation and tumour are commonly at firſt moſt conſiderable in one tonſil; and afterwards, abating in that, increaſe in the other. This diſeaſe is not contagious.

Cauſes of, and perſons ſubject, to this diſorder. This diſeaſe is commonly occaſioned by cold externally applied, particularly about the neck. It affects eſpecially the young and ſanguine; and a diſpoſition to t s often acquired by habit. It occurs eſpecially in the ſpring and autumn, when viciſſitudes of heat and cold frequently take place.

Cynanche. *Prognoſis.* This ſpecies of cynanche terminates frequently by reſolution, ſometimes by ſuppuration, but hardly ever by gangrene; though in ſome caſes ſloughy ſpots appear on the fauces: the prognoſis therefore is generally favourable.

Cure. As the principal morbid affection in this diſeaſe, on which all its characteriſing ſymptoms immediately depend, is the active inflammation in the tonſils and neighbouring parts, the object firſt and principally to be aimed at in the cure is to obtain a reſolution of this inflammation. Sometimes, however, it is neceſſary to have recourſe to practices, with the view of obviating urgent ſymptoms before a reſolution can be affected: and in other caſes, where a reſolution cannot be obtained, it muſt be the aim of the practitioner to promote a ſpeedy and favourable ſuppuration. After ſuppuration has taken place, the proper means of promoting a diſcharge of the purulent matter will conclude the cure. Here ſome bleeding may be neceſſary; but large and general evacuations are ſeldom beneficial. The opening of the ranular veins is an inſignificant remedy, according to Dr Cullen, but is recommended as efficacious by Sir John Pringle: more benefit, however, may in general be derived from leeches to the external fauces. The inflammation may be often relieved by moderate aſtringents, and particularly by acids applied to the parts affected. In many caſes, nothing has been found to give more relief than the vapour of warm water received into the fauces.

Beſides theſe, bliſtering, and ſtill more frequently rubefacient medicines, are applied with ſucceſs, as well as antiphlogiſtic purgatives; and every part of the antiphlogiſtic regimen is to be obſerved, except the application of cold. Sir John Pringle recommends a thick piece of flannel moiſtened with two parts of common ſweet oil, and one of ſpirit of hartſhorn (or in a larger proportion, if the ſkin will bear it), to be applied to the throat, and renewed once every four or five hours. By this means the neck, and ſometimes the whole body, is put into a ſweat, which after bleeding either carries off or leſſens the inflammation. When the diſeaſe has a tendency to ſuppuration, nothing will be more uſeful than receiving into the fauces the ſteams of warm water. Benefit is alſo obtained from poultices applied to the external fauces. When the abſceſs is attended with much ſwelling, if it break not ſpontaneouſly, it ought to be opened by a lancet; and this does not require much caution, as even the inflammatory ſtate may be relieved by ſome ſcarification of the tonſils. When this diſeaſe runs very rapidly to ſuch a height as to threaten ſuffocation, it is ſometimes neceſſary to have recourſe to bronchotomy as the only mean of ſaving the life of the patient. But there is reaſon to believe that this operation has ſometimes been employed where it was not neceſſary: and we may ſafely venture to ſay, that it is but ſeldom requiſite; inſomuch that Dr Cullen tells us, he has never in his practice ſeen any caſe requiring bronchotomy.

Sp. II. Cynanche maligna. 178
The *malignant*, *putrid*, or *ulcerous* Sore Throat.

Cynanche maligna, *Sauv.* ſp 3.

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Cynanche ulcerosa, *Sauv.* var. a. Journ. de Med. 1758.

Cynanche gangrænosa, *Sauv.* var. b. Journ. de Med. 1756.

Ulcera faucium et gutturis anginosa et lethalia, Hispanis *Garrotillo*, *Lud. Mercat.* consult. 24.

Angina ulcerosa, *Fothergill*'s Account of the ulcerous sore throat, edit. 1751. *Huxham* on the malignant ulcerous sore throat, from 1751 to 1753.

Febris epidemica cum angina ulcusculosa, *Douglas*'s Practical History, Boston 1736.

Angina epidemica. *Russel*, Oecon. Natur. p. 105.

Angina gangrænosa, *Withering*'s Dissert. Inaug. Edinb. 1766.

Angina suffocativa, *Bard*'s Inquiry, New York, 1771.

Angina maligna, *Johnstone* on the malignant Angina, Worcester, 1779.

History and Description. This distemper is not particularly described by the ancient physicians; though perhaps the Syrian and Egyptian ulcers mentioned by Aretæus Cappadox, and the pestilent ulcerated tonsils we read of in Aetius Amideus, were of this nature. Some of the scarlet fevers mentioned by Morton seem also to have approached near to it. In the beginning of the last century, a disease exactly similar to this is described by the physicians of that time, as raging with great violence and mortality in Spain and some parts of Italy; but no account of it was published in this country till the year 1748, when a very accurate one was drawn up by Dr Fothergill, and in 1752 by Dr Huxham. The latter observes, that this disease was preceded by long, cold, and wet seasons; by which probably the bodies of people were debilitated, and more apt to receive contagion, which possibly also might be produced by the stagnant and putrid waters.

The attack of this disease was very different in different persons. Sometimes a rigor, with fulness and soreness of the throat, and painful stiffness of the neck, were the first symptoms complained of. Sometimes alternate chills and heats, with some degree of giddiness, drowsiness, or headach, ushered in the distemper. It seized others with more severe feverish symptoms; great pain of the head, back, and limbs; a vast oppression of the præcordia, and continual sighing. Some grown persons went about for days in a drooping state, with much uneasiness and anxiety, till at last they were obliged to take to their beds.—Thus various was the disease, says Dr Huxham, at the onset. But it commonly began with chills and heats, load and pain of the head, soreness of throat, and hoarseness; some cough, sickness at stomach, frequent vomiting and purging, in children especially, which were sometimes very severe; though a contrary state was more common to the adult. There was in all a very great dejection of spirits, very sudden weakness, great heaviness on the breast, and faintness, from the very beginning. The pulse in general was quick, small, and fluttering, though sometimes heavy and undulating. The urine was commonly pale, thin, and crude; however, in many grown persons, it was passed in small quantities and high-coloured, or like turbid whey. The eyes were heavy, reddish, and as it were weeping; the countenance very often full, flushed, and bloated, though sometimes pale and sunk.

How slight soever the disorder might appear in the day-time, at night the symptoms became greatly aggravated, and the feverish habit very much increased, nay, sometimes a delirium occurred on the very first night; and this exacerbation constantly returned through the whole course of the disease. Indeed, when it was considerably on the decline, our author says he has been often pretty much surprised to find his patient had passed the whole night in a phrensy, whom he had left tolerably cool and sedate in the day.

Some few hours after the seizure, and sometimes cotemporary with it, a swelling and soreness of the throat was perceived, and the tonsils became very tumid and inflamed, and many times the parotid and maxillary glands swelled very much, and very suddenly, even at the very beginning; sometimes so much as even to threaten strangulation. The fauces also very soon appeared of a high florid red, or rather of a bright crimson, colour, very shining and glossy; and most commonly on the uvula, tonsils, velum palatinum, and back part of the pharynx, several whitish or ash-coloured spots appeared scattered up and down, which oftentimes increased very fast, and soon covered one or both the tonsils, uvula, &c.: those in the event proved sloughs of superficial ulcers (which sometimes, however, ate very deep into the parts). The tongue at this time, though only white and moist at the tip, was very foul at the root, and covered with a thick, yellowish or brown coat. The breath also now began to be very nauseous; which offensive smell increased hourly, and in some became at length intolerable, and that too sometimes even to the patients themselves.

The second or third day every symptom became much more aggravated, and the fever much more considerable; and those that had struggled with it tolerably well for 30 or 40 hours, were forced to submit. The restlessness and anxiety greatly increased, as well as the difficulty in swallowing. The head was very giddy, pained, and loaded; there was generally more or less of a delirium; sometimes a pervigilium and perpetual phrensy, though others lay very stupid, but often starting and muttering to themselves. The skin was very hot, dry, and rough; there was very rarely any disposition to sweat. The urine was pale, thin, crude; often yellowish and turbid. Sometimes vomiting was urgent, and sometimes a very great looseness, in children particularly. The sloughs were now much enlarged, and of a darker colour, and the surrounding parts tended much more to a livid hue. The breathing became much more difficult; with a kind of a rattling stertor, as if the patient was actually strangling, the voice being exceeding hoarse and hollow, exactly resembling that from venereal ulcers in the fauces: this noise in speaking and breathing was so peculiar, that any person in the least conversant with the disease might easily know it by this odd noise; from whence indeed the Spanish physicians gave it the name of *garotillo*, expressing the noise made by persons when they are strangled with a rope. Dr Fothergill never observed in one of them the shrill barking noise that we frequently hear in inflammatory cynanche. The breath

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breath of all the diseased was very nauseous; of some insufferably fetid, especially in the advance of the distemper to a crisis; and many about the fourth or fifth day spit off a vast quantity of stinking purulent mucus tinged sometimes with blood: and sometimes the matter was quite livid, and of an abominable smell. The nostrils likewise in many were greatly inflamed and excoriated, continually dripping down a very sharp ichor or sanious matter, so excessively acrid, that it not only corroded the lips, cheeks, and hands of the children that laboured under the disease, but even the fingers and arms of the very nurses that attended them: as this ulceration of the nostrils came on, it commonly caused an almost incessant sneezing in the children; but few adults were affected with it, at least to any considerable degree. It was surprising what quantities of matter some children discharged this way, which they would often rub on their face, hands, and arms, and blister them all over. A sudden stoppage of this rheum from the mouth and nostrils actually choaked several children; and some swallowed such quantities of is, as occasioned excoriations of the intestines, violent gripings, dysentery, &c. nay, even excoriations of the anus and buttocks. Not only the nostrils, fauces, &c. were greatly affected by this extremely sharp matter, but the wind-pipe itself was sometimes much corroded by it, and pieces of its internal membrane were spit up, with much blood and corruption; and the patients lingered on for a considerable time, and at length died tabid; though there were more frequent instances of its falling suddenly and violently on the lungs, and killing in a peripneumonic manner.

Dr Huxham was astonished sometimes to see several swallow with tolerable ease, though the tumour of the tonsils and throat, the quantity of thick mucus, and the rattling noise in breathing, were very terrible; which he thinks pretty clearly shows, that this malignant angina was more from the acrimony and abundance of the humours than the violence of the inflammation.

Most commonly the angina came on before the exanthemata; but many times the cuticular eruption appeared before the sore-throat, and was sometimes very considerable, though there was little or no pain in the fauces: on the contrary, a very severe angina seized some patients that had no manner of eruption; and yet, even in these cases, a very great itching and desquamation of the skin sometimes ensued; but this was chiefly in grown persons, very rarely in children. In general, however, a very considerable efflorescence broke out on the surface of the body, particularly in children; and it most commonly happened the second, third, or fourth day: sometimes it was partial, sometimes it covered almost the whole body, though very seldom the face: sometimes it was of an erysipelatous kind; sometimes more pustular: the pustules frequently eminent, and of a deep fiery red colour, particularly on the breast and arms; but oftentimes they were very small, and might be better felt than seen, and gave a very odd kind of roughness to the skin. The colour of the efflorescence was commonly of a crimson hue, or as if the skin had been smeared over with juice of rasberries, and this even to the fingers ends; and the skin appeared inflamed and swollen, as it were; the arms, hands, and fingers, were often evidently so, and very stiff, and somewhat painful. This crimson colour of the skin seemed indeed peculiar to this disease. Though the eruption seldom failed of giving some manifest relief to the patient, as to anxiety, sickness at stomach, vomiting, purging, &c. yet there was observed an universal fiery eruption on some persons, without the least abatement of the symptoms, nay almost every symptom seemed more aggravated, particularly the fever, load at breast, anxiety, and delirium; Dr Huxham knew more than one or two patients die in the most raging phrensy, covered with the most universal fiery rash he ever saw: so that, as in the highly confluent smallpox, it seemed only to denote the quantity of the disease, as he terms it.

He had under his care a young gentleman, about 12 years of age, whose tongue, fauces, and tonsils, were as black as ink, and he swallowed with extreme difficulty; he continually spit off immense quantities of a black, sanious, aud very fetid matter, for at least eight or ten days:—about the seventh day, his fever being somewhat abated, he fell into a bloody dysentery, though the bloody, sanious, fetid expectoration still continued, with a most violent cough. He at length indeed got over it, to the very great surprise of every one that saw him. Now, in this patient, a severe and universal rash broke out upon the second and third day; and the itching of his skin was so intolerable, that he tore it all over his body in a most shocking manner: yet this very great and timely eruption very little relieved his fever and phrensy, or prevented the other dreadful symptoms mentioned.

An early and kindly eruption, however, was most commonly a very good omen; and, when succeeded by a very copious desquamation of the cuticle, one of the most favourable symptoms that occurred: but when the eruption turned of a dusky or livid colour, or prematurely or suddenly receded, every symptom grew worse, and the utmost danger impended, especially if purple or black spots appeared up and down, as sometimes happened; the urine grew limpid, and convulsions came on, or a fatal suffocation soon closed the tragedy.

The disease was generally at the height about the fifth or sixth day in young persons, in the elder not so soon; and the crisis many times was not till the 11th or 12th, and then very imperfect; some adults, however, were carried off in two or three days; the distemper either falling on the lungs, and killing in a peripneumonic manner; or on the brain, in which case the patient either died raving or comatose. In some, the disease brought on a very troublesome cough, purulent expectoration, hæmoptoë, and hectic fever; in which they lingered on for several weeks, and then died tabid.

If a gentle easy sweat took place on the third or fourth day; if the pulse became more slow, firm, and equal; if the sloughs of the fauces cast off in a kindly manner, and appeared at the bottom tolerably clean and florid; if the breathing was more soft and free, and some degree of vigour and quickness returned in the eyes; all was well, and a salutary crisis followed soon by a continuance of the sweat, and a turbid, subsiding, farinaceous urine, a plentiful expectoration, and a very large desquamation of the cuticle. But if a rigor came on, and the exanthemata suddenly disappeared or turned livid;

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livid; if the pulse grew very fmall and quick, and the fkin remained hot and parched as it were, the breathing more difficult, the eyes dead and glaffy, the urine pale and limpid, a phrenfy or coma fucceeded, with a coldifh clammy fweat on the face or extremities; life was defpaired of, efpecially if a fingultus and choaking or gulping in the throat attended, with fudden, liquid, involuntary, livid ftools, intolerably fetid. In fome few patients Dr Huxham obferved, fome time before the fatal period, not only the face bloated, fallow, fhining and greafy as it were, but the whole neck very much fwollen, and of a cadaverous look; and even the whole body became in fome degree œdematous; and the impreffion of a finger would remain fixed in a part, the fkin not rifing again as ufual; an indication that the blood ftagnated in the capillaries, and that the elafticity of the fibres was quite loft.

Medical writers are ftill much divided in opinion, whether the cynanche maligna is to be confidered as the fame difeafe with the fcarlatina anginofa, afterwards to be treated of, or not. This queftion will afterwards come to be more fully difcuffed. At prefent we may only obferve, that although ulcerous fore throats of a malignant nature often appear fporadically, yet that the difeafe above defcribed appears only as an epidemic, and is always the confequence of contagion.

We have, therefore, no doubt that the cynanche maligna of Huxham, Fothergill, and Cullen, is precifely the fame difeafe with the fcarlatina anginofa of Sauvage, Withering, and other late writers. This is abundantly demonftrated by the diverfities which take place in the appearance of the difeafe among children of the fame family during the fame epidemic.

Prognofis. This may be eafily gathered from the above defcription. The malignant and putrid tendency of the difeafe is evident, and an increafe of the fymptoms which arife from that putrefcent difpofition of the body muft give an unfavourable prognoftic. On the contrary, a decreafe of thefe, and an apparent increafe of the *vis vitæ*, are favourable: in general, what is obferved to be favourable in the nervous and putrid malignant fevers, is alfo favourable in this, and *vice verfa*.

Caufes. Since the accurate accounts given by Dr Fothergill and Huxham of the epidemics which prevailed about 50 years ago, this difeafe has frequently been obferved at times epidemic in almoft every different part of Britain. Like fmall-pox, meafles, and chincough, it feems in every cafe to be the effect of a peculiar and fpecific contagion. It has been obferved to prevail, equally generally in every fituation, and at every feafon; and on expofure to the contagion, no age, fex, or condition, is exempted from it. But the having once had the difeafe, feems in this affection to afford the fame fecurity againft future contagion as in the fmall-pox: at leaft inftances, where it can be faid that the fame individual has been twice affected with it, are both very rare and very doubtful, as well as in fmall pox.

Cure. Like other febrile contagions, the malignant ulcerous fore throat is terminated only by a natural courfe; and the chief bufinefs of the practitioner is to combat unfavourable occurrences. In this the feptic tendency of the difeafe is chiefly to be kept in view. The debility with which it is attended renders all evacuations by bleeding and purging improper, except in a few inftances where the debility is lefs, and the inflammatory fymptoms more confiderable. The fauces are to be preferved from the effects of the acrid matter poured out upon them, and are therefore to be frequently wafhed out by antifeptic gargles or injections; and the putrefcent ftate of the whole fyftem fhould be guarded againft and corrected by internal antifeptics, efpecially by the Peruvian bark given in the beginning and continued through the courfe of the difeafe. Great benefit is alfo often derived from the liberal ufe of the mineral acids. Both the fulphuric and muriatic, in a ftate of proper dilution, have been highly extolled by different medical writers, and are productive of the beft effects in actual practice, when they can be introduced to a fufficient extent. In particular, the oxygenated muriatic acid, as recommended by Mr Braithwaite, has been found productive of the greateft advantages. Emetics, both by vomiting and naufeating, prove ufeful. When any confiderable tumor occurs, blifters applied externally will be of fervice, and in any cafe may be proper to moderate the inflammation.

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Very lately, the internal ufe of the capficum annuum, or Cayenne pepper as it is commonly called, has been highly celebrated in this affection; and it is particularly faid to have been employed with fingular fuccefs in the Weft Indies.

But of all the remedies lately propofed, none has been more highly extolled than the external ufe of cold water. It has even been contended by fome that by dafhing cold water on the furface of the body, an immediate artificial cure of this difeafe may be obtained. We are, however, fully perfuaded, that cold water will no more deftroy the contagion of this difeafe than of fmallpox; and we cannot help thinking that the practice is feldom neceffary, and fometimes hurtful.

Sp. III. Cynanche trachealis. 179

The Croup.

Cynanche trachealis, *Sauv.* fp. 5.
Cynanche laryngea auctorum, *Eller* de cogn. et curand. morb. fect. 7.
Anginæ inflammatoriæ, fp. 1. *Boerh.* 801.
Angina latens et difficilis, *Dodon.* obf. 18.
Angina interna, *Tulp.* l. 1. obf. 51.
Angina perniciofa, *Greg. Horft.* Obf. l. iii. obf. 1.
Suffocatio ftridula, *Home* on the Croup.
Afthma infantum, *Millar* on the Afthma and Chincough.
Afthma infantum fpafmodicum, *Rufh*, Differtation, Lond. 1770.
Cynanche ftridula, *Crawford* Differt. Inaug. Edin. 1771.
Angina epidemica anno 1743. *Molloy* apud *Rutty's* Hiftory of the weather.
Morbus ftrangulatorius, *Starr*, Phil. Tranf. N° 495.
Morbus truculentus infantum, *Francof.* ad Viadrum et in vicinia graffans ann. 1758. C. a Bergen. A nova. N. C. tom. ii. p. 157.
Catarrhus fuffocativus Barbadenfis ann. 1758. *Hillary's* Difeafes of Barbadoes.

Angina

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Angina inflammatoria infantum, *Ruſſel*, Oecon. nat. p. 70.

Angina polypoſa ſive membranacea *Michealis*. Argentorati 1778, et auctores ab eo allegati.

The beſt deſcription of this diſeaſe we have in Dr Cullen's Practice of Phyſic. He informs us, that it conſiſts in an inflammation of the glottis, larynx, or upper part of the trachea, whether it affect the membranes of theſe parts or the muſcles adjoining. It may ariſe firſt in theſe parts, and continue to ſubſiſt in them alone; or it may come to affect theſe parts from the cynanche tonſillaris, or maligna, ſpreading into them.

In either way it has been a rare occurrence, and few inſtances of it have been marked and recorded by phyſicians. It is to be known by a peculiar croaking ſound of the voice, by difficult reſpiration, with a ſenſe of ſtraitening about the larynx, and by a pyrexia attending it.

From the nature of theſe ſymptoms, and from the diſſection of the bodies of perſons who died of this diſeaſe, there is no doubt of its being of an inflammatory kind. It does not, however, always run the courſe of inflammatory affections; but frequently produces ſuch an obſtruction of the paſſage of the air, as ſuffocates, and thereby proves ſuddenly fatal.

It particularly proves fatal, in conſequence of the trachea being obſtructed by a membranous ſubſtance lining the inſide of it, and very nearly approaching in appearance to the inflammatory exudation often diſcovered on the inteſtinal canal in thoſe dying of enteritis.

If we judge rightly of the nature of this diſeaſe, it will be obvious, that the cure of it requires the moſt powerful remedies of inflammation to be employed upon the very firſt appearance of the ſymptoms. When a ſuffocation is threatened, whether any remedies can be employed to prevent it, is not yet determined by ſufficient experience: but it is evident, that in certain caſes the life of the patient can be preſerved only by the removal of that matter which obſtructs the paſſage of air through the trachea.

The accounts which books have hitherto given us of inflammations of the larynx, and the parts connected with it, amount to what we have now ſaid; and many inſtances are recorded of the diſeaſe happening in adult perſons: but there is a peculiar affection of this kind happening to infants, which has been little taken notice of till lately. Dr Francis Home is the firſt who has given any diſtinct account of this diſeaſe; but, ſince he wrote, ſeveral other authors have taken notice of it, and have given different opinions concerning it.

This diſeaſe ſeldom attacks infants till after they have been weaned. After this period, the younger they are, the more they are liable to the diſeaſe. The frequency of it becomes leſs as children become more advanced; and there are few inſtances of children above 12 years of age being affected with it. It attacks children of the midland countries, as well as thoſe who live near the ſea; but it occurs much more frequently at certain places than at others. It does not appear to be contagious; and its attacks are frequently repeated in the ſame child. It is often manifeſtly the effect of cold applied to the body; and therefore appears moſt frequently in the winter and ſpring ſeaſons. It very commonly comes on with the ordinary ſymptoms of a catarrh; but ſometimes the peculiar ſymptoms of the diſeaſe ſhow themſelves at the very firſt.

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Theſe peculiar ſymptoms are the following: A hoarſeneſs, with ſome ſhrillneſs and ringing ſound, both in ſpeaking and coughing, as if the noiſe came from a brazen tube. At the ſame time, there is a ſenſe of pain about the larynx, ſome difficulty of reſpiration, with a whizzing ſound in inſpiration, as if the paſſage of the air were ſtraitened. The cough which attends it, is commonly dry; and if any thing be ſpit up, it is matter of a purulent appearance, and ſometimes films reſembling portions of a membrane. With all theſe ſymptoms, there is a frequency of pulſe, a reſtleſſneſs, and an uneaſy ſenſe of heat. When the internal fauces are viewed, they are ſometimes without any appearance of inflammation; but frequently a redneſs, and even ſwelling, appears; and ſometimes there is an appearance of matter like to that rejected by coughing, together with the ſymptoms now deſcribed, and particularly with great difficulty of breathing, and a ſenſe of ſtrangling in the fauces, by which the patient is ſometimes ſuddenly taken off.

Many diſſections have been made of infants who had died of this diſeaſe, and almoſt conſtantly there has appeared a preternatural ſubſtance, apparently membranous, lining the whole internal ſurface of the upper part of the trachea, and extending in the ſame manner downwards into ſome of its ramifications. This preternatural membrane may be eaſily ſeparated, and ſometimes has been found ſeparated in part from the ſubjacent proper membrane of the trachea. This laſt is commonly found entire, that is, without any appearance of eroſion or ulceration; but it frequently ſhows the veſtiges of inflammation, and is covered by a matter reſembling pus, like to that rejected by coughing; and very often a matter of the ſame kind is found in the bronchiæ, ſometimes in conſiderable quantity.

From the remote cauſes of this diſeaſe; from the catarrhal ſymptoms commonly attending it; from the pyrexia conſtantly preſent with it; from the ſame kind of preternatural membrane being found in the trachea when the cynanche maligna is communicated to it; and from the veſtiges of inflammation on the trachea diſcovered upon diſſection; we muſt conclude, that this diſeaſe conſiſts in an inflammatory affection of the mucous membrane of the larynx and trachea, producing an exudation analogous to that found on the ſurface of inflamed viſcera, and appearing partly in a membranous cruſt, and partly in a fluid form reſembling pus.

Though this diſeaſe conſiſts in an inflammatory affection, it does not commonly end either in ſuppuration or gangrene. The moſt troubleſome circumſtance of it ſeems to conſiſt in a ſpaſm of the muſcles of the glottis, threatening ſuffocation.

When this diſeaſe terminates in health, it is by reſolution of the inflammation, by ceaſing of the ſpaſm of the glottis, by an expectoration of the matter exuding from the trachea, and of the cruſts formed there,

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there, and frequently it ends without any expectoration, or at leaſt with ſuch only as attends an ordinary catarrh. But in ſome inſtances, a ſalutary termination has very ſpeedily taken place, in conſequence of the diſcharge of the membranous ſubſtance from the trachea, even under its proper tubular form.

When the diſeaſe ends fatally, it is by a ſuffocation ſeemingly depending upon a ſpaſm affecting the glottis; but ſometimes, probably, depending upon a quantity of matter filling the bronchiæ, or obſtructing the trachea.

As we ſuppoſe the diſeaſe to be an inflammatory affection, ſo we attempt the cure of it by the uſual remedies of inflammation. Bleeding, both general and topical, has often given immediate relief, and, by being repeated, has entirely cured the diſeaſe. Bliſtering alſo, near to the part affected, has been found uſeful. Upon the firſt attack of the diſeaſe, vomiting, immediately after bleeding, ſeems to be of conſiderable uſe, and ſometimes ſuddenly removes the diſeaſe. But emetics are ſtill more uſeful in advanced periods. By the employment of theſe, the matter obſtructing the trachea, and inducing ſpaſmodic affections, has often been ſucceſsfully removed, when the ſituation of the patient ſeemed to be almoſt deſperate. And as in the progreſs of the diſeaſe freſh effuſions of this matter are very apt to take place, the frequent repetition of emetics becomes neceſſary. It is often neceſſary to have recourſe to thoſe operating the moſt expeditiouſly, ſuch as ſulphate of zinc even in large doſes. In every ſtage of the diſeaſe, the antiphlogiſtic regimen is neceſſary, and particularly the frequent uſe of laxative glyſters. Some practitioners conſider mercury, particularly under the form of calomel, as an almoſt infallible remedy in this diſeaſe. It has particularly been extolled by Mr James Anderſon, an eminent ſurgeon in Edinburgh. But we are ſorry to ſay that in ſome caſes at leaſt, after the faireſt trial, it has been found to fail. Though we ſuppoſe that a ſpaſm affecting the glottis is often fatal in this diſeaſe, antiſpaſmodic medicines have not in general been found of great ſervice. Some, however, have ſtrongly recommended the uſe of aſafœtida under the form of injection; others place great confidence in oil, or oily mixtures, taken by the mouth: but more immediate benefit is derived from tepid bathing, and the employment of ſulphuric ether, both externally and internally.

By theſe, when the diſeaſe is ſpaſmodic, it is often ſucceſsfully removed. But by much the moſt dangerous form of the diſeaſe is the inflammatory ſtate giving the exudation. And when this inflammatory exudation has even been removed from the upper part of the trachea, yet it has ſometimes proved fatal, from the inflammation and exudation extending to the branches of the aſpera arteria. By ſuch an occurrence, the writer of the preſent article had the misfortune to loſe a favourite ſon; an aimable youth, in the fourteenth year of his age, who was highly admired and ſincerely regretted by all to whom he was known.

180 Sp. IV. Cynanche pharyngea.

Cynanche pharyngea, *Sauv.* ſp. 6. *Eller* de cogn. et cur. ſect. 7.

Anginæ inflammatoriæ, ſp. 4. *Boerh.* 804.

This is not materially different from the cynanche tonſillaris; only that the inflammation is ſaid to begin in the pharynx, though Dr Cullen ſays he never knew an inſtance of it. The ſymptoms are almoſt the ſame, and the cure is preciſely ſo with that of the cynanche tonſillaris.

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Sp. V. Cynanche parotidæa. 181

Cynanche parotidæa, *Sauv.* ſp. 14. *Gallis* Oreillons et Ourles, *Tiſſot* Avis au peuple, N° 116. *Encyclopédie*, au mot *Oreillons*.

Angina externa, *Anglis* the Mumps, *Ruſſel* œcon. natur. p. 114. *Scotis* the Branks.

Catarrhus Bellinſulanus, *Sauv.* ſp. 4.

Oſſervazioni di *Girol. Gaſpari*, Venez. 1731.

Oſſervazioni di *Targ. Tozetti*, Racolta 1ma, p. 176.

This is a diſeaſe well known to the vulgar, but little taken notice of by medical writers. It is often epidemic, and manifeſtly contagious. It comes on with the uſual ſymptoms of pyrexia, which is ſoon after attended with a conſiderable tumor of the external fauces and neck. The ſwelling appears firſt as a glandular moveable tumor at the corner of the lower jaw; but it ſoon becomes uniformly diffuſed over a great part of the neck, ſometimes on one ſide only, but more commonly on both. The ſwelling continues to increaſe till the fourth day; but from that period it declines, and in a few days more goes off entirely. As the ſwelling of the fauces recedes, it not unfrequently happens that ſome tumor affects the teſticles in the male ſex, or the breaſts in the female. Theſe tumors are ſometimes large, hard, and ſomewhat painful; but are ſeldom either very painful or of long continuance. The pyrexia attending this diſeaſe is commonly ſlight, and goes off with the ſwelling of the fauces; but ſometimes, when the ſwelling of the teſticles does not ſucceed to that of the fauces, or when the one or the other has been ſuddenly repreſſed, the pyrexia becomes more conſiderable, is often attended with delirium, and has ſometimes proved fatal.

As this diſeaſe commonly runs its courſe without either dangerous or troubleſome ſymptoms, ſo it hardly requires any remedies. An antiphlogiſtic regimen, and avoiding cold, are all that will be commonly neceſſary. But when, upon the receding of the ſwellings, the pyrexia comes to be conſiderable, and threatens an affection of the brain, it will be proper, by warm fomentations, to bring back the ſwelling; and by vomiting, bleeding, or bliſtering, to obviate the conſequences of its abſence.

Genus XI. PNEUMONIA. 182

Febris pneumonica, *Hoffm.* II. 136.

Sp. I. Peripneumonia. 183

Peripneumony, or Inflammation of the Lungs.

Peripneumonia, *Sauv.* gen. 112. *Lin.* 34. *Vog.* 51. *Sag.* gen. 311. *Boerh.* 820. *Juncker* 67.

Peripneumonia pura ſive vera Auctorum, *Sauv.* ſp. 1.

Peripneumonia gaſtrica, *Sauv.* ſp. 11. *Morgagn.* de cauſ. et ſed. Epiſt. xx. art. 30, 31.

Peripneumonia catarrhalis, *Sauv.* ſp. 6.

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Peripneumonia notha, *Sydenh.* sect. 6. cap. 4. *Boerh.* 867. *Morgagni* de cauſ. et ſed. Epiſt. xxi. 11.—15.
Peripneumonia putrida, *Sauv.* ſp. 2.
Peripneumonia ardens, *Sauv.* ſp. 3.
Peripneumonia maligna, *Sauv.* ſp. 4.
Peripneumonia typhodes, *Sauv.* ſp. 5.
Amphimerina peripneumonica, *Sauv.* ſp. 15.

184 Sp. II. Pleuritis.

The *Pleuriſy*, or Inflammation of the Pleura.

Pleuritis, *Sauv.* gen. 103. *Lin.* 27. *Vog.* 56. *Sag.* gen. 303. *Boerh.* 875. *Junck.* 67.
Paraphreneſis, *Sauv.* gen. 102. *Lin.* 26.
Paraphrenitis, *Vog.* 55. *Boerh.* 907.
Diaphragmitis, *Sag.* gen. 304.
Pleuritis vera, *Sauv.* ſp. 1. *Boerh.* 875. *Verna* princeps morb. acut. pleuritis, l. 1. cap. 2. 3. *Zeviani* della parapleuritide, cap. 3. *Morgagni* de ſed. et cauſ. morb. Epiſt. xx. art. 56. xxi. 45. *Wendt* de pleuritide, apud *Sandifort*, theſ. ii.
Pleuritis pulmonis, *Sauv.* ſp. 2. *Zevian.* dell. parapleur. iii. 28, &c.
Pleuropneumonia, pleuro-peripneumonia, peripneumo-pleuritis Auctorum. *Baronius* de pleuri-pneumonia. Ill. *Halleri* opuſcul. patholog. obſ. 13. *Morgagni* de ſed. et cauſ. Epiſt. xx. and xxi. paſſim. *Cleghorn*, Minorca. p. 247. *Triller* de pleuritide, aph. 1, 2, 3, cap. i. 8. *Huxham*, Differt. on pleuriſies, &c. chap. i. Ill. *Pringle*, Diſ. of the army.
Pleuritis convulſiva, *Sauv.* ſp. 13. *Bianch.* Hiſt. hep. vol. i. p. 234.
Pleuritis hydrothoracica, *Sauv.* ſp. 15. *Morgagni* de cauſ. et ſed. xx. 34.
Pleuritis dorſalis, *Sauv.* ſp. 3. *Verna*, p. 3. cap. 8.
Pleuritis mediaſtini, *Sauv.* ſp. 3. *P. Sal. Div.* de affec. part. cap. 6. *Friend*, Hiſt. Med. de Avenzoare.
Mediaſtina, *Vog.* 52.
Pleuritis pericardii, *Sauv.* ſp. 5. *Verna*, p. iii. cap. 9.
Parapleuritis, *Zeviani* della parapleuritide.
Pleurodyne parapleuritis, *Sauv.* ſp. 19.
Paraphreneſis diaphragmatica, *Sauv.* ſp. 1. *De Haen.* Rat. med. i. 7. iii. p. 31.
Paraphreneſis pleuritica, *Sauv.* ſp. 2.
Paraphreneſis hepatica, *Sauv.* ſp. 3.

Under the general head of *Pneumonia*, Dr Cullen, comprehends all inflammattions of the thoracic viſcera, or membrane lining the inſide of that cavity; as the ſymptoms do not always ſufficiently diſtinguiſh the ſeat of the affection, nor does a difference in the ſituation of the affected place make any difference in the cure.

Deſcription. Pneumonic inflammation, however various in the ſeat, always diſcovers itſelf by pyrexia, difficult breathing, cough, and pain in ſome part of the thorax. It almoſt always comes on with a cold ſtage, and is accompanied with the other ſymptoms of pyrexia; though in ſome few inſtances the pulſe may not be more frequent, nor the heat of the body increaſed beyond what is natural. Sometimes the pyrexia is from the beginning accompanied with the other ſymptoms; but frequently it is formed ſome hours before them, and particularly before the pain be felt. The pulſe for the moſt part is frequent, full, ſtrong, hard, and quick; but, in a few inſtances, eſpecially in the advanced ſtate of the diſeaſe, it is weak, ſoft, and at the ſame time irregular. The difficulty of breathing is moſt conſiderable in inſpiration, both becauſe the lungs do not eaſily admit of a full dilatation, and becauſe the dilatation increaſes the pain attending the diſeaſe. The difficulty of breathing is alſo greater when the patient is in one poſture of the body rather than another. It is generally greater when he lies on the ſide affected; though ſometimes the contrary happens. Very often the patient cannot lie upon either ſide, and can find eaſe only when lying on the back; and ſometimes he cannot breathe readily, except when in ſomewhat of an erect poſture. The cough, in different caſes, is more or leſs urgent or painful. It is ſometimes dry, or without any expectoration, eſpecially in the beginning of the diſeaſe; but more commonly it is, even from the beginning, moiſt, and the matter ſpit up various both in conſiſtence and colour, and frequently it is ſtreaked with blood. The pain is alſo different in different caſes, and felt in different parts of the thorax, but moſt frequently in one ſide. It has been ſaid to affect the right ſide more frequently than the left; but this is uncertain, and we are ſure that the left ſide has been very often affected. Sometimes it is felt as if it was under the ſternum; ſometimes in the back between the ſhoulders; and when in the ſides, its place has been higher or lower, more forward or backward; but the place of all moſt frequently affected is about the ſixth or ſeventh rib, near the middle of its length, or a little more forward. The pain is often ſevere and pungent; but ſometimes more dull and obtuſe, with a ſenſe of weight rather than of pain. It is moſt eſpecially ſevere and pungent when occupying the place laſt mentioned. For the moſt part it continues fixed in one part, but ſometimes ſhoots from the ſide to the ſcapula on one hand, or to the ſternum and clavicle on the other.

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Dr Cullen ſuppoſes that the diſeaſe is always ſeated, or at leaſt begins, in ſome part of the pleura, taking that membrane in its greateſt extent, as now commonly underſtood; that is, as covering not only the internal ſurface of the cavity of the thorax, but alſo as forming the mediaſtinum, and as extended over the pericardium, and over the whole ſurface of the lungs. But as the ſymptoms never clearly indicate where the ſeat of the diſeaſe is, there is but little foundation for the different names by which it has been diſtinguiſhed. The term *pleuriſy* is improperly limited to that inflammation which begins in and chiefly affects the pleura coſtalis. This Dr Cullen thinks is a rare occurrence; and that the pneumonia much more frequently begins in the pleura inveſting the lungs, producing all the ſymptoms which belong to what hath been called the *pleuritis vera.* The word *peripneumony* has been applied to an inflammation beginning in the parenchyma, or cellular texture of the lungs, and having its ſeat chiefly there. But to Dr Cullen it ſeems very doubtful if any acute inflammation of the lungs, or any diſeaſe which has been called *peripneumony*, be of that kind. It ſeems probable, that

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that every acute inflammation begins in membranous parts; and in every diffection of perfons who have died of peripneumony, the external membrane of the lungs, or fome part of the pleura, has appeared to have been confiderably affected. An inflammation of the pleura covering the upper furface of the diaphragm, has been diftinguifhed by the appellation of *paraphrenitis*, as fuppofed to be attended with the peculiar fymptoms of delirium, *rifus fardonicus*, and other convulfive motions: but it is certain, that an inflammation of that portion of the pleura, and affecting alfo even the mufcular fubftance of the diaphragm, has often taken place without any of the fymptoms above-mentioned; and neither the diffections which have fallen under Dr Cullen's obfervation, nor any accounts of diffections, fupport the opinion that an inflammation of the pleura covering the diaphragm is attended with delirium more commonly than any other pneumonic inflammation.—It is to be obferved, however, that though the inflammation may begin in one particular part of the pleura, the morbid affection is commonly communicated to the whole extent of the membrane.

The pneumonic inflammation, like others, may terminate by refolution, fuppuration, or gangrene: but it has alfo a termination peculiar to itfelf; namely, when it is attended with an effufion of blood into the cellular texture of the lungs, which, foon interrupting the circulation of the blood through the vifcus, produces a fatal fuffocation. This indeed appears to be the moft common termination of pneumonic inflammation when it ends fatally; for upon the diffection of almoft every perfon who has died of this difeafe, it appears that fuch an effufion had happened. From the fame diffections we learn, that pneumonic inflammation commonly produces an exfudation from the internal furface of the pleura, which appears partly as a foft vifcid cruft, often of a compact membranous form, covering every where the furface of the pleura, and particularly thofe parts where the lungs adhere to the pleura coftalis, or mediaftinum; and this cruft feems always to be the cement of fuch adhefion. The fame exfudation fhows itfelf alfo by a quantity of a ferous fluid commonly found in the cavity of the thorax; and fome exfudation or effufion is ufually found to have been made into the cavity of the pericardium. It feems likewife probable, that an effufion of this kind is fometimes made into the cavity of the bronchiæ; for in fome perfons who have died after labouring under a pneumonic inflammation for a few days only, the bronchiæ have been found filled with a confiderable quantity of ferous and thickifh fluid, which muft be confidered rather as the effufion abovementioned, having had its thinner parts taken off by refpiration, than as a pus fo fuddenly formed in the inflamed part. It is, however, not improbable, that this effufion, as well as that made into the cavities of the thorax and pericardium, may be a matter of the fame kind with that which in other inflammations is poured into the cellular texture of the parts inflamed, and there converted into pus; but in the thorax and pericardium it does not always put on this appearance, becaufe the cruft covering the furface prevents the abforption of the thinner part. This abforption, however, may be compenfated in the bronchiæ, by the drying power of the air; and therefore the effufion into them may affume a more purulent appearance. In many cafes of pneumonic inflammation, when the expectoration is very copious, it is difficult to fuppofe that the whole proceeds from the mucous follicles of the bronchiæ; and it feems probable that a great part of it may come from the effufed ferous fluid juft mentioned; and this too will account for the appearance of the expectoration being fo often purulent. Perhaps the fame thing will account for that purulent matter found in the bronchiæ, which Mr de Haen fays he had often obferved when there was no ulceration in the lungs, and which he accounts for in a very ftrange manner, namely, by fuppofing a pus formed in the circulating blood.

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Dr Cullen is of opinion, that the effufion into the bronchiæ above-mentioned often concurs with the effufion of red blood into the cellular fubftance of the lungs to occafion the fatal fuffocation which frequently terminates peripneumony; that the effufion of ferum alone may have this effect: and that the ferum poured out in a certain quantity, rather than any debility in the powers of expectoration, is the caufe of that ceffation of fpitting which precedes the fatal event; for in many cafes the expectoration has ceafed, when no other fymptoms of debility have appeared, and when, upon diffection the bronchiæ have been full of liquid matter. Nay, it is even probable, that in fome cafes fuch an effufion may take place without any fymptoms of violent inflammation; and in other cafes the effufion taking place may feem to remove the fymptoms of inflammation which had appeared before, and thus account for thofe unexpected fatal terminations which have fometimes happened.

Pneumonic inflammation feldom terminates by refolution, without being attended with fome evident evacuation. An hæmorrhagy from the nofe happening on fome of the firft days of the difeafe has fometimes put an end to it; and it is faid, that an evacuation from the hæmorrhoidal veins, a bilious evacuation by ftool, and an evacuation of urine with a copious fediment, have feverally had the fame effect; but fuch occurrences have been rare. The evacuatiom moft frequently attending, and feeming to have the greateft effect in promoting refolution, is an expectoration of a thick, white, or yellowifh matter, a little ftreaked with blood, copious, and brought up without much or violent coughing. Very frequently the refolution of this difeafe is attended with, and perhaps produced by, a fweat, if it be warm, fluid, copious, over the whole body, and attended with an abatement of the frequency of the pulfe, heat of the body, and other febrile fymptoms. Although, from the hiftory now given, it appears that pleurify and peripneumony cannot with propriety be confidered as different difeafes, yet it is certain that in different cafes this affection occurs with an affemblage of fymptoms feparate and diftinct. Thus even Dr Cullen himfelf, in his Nofology, has defined pleuritis to confift in pyrexia, attended with pungent pain of the fide, painful refpiration, difficulty of lying down, particularly on the affected fide, and diftreffing cough, in the beginning dry, but afterwards humid, and often with bloody expectoration. While again he has defined peripneumony to confift in pyrexia, attended with a dull pain under the fternum and between the fhoulders, anxiety, difficulty of breathing, humid

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mid cough, expectoration generally bloody, a soft pulse, and a tumid livid appearance of the countenance. It is highly probable, that the first of these sets of symptoms chiefly arises from a state of active inflammation, and the second from effusion. Thus, in certain cases, the symptoms may appear perfectly separate and distinct; but more frequently both inflammation and effusion are united; and thus the symptoms in both definitions are in general combined in the same patient. But still pleuritis, strictly so called, may be considered as characterized by the acute pungent pain at a particular spot of the chest, and that pain much aggravated on a full inspiration; while proper peripneumonia is distinguished by the dull gravative pain extended over the whole chest, and by the laborious respiration.

Causes of, and persons subject to, this disorder. The remote cause of pneumonic inflammation is commonly cold applied to the body, obstructing perspiration, and determining to the lungs, while at the same time the lungs themselves are exposed to the action of cold. These circumstances operate chiefly when an inflammatory diathesis prevails in the system; and therefore those principally affected with this disease are persons of the greatest vigour, in cold climates, often in the winter season, but particularly in the spring, when vicissitudes of heat and cold are frequent. This disease, however, may arise in any season when such varieties take place. Other remote causes also may have a share in producing this distemper; such as every means of obstructing, straining, or otherwise injuring, the pulmonary organs. The pneumonic inflammation has sometimes been so much an epidemic, that it hath been suspected of depending on a specific contagion; but Dr Cullen never met with an instance of its being contagious.

Prognosis. In pneumonic inflammations, a violent pyrexia is always dangerous. The danger, however, is chiefly denoted by the difficulty of breathing. When the patient can lie on one side only; when he can lie on neither side, but only on his back; when he cannot breathe with tolerable ease, except when the trunk of his body is erect; when even in this posture the breathing is very difficult, and attended with a turgescence and flushing of the face, with partial sweats about the head and neck, and an irregular pulse; these circumstances mark the difficulty of breathing in different degrees; and consequently, in proportion, the danger of the disease. A frequent violent cough, aggravating the pain, is always the symptom of an obstinate disease; and as the disease is seldom or never resolved without some expectoration, so a dry cough must always be an unfavourable symptom.

The proper characteristics of the expectoration have been already laid down; and though an expectoration which has not these marks must indicate a doubtful state of the disease, yet the colour alone can give no certain prognostic. An acute pain, very much interrupting inspiration, is always the mark of a violent disease; but not of a more dangerous disease than an obtuse pain, attended with very difficult respiration, demonstrating effusion into the cells.

When the pains, which had at first affected one side only, shall afterwards spread into the other; or when, leaving the side first affected, they pass entirely into the other; these are always marks of a dangerous disease.

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A delirium coming on during a pneumonic inflammation is always a symptom denoting much danger.

When pneumonic disorders terminate fatally, it is on one or other of the days of the first week, from the third to the seventh. This is the most common case; but, in a few instances, death has happened at a later period. When the disease is violent, but admitting of resolution, this also happens frequently in the course of the first week; but in a more moderate disease the resolution is often put off to the second week. The disease generally suffers a remission on some of the days from the third to the seventh: which, however, may be often fallacious, as it sometimes returns again with as much violence as before; and in such a case with great danger. Sometimes it disappears on the third day, while an erysipelas makes its appearance on some external part; and if this continue fixed, the pneumonic inflammation does not recur. If the disease continue beyond the 14th day, it will terminate in a suppuration, or PHTHISIS. The termination by gangrene is much more rare than has been imagined: and when it does occur, it is usually joined with the termination by effusion; the symptoms of the one being hardly distinguishable from those of the other.

Cure. This must proceed upon the general plan mentioned under SYNOCHA; but, on account of the importance of the part affected, the remedies must be employed early, and as fully as possible: and these are chiefly directed with one of three views, viz. for obtaining a resolution of the inflammation in the thorax, for mitigating the urgent symptoms before a resolution can be effected, and for counteracting or obviating the consequences of the disease. Venesection is the remedy chiefly to be depended on; and may be performed in either arm, as the surgeon finds most convenient; and the quantity taken away ought in general to be as large as the patient's strength will allow. The remission of pain, and the relief of respiration, during the flowing of the blood, may limit the quantity to be then drawn; but if these symptoms of relief do not appear, the bleeding should be continued to a considerable extent, unless symptoms of a beginning syncope come on. It is seldom that one bleeding, however large, will cure this disease; and though the pain and difficulty of breathing may be much relieved by the first bleeding, these symptoms commonly and after no long interval recur, often with as much violence as before. In this case the bleeding is to be repeated even on the same day, and perhaps to the same quantity as before. Sometimes the second bleeding may be larger than the first. There are persons who, by their constitution, are ready to faint even upon a small bleeding; and in such persons this may prevent the drawing so much blood at first as a pneumonic inflammation may require: but as the same persons are found to bear after-bleedings better than the first, this allows the second and subsequent bleedings to be larger, and to such a quantity as the symptoms of the disease may seem to require.

Bleedings are to be repeated according to the state of the symptoms, and they will be more effectual when practised in the course of the first three days than afterwards; but they are not to be omitted though four days of the disease may already have elapsed. If the physician has not been called in time, or the first bleedings

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ings have not been ſufficiently large, or even though they ſhould have procured ſome remiſſion, yet upon the return of the urgent ſymptoms, bleeding may be repeated at any time within the firſt fortnight, or even after that period, if a ſuppuration be not evident, or if after a ſeeming ſolution the diſeaſe ſhall have returned.

With reſpect to the quantity of blood which may be taken away with ſafety, no general rules can be given; as it muſt be very different according to the ſtate of the diſeaſe, and the conſtitution of the patient. In an adult male of tolerable ſtrength, a pound of blood is a full bleeding. Any quantity above 20 ounces is a large, and any quantity below 12 is a ſmall, bleeding. An evacuation of four or five pounds, in the courſe of two or three days, is generally as much as moſt patients will bear; but if the intervals between the bleedings, and the whole of the time during which the bleedings have been employed, have been long, the quantity taken upon the whole may be greater.

When a large quantity of blood has been taken from the arm, and it is doubtful if more can be taken in that manner with ſafety, ſome blood may ſtill be taken by cupping and ſcarifying. This will eſpecially be proper, when the recurrence of the pain, rather than the difficulty of breathing, becomes the urgent ſymptom; and then the cupping and ſcarification ſhould be made as near as poſſible to the pained part.

An expectoration ſometimes takes place very early in this diſeaſe; but if the ſymptoms continue urgent, the bleedings muſt be repeated notwithſtanding the expectoration: but in a more advanced ſtate, and when the ſymptoms have ſuffered a conſiderable remiſſion, we may then truſt the cure to the expectoration alone. It is not obſerved that bleeding, during the firſt days of the diſeaſe, ſtops expectoration; on the contrary, it has been often found to promote it; and it is only in a more advanced ſtate of the diſeaſe, when the patient has been already exhauſted by large evacuations and a continuance of his illneſs, that bleeding ſeems to put a ſtop to expectoration; and even then, this ſtoppage ſeems not to take place ſo much from the powers of expectoration being weakened by bleeding, as by its favouring the ſerous effuſion in the bronchiæ, already taken notice of.

Beſides bleeding, every part of the antiphlogiſtic regimen ought here to be carefully employed: the patient muſt keep out of bed as much as he can bear; muſt have plenty of warm diluting drinks, impregnated with vegetable acids, accompanied with nitre or ſome other cooling neutral ſalt; and the belly alſo ought to be kept open by emollient clyſters or cooling laxative medicines. Vomiting in the beginning is dangerous; but in a ſomewhat advanced ſtate of the diſeaſe emetics have been found the beſt means of promoting expectoration. Fomentations and poultices to the pained part have been found uſeful; but bliſtering is found to be much more effectual. A bliſter, however, ought not to be applied till at leaſt one bleeding has been premiſed, as veneſection is leſs effectual when the irritation of a bliſter is preſent. If the diſeaſe be moderate, a bliſter may be applied immediately after the firſt bleeding; but in violent caſes, where it may be preſumed that a ſecond bleeding may ſoon be neceſſary after the firſt, it will be proper to delay the bliſter till after the ſecond bleeding, when it may be ſuppoſed that the irritation occaſioned by the bliſter will be over before another bleeding becomes neceſſary.

Pneumonia.

It may frequently be of uſe in this diſeaſe to repeat the bliſtering; and in that caſe the plaſters ſhould always be applied ſomewhere on the thorax, for when applied to more diſtant parts they have leſs effect. The keeping the bliſtered parts open, and making what is called a *perpetual bliſter*, has much leſs effect than a repeated bliſtering.

Many methods have been propoſed for promoting expectoration, but none appear to be ſufficiently effectual; and ſome of the expectorants, being acrid ſtimulant ſubſtances, are not very ſafe. The gums uſually employed ſeem to be too heating; the ſquills leſs ſo; but they are not very powerful, and ſometimes inconvenient, by the conſtant nauſea they occaſion. The volatile alkali may be of ſervice as an expectorant, but it ought to be reſerved for an advanced ſtate of the diſeaſe. Mucilaginous and oily demulcents appear to be uſeful, by allaying that acrimony of the mucus which occaſions too frequent coughing; and which coughing prevents the ſtagnation and thickening of the mucus, and thereby its becoming mild. The receiving into the lungs the ſteams of warm water, impregnated with vinegar, has often proved uſeful in promoting expectoration; and, for this purpoſe, the machine called the Inhaler, lately invented by Dr Mudge of Plymouth, promiſes to be of great ſervice. But of all others, the antimonial emetics, given in nauſeating doſes, are perhaps the moſt powerful for promoting expectoration. The kermes mineral has been greatly recommended; but does not ſeem to be more efficacious than tartrite of antimony or antimonial wine; and the doſe of the kermes is much more uncertain than that of the others.

Though this diſeaſe often terminates by a ſpontaneous ſweating, this evacuation ought not to be excited by art, unleſs with much caution. When, after ſome remiſſion of the ſymptoms, ſpontaneous ſweats ariſe, they may be encouraged; but it ought to be without much heat, and without ſtimulant medicines. If, however, the ſweats be partial and clammy only, and a great difficulty of breathing ſtill remain, it will be very dangerous to encourage them.

Phyſicians have differed much with regard to the uſe of opiates in pneumonic affections. It appears, however, that in the beginning of the diſeaſe, and before bleeding and bliſtering have produced ſome remiſſion of the pain, and of the difficulty of breathing, opiates have had a bad tendency, by their increaſing the difficulty of breathing and other inflammatory ſymptoms. But in a more advanced ſtate of the diſeaſe, when the difficulty of breathing has abated, and when the urgent ſymptom is a cough, proving the chief cauſe of the continuance of pain and want of reſt, opiates may be employed with great advantage and ſafety. The interruption of the expectoration which they ſeem to occaſion, is for a ſhort time only; and they ſeem often to promote it, as they occaſion a ſtagnation of what was by frequent coughing diſſipated inſenſibly: and therefore give the appearance of what phyſicians have called *concocted matter*.

Opium combined with calomel has of late been highly extolled in this and other inflammatory diſeaſes by Dr Hamilton of Lynn-Regis; who has given a full account

Phlegmasiæ. count of the ſucceſs attending his practice with this remedy, for the ſpace of 16 years, in the 9th volume of the Edinburgh Medical Commentaries. And ſince his recommendation, the ſame remedy has often been employed by others with great benefit.

186 *VOMICA*, or *Abſceſs* of the *Lungs*.

Vomica, *Boerh.* 835. *Junck.* 35.
Pleurodyne vomica, *Sauv.* ſp. 21.

Phthiſis ſometimes follows pneumonia, though the caſe is not frequent. The ſymptoms of it ſo much reſemble ordinary phthiſis, that it can moſt properly be treated of under that head.

187 EMPYEMA.

This is another conſequence of a pneumonia terminating unfavourably, and is occaſioned by the effuſion of a quantity of purulent matter into the cavity of the thorax, producing a lingering and painful diſorder, very often incurable.

Deſcription. The firſt ſign of an empyema is a ceſſation of the pain in the breaſt, which before was continual: this is followed by a ſenſation of weight on the diaphragm; and a fluctuation of matter, ſometimes making a noiſe that may be heard by the byſtanders: the acute fever is changed into a hectic, with an exacerbation at night: a continual and troubleſome dry cough remains. The reſpiration is exceedingly difficult, becauſe the lungs are prevented by the matter from fully expanding themſelves. The patient can lie eaſily on that ſide where the matter is effuſed, but not on the other, becauſe then the weight of the matter on the mediaſtinum produces uneaſineſs. The more the hectic heat is augmented, the more is the body emaciated, and its ſtrength decayed. In ſome there is danger of ſuffocation when they ſtoop down, which goes off when they alter that poſture of the body; and in ſome there is a purulent ſpitting.—Theſe ſymptoms are accompanied with great anxiety, palpitations of the heart, and faintings. Sometimes the patients have a ſenſation like a hot vapour aſcending from the cavity of the thorax to their mouth. Others, in a more advanced ſtate of the diſeaſe, have a putrid taſte in the mouth. At the ſame time, profuſe night ſweats waſte the body, and greatly weaken the patient. The face at firſt grows red on that ſide where the matter lies, at laſt the Hippocratic face comes on, and the eyes become hollow. The pulſe is quick, but more frequently intermitting. Sometimes the nails are crooked, and puſtules appear on the thorax; and frequently, according to the teſtimony of Hippocrates, the feet ſwell, and, on the affected ſide of the breaſt, there is an inflation and ſwelling of the ſkin.

Cauſes, &c. An empyema may ariſe either from the burſting of a vomica of the lungs, or from a ſuppuration taking place after the inflammatory ſtage of pneumonia; or ſometimes from a ſuppuration in the caſe of a quinſy, when the inflammation had extended to the aſpera arteria, from whence ariſes a kind of bloody ſpittle, and the patients are afflicted with an empyema, unleſs they die on the 7th day of the diſeaſe, according to the obſervation of Hippocrates. It may ariſe alſo from external violence, as wounds of the thorax, &c. blood extravaſated, corrupted, or changed into pus. Like the vomica, it is a rare diſtemper, but may attack all thoſe ſubject to pneumonia. Peritonitis.

Prognoſis. Very few recover after an empyema has been once formed, eſpecially if the operation of paracenteſis be neglected. After this operation is performed, if a great quantity of bloody fetid pus be diſcharged, if the fever continue, and if the patient ſpit up a purulent, pale, frothy, livid, or green matter, with a decay of ſtrength, there is no hope: But when a ſmall quantity of pus, of a white colour, not very fetid, is diſcharged; when the fever and thirſt preſently ceaſe, the appetite returns, and fæces of a good conſiſtence are diſcharged, the ſtrength alſo returning in ſome degree; there is then hope of a perfect recovery. If the matter be not dried up in ſeven weeks time, the diſeaſe readily changes to a fiſtulous ulcer, which is very difficult to cure. An empyema affecting both ſides of the thorax is more dangerous than that which affects only one.

Cure. This conſiſts in evacuating the purulent matter contained in the cavity of the thorax, which is beſt done by the operation of paracenteſis of the thorax. See SURGERY. Afterwards the ulcer is to be treated with abſtergent and conſolidating medicines, and the ſame internal ones are to be given as in a PHTHISIS.

GENUS XIII. CARDITIS.

Inflammation of the HEART. 188

Carditis, *Sauv.* gen. 111. *Vog.* 54.
Pericarditis, *Vog.* 53.
Carditis ſpontanea, *Sauv.* ſp. 1. *Senac.* Traité de Cœur, l. iv. c. 7. *Meckel*, Mem. de Berlin, 1756.
Eryſipelas pulmonis, *Lomm.* Obſerv. lib. ii.

Deſcription. This diſeaſe is attended with all the ſymptoms of pneumonia, but in a higher degree; it is beſides ſaid to be accompanied with hydrophobic ſymptoms, fainting, palpitation of the heart, a ſeeming madneſs, a ſunk and irregular pulſe, watery eyes, and a dejected countenance, with a dry and black tongue. On diſſection, the heart and pericardium are found very much inflamed, and even ulcerated, with many polypous concretions.

Cauſes, &c. The ſame as in the pneumonia.

Prognoſis. In the carditis the prognoſis is more unfavourable than in the pneumonia; and indeed, unleſs the diſeaſe very quickly terminates, it muſt prove fatal, on account of the conſtant and violent motion of the heart, which exaſperates the inflammation, and increaſes all the ſymptoms.

Cure. Here bleeding is neceſſary in as great a degree as the patient can poſſibly bear, together with bliſtering, and the antiphlogiſtic regimen likewiſe carried to a greater height than in the pneumonia; but the general method is the ſame as in other inflammatory diſeaſes.

GENUS XIV. PERITONITIS. 189

Inflammation of the PERITONÆUM.

Sp. I. *Inflammation* of the PERITONÆUM properly ſo called.

Peritonitis, *Vog.* 62. *Lieutad.* Hiſt. anat. med. lib. i. obſ.

Phlegmaſiæ.

obſ. 3. *Raygerus* apud eund. lib. i. obſ. 341. *Morgagn.* de ſed. LVII. 20.

190 Sp. II. *Inflammation* of the PERITONÆUM extended over the *Omentum*.

Epiploitis, *Sauv.* gen. 106. *Sag.* gen. 308.
Omentitis, *Vog.* 61.
Omenti inflammatio, *Boerh.* 985. et Ill. *Van Swieten*, Comm. *Stork.* An. Med. I. 132. *Hulme* on the puerperal fever.

191 Sp. III. *Inflammation* of the PERITONÆUM ſtretched over the *Meſentery*.

Meſenteritis, *Vog.* 60.
Enteritis meſenterica, *Sauv.* ſp. 4.

GENUS XV. GASTRITIS.

192 *Inflammation* of the STOMACH.

193 A. *GASTRITIS PHLEGMONODÆA*, or the *genuine Gaſtritis*.

Gaſtritis legitima, *Sauv.* ſp. 1. *Eller.* de cogn. et cur. morb. ſect. xii. *Haller.* obſ. 14. hiſt. 3. *Lieut.* Hiſt. Anat. Med. lib. i. 74.
Gaſtritis eryſipelatoſa, *Sauv.* ſp. 4.
Cardialgia inflammatoria, *Sauv.* ſp. 13. *Tralles*, de opio, ſect. ii. p. 231.

Theſe diſeaſes Dr Cullen has thought proper to conſider all under the general head of GASTRITIS, as there are no certain ſigns by which they can be diſtinguiſhed from each other, and the method of cure muſt be the ſame in all.

Deſcription. The inflammation of the ſtomach is attended with great heat and pain in the epigaſtric region, extreme anxiety, an almoſt continual and painful hiccough, with a moſt painful vomiting of every thing taken into the ſtomach. Sometimes a temporary madneſs enſues; and there is an inſtance in the Edinburgh Medical Eſſays of the diſorder being attended with an hydrophobia. The pulſe is generally more ſunk than in other inflammations, and the fever inclines to the nature of a typhus. The diſorder is commonly of the remitting kind, and during the remiſſions the pulſe frequently intermits. During the height of the diſeaſe, a mortal phrenſy frequently ſupervenes. The diſeaſe terminates on the fourth, ſeventh, or ninth day, or from the eleventh to the fifteenth; and is more apt to end in a gangrene than pneumonic inflammations, and more frequently in a ſcirrhus than in an abſceſs.

Cauſes, &c. The inflammation of the ſtomach may ariſe from any acrid ſubſtance taken into it; from a vehement paſſion, too large draughts of cold liquor, eſpecially when the perſon is very hot; from a ſurfeit; a ſtoppage of perſpiration; repulſion of the gout; inflammations of the neighbouring viſcera; or from external injuries, ſuch as wounds, contuſions, &c.—It affects chiefly thoſe of a plethoric habit and hot bilious conſtitution.

Prognoſis. This diſeaſe is always very dangerous, and the prognoſis doubtful, which alſo muſt always be in proportion to the ſeverity of the ſymptoms. A ceſſation of pain, coldneſs about the præcordia, great debility, with a languid and intermitting pulſe, with an abatement of the hiccough, denote a gangrene and ſpeedy death. From the ſenſibility of the ſtomach alſo, and its great connexion with the reſt of the ſyſtem, it muſt be obvious, that an inflammation of it, by whatever cauſes produced, may be attended with fatal conſequences; particularly, by the great debility it produces, it may prove ſuddenly fatal, without running through the uſual courſe of inflammations.—Its tendency to admit of reſolution may be known by its having ariſen from no violent cauſe, by the moderate ſtate of the ſymptoms, and by a gradual remiſſion of theſe ſymptoms in the courſe of the firſt or at moſt of the ſecond week of the diſeaſe. The tendency to gangrene may be ſuſpected from the ſymptoms continuing with unremitting violence, notwithſtanding the uſe of proper remedies; and a gangrene already begun may be known by the ſymptoms above mentioned, particularly great debility and ſudden ceſſation of pain. The tendency to ſuppuration may be known by the ſymptoms continuing but in a moderate degree for more than one or two weeks, and by a conſiderable remiſſion of the pain, while a ſenſe of weight and anxiety ſtill remain. When an abſceſs has been formed, the frequency of the pulſe is firſt abated: but ſoon after it increaſes, with frequent cold ſhivering, and an exacerbation in the afternoon and evening; followed by night ſweats, and other ſymptoms of hectic fever. Theſe at length prove fatal, unleſs the abſceſs open into the cavity of the ſtomach, the pus be evacuated by vomiting, and the ulcer ſoon healed.

Gaſtritis.

Cure. It appears from diſſections, that the ſtomach may very often be inflamed when the characteriſtic marks of it have not appeared; and therefore we are often expoſed to much uncertainty in the cure. But when we have ſufficient evidence that a ſtate of active inflammation has taken place in the ſtomach, the principal object to be aimed at is to obtain a reſolution. Before, however, this can be accompliſhed, it will often be neceſſary to employ meaſures with the view of obviating urgent ſymptoms. When the ſymptoms appear in the manner above deſcribed, the cure is to be attempted by large and repeated bleedings employed early in the diſeaſe; and from theſe we are not to be deterred by the weakneſs of the pulſe, for it will commonly become fuller and ſofter after the operation. A bliſter ought alſo to be applied to the region of the ſtomach; and the cure will be aſſiſted by fomentations of the whole abdomen, and by frequent emollient and laxative clyſters. The irritability of the ſtomach in this diſeaſe will admit of no medicines being thrown into it; and if any can be ſuppoſed neceſſary, they muſt be exhibited in clyſters. Diluting drinks may be tried; but they muſt be of the very mildeſt kind, and given in very ſmall quantities at a time. Opiates, in whatever manner exhibited, cannot be retained in the ſtomach during the firſt days of the diſeaſe; but when the violence of the diſeaſe ſhall have abated, and when the pain and vomiting recur at intervals only, opiates give in clyſters are frequently employed with advantage; and after bleeding and bliſters no remedy is more effectual either in allaying the pain or vomiting. As ſoon as the ſtomach will retain any laxative, gentle refrigerant cathartics, taken by the mouth, ſuch as the ſoda phoſphorata, ſoda tartariſata, or the like,

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Phlegmasiæ. are productive of great benefit. A tendency to gangrene in this disease is to be obviated only by the means just now mentioned; but when it does actually supervene, it admits of no remedy. A tendency to suppuration is to be obviated by the same means employed early in the disease. After a certain period it cannot be prevented by any means whatever; and, when actually begun, must be left to nature; the only thing that can be done by art being to avoid all irritation.

194 B. *Gastritis Erysipelatosa*, or the *Erysipelatous Gastritis*.

Description. This species of inflammation takes place in the stomach much more frequently than the former. From dissections it appears that the stomach has been often affected with inflammation, when neither pain nor fever had given any notice of it; and such is justly looked upon to have been of the erysipelatous kind. This kind of inflammation also is especially to be expected from acrimony of any kind applied to the stomach; and would certainly occur much more frequently, were not the interior surface of this organ commonly defended by mucus exsuding in large quantity from the numerous follicles placed immediately under the villous coat. On many occasions, however, the exsudation of mucus is prevented, or the liquid poured out is of a less viscid kind, so as to be less fitted to defend the subjacent nerves; and it is in such cases that acrid matters may readily produce an erysipelatous affection of the stomach.

In many cases this kind of inflammation cannot be discovered, as it takes place without pain, pyrexia, or vomiting: but in some it may; namely, when it spreads into the œsophagus, and appears on the pharynx and on the whole internal surface of the mouth. When therefore an erysipelatous inflammation affects the mouth and fauces, and there shall be at the same time in the stomach an unusual sensibility to all acrids, and also a frequent vomiting, there can be little doubt of the stomach's being affected in the same manner. Even when no inflammation appears in the fauces, if some degree of pain be felt in the stomach, if there be a want of appetite, an anxiety and frequent vomiting, an unusual sensibility with regard to acrids, some thirst, and frequency of pulse, there will then be room to suspect an inflammation in the stomach; and such symptoms, after some time, have been known to discover their cause by the inflammation rising to the fauces or mouth. Inflammation of this kind is often disposed to pass from one place to another on the same surface, and, in doing so, to leave the place it had at first occupied. Such an inflammation has been known to spread successively along the whole tract of the alimentary canal; occasioning, when in the intestines, diarrhœa, and in the stomach vomitings; the diarrhœa ceasing when the vomitings came on, and the vomitings on the coming on of the diarrhœa.

Causes, &c. An erysipelatous inflammation may arise from acrid matters taken into the stomach; or from some internal causes not yet well known. It frequently occurs in putrid diseases, and in those recovering from fevers.

Cure. When the disease is occasioned by acrid matters taken internally, and these may be supposed still present in the stomach, they are to be washed out by drinking a large quantity of warm and mild medicines, and exciting gentle vomiting. At the same time, if the nature of the acrimony and its proper corrector be known, this should be thrown in; or if a specific corrector be not known, some general demulcents should be employed.

Enteritis. These measures, however, are more suited to prevent than to cure inflammation after it has taken place. When this last may be supposed to have happened, if it be attended with a sense of heat, with pain and pyrexia, according to the degree of these symptoms, the measures proposed for the cure of the other kind are to be more or less employed. When an erysipelatous inflammation of the stomach has arisen from internal causes, if pain and pyrexia occur, bleeding may be employed in persons not otherwise weakened; but in case of its occurring in putrid diseases, or where the patients are already debilitated, bleeding is inadmissible; all that can be done being to avoid irritation, and only throwing into the stomach what quantity of acids and acescent aliments it shall be found able to bear. In some conditions of the body in which this disease is apt to occur, cinchona and bitters may seem to be indicated; but an erysipelatous state of the stomach with seldom allow them to be used.

Genus XVI. ENTERITIS.

Inflammation of the *Intestines*. 195

Enteritis, *Sauv.* gen. 105. *Lin.* 29. *Vog.* 57. *Sag.* gen. 307.
Intestinorum inflammatio, *Boerh.* 959.
Febris intestinorum inflammatoria ex mesenterio, *Hoffm.* ii. 170.

Sp. I. *Enteritis Phlegmonodæa*, or the *Acute Enteritis*. 196

Enteritis iliaca, *Sauv.* sp. 1.
Enteritis colica, *Sauv.* sp. 2. *Boerh.* 963.

Description. This disease shows itself by a fixed pain in the abdomen, attended with fever, vomiting, and costiveness. The pain is often felt in different parts of the abdomen, but more frequently spreads over the whole, and is particularly violent about the navel.

Causes, &c. Inflammations of the intestines may arise from the same causes as those of the stomach; though commonly the former will more readily occur from cold applied to the lower extremities, or to the belly itself. It is also found supervening on the spasmodic colic, incarcerated hernia, and volvulus.

Prognosis. Inflammations of the intestines have the same terminations with those of the stomach, and the prognosis in both cases is much the same.

Cure. The cure of enteritis is in general the same with that of gastritis; but in this disease there is commonly more opportunity for the introduction of liquids, of acid, acescent, and other cooling remedies, and even of laxatives; but as a vomiting frequently attends the enteritis, care must be taken not to excite that vomiting by the quantity or quality of any thing thrown into the stomach. With regard to the suppuration

Phlegmasiæ. ration and gangrene of the inteſtines following the enteritis, the obſervations made reſpecting theſe terminations of gaſtritis are equally applicable in this diſeaſe.

197 Sp. II. *Enteritis Erysipelatosa*, or *Erysipelatous Enteritis*.

Concerning this nothing farther can be ſaid, than what hath been already delivered concerning the gaſtritis.

Genus XVII. HEPATITIS.

198 *Inflammation* of the *Liver*.

Hepatitis, *Sauv.* gen. 113. *Lin.* 35. *Vog.* 58. *Sag.* gen. 312. *Boerh.* 914. *Hoffm.* ii. 14. *Junck.* 66.

Deſcription. The inflammation of the liver is thought to be of two kinds, acute and chronic; but the latter very often does not diſcover itſelf except by an abſceſs found in the liver after death, and which is ſuppoſed to have been occaſioned by ſome degree of inflammation; for this reaſon the chronic inflammation often eſcapes obſervation, and we ſhall here only treat of the acute hepatitis.

The acute hepatitis is attended with conſiderable fever; a frequent, ſtrong, and hard pulſe; high coloured urine; an acute pain in the right hypochondrium, increaſed by preſſing upon the part. The pain is very often in ſuch a part of the ſide as to make it appear like a pleuriſy; and frequently, like that, is increaſed on inſpiration. The diſeaſe is alſo commonly attended with a cough, which is generally dry, though ſometimes moiſt; and when the pain thus reſembles a pleuriſy, the patient cannot lie eaſily except upon the ſide affected. The pain is frequently extended to the clavicle, and to the top of the ſhoulder; and is attended ſometimes with hiccough, and ſometimes with vomiting. Some have added jaundice, or a yellowneſs of the eyes, to the ſymptoms of this diſtemper; but experience ſhows that it has often occurred without any ſuch ſymptom.

When hepatitis is of the chronic kind, depending more on an accumulation and effuſion in the liver, than on an increaſed action of its ſmall veſſels, the patient complains rather of a ſenſe of weight than of pain; and the fever is by no means either acute or conſtant: but it often returns in paroxyſms ſomewhat reſembling the attacks of an intermittent. This diſeaſe is very ſlow in its progreſs, frequently continuing for many months, and at laſt terminating in a very conſiderable ſuppuration. In moſt caſes, however, it may be diſcovered by careful examination of the region of the liver externally. By this means, a conſiderable enlargement of that viſcus may in general be detected.

Cauſes, &c. The remote cauſes of hepatitis are not always to be diſcerned, and many have been aſſigned on a very uncertain foundation. It is principally a diſeaſe of warm climates. It has been ſuppoſed that the diſeaſe may be an affection either of the extremities of the hepatic artery, or thoſe of the vena portarum; and the ſuppoſition is by no means improbable. The opinion, however, moſt commonly adopted is, that the acute hepatitis is an affection of the external membrane of the liver, and the chronic kind an affection of the parenchyma of that viſcus. The acute diſeaſe may be ſeated either on the convex or concave ſurface of the liver; and in the former caſe a more pungent pain and hiccough may be produced, and the reſpiration is more conſiderably affected. In the latter there occurs leſs pain; and a vomiting is produced, commonly by ſome inflammation communicated to the ſtomach. The inflammation on the concave ſurface of the liver may be readily communicated to the gall-bladder and biliary ducts: and this, perhaps, is the only caſe of idiopathic hepatitis attended with jaundice. Hepatitis.

Prognoſis. The inflammation of the liver, like others, may end by reſolution, ſuppuration, or gangrene; and the tendency to the one or to the other of thoſe events may be known from what has been already mentioned concerning the prognoſis in gaſtritis. The reſolution of hepatitis is often the conſequence of, or is attended with, evacuations of different kinds. A hæmorrhage ſometimes from the noſe, and ſometimes from the hæmorrhoidal veſſels, gives a ſolution of the diſeaſe. Sometimes the ſame thing is accompliſhed by a bilious diarrhœa; and ſometimes the reſolution is attended with ſweating, and an evacuation of urine depoſiting a copious ſediment. Sometimes it may be cured by an eryſipelas appearing in ſome external part. When the diſeaſe has ended in ſuppuration, the pus collected may be diſcharged by the biliary ducts; or, if the ſuppurated part does not adhere anywhere cloſely to the neighbouring parts, it may be diſcharged into the cavity of the abdomen: but if, during the firſt ſtate of inflammation, the affected part of the liver ſhall have formed a cloſe adheſion to ſome of the neighbouring parts, the diſcharge after ſuppuration may be various, according to the different ſeat of the abſceſs. When ſeated on the convex part of the liver, if the adheſion be to the peritonæum lining the common teguments, the pus may make its way though theſe, and be diſcharged outwardly: or if the adheſion ſhall have been to the diaphragm, the pus may penetrate through this, and into the cells of the lungs; from whence it may be diſcharged by coughing. When the abſceſs is ſeated on the concave part of the liver, in conſequence of adheſions, the pus may be diſcharged into the ſtomach or inteſtines; and into theſe laſt, either directly, or by the intervention of the biliary ducts. Upon a conſideration of all theſe different circumſtances, therefore, together with the general principles of inflammation, muſt the prognoſis of this diſeaſe be eſtabliſhed.

Cure. For the cure of hepatitis, we muſt have recourſe to the general means of reſolving other inflammatory diſorders. Bleeding is to be uſed according to the degree of fever and pain. Bliſters are to be applied: fomentations of the external parts, emollient clyſters, gentle laxatives, diluents and refrigerants, are alſo uſeful. The cure, however, particularly in warm climates, where the diſeaſe is much more common than it is in Britain, is chiefly truſted to mercury. Not only in caſes of the chronic kind, but in acute hepatitis alſo, after an attempt has been made to alleviate the urgent ſymptoms by bleeding and bliſtering, recourſe is immediately had to this powerful mineral. It is employed by different practitioners, and in in different caſes, under various forms. Some are very fond of the uſe of calomel. But the preference is in general given, and perhaps with juſtice, to friction with mercurial ointment over the region of the liver. But under whatever form it may be employed, it is neceſſary that it ſhould be introduced to ſuch an extent as to keep the patient on the verge of ſalivation for ſome length of time; the duration being regulated by the circumſtances of the caſe.

From the liberal uſe of mercury, there can be no doubt that a ſucceſsful reſolution has been obtained in many caſes, which would otherwiſe have infallibly terminated in ſuppuration. But notwithſtanding the moſt careful employment of it in ſome caſes, ſuppuration will enſue; and then it is very doubtful whether any benefit will be derived from the continuance of it. But when a ſuppuration has been formed, and the abſceſs points outwardly, the part muſt be opened, the pus evacuated, and the ulcer healed according to the ordinary methods in uſe for healing abſceſſes and ulcers in other parts.

Chronic hepatitis often terminates in ſcirrhus. Againſt this, after mercury has failed, nitric acid taken internally has ſometimes been employed with ſucceſs.

Genus XVIII. SPLENITIS.

199 *Inflammation* of the SPLEEN.

Splenitis, *Sauv.* gen. 114. *Lin.* 36. *Vog.* 59. *Junck.* 67. *Sag.* gen. 313.
Lienis inflammatio, *Boerh.* 958. et *Van Swieten*, Comm.
Splenitis phlegmonodæa, *Sauv.* ſp. 1. *Foreſt*, l. xx. obſ. 5, 6. *De Haen*, apud *Van Swieten*, p. 958.
Pleuritis ſplenica, *Sauv.* ſp. 19.
Splenalgia ſuppuratoria, *Sauv.* ſp. 3.

Deſcription. This diſeaſe, according to *Juncker*, comes on with a remarkable ſhivering, ſucceeded by a moſt intenſe heat and very great thirſt; a pain and tumour are perceived in the left hypochondrium, and the paroxyſms for the moſt part aſſume a quartan form. When the patients expoſe themſelves for a little to the free air, their extremities immediately grow very cold. If a hæmorrhage happens, the blood flows out of the left noſtril. The other ſymptoms are the ſame with thoſe of the hepatitis. Like the liver, the ſpleen is alſo ſubject to a chronic inflammation, which often happens after agues; and the tumour which ſucceeds the inflammation is in many caſes very conſiderable, and is called the *ague cake*, though that name is alſo frequently given to a ſcirrhous tumour of the liver ſucceeding intermittents.

Cauſes, &c. The cauſes of this diſtemper are in general the ſame with thoſe of other inflammatory diſorders; but thoſe which determine the inflammation to that particular part more than another, are very much unknown. It attacks perſons of a very plethoric and ſanguine habit of body rather than others.

Prognoſis. What has been ſaid of the inflammation of the liver applies alſo to that of the ſpleen, though the latter is leſs dangerous than the former. Here alſo a vomiting of black matter, which in other acute diſeaſes is ſuch a fatal ſymptom, ſometimes proves critical, according to the teſtimony of Juncker. Sometimes the hæmorrhoids prove critical; but very often the inflammation terminates by ſcirrhus.

Cure. This is not at all different from what has been already laid down concerning the hepatitis.

Genus XIX. NEPHRITIS. 200

Inflammation of the KIDNEYS.

Nephritis, *Sauv.* gen. 115. *Lin.* 37. *Vog.* 65. *Sag.* gen. 314.
Nephritis vera, *Sauv.* ſp. 1.

Deſcription. The nephritis has the ſame ſymptoms which take place in other inflammations; but its diſtinguiſhing mark is the pain in the region of the kidney, which is ſometimes obtuſe, but more frequently pungent. The pain is not increaſed by the motion of the trunk of the body ſo much as a pain of the rheumatic kind affecting the ſame region. It may alſo frequently be diſtinguiſhed by the pain ſhooting along the courſe of the ureter, and it is often attended with a drawing up of the teſticle, and a numbneſs of the limb on the ſide affected; though indeed theſe ſymptoms moſt commonly attend the inflammation ariſing from a calculus in the kidney or ureter. The diſeaſe is alſo attended with frequent vomiting, and often with coſtiveneſs and colic pains. The urine is moſt commonly of a deep red colour, and is voided frequently and in a ſmall quantity at a time. In more violent caſes the urine is commonly colourleſs.

Cauſes, &c. The remote cauſes of this diſeaſe may be various; as external contuſion, violent or long-continued riding; ſtrains of the muſcles of the back incumbent on the kidneys; various acrids in the courſe of circulation conveyed to the kidneys; and perhaps ſome other internal cauſes not yet well known: the moſt frequent is that of calculous matter obſtructing the *tubuli uriniferi*, or calculi formed in the pelvis of the kidneys, and either ſticking there or falling into the ureter.

Prognoſis. This is not different from that of other inflammatory diſeaſes.

Cure. When any of thoſe cauſes operating as inducing the inflammation ſtill continue to act, the firſt object in the cure muſt be the removal of theſe; but the principal intention to be had in view, is the reſolution of the inflammation which has already taken place. But when, notwithſtanding efforts for this purpoſe, the diſeaſe terminates in ſuppuration, it muſt be the endeavour of the practitioner to promote the diſcharge of purulent matter, and the healing of the ulceration in the kidney.

Theſe different objects are principally accompliſhed by bleeding, external fomentation, frequent emollient clyſters, antiphlogiſtic purgatives, and by the free uſe of mild and demulcent liquids. The uſe of bliſters is ſcarce admiſſible, or at leaſt will require great care to avoid any conſiderable abſorption of the cantharides.

The other ſpecies of nephritis enumerated by authors are only ſymptomatic.

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Genus XX. CYSTITIS.

201 *Inflammation* of the Bladder.

Cyſtitis, *Sauv.* gen. 108. *Lin.* 31. *Vog.* 66. *Sag.* gen. 309.
Inflammatio veſicæ, *Hoffm.* ii. 157.

202 The Cystitis from *Internal Cauſes.*

Cyſtitis ſpontanea, *Sauv.* ſp. 1.

203 The Cystitis from *External Cauſes.*

Cyſtitis à cantharidibus, *Sauv.* ſp. 2.
Cyſtitis traumatica, *Sauv.* ſp. 3.

The inflammation of the bladder from internal cauſes is a very rare diſtemper; and when it does at any time occur, is to be cured in the ſame manner with other inflammations, avoiding only the uſe of bliſters. When the diſeaſe ariſes from the internal uſe of theſe flies, camphor is recommended, beſides other cooling medicines, and particularly cooling and emollient clyſters.

204 Genus XXI. HYSTERITIS.

Inflammation of the Uterus.

Hyſteritis, *Lin.* 38. *Vog.* 63.
Metritis, *Sauv.* gen. 107. *Sag.* gen. 315.
Inflammatio et febris uterina, *Hoffm.* II. 156.

Deſcription. This diſeaſe is often confounded with that called the *puerperal* or *child-bed fever;* but is eſſentially diſtinct from it, as will be ſhown in its proper place. The inflammation of the uterus is often apt to terminate by gangrene: there is a pain in the head, with delirium; and the uterine region is ſo exceedingly tender, that it cannot bear the moſt gentle preſſure without intolerable pain. When the *fundus uteri* is inflamed, there is great heat, throbbing, and pain, above the pubes; if its poſterior part, the pain is more confined to the loins and rectum, with a teneſmus; if its anterior part, it ſhoots from thence towards the neck of the bladder, and is attended with a frequent irritation to make water, which is voided with difficulty; and if its ſides or the ovaria are affected, the pains will then dart into the inſide of the thighs.

Cauſes, &c. Inflammations of the uterus, and indeed of the reſt of the abdominal viſcera, are very apt to take place in child-bed women; the reaſon of which ſeems to be the ſudden change produced in the habit, and an alteration in the courſe of the circulating blood by the contraction of the uterus after delivery. The preſſure of the gravid uterus being ſuddenly taken off from the *aorta deſcendens* after delivery, the reſiſtance to the impulſe of the blood paſſing through all the veſſels derived from it, and diſtributed to the contiguous viſcera, will be conſiderably leſſened: it will therefore ruſh into thoſe veſſels with a force ſuperior to their reſiſtance; and, by putting them violently on the ſtretch, may occaſion pain, inflammation, and fever. This contraction of the uterus alſo renders its veſſels impervious to the blood which had freely paſſed through them for the ſervice of the child during pregnancy; and conſequently a much larger quantity will be thrown upon the contiguous parts, which will ſtill add to their diſtention, and increaſe their tendency to inflammation.

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Prognoſis. An inflammation of the uterus may in general be expected to produce an obſtruction of the lochia; but the fever produced ſeldom proves fatal, unleſs the inflammation be violent, and end in a gangrene.

Cure. This is to be attempted by the ſame general means already recommended, and the management of this diſorder entirely coincides with that of the puerperal fever.

Genus XXII. RHEUMATISMUS. 205

The Rheumatism.

Rheumatiſmus, *Sauv.* gen. 185. *Lin.* 62. *Vog.* 138. *Boerh.* 1400. *Junck.* 19.
Dolores rheumatici et arthritici, *Hoffm.* II. 317.
Myoſitis, *Sag.* gen. 301.

The *Acute* Rheumatism.

Rheumatiſmus acutus, *Sauv.* ſp. 1.
Rheumatiſmus vulgaris, *Sauv.* ſp. 2.

A. The Lumbago, or *Rheumatiſm in the Muſcles of the Loins.* 206

Lumbago rheumatica, *Sauv.* gen. 212. *Sag.* p. 1.
Nephralgia rheumatica, *Sauv.* ſp. 4.

B. The Sciatica, *Iſchias,* or *Hip-Gout.* 207

Iſchias rheumaticum. *Sauv.* 213. ſp. 10.

C. The *Baſtard* Pleurisy, or *Rheumatiſm in the Muſcles of the Thorax.* 208

Pleurodyne rheumatica, *Sauv.* gen. 148. ſp. 3.
Pleuritis ſpuria, *Boerh.* 878.

The other ſpecies, which are very numerous, are all ſymptomatic; as,
Lumbago plethorica, *Sauv.* ſp. 3.
Iſchias ſanguineum, *Sauv.* ſp. 2.
Pleurodyne plethorica, *Sauv.* ſp. 1.
Rheumatiſmus hyſtericus, *Sauv.* ſp. 7.
Iſchias hyſtericum, *Sauv.* ſp. 3.
Pleurodyne hyſterica, *Sauv.* ſp. 6.
Rheumatiſmus ſaltatorius, *Sauv.* ſp. 8.
Pleurodyne flatulenta, *Sauv.* ſp. 4.
Pleurodyne à ſpaſmate, *Sauv.* ſp. 9.
Rheumatiſmus ſcorbuticus, *Sauv.* ſp. 4.
Lumbago ſcorbutica, *Sauv.* ſp. 5.
Pleurodyne ſcorbutica, *Sauv.* ſp. 11.
Iſchias ſyphiliticum, *Sauv.* ſp. 7.
Pleurodyne venerea, *Sauv.* ſp. 5.
Lumbago ſympathica, *Sauv.* p. 13.
Lumbago à ſaburrâ, *Sauv.* ſp. 8.
Pleurodyne à cocochyliâ, *Sauv.* ſp. 7.
Rheumatiſmus ſaltatorius verminoſus, *Sauv.* ſp. 8.
Iſchias verminoſum, *Sauv.* ſp. 8.
Pleurodyne verminoſa, *Sauv.* ſp. 2.
Rheumatiſmus metallicus, *Sauv.* ſp. 10.
Lumbago à hydrothorace, *Sauv.* ſp. 14.
Lumbago pſeudoiſchuria, *Sauv.* ſp. 16.
Pleurodyne à rupto œſophago, *Sauv.* ſp. 20.
Pleurodyne rachitica, *Sauv.* ſp. 13.
Iſchias à ſparganoſi, *Sauv.* ſp. 5.
Pleurodyne catarrhalis, *Sauv.* ſp. 14.

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Rheumatismus necroseos, *Sauv.* sp. 14.
Rheumatismus dorsalis, *Sauv.* sp. 11.
Lumbago à satyriasi, *Sauv.* sp. 15.
Rheumatismus febricosus, *Sauv.* sp. 9.
Lumbago febrilis, *Sauv.* sp. 4.
&c. &c.

Description. The rheumatism is particularly distinguished by pains affecting the joints, and for the most part the joints alone; but sometimes also the muscular parts. Very often they shoot along the course of the muscles from one joint to another, and are always much increased by the action of the muscles belonging to the joint or of joints affected. The larger joints are those most frequently affected, such as the hip-joint and knees, of the lower extremities, and the shoulders and elbows of the upper ones. The ancles and wrists are also frequently affected; but the smaller joints, such as those of the toes or fingers, seldom suffer. Sometimes the disease is confined to one part of the body, yet very frequently it affects many parts; and then it begins with a cold stage, which is immediately succeeded by the other symptoms of pyrexia, and particularly by a frequent, full, and hard pulse. Sometimes the pyrexia is formed before any pains are perceived; but more commonly pains are felt in particular parts before any symptoms of fever occur. When no pyrexia is present, the pain may be confined to one joint only; but when any considerable pyrexia takes place, though the pain may chiefly be felt in one joint, yet it seldom happens that it does not affect several joints, often at the very same time, but for the most part shifting their place, and having abated in one joint they become more violent in another. They do not commonly remain long in the same joint, but frequently shift from one to another, and sometimes return to joints formerly affected; and in this manner the disease often continues for a long time. The fever attending these pains has an exacerbation every evening, and is most considerable during the night, when the pains also become more violent; and it is at the same time that the pains shift their place from one joint to another. These seem to be also increased during the night by the body being covered more closely, and kept warmer.

A joint, after having been for some time affected with pain, commonly becomes also affected with some swelling and redness, which is painful to the touch. It seldom happens that a swelling coming on does not take off the pain entirely, but it rarely secures the joint against a return of it. This disease is commonly attended with more or less sweating, which occurs early, but is seldom free or copious, and seldom proves critical, though it may give temporary relief of the pain. The urine is high-coloured, and in the beginning without sediment. This, however, does not prove entirely critical, for the disease often continues long after such a sediment has appeared in the urine. The blood is always sizy. The acute rheumatism differs from all other inflammatory diseases, in not being liable to terminate in suppuration: this almost never happens; but the disease sometimes produces effusions of a transparent gelatinous fluid into the sheaths of the tendons: but if these effusions be frequent, it is certain that the liquor must often be absorbed; for it very seldom happens, that considerable or permanent tumours have been produced, or such as required to be opened and to have the contained fluid evacuated. Such tumors, however, have sometimes occurred, and the opening made in them has produced ulcers very difficult to heal.

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Sometimes rheumatism will continue for several weeks; but it seldom proves fatal, and it is rare that the pyrexia continues to be considerable for more than two or three weeks. While the pyrexia abates in its violence, if the pains of the joints continue, they are less violent; more limited in their place, being confined commonly to one or a few joints only; and are less ready to change their place.

It is often a very difficult matter to distinguish rheumatism from gout: but in rheumatism there in general occurs much less affection of the stomach; it affects chiefly the larger joints, and several of these are often affected with severe pain at the same time: it occurs at an earlier period of life than gout; it is not observed to be hereditary; and it can in general be traced to some obvious exciting cause, particularly to the action of cold.

Causes, &c. This disease is frequent in cold, and more uncommon in warm climates. It appears most frequently in autumn and spring; less frequently in winter, while the frost is constant; and very seldom during the heat of summer. It may, however, occur at any season, if vicissitudes of heat and cold be for the time frequent. For the most part, the acute rheumatism arises from the application of cold to the body when unusually warm; or when the cold is applied to one part of the body, whilst the other parts are kept warm; or lastly, when the application of the cold is long continued, as when moist or wet clothes are applied to any part of the body.—These causes may affect persons of all ages; but the rheumatism seldom appears either in very young or in elderly persons, and most commonly occurs from the age of puberty to that of 35. These causes may also affect persons of any constitution, but they most commonly affect those of a sanguine temperament.

With respect to the proximate cause of rheumatism, there have been various opinions. It has been imputed to a peculiar acrimony; of which, however, there is no evidence; and the consideration of the remote causes, the symptoms, and cure, render it very improbable. A disease of a rheumatic nature, however, may be occasioned by an acrid matter applied to the nerves, as is evident from the toothach, a rheumatic affection generally arising from a carious tooth. Pains arising from deep-seated suppurations may also resemble the rheumatism; and many cases have occurred in which such suppurations occasioned pains resembling the lumbago and ischias; but from what has been already said, it seems improbable that ever any pure rheumatic case should end in suppuration.

The proximate cause of rheumatism has by many been supposed to be a lentor in the fluids obstructing the vessels of the part; but in the observations formerly made, sufficient reasons have been already laid down for rejecting the doctrine of lentor. While we cannot therefore find either evidence or reason for supposing that the rheumatism depends on any change in the state of the fluids, we must conclude that the proximate cause of it is the same with that of other inflammations not depending upon a direct stimulus.

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In the case of rheumatism, it is supposed that the most common remote cause of it, that is, cold applied, operates especially on the vessels of the joints, these being less covered by a cellular texture than those of the intermediate parts of the limbs. It is farther supposed, that the application of cold produces a constriction of the extreme vessels, and at the same time an increase of tone or phlogistic diathesis in the course of them, from which arises an increased impetus of the blood, and at the same time a resistance to the free passage of it, and consequently inflammation and pain. It is also supposed, that the resistance formed excites the *vis medicatrix* to a further increase of the impetus of the blood; and to support this, a cold stage arises, a spasm is formed, and a pyrexia and phlogistic diathesis are produced in the whole system.

Hence the cause of rheumatism appears to be exactly analogous to that of inflammations depending on an increased afflux of blood to a part while it is exposed to the action of cold. But there seems to be further in this disease some peculiar affection of the muscular fibres. These seem to be under some degree of rigidity; and therefore less easily admit of motion, and are pained upon the exertions of it. This also seems to be the affection which gives opportunity to the propagation of pains from one joint to another, and which are most severely felt in the extremities terminating in the joints, because beyond these the oscillations are not propagated. This affection of the muscular fibres explains the manner in which strains and spasms produce rheumatic affections; and, on the whole, shows, that with an inflammatory affection of the sanguiferous system, there is also in rheumatism a peculiar affection of the muscular fibres, which has a considerable share in producing the phenomena of the disease. And it would even appear, that in what has commonly been called *acute rheumatism*, in contradistinction to the chronic, of which we are next to treat, there exists not only a state of active inflammation in the affected parts, but also of peculiar irritability; and that this often remains after the inflammation is very much diminished or has even entirely ceased. Hence a renewal of the inflammation and recurrence of the pain take place from very slight causes; and in the treatment of the disease both the state of inflammation and irritability must be had in view.

Cure. For counteracting the state of active inflammation, the chief aim of the practitioner must be to diminish the general impetus of the circulation, and the impetus at the part particularly affected. For counteracting the state of irritability, he must endeavour to remove the disposition to increased action in the vessels; to prevent the action of causes exciting painful sensations; and to obviate their influence on the part. The cure therefore requires, in the first place, an antiphlogistic regimen, and particularly a total abstinence from animal food, and from all fermented or spirituous liquors; substituting a mild vegetable or milk diet, and the plentiful use of soft diluting liquors. On this principle also, blood-letting is the chief remedy of acute rheumatism. The blood is to be drawn in large quantity; and the bleeding is to be repeated in proportion to the frequency, fulness, and hardness of the pulse, and the violence of the pain. For the most

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part, large and repeated bleedings during the first days of the disease seem to be necessary, and accordingly have been very much employed: but to this some bounds are to be set; for very profuse bleedings occasion a slow recovery, and are ready to produce a chronic rheumatism.

To avoid that debility of the system which general bleedings are apt to occasion, the urgent symptom of pain may be often relieved by topical bleedings; and when any swelling or redness has come upon a joint, the pain may very certainly be relieved by this evacuation: but as the pain and continuance of the disease seem to depend more upon the phlogistic diathesis of the whole system than upon the affection of particular parts, so topical bleedings will not supply the place of the general bleedings proposed above in most instances.

To take off the phlogistic diathesis prevailing in this disease, purging may be useful, if procured by medicines which do not stimulate the whole system, as neutral salts, and other medicines which have a refrigerant power. Purging, however, is not so useful as bleeding in removing the phlogistic diathesis; and when the disease has become general and violent, frequent stools are inconvenient, and even hurtful, by the motion and pain which they occasion.

Next to blood-letting, nothing is of so much service, both in alleviating the pains in this disease and in removing the phlogistic diathesis, as the use of sudorifics: and of all the medicines belonging to this class, what has commonly been known by the name of Dover's powder, a combination of powder of ipecacuan and opium, is the most convenient and the most effectual. Copious sweating, excited by this medicine, and supported for 10 or 12 hours by tepid diluents, such as decoction of the woods, or the like, will in most instances produce a complete remission of the pain: and by this practice, combined with blood-letting and proper regimen, the disease may often be entirely removed.

If, however, after complete intermissions from pain for some length of time have been obtained by these means, it be found that there is a great tendency to a return of the pains without any obvious cause, recourse may be had with very great benefit to the use of the Peruvian bark. By the early use of this, where a complete intermission from pain is obtained, the necessity of repeated blood-letting and sweating is often superseded; but where a complete remission cannot be obtained, it has been suspected by some to be hurtful: and in these cases, when blood-letting and sudorifics have been pushed as far as may be thought prudent, without being productive of the desired effect, very great benefit is often derived from the use of calomel combined with opium, as recommended in the Edinburgh Medical Commentaries, by Dr Hamilton of Lynn-Regis.

In this disease, external applications are of little service. Fomentations in the beginning of the disease rather aggravate than relieve the pains. The rubefacients and camphire are more effectual: but they commonly only move them from one part to another, and do not prove any cure of the general affection. Blistering may also be very effectual in removing the pain

pain from a particular part; but will be of little use, except where the pains are much confined to one place.

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ARTHRODYNIA, or *Chronic* RHEUMATISM.

Rheumatismus chronicus Auctorum.

Description. When the pyrexia attending the acute rheumatism has ceased; when the swelling and redness of the joints are entirely gone, but pains still continue to affect certain joints, which remain stiff, feel uneasy upon motion, changes of weather, or in the night time only, the disease is then called the *chronic rheumatism*, as it often continues for a very long time.

The limits between the acute and chronic rheumatisms are not always exactly marked. When the pains are still ready to shift their place; when they are especially severe in the night time; when, at the same time, they are attended with some degree of pyrexia, and with some swelling, and especially some redness of the joints; the disease is to be considered as partaking of the nature of the acute rheumatism. But when there is no longer any degree of pyrexia remaining; when the pained joints are without redness; when they are cold and stiff; when they cannot easily be made to sweat; or when, while a free and warm sweat is brought out on the rest of the body, it is only clammy and cold on the pained joints; and when, further, the pains of these are increased by cold, and relieved by heat, applied to them; the case is to be considered as that of a purely chronic rheumatism: or perhaps more properly the first of the conditions now described may be termed the state of irritability, and the second the state of atony.

The chronic rheumatism, or rather the atonic, may affect different joints; but is especially apt to affect those which are surrounded with many muscles, and those of which the muscles are employed in the most constant and vigorous exertions. Such is the case of the vertebræ of the loins, the affection of which is named *lumbago;* or of the hip-joint, when the disease is named *ischias* or *sciatica*.

Violent strains and spasms occurring on sudden and somewhat violent exertions, bring on rheumatic affections, which at first partake of the acute, but very soon change into the nature of the chronic, rheumatism.—Such are frequently the lumbago, and other affections, which seem to be more seated in the muscles than in the joints. The distinction of the rheumatic pains from those resembling them which occur in the siphylis and scurvy must be obvious, either from the seat of the pains, or from the concomitant symptoms peculiar to those diseases. The distinction of the rheumatism from the gout will be more fully understood from what is laid down under the genus Podagra.

Causes, &c. The phenomena of the purely chronic rheumatism lead us to conclude, that its proximate cause is an atony both of the blood-vessels and of the muscular fibres of the part affected, together with such a degree of rigidity and contraction in the latter as frequently attend them in a state of atony: and indeed this atony, carried to a certain extent, gives rise to a state of paralysis, with an almost total loss of motion in the affected limbs. The paralytic state of rheumatism therefore may be pointed out as a fourth condition of the disease, often claiming the attention of the practitioner.

Cure. From the view just now given of the proximate cause of chronic rheumatism, the chief indication of cure must be, to restore the activity and vigour of the part, which is principally to be done by increasing the tone of the moving fibres, but which may sometimes also be aided by giving condensation to the simple solid. When, however, the disease has degenerated into the state of paralysis, the objects to be aimed at are, the restoration of a due condition to the nervous energy in the part affected; the obtaining free circulation of blood through the vessels of the part; and the removal of rigidity in membranes and ligaments.

For answering these purposes, a great variety of remedies, both external and internal, are had recourse to. The chief of the external are, the supporting the heat of the part, by keeping it constantly covered with flannel; the increasing the heat of the part by external heat, applied either in a dry or humid form; the diligent use of the flesh-brush, or other means of friction; the application of electricity in sparks or shocks; the application of cold water by affusion or immersion; the application of essential oils of the most warm and penetrating kind; the application of salt brine; the employment of the warm bath or of the vapour baths, either to the body in general or to particular parts; and, lastly, the employment either of exercise of the part itself as far as it can easily bear, or by riding or other modes of gestation.

The internal remedies are, large doses of essential oils drawn from resinous substances, such as turpentine; substances containing such oils, as guaiac.; volatile alkaline salts, &c. These or other medicines are directed to procure sweat; and calomel, or some other preparation of mercury, in small doses, may be continued for some time. But of all the remedies which have been found useful in atonic rheumatism, perhaps the best is cinchona. It is particularly serviceable in the earlier periods of the disease. It has often been highly efficacious in preventing the degeneracy of the inflammatory into the atonic state of the disease; and by some practitioners, particularly Dr Haygarth of Bath, it has been highly extolled in acute rheumatism. Besides these, there are several other remedies recommended. The cicuta, aconitum, and hyosciamus, have in particular been highly extolled; and an infusion of the rhododendron chrysanthum is said to be employed by the Siberians with very great success. An account of the Siberian mode of practice is given by Dr Matthew Guthrie of Petersburgh, in the fifth volume of the Edinburgh Medical Commentaries, and has been followed with success at other places. Among other internal remedies for rheumatism, the use of arsenic has of late been recommended by Dr Bardsley of Liverpool. It is advised to be given under the form of the mineral solution proposed by Dr Fowler as a remedy in intermittent fever and in periodic headachs. Under this form, it is now ascertained by extensive experience that arsenic may be taken internally with as much safety as any other active medicine; and in some cases of rheumatism in which it has been employed at Edinburgh, there is reason to believe that it has been productive of benefit.

210 Genus XXIII. ODONTALGIA, the Toothach.

Odontalgia, *Sauv.* gen. 198. *Lin.* 45. *Vog.*. 145. *Sag.* gen. 159. *Junck.* 25.
Odontalgia ſive rheumatiſmus odontalgicus, *Hoffm.* II. 330.
Odontalgia carioſa, *Sauv.* ſp. 1.
Odontalgia ſcorbutica, *Sauv.* ſp. 4.
Odontalgia catarrhalis, *Sauv.* ſp. 3.
Odontalgia arthritica, *Sauv.* ſp. 6.
Odontalgia gravidarum, *Sauv.* ſp. 2.
Odontalgia hyſterica, *Sauv.* ſp. 8.
Odontalgia ſtomachica, *Sauv.* ſp. 9.

Deſcription. This well known diſeaſe makes its attack by a moſt violent pain in the teeth, moſt frequently in the *molares*, more rarely in the *inciſores*, reaching ſometimes up to the eyes, and ſometimes backward into the cavity of the ear. At the ſame time there is a manifeſt determination to the head; and a remarkable tenſion and inflation of the veſſels takes place, not only in the parts next to that where the pain is ſeated, but over the whole head.

Cauſes, &c. The toothach is ſometimes merely a rheumatic affection, ariſing from cold, but more frequently from a carious tooth. It is alſo a ſymptom of pregnancy, and takes place in ſome nervous diſorders; it may attack perſons at any time of life, though it is moſt frequent in the young and plethoric.

Cure. Many empirical remedies have been propoſed for the cure of the toothach, but none have in any degree anſwered the purpoſe. When the affection is purely rheumatic, bliſtering behind the ear will almoſt always remove it; but when it proceeds from a carious tooth, the pain is much more obſtinate. In this caſe it has been recommended to touch the pained part with a hot iron, or with ſulphuric acid, in order to deſtroy the aching nerve; to hold ſtrong ſpirits in the mouth; to put a drop of oil of cloves into the hollow of the tooth, or a pill of equal parts of opium and camphor: but one of the moſt uſeful applications of this kind is ſtrong nitrous acid, diluted with three or four times its weight of ſpirit of wine, and introduced into the hollow of a tooth from which great pain ariſes, either by means of a hair pencil or a little cotton. Cinchona has alſo been recommended, and perhaps with more juſtice, on account of its tonic and antiſeptic powers; but very often all theſe remedies will fail, and the only infallible cure is the extraction of the tooth. See Surgery.

211 Genus XXIV. PODAGRA, the Gout.

Podagra, *Vog.* 175. *Boerh.* 1254.
Febris podagrica, *Vog.* 69.
Arthritis, *Sauv.* gen. 183. *Lin.* 60. *Vog.* 139. *Sag.* gen. 142.
Dolor podagricus et arthriticus verus, *Hoffm.* II. 339.
Dolores arthritici, *Hoffm.* II. 317.
Affectus ſpaſtico-arthritici, *Junck.* 46.

212 Sp. I. The *Regular* Gout.

Arthritis podagrica, *Sauv.* ſp. 1.
Arthritis rachialgica, *Sauv.* ſp. 11.
Arthritis æſtiva, *Sauv.* ſp. 4.

Sp. II. The *Atonic* Gout. 213

Arthritis melancholica, *Sauv.* ſp. 6.
Arthritis hiemalis, *Sauv.* ſp. 2.
Arthritis chlorotica, *Sauv.* ſp. 5.
Arthritis aſthmatica, *Sauv.* ſp. 9.

Sp. III. The *Retrocedent* Gout. 214

Sp. IV. The *Miſplaced* Gout. 215

Deſcription. What we call a *paroxyſm of the gout* is principally conſtituted by an inflammatory affection of ſome of the joints. This ſometimes comes on ſuddenly, without any warning, but is generally preceded by ſeveral ſymptoms; ſuch as the ceaſing of a ſweating which the feet had been commonly before affected with; an unuſual coldneſs of the feet and legs; a frequent numbneſs, alternating with a ſenſe of prickling along the whole of the lower extremities; frequent cramps of the muſcles of the legs; and an unuſual turgeſcence of the veins.

While theſe ſymptoms take place in the lower extremities, the body is affected with ſome degree of torpor and languor, and the functions of the ſtomach in particular are more or leſs diſturbed. The appetite is diminiſhed; and flatulency, or other ſymptoms of indigeſtion, are felt. Theſe ſymptoms take place for ſeveral days, ſometimes for a week or two, before a paroxyſm comes on; but commonly, upon the day immediately preceding it, the appetite becomes keener than uſual.

The circumſtances of paroxyſms are chiefly the following. They come on moſt commonly in the ſpring, and ſooner or later according as the vernal heat ſucceeds ſooner or later to the winter's cold, and, perhaps, ſooner or later alſo, according as the body may happen to be more or leſs expoſed to viciſſitudes of heat and cold.

The attacks are ſometimes felt firſt in the evening, but more commonly about two or three o'clock in the morning. The paroxyſm begins with a pain affecting one foot, moſt frequently in the ball or firſt joint of the great toe, but ſometimes in other parts of the foot. With the attack of this pain, there is commonly more or leſs of a cold ſhivering; which, as the pain increaſes, gradually ceaſes; and is ſucceeded by a hot ſtage of pyrexia, which continues for the ſame time with the pain itſelf. From the firſt attack, the pain becomes, by degrees, more violent, and continues in this ſtate with great reſtleſſneſs of the whole body till next midnight, after which it gradually remits; and, after it has continued for twenty-four hours from the commencement of the firſt attack, it commonly ceaſes almoſt entirely; and, with the coming on of a gentle ſweat, allows the patient to fall aſleep. The patient, upon coming out of this ſleep in the morning, finds the pained part affected with ſome redneſs and ſwelling, which, after having continued for ſome days, gradually abate.

When a paroxyſm has thus come on, although the violent pain after 24 hours be conſiderably abated, the patient is not entirely relieved from it. For ſome

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days he has every evening a return of more considerable pain and pyrexia, and theſe continue with more or leſs violence till morning. After going on, in this manner, for ſeveral days, the diſeaſe ſometimes goes entirely off, not to return till after a long interval.

When the diſeaſe, after having thus remained for ſome time in a joint, ceaſes entirely, it generally leaves the perſon in very perfect health, enjoying greater eaſe and alacrity in the functions of both body and mind than he had for a long time before experienced.

At the beginning of the diſeaſe, the returns of it are ſometimes only once in three or four years: but as it advances, the intervals become ſhorter, and at length the attacks are annual; afterwards they come twice each year; and at length recur ſeveral times during the courſe of autumn, winter, and ſpring; and as, when the fits are frequent, the paroxyſms become alſo longer, ſo, in the advanced ſtate of the diſeaſe, the patient is hardly ever tolerably free from it, except perhaps for two or three months in ſummer.

The progreſs of the diſeaſe is alſo marked by the parts which it affects. At firſt, it commonly affects one foot only; afterwards every paroxyſm affects both feet, the one after the other; and as the diſeaſe proceeds, it not only affects both feet at once, but, after having ceaſed in the foot which was laſt attacked, returns again into the firſt, and perhaps a ſecond time alſo into the other. Its changes of places are not only from one foot to another, but from the feet into other joints, eſpecially thoſe of the upper extremities; ſo ſo that there is hardly a joint of the body which, on one occaſion or another, is not affected. It ſometimes affects two different joints at the very ſame time; but more commonly it is at any one time ſevere in a ſingle joint only, and paſſes in ſucceſſion from one joint to another; ſo that the patient's affliction is often protracted for a long time.

When the diſeaſe has often returned, and the paroxyſms have become very frequent, the pains are commonly leſs violent than they were at firſt; but the patient is more affected with ſickneſs, and the other ſymptoms of the atonic gout, which ſhall be hereafter mentioned.

After the firſt paroxyſm of the diſeaſe, the joints which have been affected are entirely reſtored to their former ſuppleneſs and ſtrength: but after the diſeaſe has recurred very often, the joints affected do neither ſo ſuddenly nor entirely recover their former ſtate, but continue weak and ſtiff; and theſe effects at length proceed to ſuch a degree, that the joints loſe their motion entirely.

In many perſons, but not in all, after the diſeaſe has frequently recurred, concretions of a chalky nature are formed upon the outſide of the joints, and for the moſt part immediately under the ſkin. The matter ſeems to be depoſited at firſt in a fluid form, afterwards becoming dry and firm. In their firm ſtate, theſe concretions are a hard earthy ſubſtance, very entirely ſoluble in acids. After they have been formed, they contribute, with other circumſtances, to deſtroy the motion of the joint.

In moſt perſons who have laboured under the gout for many years, a nephritic affection comes on, and diſcovers itſelf by all the ſymptoms which uſually attend calculous concretions in the kidneys, and which we ſhall have occaſion to deſcribe in another place. All that is neceſſary to be obſerved here is, that the nephritic affection alternates with paroxyſms of the gout; and that the two affections, the nephritic and the gouty, are hardly ever preſent at the ſame time. This alſo may be obſerved, that children of gouty or nephritic parents commonly inherit one or other of theſe diſeaſes; but whether the principal diſeaſe of the parent may have been either gout or nephritis alone, ſome of the children have the one and ſome the other. In ſome of them, the nephritic affection occurs alone, without any gout ſupervening; and this happens to be frequently the caſe with the female children of gouty parents.

In the whole of the hiſtory already given, we have deſcribed the moſt common form of the diſeaſe, and which therefore, however diverſified in the progreſs of it, may be ſtill called the regular ſtate of the gout.—Upon ſome occaſions, however, the diſeaſe aſſumes different appearances: but as we ſuppoſe the diſeaſe to depend always upon a certain diatheſis, or diſpoſition of the ſyſtem; ſo every appearance which we can perceive to depend upon that ſame diſpoſition, we ſtill conſider as ſymptomatic, and view the diſeaſe to be a caſe of the gout. The principal circumſtance, in what we term the *regular gout*, is the inflammatory affection of the joints; and whatever ſymptoms we can perceive to be connected with, or to depend upon, the diſpoſition which produces that inflammatory affection, but without its taking place or being preſent at the ſame time, we name the *irregular gout*.

Of ſuch irregular gout there are three different ſtates, which may be named the *atonic*, the *retrocedent*, and the *miſplaced* gout.

The firſt is, when the gouty diatheſis prevails in the ſyſtem; but, from certain cauſes, does not produce the inflammatory affection of the joints. In this caſe, the morbid ſymptoms which appear, are chiefly affections of the ſtomach, ſuch as loſs of appetite, indigeſtion, and its various attendants of ſickneſs, nauſea, vomiting, flatulency, acid eructations, and pains in the region of the ſtomach. Theſe ſymptoms are frequently accompanied with pains and cramps in ſeveral parts of the trunk and the upper extremities of the body, which are relieved by the diſcharge of wind from the ſtomach. Together with theſe affections of the ſtomach, there commonly occurs a coſtiveneſs; but ſometimes a looſeneſs, with colic pains. Theſe affections of the alimentary canal are often attended with all the ſymptoms of hypochondriaſis, ſuch as dejection of mind, a conſtant and anxious attention to the ſlighteſt feelings, an imaginary aggravation of theſe, and an apprehenſion of danger from them.

In the ſame atonic gout, the viſcera of the thorax alſo are ſometimes affected, and palpitations, faintings, and aſthma, occur.

In the head alſo occur headachs, giddineſs, apoplectic and paralytic affections.

When the ſeveral ſymptoms now mentioned occur in habits having the marks of a gouty diſpoſition, this may be ſuſpected to have laid the foundation for them; and eſpecially when either, in ſuch habits, a manifeſt tendency to the inflammatory affection has formerly appeared, or when the ſymptoms mentioned are

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are intermixed with, and are relieved by ſome degree of the inflammatory gout. In ſuch caſes there can be no doubt of conſidering the whole as a ſtate of the gout.

Another ſtate of the diſeaſe we name the *retrocedent* gout. This occurs when an inflammatory ſtate of the joints has, in the uſual manner, come on, but without ariſing to the ordinary degree of pain and inflammation; or at leaſt without theſe continuing for the uſual time, or without their receding gradually in the uſual manner; theſe affections of the joints ſuddenly and entirely ceaſe, while ſome internal part becomes affected. The internal part moſt commonly attacked is the ſtomach; which then is affected with anxiety, ſickneſs, vomiting, or violent pain: but ſometimes the internal part is the heart, which gives occaſion to a ſyncope; ſometimes it is the lungs, which are affected with aſthma; and ſometimes it is the head, giving occaſion to apoplexy or palſy. In all theſe caſes there can be no doubt that the ſymptoms are all a part of the ſame diſeaſe, however different the affection may ſeem to be in the parts which it attacks.

The third ſtate of irregular gout, which we name the *miſplaced*, is when the gouty diatheſis, inſtead of producing the inflammatory affection of the joints, produces an inflammatory affection of ſome internal part, and which appears from the ſame ſymptoms that attend the inflammations of thoſe parts ariſing from other cauſes.

Whether the gouty diatheſis does ever produce ſuch inflammation of the internal parts without having firſt produced it in the joints, or whether the inflammation of the internal part be always a tranſlation from the joints previouſly affected, we dare not determine; but, even ſuppoſing the latter to be always the caſe, we think the difference of the affection of the internal part muſt ſtill diſtinguiſh the *miſplaced* from what we have named the *retrocedent gout*.

With regard to the miſplaced gout, Dr Cullen, whom we here follow, tells us, that he never met with any caſes of it in his practice, nor does he find any diſtinctly marked by practical writers, except that of a pneumonic inflammation.

There are two caſes of a tranſlated gout; the one of which is an affection of the neck of the bladder, producing pain, ſtrangury, and a *catarrhus veſicæ*: the other is an affection of the rectum, ſometimes indicated by pain alone in that part, and ſometimes by hæmorrhoidal ſymptoms. In gouty perſons ſuch affections have been known to alternate with inflammatory affections of the joints; but whether theſe belong to the retrocedent or to the miſplaced gout, Dr Cullen pretends not to determine.

It is commonly ſuppoſed, that there are ſome caſes of rheumatiſm which are ſcarcely to be diſtinguiſhed from the gout: but theſe, Dr Cullen thinks, are but few; and that the two diſeaſes may be for the moſt part diſtinguiſhed with great certainty, by obſerving the prediſpoſition, the antecedent circumſtances, the parts affected, the recurrences of the diſeaſe, and its connection with the ſyſtem; which circumſtances, for the moſt part, appear very differently in the two diſeaſes.

Cauſes, &c. The gout is generally an hereditary diſeaſe: but ſome perſons, without any hereditary diſ-

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poſition, ſeem to acquire it; and in ſome an hereditary diſpoſition may be counteracted from various cauſes. It attacks the male ſex eſpecially; but it ſometimes, though more rarely, attacks alſo the female. The females liable to it are thoſe of the more robuſt and full habits; and it very often happens to thoſe before the menſtrual evacuation has ceaſed. Dr Cullen hath alſo found it occurring in ſeveral females whoſe menſtrual evacuations were more abundant than uſual.

The gout ſeldom attacks eunuchs; and when it does, ſeems to fall upon thoſe who happen to be of a robuſt habit, to lead an indolent life, and to live very full. It attacks eſpecially men of robuſt and large bodies, who have large heads, are of full and corpulent habits, and whoſe ſkins are covered with a thick *rete mucoſum*, which gives a coarſe ſurface. To ſpeak in the ſtyle of the ancient phyſicians, the gout will ſeldom be found to attack thoſe of a ſanguine, or ſuch as are of a purely melancholic temperament; but very readily thoſe of a *cholerico-ſanguine* temperament. It is, however, very difficult to treat this matter with preciſion. The gout ſeldom attacks perſons employed in conſtant bodily labour, or thoſe who live much upon vegetable aliment. It does not commonly attack men till after the age of 35; and generally not till a ſtill later period. There are indeed inſtances of the gout appearing more early; but theſe are few in compariſon of the others. When the diſeaſe does appear early in life, it ſeems to be in thoſe who have the hereditary diſpoſition very ſtrong, and to whom the remote cauſes hereafter mentioned have been applied in a very conſiderable degree.

As the gout is an hereditary diſeaſe, and affects men particularly of a certain habit, its remote cauſes may be conſidered as prediſponent and occaſional. The prediſponent cauſe, as far as expreſſed by external appearances, has been already marked; and phyſicians have been very confident in aſſigning the occaſional cauſes: but in a diſeaſe depending ſo much upon a prediſpoſition, the aſſigning occaſional cauſes muſt be uncertain; as in the prediſpoſed the occaſional cauſes may not always appear, and in perſons not prediſpoſed they may appear without effect; and this uncertainty muſt particularly affect the caſe of the gout.

The occaſional cauſes of the diſeaſe ſeem to be of two kinds. Firſt, Thoſe which induce a plethoric ſtate of the body. Secondly, Thoſe which in plethoric habits, induce a ſtate of debility. Of the firſt kind are a ſedentary, indolent manner of life, and a full diet of animal food. Of the ſecond kind of occaſional cauſes which induce debility are exceſs in venery; intemperance in the uſe of intoxicating liquors; indigeſtion, produced either by the quantity or quality of the aliments; much application to ſtudy or buſineſs, night-watching, exceſſive evacuations; the ceaſing of uſual labour; a ſudden change from a very full to a very ſpare diet; the large uſe of acids and aceſcents; and, laſtly, cold applied to the lower extremities. The former ſeem to act by increaſing the prediſpoſition; the latter are commonly the exciting cauſes, both of the firſt attacks, and of the repetitions of the diſeaſe.

With reſpect to the proximate cauſe of the gout, it has generally been thought that it depends on a certain

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This doctrine, however ancient and generally received, appears to Dr Cullen to be very doubtful. For,

First, There is no direct evidence of any morbific matter being present in persons disposed to the gout. There are no experiments or observations which show that the blood or other humours of gouty persons are in any respect different from those of the sound. Previous to attacks of the gout, there appear no marks of any morbid state of the fluids; for the disease generally attacks those persons who have enjoyed the most perfect health, and appear to be in that state when the disease comes on. At a certain period of the disease, a peculiar matter indeed appears in gouty persons; but this, which does not appear in every instance, and which appears only after the disease has subsisted for a long time, seems manifestly to be the effect, not the cause, of the disease. Further, Though there be certain acrids which, taken into the body, seem to excite the gout, it is probable that these acrids operate otherwise in exciting the disease, than by affording the material cause of it. In general, therefore, Dr Cullen thinks there is no proof of any morbific matter being the cause of the gout.

Secondly, The suppositions concerning the particular nature of the matter producing the gout, have been so various, and so contradictory, as to allow us to conclude, that there is truly no proof of the existence of any of them. With respect to many of these suppositions, they are so inconsistent with chemical philosophy, and with the laws of the animal economy, that they must be entirely rejected.

Thirdly, The supposition of a morbific matter as the cause, is not consistent with the phenomena of the disease, particularly with its frequent and sudden translations from one part to another.

Fourthly, The supposition is further rendered improbable by this, that, if a morbific matter did exist, its operation should be similar in the several parts which it attacks; whereas it seems to be very different, being stimulant, and exciting inflammation, in the joints; but sedative and destroying tone in the stomach; which, upon the supposition of the same particular matter acting in both cases, is not to be explained by any difference in the part affected.

Fifthly, Some facts alleged in proof of a morbific matter, are not confirmed; such as those which would prove the disease to be contagious. There is, however, no proper evidence of this, the facts given being not only few, but exceptionable, and the negative observations innumerable.

Sixthly, Some arguments brought in favour of a morbific matter are founded upon a mistaken explanation. The disease has been supposed to depend upon a morbific matter, because it is hereditary. But the inference is not just: for most hereditary diseases do not depend upon any morbific matter, but upon a particular conformation of the structure of the body transmitted from the parent to the offspring; and this last appears to be particularly the case in the gout. It may be also observed, that hereditary diseases depending upon a morbific matter, appear always much more early in life than the gout commonly does.

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Seventhly, The supposition of a morbific matter being the cause of the gout, has been hitherto useless, as it has not suggested any successful method of cure. Particular theories of gout have often corrupted the practice, and have frequently led from those views which might have been useful, and from that practice which experience had approved. Further, Though the supposition of a morbific matter has been generally received, it has been as generally neglected in practice. When the gout has affected the stomach, nobody thinks of correcting the matter supposed to be present there, but merely of restoring the tone of the moving fibres.

Eighthly, The supposition of a morbific matter is quite superfluous: for it explains nothing, without supposing that matter to produce a change in the state of the moving powers; and a change in the state of the moving powers, produced by other causes, explains every circumstance without the supposition of a morbific matter; and it may be observed, that many of the causes exciting the gout, do not operate upon the state of the fluids, but directly and solely upon that of the moving powers.

Lastly, Dr Cullen contends that the supposition of a morbific matter is superfluous; because, without that, the disease can be explained, he thinks, in a manner more consistent with its phenomena, with the laws of the animal economy, and with the method of cure which experience has approved. We now proceed to give this explanation; but, before entering upon it, we must premise some general observations which Dr Cullen states.

The first observation is, That the gout is a disease of the whole system, or depends upon a certain general conformation and state of the body, which manifestly appears from the facts above mentioned. But the general state of the system depends chiefly upon the state of its primary moving powers; and therefore the gout may be supposed to be an affection of these.

The second observation is, That the gout is manifestly an affection of the nervous system; in which the primary moving powers of the whole system are lodged. The occasional or exciting causes are almost all such as act directly upon the nerves and nervous system; and the greater part of the symptoms of the atonic or retrocedent gout are manifestly affections of the same system. This leads us to seek for an explanation of the whole of the disease, in the laws of the nervous system, and particularly in the changes which may happen in the balance of its several parts.

The third observation is, That the stomach, which has so universal a consent with the rest of the system, is the internal part that is the most frequently, and often very considerably, affected by the gout. The paroxysms of the disease are commonly preceded by an affection of the stomach; many of the exciting causes act first upon the stomach; and the symptoms of the atonic and retrocedent gout are most commonly and chiefly affections of the same organ. This observation leads us to remark, that there is a balance subsisting between the state of the internal and that of the external parts; and, in particular, that the state of the stomach is connected with that of the external parts, so that the state

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state of tone in the one may be communicated to the other.

These observations being premised, Dr Cullen offers the following pathology of the gout.

In some persons there is a certain vigorous and plethoric state of the system, which at a certain period of life is liable to a loss of tone in the extremities. This is in some measure communicated to the whole system, but appears more especially in the functions of the stomach. When this loss of tone occurs while the energy of the brain still retains its vigour, the *vis medicatrix naturæ* is excited to restore the tone of the parts; and accomplishes it, by exciting an inflammatory affection in some part of the extremities. When this has subsisted for some days, the tone of the extremities and of the whole system is restored, and the patient returns to his ordinary state of health.

This is the course of things in the ordinary form of the disease, which we name the *regular gout;* but there are circumstances of the body, in which this course is interrupted or varied. Thus, when the atony has taken place, if the reaction do not succeed, the atony continues in the stomach, or perhaps in other internal parts; and produces that state which Dr Cullen, for reasons now obvious, named the *atonic gout.*

A second case of variation in the course of the gout is, when to the atony the reaction and inflammation have to a certain degree succeeded, but from causes either internal or external the tone of the extremities and perhaps of the whole system is weakened; so that the inflammatory state, before it had either proceeded to the degree, or continued for the time, requisite for restoring the tone of the system, suddenly and entirely ceases: whence the stomach, and other internal parts, relapse into the state of atony; and perhaps have that increased by the atony communicated from the extremities: all which appears in what has been termed the *retrocedent state of the gout.*

A third case of variation from the ordinary course of the gout, is, when to the atony, usually preceding, an inflammatory reaction fully succeeds, but has its usual determination to the joints prevented by some circumstances; and is therefore directed to some internal part, where it produces an inflammatory affection, and that state of things which we have named the *misplaced gout.*

Though this theory of Dr Cullen's be supported with much ingenuity, yet we may confidently venture to assert, that on this subject he has been less successful in establishing his own opinions, than in combating those of others; and this theory, as well as others formerly proposed, is liable to numerous and unsurmountable objections. According to the hypothesis, a vigorous and plethoric habit should in every case exist prior to the appearance of gout; which is by no means consistent with fact: nor is it true that a vigorous and plethoric habit is liable at a certain age to a loss of tone in the extremities; which is another necessary condition in the hypothesis. Loss of tone often occurs in the extremities without exerting any peculiar influence on the stomach; and why a loss of tone in the stomach should excite the *vis medicatrix naturæ* to restore it, by exciting an inflammatory affection in some part of the extremities, is very inconceivable. Were the hypothesis true, every dyspeptic

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patient should infallibly be affected with gout; which however, is by no means the case. In short, every step in the theory is liable to unsurmountable objections; and it by no means, any more than former hypotheses, explains the phenomena of the disease, particularly what Dr Cullen has himself so accurately pointed out, the connection of gouty with calculous complaints.

A very ingenious work has lately been published by an anonymous author, entitled "a Treatise on Gravel and upon Gout;" in which the sources of each are investigated, and effectual means of preventing or removing these diseases recommended. In this treatise an attempt is made to prove, that both diseases depend upon a peculiar concreting acid, the acid of calculi, or the *lithic* or *uric acid,* as it has been styled by some. He supposes this acid, constantly present to a certain degree in the circulating fluids, to be precipitated by the introduction of other acids; and in this manner he explains the influence of acid wines and other liquors, as claret, cyder, &c. inducing gout; for he considers the circumstance chiefly constituting the disease as being an inflammation in parts of which the functions have been interrupted by the redundant acid precipitated. Although this theory be supported with much ingenuity, yet it is also liable to many objections. The sudden attack of the affection; its sudden transition from one part of the body to another; the instant relief of one part when another comes to be affected; and the various anomalous forms which the disease puts on, having an exact resemblance to different affections; are altogether irreconcileable to the idea of its depending on any fixed obstruction at a particular part arising from concreting acid. Nor does the plan of prevention and cure which he proposes, and which consists chiefly in abstinence from acid, and in the destruction of acid, by any means correspond in every particular to the best established facts respecting the treatment of gout; to which we next proceed.

Cure. In entering upon this, we must observe, in the first place, that a cure has been commonly thought impossible; and we acknowledge it to be very probable, that the gout, as a disease of the whole habit, and very often depending upon original conformation, cannot be cured by medicines, the effects of which are always very transitory, and seldom extend to the producing any considerable change of the whole habit.

It would perhaps have been happy for gouty persons if this opinion had been implicitly received by them; as it would have prevented their having been so often the dupes of self-interested pretenders, who have either amused them with inert medicines, or have rashly employed those of the most pernicious tendency. Dr Cullen, who has treated of the cure of the disease with great judgement, as he has done the theory with much ingenuity, is much disposed to believe the impossibility of a cure of the gout by medicines; and more certainly still inclined to think, that, whatever may be the possible power of medicines, yet no medicine for curing the gout has hitherto been found. Although almost every age has presented a new remedy, all hitherto offered have, very soon after, been neither neglected as useless, or condemned as pernicious.

But, though unwilling to admit the power of medicines, yet he contends, that a great deal can be done towards

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towards the cure of the gout by a regimen: and he is firmly persuaded, that any man who, early in life, will enter upon the constant practice of bodily labour, and of abstinence from animal food, will be preserved entirely from the disease.

Whether there be any other means of radically curing the gout, the Doctor is not able to say. There are histories of cases of the gout, in which it is said, that by great emotions of mind, by wounds, and by other accidents, the symptoms have been suddenly relieved, and never again returned; but how far these accidental cures might be imitated by art, or would succeed in other cases, is at least extremely uncertain.

The practices proper and necessary in the treatment of the gout, are to be considered under two heads: *First*, As they are to be employed in the intervals of paroxysms; or, *secondly*, As during the time of these. In the intervals of paroxysms, the indications are, to prevent altogether the return of paroxysms; or at least to render them less frequent and more moderate. During the time of paroxysms, the indications are, to moderate the violence and shorten the duration of them as much as can be done with safety.

It has been already observed, that the gout may be entirely prevented by constant bodily exercise, and by a low diet; and Dr Cullen is of opinion, that this prevention may take place even in persons who have a hereditary disposition to the disease. Even when the disposition has discovered itself by several paroxysms of inflammatory gout, he is persuaded that labour and abstinence will absolutely prevent any returns of it for the rest of life. These, therefore, are the means of answering the first indication to be pursued in the intervals of paroxysms.

Exercise in persons exposed to the gout, in Dr Cullen's opinion, operates by answering two purposes: One of these is the strengthening of the tone of the extreme vessels; and the other, the guarding against a plethoric state. For the former, if exercise be employed early in life, and before intemperance has weakened the body, a very moderate degree of it will answer the purpose; and, for the latter, if abstinence be at the same time observed, less exercise will be necessary.

With respect to exercise, this in general is to be observed, that it should never be violent; for if violent, it cannot be long continued, and must always endanger the bringing on an atony in proportion to the violence of the preceding motions.

It is also to be observed, that the exercise of gestation, though considerable and constant, will not, if it be entirely without bodily exercise, answer the purpose of preventing the gout. For this end, therefore, the exercise must be in some measure that of the body; and must be moderate, but at the same time constant and continued through life.

In every case and circumstance of the gout in which the patient retains the use of his limbs, bodily exercise, in the intervals of paroxysms, will be always useful; and in the beginning of the disease, when the disposition to it is not yet strong, exercise may prevent a paroxysm which otherwise would have come on. In more advanced states of the disease, however, when there is some disposition to a paroxysm, much walking will bring it on; either as it weakens the tone of the lower extremities, or as it excites an inflammatory disposition in them; and thus it seems to be that sprains or contusions often bring on a paroxysm of the gout.

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Abstinence, the other part of the regimen for preventing the gout, is of more difficult application. If an abstinence from animal food be entered upon early in life, while the vigour of the system is yet entire, Dr Cullen has no doubt of its being both safe and effectual: but if the motive for this diet shall not have occurred till the constitution has been broken by intemperance, or by the decline of life, a low diet may then endanger the induction of an atonic state.

Further, If a low diet be entered upon only in the decline of life, and be at the same time a very great change from the former manner of living, the withdrawing of an accustomed stimulus of the system may readily throw it into an atonic state.

The safety of an abstemious course will be greater or less according to the management of it. Animal food especially disposes to the plethoric and inflammatory state, and that food is to be therefore especially avoided; but, on the other hand, vegetable aliment of the lowest quality is in danger of weakening the system too much by not affording sufficient nourishment, and more particularly of weakening the tone of the stomach by its acescency. It is therefore a diet of a middle nature that is to be chosen; and milk is precisely of this kind, as containing both animal and vegetable matter.

As approaching to the nature of milk, and as being a vegetable matter containing the greatest portion of nourishment, the farinaceous seeds are next to be chosen, and are the food most proper to be joined with milk.

With respect to drink, fermented liquors are useful only when they are joined with animal food, and that by their acescency; and their stimulus is only necessary from custom. When, therefore, animal food is to be avoided, fermented liquors are unnecessary; and by increasing the acescency of vegetables, these liquors may be hurtful. The stimulus of fermented or spirituous liquors is not necessary to the young and vigorous, and when much employed impairs the tone of the system. These liquors, therefore, are to be avoided, excepting as custom and the declining state of the system may have rendered them necessary. For preventing or moderating the regular gout, water is the only proper drink.

With respect to an abstemious course, it has been supposed, that an abstinence from animal food and fermented liquors, or the living upon milk and farinacea alone for the space of one year, might be sufficient for a radical cure of the gout: and it is possible that, at a certain period of life, in certain circumstances of the constitution, such a measure might answer the purpose. But this is very doubtful: and it is more probable, that the abstinence must, in a great measure, be continued, and the milk diet be persisted in, for the remainder of life. It is well known, that several persons who had entered on an abstemious course, and had been thereby delivered from the gout, have, however, upon returning to their former manner of full living, had the disease return upon them with as much violence

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violence as before, or in a more irregular and more dangerous form.

It has been alleged, that, for preventing the return of the gout, blood-letting or scarifications of the feet, frequently repeated, and at stated times, may be practised with advantage; but of this Dr Cullen tells us he has had no experience; and the benefit of the practice is not, as far as we know, confirmed by the observation of any other practitioner.

Exercise and abstinence are the means of avoiding the plethoric state which gives the disposition to the gout; and are therefore the means proposed for preventing the paroxysms, or at least for rendering them less frequent and more moderate. But many circumstances prevent the steadiness necessary in pursuing these measures: and therefore in such cases, unless great care be taken to avoid the exciting causes, the disease may frequently return, and, in many cases, the preventing of paroxysms is chiefly to be obtained by avoiding those exciting causes already enumerated.

A due attention in avoiding these different causes will certainly prevent fits of the gout; and the taking care that the exciting causes be never applied in a great degree, will certainly render fits more moderate when they do come on. But, upon the whole, it will appear, that a very strict attention to the general conduct of life, is in this matter necessary; and therefore, when the predisposition has taken place, it will be extremely difficult to avoid the disease.

Dr Cullen is firmly persuaded, that, by obviating the predisposition, and by avoiding the exciting causes, the gout may be entirely prevented: but, as the measures necessary for this purpose will, in most cases, be pursued with difficulty, and even with reluctance, men have been very desirous to find a medicine which might answer the purpose without any restraint on their manner of living. To gratify this desire, physicians have proposed, and, to take advantage of it, empirics have feigned, many remedies. Of what nature several of these remedies have been, it is difficult to say: but of those which are unknown, we conclude, from their having been only of temporary fame, and from their having soon fallen into neglect, that they have been either inert or pernicious. We shall therefore make no inquiry after them; and shall now remark only upon one or two known remedies for the gout which have been lately fashionable.

One of these is what has been named in England the *Portland powder*. This is not a new medicine, but is mentioned by Galen, and, with some little variation in its composition, has been mentioned by the writers of almost every age since that time. It appears to have been at times in fashion, and to have again fallen into neglect; and Dr Cullen thinks that this last has been owing to its having been found to be, in many instances, pernicious. In every instance which he has known of its exhibition for the length of time prescribed, the persons who had taken it were indeed afterwards free from any inflammatory affection of the joints; but they were affected with many symptoms of the atonic gout; and many, soon after finishing their course of the medicine, have been attacked with apoplexy, asthma, or dropsy, which proved fatal.

Another remedy which has had the appearance of preventing the gout, is alkali in various forms; such as the fixed alkali, both mild and caustic, lime water, soap, and absorbent earths; and of late the alkaline aërated water has been more fashionable than any other. Since it became common to exhibit these medicines in nephritic and calculous cases, it has often happened that they were given to those who were at the same time subject to the gout; and it has been observed, that under the use of these medicines, gouty persons have been longer free from the fits of their disease. That, however, the use of these medicines has entirely prevented the returns of gout, Dr Cullen does not know; because he never pushed the use of them for a long time, being apprehensive that the long-continued use of them might produce a hurtful change in the state of the fluids.

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As the prevention of gout depends very much on supporting the tone of the stomach, and avoiding indigestion; so costiveness, by occasioning this, is very hurtful to gouty persons. It is therefore necessary for such persons to prevent or remove costiveness, by a laxative medicine, when needful; but it is at the same time proper, that the medicine employed should be such as may keep the belly regular, without much purging. Aloetics, rhubarb, magnesia alba, oleum ricini, or flowers of sulphur, may be employed, as the one or the other may happen to be best suited to particular persons.

These are the several measures to be pursued in the intervals of the paroxysms; and we are next to mention the measures proper during the time of them.

As during the time of paroxysms the body is in a feverish state, no irritation should then be added to it; every part, therefore, of the antiphlogistic regimen, except the application of cold, ought to be strictly observed.

An exception to the general rule, however, may occur when the tone of the stomach is weak, and when the patient has been before much accustomed to the use of strong drink; for then it may be allowable, and even necessary, to give some animal food and a little wine.

That no irritation is to be added to the system during the paroxysms of gout, except in the cases mentioned, is agreed upon among physicians: but it is a more difficult matter to determine, whether, during the time of paroxysms any measures may be pursued to moderate the violence of reaction and of inflammation. Dr Sydenham has given it as his opinion, that the more violent the inflammation and pain, the paroxysm will be the shorter, as well as the interval between the present and the next paroxysm longer; and, if this opinion be admitted as just, it will forbid the use of any remedies which might moderate the inflammation; which is, to a certain degree, undoubtedly necessary for the health of the body. On the other hand, acute pain presses for relief; and although a certain degree of inflammation may seem absolutely necessary, there is reason to believe, a moderate degree of it may answer the purpose; and it is even probable, that in many cases the violence of inflammation may weaken the tone of the parts, and thereby invite a return of paroxysms. It seems to be in this way, that, as the disease advances, the paroxysms become more frequent.

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From these last considerations, it seems probable, that, during the time of paroxysms some measures may be taken to moderate the violence of the inflammation and pain, and particularly, that in first paroxysms, and in the young and vigorous, blood-letting at the arm may be practised with advantage: but this practice cannot be repeated often with safety; because blood-letting not only weakens the tone of the system, but also contributes to produce plethora. However, bleeding by leeches on the foot, and upon the inflamed part, may be practised and repeated with greater safety; and instances have been known of its having been employed with safety to moderate and shorten paroxysms; but how far it may be carried, we have not had experience enough to determine.

Besides blood-letting and the antiphlogistic regimen, it has been proposed to employ remedies for moderating the inflammatory spasm of the part affected, such as warm bathing and emollient poultices. These have sometimes been employed with advantage and safety; but, at other times, have been found to give occasion to a retrocession of the gout.

Blistering is a very effectual means of relieving and discussing a paroxysm of the gout; but has also frequently had the effect of rendering it retrocedent. The stinging with nettles is analogous to blistering; and probably would be attended with the same danger. The burning with moxa, or other substances, is a remedy of the same kind; but though not found hurtful, there is no sufficient evidence of its proving a radical cure.

Camphor, and some aromatic oils, have the power of allaying the pain, and of removing the inflammation from the part affected: but these remedies commonly make the inflammation only shift from one part to another, and therefore with the hazard of its falling upon a part where it may be more dangerous; and they have sometimes rendered the gout retrocedent.

Among other remedies which have of late been highly extolled during a paroxysm of gout, some have recommended the use of strong purgatives frequently repeated; others have highly extolled the assiduous application of cold water to the affected foot. But we may safely venture to assert that both practices are very doubtful, if not very dangerous.

From these reflections it will appear, that some danger must attend every external application to the parts affected during a paroxysm; and that therefore the common practice of committing the person to patience and flannel alone, is established upon the best foundation. Opiates give the most certain relief from pain; but, when given in the beginning of gouty paroxysms, it has by some been thought that they occasion these to return with greater violence. When, however, the paroxysms shall have abated in their violence, but still continue to return, so as to occasion painful and restless nights, opiates may be given with safety and advantage; especially in the case of persons advanced in life, and who have been often affected with the disease. When, after paroxysms have ceased, some swelling and stiffness still remain in the joints, these symptoms are to be discussed by the diligent use of the flesh-brush. Purging immediately after a paroxysm will be always employed with the hazard of bringing it on again; but keeping the belly gently open even during the continuance of the paroxysm is highly proper.

Thus far of the REGULAR gout. We now proceed to consider the management of the disease when it has become IRREGULAR.

In the *atonic* gout, the cure is to be accomplished by carefully avoiding all debilitating causes; and by employing, at the same time, the means of strengthening the system in general, and the stomach in particular.

For strengthening the system in general, Dr Cullen recommends frequent exercise on horseback, and moderate walking. Cold bathing also may answer the purpose; and may be safely employed, if it appear to be powerful in stimulating the system, and be not applied when the extremities are threatened with any pain.

For supporting the tone of the system in general, when threatened with atonic gout, some animal food ought to be employed, and the more acescent vegetables ought to be avoided. In the same case, some wine also may be necessary; but it should be in moderate quantity, and of the least acescent kinds, and if every kind of wine shall be found to increase the acidity of the stomach, ardent spirits and water must be employed.

For strengthening the stomach, bitters and the Peruvian bark may be used; but care must be taken that they be not constantly employed for any great length of time.

The most effectual medicine for strengthening the stomach is iron, which may be employed under various preparations; but the best appears to be the rust in fine powder, which may be given in large doses.

For supporting the tone of the stomach, aromatics may be exhibited; but should be used with caution, as the frequent and copious use of them have an opposite effect; and they should therefore be given only in compliance with former habits, or for palliating present symptoms.

When the stomach happens to be liable to indigestion, gentle vomits may be frequently given, and proper laxatives should be always employed to obviate or to remove costiveness.

In the atonic gout, or in persons liable to it, to guard against cold is especially necessary; and the most certain means of doing this, is by repairing to a warm climate during the winter season. In the more violent cases, blistering the lower extremities may be useful; but that remedy should be avoided when any pain threatens the extremities. In persons liable to the atonic gout, issues may be established in the extremities as in some measure a supplement to the disease.

A second case of the irregular gout, is the *retrocedent*.

When this affects the stomach and intestines, relief is to be instantly attempted by the free use of strong wines, joined with aromatics, and given warm; or, if these shall not prove powerful enough, ardent spirits must be employed, and are to be given in a large dose. In moderate attacks, ardent spirits, impregnated with garlic or with asafœtida, may be used; or, even without the ardent spirits, a solution of asafœtida with the volatile alkali, may answer the purpose. Opiates are often an effectual remedy; and may be

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joined with aromatics, as in the electuarium opiatum; or they may be usefully joined with volatile alkali and camphor. Musk has likewise proved useful in this disease.

When the affection of the stomach is accompanied with vomiting, this may be encouraged, by taking draughts of warm water, at first with wine, and afterwards without it; having at length recourse, if necessary, to some of the remedies above mentioned, and particularly the opiates.

In like manner, if the intestines be affected with diarrhœa, this is to be at first encouraged by taking plentifully of weak broth; and when this shall have been done sufficiently, the tumult is to be quieted by opiates.

When the retrocedent gout shall affect the lungs, and produce asthma, this is to be cured by opiates, by antispasmodics, and perhaps by blistering on the back or breast.

When the gout, leaving the extremities, shall affect the head, and produce pain, vertigo, apoplexy, or palsy, our resources are very precarious. The most probable means of relief is, blistering the head; and, if the gout shall have receded very entirely from the extremities, blisters may be applied to these also. Together with these blisterings, aromatics, and the volatile alkali, may be thrown into the stomach.

The third case of the irregular place is the *misplaced;* that is, when the inflammatory affection of the gout, instead of falling upon the extremities, falls upon some internal part. In this case, the disease is to be treated by blood-letting, and by such other remedies as would be proper in an idiopathic inflammation of the same parts.

Whether the translation so frequently made from the extremities to the kidneys, is to be considered as an instance of the misplaced gout, seems uncertain: but Dr Cullen is disposed to think it something different; and therefore is of opinion, that, in the *nephralgia calculosa* produced upon this occasion, the remedies of inflammation are to be employed no farther than they may be sometimes necessary in that disease, arising from other causes than the gout.

Besides what have been mentioned, a variety of other practices may be necessary and proper against the various anomalous symptoms, which are at times produced by irregular gout. But of these we cannot propose to treat. And we may conclude with observing, that in every form of gout, the cure principally depends on avoiding occasional causes, particularly luxury and laziness.

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Lumbago psoadica, *Sauv.* sp. 6. *Fordyce*, Practice of Physic, part ii. p. 70.
Lumbago apostematosa, *Sauv.* sp. 12.
Lumbago ab arthrocace, *Sauv.* p. 17.
Ischias ex abscessu, *Sauv.* sp. 6.
Morbus coxarius, *De Haen*, Rat. Med. Vol. I. c. xxxii.

This is a disease very much resembling the rheumatism; but differing both from it and the gout, in that it occasions suppurations, which they seldom or never do. It frequently, according to Sauvages, attacks the psoas muscle; and occasions excruciating pains, and then collections of purulent matter.

Erysipelas.

The only cure, if suppuration cannot be prevented, is to lay open the part where the matter is contained, which would otherwise be absorbed, and occasion a fatal hectic.

ORDER III. EXANTHEMATA. 217

Exanthemata, *Sag.* Class X.
Phlegmasiæ exanthematicæ, *Sauv.* Class III. Ord. I.
Morbi exanthematici, *Lin.* Class I. Ord. II.
Febres exanthematicæ, *Vog.* Class I. Ord. II.

GENUS XXVI. ERYSIPELAS.

St Anthony's Fire. 218

Erysipelas, *Sauv.* gen. 97. *Lin.* 10. *Sag.* gen. 296.
Febris erysipelacea, *Vog.* 68. *Hoffm.* II. 98.

Sp. I. ERYSIPELAS with *Blisters.* 219

Erysipelas roseum, *Sauv.* sp. 1. *Sennert. de febr.* lib. ii. c. 15.
Febris erysipelatosa, *Sydenham*, sect. vi. cap. 5.
Erysipelas typhodes, *Sauv.* sp. 2.
Erysipelas pestilens, *Sauv.* sp. 5.
Erysipelas contagiosum, *Sauv.* sp. 9.

Description. The erysipelas of the face, where this affection very frequently appears, comes on with a cold shivering, and other symptoms of pyrexia. The hot stage of this is frequently attended with a confusion of the head, and some degree of delirium; and almost always with drowsiness, and perhaps coma. The pulse is always frequent, and commonly full and hard.—When these symptoms have continued for one, two, or at most three days, an *erythema* appears on some part of the face. This at first is of no great extent; but gradually spreads from the part it first occupied to the other parts of the face, till it has affected the whole; and frequently from the face it spreads over the hairy scalp, or descends on some part of the cheek. As the redness spreads, it commonly leaves, or at least is abated in the parts it had before occupied. All the parts which the redness affects are also affected with some swelling, which continues for some time after the redness has abated. The whole face becomes considerably turgid; and the eyelids are often so much swelled as entirely to shut up the eyes. When the redness and swelling have continued for some time, there commonly arise, sooner or later, blisters of a larger or smaller size on several parts of the face. These contain a thin colourless liquor, which sooner or later runs out. The surface of the skin, in the blistered places, sometimes becomes livid and blackish; but this seldom goes deeper, or discovers any degree of gangrene affecting the cutis vera. On the parts of the face not affected with blisters, the cuticle suffers, towards the end of the disease, a considerable desquamation. Sometimes the tumor of the eyelids ends in a suppuration.

The inflammation coming upon the face does not produce any remission of the fever which had before prevailed; and sometimes the fever increases with the spreading and increasing inflammation. The inflammation

Exanthemata.

tion commonly continues for eight or ten days; and for the ſame time, the fever and ſymptoms attending it alſo continue. In the progreſs of the diſeaſe, the delirium and coma attending it ſometimes go on increaſing, and the patient dies apoplectic on the ſeventh, ninth, or eleventh day of the diſeaſe. In ſuch caſes it has been commonly ſuppoſed, that the diſeaſe is tranſlated from the external to the internal parts. But Dr Cullen thinks that the affection of the brain is merely a communication from the external affection, as this continues increaſing at the ſame time with the internal. When a fatal event does not take place, the inflammation, after having affected the whole face, and perhaps the other external parts of the head, ceaſes, and with that the fever alſo; and, without any other criſis, the patient returns to his ordinary health. This diſeaſe is not commonly contagious; but as it may ariſe from an acrid matter externally applied, ſo it is poſſible that the diſeaſe may ſometimes be communicated from one perſon to another; and certainly there are ſeveral well authenticated inſtances of its prevailing in ſuch a manner, even in particular wards of hoſpitals, as to leave no doubt reſpecting its contagious nature. Perſons who have once laboured under this diſeaſe are liable to returns of it.

Prognoſis. The event of this diſeaſe may be foreſeen from the ſtate of the ſymptoms which denote more or leſs the affection of the brain. If neither delirium nor coma come on, the diſeaſe is ſeldom attended with any danger; but when theſe ſymptoms appear early in the diſeaſe, and are in a conſiderable degree, the utmoſt danger is to be apprehended.

Cure. The eryſipelas of the face is to be cured, according to the opinion of moſt practitioners, much in the ſame manner as phlegmonic inflammations; by blood-letting, cooling purgatives, and by employing every part of the antiphlogiſtic regimen. Many obſervations, however, would lead us to conclude, that in not a few caſes the concomitant fever has here a tendency to the typhoid type; and therefore evacuations, apparently ſerviceable in the firſt inſtance, have afterwards a bad effect. The evacuations of blood-letting and purging are to be employed more or leſs according to the urgency of ſymptoms; particularly thoſe which mark an affection of the brain. As the pyrexia continues, and often increaſes with the inflammation of the face, ſo the evacuations above mentioned are to be employed at any time of the diſeaſe. When, however, the fever, in place of marks of the phlogiſtic diatheſis, particularly a full, hard, and ſtrong pulſe, is attended with ſymptoms of great debility, and with a ſmall pulſe eaſily compreſſible; evacuations, particularly under the form of blood-letting, muſt be uſed with very great caution. Even in ſuch caſes, however, the uſe of refrigerant cathartics may ſtill be perſiſted in with more ſafety and greater advantage. But whether evacuants have been employed or not, when ſymptoms of debility run to a great height, and marks of a putreſcent tendency appear, recourſe muſt be had to wine and the cinchona. In caſes which at the commencement require evacuation, theſe are often in the after periods employed with very great benefit.

Pestis.

In this, as in other diſeaſes of the head, when that part happens to be the ſeat of eryſipelas, it is proper to put the patient, as often as he can eaſily bear it, into ſomewhat of an erect poſture; and as there is always an external affection, ſo various external applications have been propoſed to be made to the part affected; but almoſt all of them are of doubtful effect.

An eryſipelas frequently appears on other parts of the body beſides the face, and ſuch other eryſipelatous inflammations frequently end in ſuppuration; but theſe caſes are ſeldom dangerous. At coming on they are ſometimes attended with drowſineſs, and even with ſome delirium; but this ſeldom happens, and theſe ſymptoms do not continue after the inflammation is formed; and Dr Cullen does not remember to have ſeen an inſtance of the tranſlation of an inflammation from the limbs to an internal part; and though theſe inflammations of the limbs be attended with pyrexia, they ſeldom require the ſame evacuations as the eryſipelas of the face.

Sp. II. Erysipelas with *Phlyctenæ*. 220

Eryſipelas zoſter, *Sauv.* ſp. 8.
Zona; Anglis, *The* Shingles, *Ruſſel* de tab. gland. p. 124. Hiſt. 35.
Herpes zoſter, *Sauv.* ſp. 9.

This differs from the former in no other way than in being attended with an eruption of phlyctenæ or ſmall watery bladders on ſeveral parts of the body.—The method of cure is the ſame.

Genus XXVII. PESTIS, the *Plague*. 222

Peſtis, *Sauv.* gen. 91. *Lin.* 2. *Junck.* 78.
Febris peſtilentialis, *Vog.* 33. *Hoffm.* II. 93.
Peſtis benigna, *Sauv.* ſp. 2. Peſtis Maſſilienſis, Claſs III. Traité de la peſte, p. 41. Ejuſdem peſtis, Cl. 5ta, Traité, p. 228.
Peſtis remittens, *Sauv.* ſp. 9.
Peſtis vulgaris, *Sauv* ſp. 1. Peſtis Maſſil. Cl. II. Traité, p. 38. Ejuſd. Cl. III. et IV. Traité, p. 225, &c. *Waldſchmidt.* de peſte Holſatica, apud *Halleri*, Diſſ. Pract. Tom. V. *Chenot.* de peſte Tranſylvanica, 1755, 1759, *De Haen*, Rat. Med. pars xiv.
Peſtis Egyptiaca, *Sauv.* ſp. 11. *Alpin.* de Med. Egypt.
Peſtis interna, *Sauv.* ſp. 3. Peſt. Maſſil. Cl. I. Traité, p. 37—224.

Hiſtory. Of this diſtemper Dr Cullen declines giving any particular hiſtory, becauſe he never ſaw it; from the accounts of other authors, however, he is of opinion, that the circumſtances peculiarly characteriſtic of it, eſpecially of its more violent and dangerous ſtates, are. 1. The great loſs of ſtrength in the animal functions, which often appears early in the diſeaſe. 2. The ſtupor, giddineſs, and conſequent ſtaggering, which reſembles drunkenneſs, or the head-ach and various delirium, all of them denoting a great diſorder in the functions of the brain. 3. Anxiety, palpitation, ſyncope, and eſpecially the weakneſs and irregularity of the pulſe, denoting a conſiderable diſturbance in the action of the heart. 4 Nauſea and vomiting, particularly the vomiting of bile, which ſhows an

Exanthemata. Pestis.

an accumulation of vitiated bile in the gall-bladder and biliary ducts, and from thence derived into the intestines and stomach; and which denote a considerable spasm, and loss of tone in the extreme vessels on the surface of the body. 5. The buboes and carbuncles, which denote an acrimony prevailing in the fluids; and, lastly, The petechiæ, hæmorrhages, and colliquative diarrhœa, which denote a putrescent tendency prevailing in a great degree in the mass of blood.

To these characteristics of the plague enumerated by Dr Cullen, we shall add one mentioned by Sir John Pringle, which, though perhaps less frequent than the others, yet seems worthy of notice. It is this, That in the plague there is an extraordinary enlargement of the heart and liver. In nine dissections of bodies dead of the plague at Marseilles, this extraordinary enlargement of the heart is taken notice of in all of them, and of the liver in seven of them. The account was sent to the Royal Society by M. Didier, one of the physicians to the king of France, and has been published in the Philosophical Transactions. In the first case, the author takes notice, that "the heart was of an extraordinary bigness; and the liver was of double the natural size.—Case 2. The heart was of a prodigious bigness, and the liver much enlarged.—Case 3. The heart double the natural bigness.—Case 4. The heart was very large, and the liver was bigger and harder than ordinary.—Case 5. The heart was of a prodigious bigness.—Case 6. The heart was larger than in its natural state; the liver also was very large.—Case 7. The heart was of a prodigious size, and the liver was very large.—Case 8. The heart was much larger than natural, and the liver of a prodigious size.—Case 9. The heart was double the natural bigness, and the liver was larger than ordinary."—This preternatural enlargement, Sir J. Pringle thinks, is owing to the relaxation of the solid parts, by which means they become unable to resist the impetus of blood, and therefore are easily extended; as in the case of infancy, where the growth is remarkably quick. And a similar enlargement he takes notice of in the scurvy, and other putrid diseases.

A very elaborate work has lately been published on the subject of the plague by Dr Patrick Russel, formerly physician to the British factory at Aleppo. In this work, a very full history is given of the various forms and varieties of the disease. He makes particular observations on the following symptoms, which, in addition to the pestilential eruptions, he considers as the most important concomitants of plague, viz. fever, delirium, coma, impediment or loss of speech, deafness, muddiness of the eyes, white tongue, state of the pulse, respiration, anxiety, pain at the heart, inquietude, debility, fainting, convulsion, appearances of the urine, perspiration, vomiting, looseness, and hæmorrhage; and he concludes these remarks with some observations on the occurrence of the plague with pregnant women. To point out more distinctly the stable varieties of the disease, he arranges the pestilential cases which fell under his observation at Aleppo under six classes: and he concludes his description with a very minute and particular account of the pestilential eruptions, appearing under the form either of buboes, carbuncles, or other exanthemata. The presence of the two first, he observes, either separately or conjunctly, leaves the nature of the distemper unequivocal. But fatal has been the error of rashly pronouncing a distemper not to be a plague from their absence. Buboes affected the inguinal, axillary, parotid, maxillary, and cervical glands. But the first were the most commonly affected, and the two latter seldom observed to swell, without either the parotid swelling at the time, or soon after. Of the carbuncles, Dr Russel describes five different varieties. The other exanthemata, which he observed sometimes, though less frequently, attending the plague, were petechiæ, a marbled appearance of the skin, an erysipelatous redness, streaks of a reddish purple or livid colour, vibices or weals, and large blue or purple spots, the *maculæ magnæ* of authors. In some cases, an extraordinary concurrence of eruptions took place, which was chiefly observed among children under 10 years of age.

Causes, &c. From a consideration of the symptoms above mentioned, Dr Cullen concludes, that the plague is owing to a specific contagion, often suddenly producing the most considerable debility in the nervous system, or moving powers, and a general putrescency in the fluids. Dr Russel also considers the disease as being universally the consequence of what may be called *pestilential contagion;* and has judiciously repelled the objections which have been brought against this doctrine.

Prevention. Here we must refer to all those methods of preventing and removing the incipient contagion of putrid fevers, which have been so fully enumerated. Dr Cullen is persuaded that the disease never arises in the northern parts of Europe, but in consequence of being imported from some other country. The magistrate's first care, therefore, ought to be, to prevent the importation; and this may generally be done by a due attention to bills of health, and to the proper performance of quarantines.—With respect to the latter, he is of opinion, that the quarantines of persons may with safety be much less than 40 days; and if this were allowed, the execution of the quarantine would be more exact and certain, as the temptation to break it would be in a great measure avoided. With respect to the quarantine of goods, it cannot be perfect unless the suspected goods be unpacked, duly ventilated, and other means be employed for correcting the infection they may carry; and if all this be properly done, it is probable that the time commonly prescribed for quarantine may be also shortened.

A second measure in the way of prevention is required, when an infection has reached and prevailed in any place, to prevent that infection from spreading into others. This can only be done by preventing the inhabitants or the goods of any infected place from going out of it till they have undergone a proper quarantine.

The third measure, and which ought to be employed with great care, is, to prevent the infection from spreading among the inhabitants of a place in which it has arisen. And in this case, a great deal may be done by the magistrate: 1. By allowing as many of the inhabitants as are free from infection, and are not necessary to the service of the place, to go out of it. 2. By discharging all assemblies, or unnecessary intercourse of the people. 3. By ordering some necessary communications to be performed without contact.

Exanthemata. contact. 4. By making such arrangements and provisions as may render it easy for the families remaining to shut themselves up in their own houses. 5. By allowing persons to quit houses where an infection appears, upon condition that they go into lazarettos. 6. By ventilating and purifying, or destroying, at the public expence, all infected goods. 7. By avoiding hospitals, and providing separate apartments for infected persons.

The fourth and last part of the business of prevention respects the conduct of persons necessarily remaining in infected places, especially those obliged to have some communication with persons infected. Those obliged to remain in places infected, but not to have any near communication with the sick, must avoid all near communication with other persons or their goods; and it is probable, that a small distance will serve, if, at the same time, there be no stream of air to carry the effluvia of persons or goods to some distance. Those who are obliged to have a near communication with the sick ought to avoid any of the debilitating causes which render the body susceptible of infection, as a spare diet, intemperance in drinking, excess in venery, cold, fear, or other depressing passions of the mind. A full diet of animal food is also to be avoided, because it increases the irritability of the body, and favours the operation of contagion; and indigestion, whether from the quantity or quality of the food, contributes very much to the same end.

Besides these, it is probable that the moderate use of wine and spirituous liquors, moderate exercise, and the cold bath, may be of use; tonic medicines also, of which cinchona is deservedly accounted the chief, may be used with some probability of success. If any thing is to be expected from antiseptics, Dr Cullen thinks camphor preferable to every other. In general, however, every one is to be indulged in the medicine of which he has the best opinion, provided it is not evidently hurtful. Whether issues be useful in preserving from the effects of contagion, is a matter of doubt. Dr Russel in his treatise enters very fully into the consideration of the means of prevention, both with respect to quarantines, lazarettos, and bills of health. He is of opinion, that the present laws on these subjects are in many respects defective: and he thinks, that a set of new regulations would have the best chance of a deliberate and impartial discussion in the senate, if the inquiry were taken at a time free from all apprehension of immediate danger.

Cure. According to Dr Cullen, the indications are the same as in fever in general, but are not all equally important. The measures for moderating the violence of reaction, which operate by diminishing the action of the heart and arteries, have seldom, he thinks, any place here, excepting that the antiphlogistic regimen is generally proper. Some physicians have recommended bleeding, and Sydenham even seems to think it an effectual cure; but Dr Cullen supposes, that for the most part it is unnecessary, and in many cases might do much hurt. Dr Russel, however, who on this subject speaks from experience and actual observation, is of a different opinion. With most of his patients, a single bleeding was employed with advantage; and even where the sick under his inspection were bled oftener than once, he did not find that the low state was thereby hurried on. Purging has also been recommended; and in some degree it may be useful in drawing off the putrescent matter frequently present in the intestines; but a large evacuation in this way may certainly be hurtful.

Pestis. The moderating the violence of reaction, as far as it can be done, by taking off the spasm of the extreme vessels, is a measure, in Dr Cullen's opinion, of the utmost necessity in the cure of the plague; and the whole of the means formerly mentioned, as suited to this indication, are extremely proper. The giving an emetic, at the first approach of the disease, would probably be of great service; and it is probable, that, at some other periods of the disease, emetics might be useful, both by evacuating bile abounding in the alimentary canal, and by taking off the spasm of the extreme vessels. Indeed Baron Ash, and some other of the Russian practitioners, represent the early and repeated use of emetics as the only effectual mode of cure.

According to the observations of Dr de Mertens, who wrote a very interesting treatise on the fatal plague which raged at Moscow in 1771, and which carried off upwards of 20,000 inhabitants in the space of one month, emetics were often of the greatest service.

From some principles with respect to fever in general, and with respect to the plague in particular, Dr Cullen is of opinion, that after the exhibition of the first vomit, the body should be disposed to sweat; but this sweat should be raised only to a moderate degree, though it must be continued for 24 hours or more if the patient bears it easily. The sweating is to be excited and conducted according to the rules laid down under SYNOCHA; and must be promoted by the plentiful use of diluents rendered more grateful by vegetable acids, or more powerful by being impregnated with some portion of neutral salts. To support the patient under the continuance of the sweat, a little weak broth, acidulated with the juice of lemons, may be given frequently, and sometimes a little wine if the heat of the body be not considerable. If sudorific medicines be judged necessary, opiates will be found more effectual and safe; but they should not be combined with aromatics, and probably may be more effectual if joined with a portion of emetics and of neutral salts. But if, notwithstanding the use of emetics and sudorifics in the beginning, the disease should still continue, the cure must turn upon the use of means for obviating debility and putrescency; and for this purpose tonic medicines, especially cinchona and cold drink, are the most proper.

GENUS XXVIII. VARIOLA.

The SMALLPOX. 222

Variola, *Sauv.* gen. 92. *Lin.* 3. *Sag.* gen. 290.
Febris variolosa, *Vog.* 35. *Hoffm.* II. 49.
Variolæ, *Boerh.* 1371. *Junck.* 76.

Sp. I. *The Distinct* SMALLPOX. 223

Variola discreta benigna, *Sauv.* sp. 2.
Variolæ regulares discretæ, *Sydenh.* sect. iii. cap. 2.
Variolæ

Exanthemata.

Variolæ discretæ simplices, *Helvet.* Ob. sp. 1.
Variola discreta complicata, *Sauv.* sp. 2. *Helvet.* sp. 2.
Variolæ anomalæ, *Sydenh.* sect. iv. cap. 6.
Variola discreta dysenteriodes, *Sauv.* sp. 4. *Sydenh.* sect. iv. cap. 1.
Variola discreta vesicularis, *Sauv.* sp. 5.
Variola discreta crystallina. *Mead.* de variol. cap. 2.
Variola discreta verrucosa, *Sauv.* sp. 6. *Mead* ibid.
Variola discreta siliquosa, *Sauv.* sp. 7. *Freind* Oper. p. 358.
Variola discreta miliaris, *Sauv.* sp. 8. *Helvet.* Obs. sp. 3.

224 Sp. II. *The Confluent* SMALLPOX.

Variola confluens, *Sauv.* sp. 9.
Variolæ regulares confluentes, ann. 1667. *Sydenham*, sect. iii. cap. 2.
Variolæ confluentes simplices, *Helvet.* Obs. sp. 1.
Variola confluens crystallina, *Sauv.* sp. 10.
Variola japonica, *Kempfer.*
Vesiculæ divæ Barbaræ, *C. Pis.* Obs. 149.
Variola confluens maligna, *Helvet.* Obs. sp. 1.
Variola confluens cohærens, *Sauv.* sp. 11.
Variola confluens maligna, *Helvet.* sp. 2.
Variola confluens nigra, *Sauv.* sp. 12. *Sydenham*, sect. v. cap. 4.
Variola confluens maligna, *Helvet.* sp. 3.
Variola sanguinea, *Mead* de variolis, cap. 2.
Variola confluens corymbosa, *Sauv.* sp. 13.
Variola confluens maligna, *Helvet.* sp. 4.

Description. In the distinct smallpox, the disease begins with a synocha or inflammatory fever. This fever generally comes on about mid-day, with some symptoms of a cold stage, and commonly with a considerable languor and drowsiness. A hot stage is soon formed, and becomes more considerable on the second and third day. During this course children are liable to frequent startings from their slumbers; and adults, if they are kept in bed, are disposed to much sweating. On the third day, children are sometimes affected with one or two epileptic fits. Towards the end of the third day the eruption commonly appears, and gradually increases during the fourth; appearing first on the face, and successively on the inferior parts, so as to be completed over the whole body on the fifth day. From the third day the fever abates, and by the fifth it entirely ceases. The eruption appears first in small red spots hardly eminent, but by degrees rising into pimples. There are generally but few on the face; but, even when more numerous, they are separate and distinct from one another. On the fifth or sixth day, a small vesicle, containing an almost colourless fluid, appears on the top of each pimple. For two days these vesicles increase in breadth only, and there is a small hollow pit in their middle, so that they are not raised into spheroidical pustules till the eighth day. These pustules from their first formation continue to be surrounded with an exactly circular inflamed margin, which when they are numerous diffuses some inflammation over the neighbouring skin, so as to give somewhat of a damask-rose colour to the spaces between the pustules. As the pustules increase i size the face swells considerably if they are numerous on it; and the eye-lids particularly are so much swelled, that the eyes are entirely shut. As the disease proceeds, the matter in the pustules becomes by degrees more opaque and white, and at length assumes a yellowish colour. On the 11th day the swelling of the face is abated, and the pustules seem quite full. On the top of each a darker spot appears; and at this place the pustule, on the 11th day, or soon after, is spontaneously broken, and a portion of the matter oozes out; in consequence of which the pustule is shrivelled, and subsides; while the matter oozing out dries, and forms a crust upon its surface. Sometimes only a little of the matter oozes out, and what remains in the pustule becomes thick and even hard. After some days, both the crusts and the hardened pustules fall off, leaving the skin which they covered of a brownish red colour; nor doth it resume its natural colour till many days after. In some cases, where the matter of the pustules has been more liquid, the crusts formed from it are later in falling off, and the part they covered suffers some desquamation, which occasions a small hollow or pit.

Variola.

On the legs and hands the matter is frequently absorbed; so that at the height of the disease, these pustules appear as empty as vesicles. On the 10th and 11th days, as the swelling of the face subsides, a swelling arises in the hands and feet; but which again subsides as the pustules come to maturity. When the pustules on the face are numerous, some degree of pyrexia appears on the 10th and 11th days; but disappears again after the pustules are fully ripened, or perhaps remains in a very slight degree till the pustules on the feet have finished their course; and it is seldom that any fever continues longer in the distinct smallpox. When the pustules are numerous on the face, upon the sixth or seventh day some uneasiness of the throat, with a hoarseness of the voice, comes on, and a thin liquid is poured out from the mouth. These symptoms increase with the swelling of the face; and the liquids of the mouth and throat becoming thicker are with difficulty thrown out; and there is at the same time some difficulty in swallowing, so that liquids taken in to be swallowed are frequently rejected or thrown out by the nose. But all these affections of the fauces are abated as the swelling of the face subsides.

In the confluent smallpox all the symptoms abovementioned are much more severe. The eruptive fever particularly is more violent; the pulse is more frequent and more contracted, approaching to that state of pulse which is observed in typhus. The coma is more considerable, and there is frequently a delirium. Vomiting also frequently attends, especially at the beginning of the disease. In very young infants epileptic fits are sometimes frequent on the first days of the disease, and sometimes prove fatal before any eruption appears, or they usher in a very confluent and putrid smallpox. But at the same time, it has been justly remarked by Dr Sydenham, and other accurate observers, that epileptic attacks more frequently precede distinct and mild than malignant and confluent smallpox. The eruption appears in the confluent more early on the third day, and it is frequently preceded or accompanied with an erysipelatous efflorescence. Sometimes

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times the eruption appears in clusters, like the measles. When the eruption is completed, the pimples are always more numerous upon the face, and at the same time smaller and less eminent. Upon the eruption the fever suffers some remission, but never goes off entirely; and after the fifth or sixth day it increases again, and continues to be considerable throughout the remaining part of the disease. The vesicles formed on the top of the pimples appear sooner; and while they increase in breadth, they do not retain a circular, but are every way of an irregular figure. Many of them run into one another, insomuch that very often the face is covered with one vesicle rather than with a number of pustules. The vesicles, as far as they are any way separated, do not arise to a spheroidal form, but remain flat, and sometimes the whole of the face appears an even surface. When the pustules are in any measure separated, they are not bounded by an inflamed margin, but the part of the skin that is free from pustules is commonly pale and flaccid. The liquor that is in the pustules changes from a clear to an opaque appearance, and becomes whitish or brownish, but never acquires the yellow colour and thick consistence that appears in the distinct smallpox. The swelling of the face, which only sometimes attends the distinct smallpox, always attends the confluent kind; it also comes on more early, and arises to a greater height, but abates considerably on the tenth or eleventh day. At this time the pustules or vesicles break and shrivel; pouring out at the same time a liquor, which is formed into brown or black crusts, which do not fall off for a long time after. Those of the face, in falling off, leave the skin subject to a desquamation, which pretty certainly produces pittings. On the other parts of the body the pustules of the confluent smallpox are more distinct than on the face; but never acquire the same maturity and consistence of pus as in the properly distinct kind.—The salivation, which sometimes only attends the distinct smallpox, very constantly attends the confluent; and both the salivation and the affection of the fauces above-mentioned occur, especially in adults, in a higher degree. In infants a diarrhœa comes frequently in place of a salivation.

In this kind of smallpox there is often a very considerable putrescency of the fluids, as appears from petechiæ, from serous vesicles, under which the skin shows a disposition to gangrene, and from bloody urine or other hæmorrhages; all of which symptoms frequently attend this disease. In the confluent smallpox also, the fever, which had only suffered a remission from the eruption to the maturation, at or immediately after this period is frequently renewed again with considerable violence. This is what has been called the *secondary fever*, and is of various duration and event.

Causes, &c. It is evident that the smallpox is originally produced by a contagion; and that this contagion is a ferment with respect to the fluids of the human body, which assimilates a considerable portion of them to its own nature: or, at least, we have every reason to believe that a small quantity of contagious matter introduced, is somehow multiplied and increased in the circulating fluids of the animal body. This quantity passes again out of the body, partly by insensible perspiration, and partly by being deposited in pustules: The causes which determine more of the variolous matter to pass by perspiration, or to form pustules, are probably certain circumstances of the skin, which determine more or less of the variolous matter to stick in it, or to pass freely through it. The circumstance of the skin, which seems to determine the variolous matter to stick in it, is a certain state of inflammation depending much on the heat of it: thus we have many instances of parts of the body, from being more heated, having a greater number of pustules than other parts. Thus parts covered with plasters, especially those of the stimulant kind, have more pustules than others. —Certain circumstances also, such as adult age, and full living, determining to a phlogistic diathesis, seem to produce a greater number of pustules, and *vice versa*. It is therefore probable, that an inflammatory state of the whole system, and more particularly of the skin, gives occasion to a greater number of pustules; and the causes of this may produce most of the other circumstances of the confluent smallpox, such as the time of eruption, the continuance of the fever, the effusion of a more putrescent matter, and less fit to be converted into pus, together with the form and other circumstances of the pustules.

Prognosis. The more exactly the disease retains the form of the distinct kind, it is the safer; and the more completely the disease takes the form of the confluent kind, it is the more dangerous. It is only when the distinct kind shows a great number of pustules on the face, or otherwise by fever or putrescency, approaching to the circumstances of the confluent, that the distinct kind is attended with any danger.

In the confluent kind the danger is always very considerable; and the more violent and permanent the fever is, the greater the danger; and especially in proportion to the increase of the symptoms of putrescency. When the putrid disposition is very great, the disease sometimes proves fatal before the eighth day; but in most cases death happens on the eleventh, and sometimes not till the fourteenth or seventeenth day.

Though the smallpox may not prove immediately fatal, the more violent kinds are often followed by a morbid state of the body, sometimes of very dangerous event. These consequences, according to Dr Cullen, may be imputed sometimes to an acrid matter produced by the preceding disease, and deposited in different parts; and sometimes to an inflammatory diathesis produced and determined to particular parts of the body.

Since the introduction of smallpox into Europe, there is perhaps no disease which has produced a greater number of deaths. But, fortunately, a discovery is now made, by which there is reason to hope that this loathsome disease may be altogether exterminated; its prevention, viz. by the inoculation of the vaccine or cowpox.

This most important discovery we owe to the successful exertions of Dr Edward Jenner; to whom, for these exertions, repeated rewards have been voted by the British legislature, but who unquestionably enjoys a much higher reward in the satisfaction of having conferred an inestimable blessing on the human species.

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For an account of the progrefs of this difcovery, we muft refer our readers to Dr Jenner's publication. Here we fhall only obferve, that it had long been remarked in fome parts of England, particularly in the neighbourhood of Berkley, where Dr Jenner refided, that cows were liable to a puftular difeafe on their udders, fomewhat refembling fmallpox; that this difeafe was communicated by contact to the fingers of thofe employed in milking the cows; and, finally, that thofe thus infected with cowpox, were completely protected againft the contagion of fmallpox.

Founding on thefe obfervations, Dr Jenner afcertained by experiment, that the inoculation of vaccine matter was an infallible preventive of fmallpox; and that this vaccine matter had equal power in preventing variola, when transferred from one human fubject to another, as when obtained immediately from the cow. It is not therefore wonderful that this practice of vaccine inoculation fhould foon have become general, both in Britain and in every quarter of the world. Nor is it perhaps furprifing, that it fhould have been violently oppofed by ignorant and obftinate men. Hence numerous publications have of late appeared both for and againft this practice. Many miftakes have undoubtedly been committed by ignorance and inattention; and thus the preventive has been fuppofed to fail. For the beft account both of the method of performing the operation, of conveying the vaccine matter from one place to another, and of the tefts of conftitutional affection in thofe cafes in which the inflammation is flight, and in which no fever is perceptible, we may refer our readers to a treatife publifhed at Edinburgh in 1802, by Mr James Bryce, entitled Practical Obfervations on the Inoculation of Cowpox.

Of the efficacy of vaccine inoculation as a preventive of fmallpox few candid men will entertain any doubt, after the following report on vaccination, from the Royal College of Phyficians in London, ordered to be printed on the 8th of July 1807, by the Britifh parliament.

REPORT, &c.

The Royal College of Phyficians of London, having received his majefty's commands, in compliance with an addrefs from the houfe of commons, "to inquire into the ftate of vaccine inoculation in the united kingdom, to report their opinion and obfervations upon that practice, upon the evidence which has been adduced in its fupport, and upon the caufes which have hitherto retarded its general adoption;"—have applied themfelves diligently to the bufinefs referred to them.

Deeply impreffed with the importance of an inquiry which equally involves the lives of individuals, and the public profperity, they have made every exertion to inveftigate the fubject fully and impartially. In aid of the knowledge and experience of the members of their own body, they have applied feparately to each of the licentiates of the college; they have correfponded with the colleges of phyficians of Dublin and Edinburgh; with the colleges of furgeons of London, Edinburgh, and Dublin; they have called upon the focieties eftablifhed for vaccination, for an account of their practice, to what extent it has been carried on, and what has been the refult of their experience; and they have, by public notice, invited individuals to contribute whatever information they had feverally collected. They have in confequence been furnifhed with a mafs of evidence communicated with the greateft readinefs and candour, which enables them to fpeak with confidence upon all the principal points referred to them.

I. During eight years which have elapfed fince Dr Jenner made his difcovery public, the progrefs of vaccination has been rapid, not only in all parts of the united kingdom, but in every quarter of the civilized world. In the Britifh iflands fome hundred thoufands have been vaccinated, in our poffeffions in the Eaft Indies upwards of 800,000, and among the nations of Europe the practice has become general. Profeffional men have fubmitted it to the faireft trials, and the public have, for the moft part, received it without prejudice. A few indeed have ftood forth the adverfaries of vaccination, on the fame grounds as their predeceffors who oppofed the inoculation for the fmallpox, falfely led by hypothetical reafoning in the inveftigation of a fubject which muft be fupported, or rejected, upon facts and obfervation only. With thefe few exceptions, the teftimony in favour of vaccination has been moft ftrong and fatisfactory, and the practice of it, though it has received a check in fome quarters, appears ftill to be upon the increafe in moft parts of the united kingdom.

II. The college of phyficians, in giving their obfervations and opinions on the practice of vaccination, think it right to premife, that they advance nothing but what is fupported by the multiplied and unequivocal evidence which has been brought before them, and they have not confidered any facts as proved but what have been ftated from actual obfervation.

Vaccination appears to be in general perfectly fafe; the inftances to the contrary being extremely rare. The difeafe excited by it is flight, and feldom prevents thofe under it from following their ordinary occupations. It has been communicated with fafety to pregnant women, to children during dentition, and in their earlieft infancy; in all which refpects it poffeffes material advantages over inoculation for the fmallpox; which, though productive of a difeafe generally mild, yet fometimes occafions alarming fymptoms, and is in a few cafes fatal.

The fecurity derived from vaccination againft the fmallpox, if not abfolutely perfect, is as nearly fo as can perhaps be expected from any human difcovery; for amongft feveral hundred thoufand cafes, with the refults of which the college have been made acquainted, the number of alledged failures has been furprifingly fmall, fo much fo, as to form certainly no reafonable objection to the general adoption of vaccination; for it appears that there are not nearly fo many failures, in a given number of vaccinated perfons, as there are deaths in an equal number of perfons inoculated for the fmallpox. Nothing can more clearly demonftrate the fuperiority of vaccination over the inoculation of the fmallpox, than this confideration; and it is a moft important fact, which has been confirmed in the courfe of this inquiry, that in almoft every cafe, where the fmallpox has fucceeded vaccination, whether by inoculation or by cafual infection, the difeafe has varied much from its ordinary courfe; it has neither been the fame in the violence, nor in the duration of its fymptoms, but has, with

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with very few exceptions, been remarkably mild, as if the ſmallpox had been deprived, by the previous vaccine diſeaſe, of all its uſual malignity.

The teſtimonies before the college of phyſicians are very decided in declaring, that vaccination does leſs miſchief to the conſtitution, and leſs frequently gives riſe to other diſeaſes, than the ſmallpox, either natural or inoculated.

The college feel themſelves called upon to ſtate this ſtrongly, becauſe it has been objected to vaccination, that it produces new, unheard-of, and monſtrous diſeaſes. Of ſuch aſſertions no proofs have been produced, and, after diligent inquiry, the college believe them to have been either the inventions of deſigning, or the miſtakes of ignorant men. In theſe reſpects then, in its mildneſs, its ſafety, and its conſequences, the individual may look for the peculiar advantages of vaccination. The benefits which flow from it to ſociety are infinitely more conſiderable, it ſpreads no infection, and can be communicated only by inoculation. It is from a conſideration of the pernicious effects of the ſmallpox, that the real value of vaccination is to be eſtimated. The natural ſmallpox has been ſuppoſed to deſtroy a ſixth part of all whom it attacks; and that even by inoculation, where that has been general in pariſhes and towns, about one in 300 has uſually died. It is not ſufficiently known, or not adverted to, that nearly one-tenth, ſome years more than one-tenth of the whole mortality in London, is occaſioned by the ſmallpox; and however beneficial the inoculation of the ſmallpox may have been to individuals, it appears to have kept up a conſtant ſource of contagion, which has been the means of increaſing the number of deaths by what is called the natural diſeaſe. It cannot be doubted that this miſchief has been extended by the inconſiderate manner in which great numbers of perſons, even ſince the introduction of vaccination, are ſtill every year inoculated with the ſmallpox, and afterwards required to attend two or three times a-week at the places of inoculation, through every ſtage of their illneſs.

From this, then, the public are to expect the great and uncontroverted ſuperiority of vaccination, that it communicates no caſual infection, and, while it is a protection to the individual, it is not prejudicial to the public.

III. The college of phyſicians, in reporting their obſervations and opinions on the evidence adduced in ſupport of vaccination, feel themſelves authoriſed to ſtate that a body of evidence ſo large, ſo temperate, and ſo conſiſtent, was perhaps never before collected upon any medical queſtion. A diſcovery ſo novel, and to which there was nothing analogous known in nature, though reſting on the experimental obſervations of the inventor, was at firſt received with diffidence: it was not, however, difficult for others to repeat his experiments, by which the truth of his obſervations was confirmed, and the doubts of the cautious were gradually diſpelled by extenſive experience. At the commencement of the practice, almoſt all that were vaccinated were afterwards ſubmitted to the inoculation of the ſmallpox; many underwent this operation a ſecond, and even a third time, and the uniform ſucceſs of theſe trials quickly bred confidence in the new diſcovery. But the evidence of the ſecurity derived from vaccination againſt the ſmallpox does not reſt alone upon thoſe who afterwards underwent variolous inoculation, although amounting to many thouſands; for it appears, from numerous obſervations communicated to the college, that thoſe who have been vaccinated are equally ſecure againſt the contagion of epidemic ſmallpox. Towns, indeed, and diſtricts of the country, in which vaccination had been general, have afterwards had the ſmallpox prevalent on all ſides of them without ſuffering from the contagion. There are alſo in the evidence a few examples of epidemic ſmallpox having been ſubdued by a general vaccination. It will not, therefore, appear extraordinary that many who have communicated their obſervations ſhould ſtate, that though at firſt they thought unfavourably of the practice, experience had now removed all their doubts.

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It has been already mentioned, that the evidence is not univerſally favourable, although it is in truth nearly ſo, for there are a few who entertain ſentiments differing widely from thoſe of the great majority of their brethren. The college, therefore, deemed it their duty, in a particular manner, to inquire upon what grounds and evidence the oppoſers of vaccination reſted their opinions. From perſonal examination, as well as from their writings, they endeavoured to learn the full extent and weight of their objections. They found them without experience in vaccination, ſupporting their opinions by hearſay information and hypothetical reaſoning; and, upon inveſtigating the facts which they advanced, they found them to be either miſapprehended or miſrepreſented; or that they fell under the deſcription of caſes of imperfect ſmallpox, before noticed, and which the college have endeavoured fairly to appreciate.

The practice of vaccination is but of eight years ſtanding, and its promoters, as well as opponents, muſt keep in mind, that a period ſo ſhort is too limited to aſcertain every point, or to bring the art to that perfection of which it may be capable. The truth of this will readily be admitted by thoſe acquainted with the hiſtory of inoculation for the ſmallpox. Vaccination is now, however, well underſtood, and its character accurately deſcribed. Some deviations from the uſual courſe have occaſionally occurred, which the author of the practice has called ſpurious cowpox, by which the public have been miſled, as if there were a true and a falſe cowpox; but it appears, that nothing more was meant, than to expreſs irregularity or difference from that common form and progreſs of the vaccine puſtule from which its efficacy is inferred. Thoſe who perform vaccination ought therefore to be well inſtructed, and ſhould have watched with the greateſt care the regular progreſs of the puſtule, and learnt the moſt proper time for taking the matter. There is little doubt that ſome of the failures are to be imputed to the inexperience of the early vaccinators, and it is not unreaſonable to expect that farther obſervation will yet ſuggeſt many improvements that will reduce the number of anomalous caſes, and furniſh the means of determining, with greater preciſion, when the vaccine diſeaſe has been effectually received.

Though the college of phyſicians have confined themſelves in eſtimating the evidence to ſuch facts as have occurred in their own country, becauſe the accuracy of them could beſt be aſcertained, they cannot be inſenſible

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ble to the confirmation these receive from the reports of the successful introduction of vaccination, not only into every part of Europe, but throughout the vast continents of Asia and America.

IV. Several causes have had a partial operation in retarding the general adoption of vaccination; some writers have greatly undervalued the security it affords, while others have considered it to be of a temporary nature only; but if any reliance is to be placed on the statements which have been laid before the college, its power of protecting the human body from the smallpox, though not perfect indeed, is abundantly sufficient to recommend it to the prudent and dispassionate, especially as the smallpox, in the few instances where it has subsequently occurred, has been generally mild and transient. The opinion that vaccination affords but a temporary security is supported by no analogy in nature, nor by the facts which have hitherto occurred. Although the experience of vaccine inoculation be only of a few years, yet the same disease, contracted by the milkers of cows, in some districts has been long enough known to ascertain that in them, at least the unsusceptibility of the smallpox contagion does not wear out by time.

Another cause, is the charge against vaccination of producing various new diseases of frightful and monstrous appearance. Representations of some of these have been exhibited in prints in a way to alarm the feelings of parents, and to infuse dread and apprehension into the minds of the uninformed. Publications with such representations have been widely circulated, and though they originate either in gross ignorance, or wilful misrepresentation, yet have they lessened the confidence of many, particularly of the lower classes, in vaccination; no permanent effects, however, in retarding the progress of vaccination, need be apprehended from such causes, for, as soon as the public shall view them coolly and without surprise, they will excite contempt, and not fear.

Though the college of physicians are of opinion that the progress of vaccination has been retarded in a few places by the above causes, yet they conceive that its general adoption has been prevented by causes far more powerful, and of a nature wholly different. The lower orders of society can hardly be induced to adopt precautions against evils which may be at a distance; nor can it be expected from them, if these precautions are attended with expence. Unless therefore, from the immediate dread of epidemic smallpox, neither vaccination nor inoculation appear at any time to have been general, and when the cause of terror has passed by, the public have relapsed again into a state of indifference and apathy, and the salutary practice has come to a stand. It is not easy to suggest a remedy for an evil so deeply imprinted in human nature. To inform and instruct the public mind may do much, and it will probably be found that the progress of vaccination in different parts of the united kingdom will be in proportion to that instruction. Were encouragement given to vaccination, by offering it to the poorer classes without expence, there is little doubt but it would in time supersede the inoculation for the smallpox, and thereby various sources of variolous infection would be cut off; but till vaccination becomes general, it will be impossible to prevent the constant recurrence of the natural smallpox by means of those who are inoculated, except it should appear proper to the legislature to adopt, in its wisdom, some measure by which those who still, from terror or prejudice, prefer the smallpox to the vaccine disease, may, in thus consulting the gratification of their own feelings, be prevented from doing mischief to their neighbours.

From the whole of the above considerations, the college of physicians feel it their duty strongly to recommend the practice of vaccination. They have been led to this conclusion by no preconceived opinion, but by the most unbiassed judgement, formed from an irresistible weight of evidence which has been laid before them. For when the number, the respectability, the disinterestedness, and the extensive experience of its advocates, is compared with the feeble and imperfect testimonies of its few opposers; and when it is considered that many, who were once adverse to vaccination, have been convinced by further trials, and are now to be ranked among its warmest supporters, the truth seems to be established as firmly as the nature of such a question admits; so that the college of physicians conceive that the public may reasonably look forward with some degree of hope to the time when all opposition shall cease, and the general concurrence of mankind shall at length be able to put an end to the ravages at least, if not to the existence, of the smallpox.

LUCAS PEPYS, PRESIDENT.

Royal College of Physicians, 10th of April, 1807.

JA. HERVEY, *Register.*

APPENDIX.

No. I.

To the Royal College of PHYSICIANS of London.

GENTLEMEN,

I am ordered by the King and Queen's College of Physicians, in Ireland, to thank the Royal College of Physicians of London for the communication they have had the honour to receive from them, of certain propositions relative to vaccination, whereon his majesty has been pleased to direct an inquiry to be instituted, and in the prosecution of which, the co-operation of the college in Ireland is requested.

And I am directed to acquaint you, that the said college having referred the investigations of these propositions to a committee, have received from them a report, of which the inclosed is a copy; and that they desire the same may be considered as containing their opinion upon the subject.

I have the honour to be,

Gentlemen,

Your most obedient humble servant,

HUGH FERGUSON, *Register.*

By order of the King and Queen's College of Physicians in Ireland.

Dublin, 11*th Nov.* 1806.

"The practice of vaccination was introduced into this

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this city about the beginning of the year 1801, and appears to have made inconfiderable progrefs at firft. A variety of caufes operated to retard its general adoption, amongft which the novelty of the practice, and the extraordinary effects attributed to vaccination, would naturally take the lead.

"Variolous inoculation had been long, almoft exclufively, in the hands of a particular branch of the profeffion, whofe prejudices and interefts were ftrongly oppofed to the new practice; and by their being the ufual medical attendants in families, and efpecially employed in the difeafes of children, their opinions had greater effect upon the minds of parents. The fmallpox is rendered a much lefs formidable difeafe in this country by the frequency of inoculation for it, than it is in other parts of his majefty's dominions, where prejudices againft inoculation have prevailed; hence parents, not unnaturally, objected to the introduction of a new difeafe, rather than not recur to that, with the mildnefs and fafety of which they were well acquainted.

"In the beginning of the year 1804, the cowpox inftitution was eftablifhed under the patronage of the earl of Hardwicke, and it is from this period that we may date the general introduction of vaccination into this city, and throughout all parts of Ireland.

"The fuccefs of the inftitution, in forwarding the new practice, is to be attributed in a great meafure to the refpectability of the gentlemen who fuperintend it, and to the diligence, zeal, and attention of Dr Labatt, their fecretary and inoculator. In order to fhew the progrefs which has been made in extending vaccination, your committee refer to the reports of the Cowpox Inftitution for the laft two years, and to extracts from their regifter for the prefent year.

	Patients Inoculated.	*Packets iffued to Practitioners in general.*	*Packets to Army Surgeons.*
1804	578	776	236
1805	1032	1124	178
1806	1356	1340	220
Total	2966	3240	634

"In the above ftatement, the numbers are averaged to the end of the prefent year, on the fuppofition of patients reforting to the inftitution as ufual. The correfpondence of the inftitution appears to be very general throughout every part of Ireland, and by the accounts received, as well from medical practitioners as others, the fuccefs of vaccination feems to be uniform and effectual. At the prefent period, in the opinion of your committee, there are few individuals in any branch of the profeffion, who oppofe the practice of vaccination in this part of his majefty's dominions.

"It is the opinion of your committee, that the practice of cowpox inoculation is fafe, and that it fully anfwers all the purpofes that have been intended by its introduction. At the fame time, your committee is willing to allow that doubtful cafes have been reported to them as having occurred, of perfons fuffering from fmallpox, who had been previoufly vaccinated. Upon minute inveftigation, however, it has been found, that thefe fuppofed inftances originated generally in error, mifreprefentation, or the difficulty of difcriminating between fmallpox and other eruptions, no cafe having come to the knowledge of your committee, duly authenticated by refpectable and competent judges, of genuine fmallpox fucceeding the regular vaccine difeafe.

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"The practice of vaccination becomes every day more extended; and, when it is confidered that the period at which it came into general ufe in Ireland is to be reckoned from fo late a date, your committee is of opinion, that it has made already as rapid a progrefs as could be expected.

(Signed) "JAMES CLEGHORN.
"DANIEL MILLS.
"HUGH FERGUSON."

N°. II.

Phyficians Hall, Edinburgh, 26th Nov. 1806.

GENTLEMEN,

THE Royal College of Phyficians of Edinburgh have but little opportunity themfelves of making obfervations on vaccination, as that practice is entirely conducted by furgeon apothecaries, and other medical practitioners not of their college, and as the effects produced by it are fo inconfiderable and flight, that the aid of a phyfician is never required.

The College know that in Edinburgh it is univerfally approved of by the profeffion, and by the higher and middle ranks of the community; and that it has been much more generally adopted by the lower orders of the people than ever the inoculation for fmallpox was, and they believe the fame to obtain all over Scotland.

With regard to any caufes which have hitherto prevented its general adoption, they are acquainted with none except the negligence or ignorance of parents among the common people, or their miftaken ideas of the impropriety or criminality of being acceffary to the production of any difeafe among their children, or the difficulty or impoffibility, in fome of our country diftricts, of procuring vaccine matter, or a proper perfon to inoculate.

The evidence in favour of vaccination appeared to the Royal College of Phyficians of Edinburgh fo ftrong and decifive, that in May laft, they fpontaneoufly and unanimoufly elected Dr Jenner an honorary fellow of their college;—a mark of diftinction which they very rarely confer, and which they confine almoft exclufively to foreign phyficians of the firft eminence.

They did this with a view to publifh their opinion with regard to vaccination, and in teftimony of their conviction of the immenfe benefits which have been, and which will in future be derived to the world, from inoculation for the cowpox, and as a mark of their fenfe of Dr Jenner's very great merits and ability in introducing and promoting this invaluable practice.

I have the honour to be
Gentlemen,
Your moft obedient humble fervant,
TH. SPENS, *C. R. M. Ed. Pr.*

To the Royal College of
Phyficians of London.

N°. III.

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N°. III.

At a special court of assistants of the Royal College of Surgeons, convened by order of the Master, and holden at the College on Tuesday the 17th day of March 1807;

Mr Governor LUCAS in the chair:

Mr Long, as chairman of the board of curators, reported, that the board are now ready to deliver their report on the subject of vaccination.

It was then moved, seconded, and resolved, that a report from the board of curators, on the subject of vaccination, which was referred to their consideration by the court of assistants, on the 21st day of November last, be now received.

Mr Long then delivered to Mr Governor Lucas (presiding in the absence of the master) a report from the board of curators.

It was then moved, seconded, and resolved, that the report, delivered by Mr Long, be now read; and it was read accordingly, and is as follows:

To the Court of Assistants of the Royal College of Surgeons in London.

THE report of the Board of Curators, on the the subject of vaccination, referred to them by the court, on the 21st day of November 1806; made to the court on the 17th of March 1807.

THE court of assistants having received a letter from the Royal College of Physicians of London, addressed to this college, stating, that his majesty had been graciously pleased, in compliance with an address from the honourable House of Commons, to direct his Royal College of Physicians of London to enquire into the state of vaccination in the united kingdom, to report their observations and opinion upon that practice, upon the evidence adduced in its support, and upon the causes which have hitherto retarded its general adoption; that the college were then engaged in the investigation of the several propositions thus referred to them, and requesting this college to co-operate and communicate with them, in order that the report thereupon might be made as complete as possible.

And having, on the 21st day of November last, referred such letter to the consideration of the board of curators, with authority to take such steps respecting the contents thereof as they should judge proper, and report their proceedings thereon, from time to time, to the court: the board proceeded with all possible dispatch to the consideration of the subject.

The board being of opinion, that it would be proper to address circular letters to the members of this college, with a view of collecting evidence, they submitted to the consideration of the court, holden on the 15th day of December last, the drafts of such letter as appeared to them best calculated to answer that end; and the same having been approved by the court, they caused copies thereof to be sent to all the members of the college in the united kingdom, whose residence could be ascertained, in the following form; viz.

"Sir,

"The Royal College of Surgeons being desirous to co-operate with the Royal College of Physicians of London, in obtaining information respecting vaccination, submit to you the following questions, to which the favour of your answer is requested.

"By order of the Court of Assistants,

"OKEY BELFOUR, *Secretary*."

Lincoln's-Inn Fields,
Dec. 15. 1806.

"1st. How many persons have you vaccinated?

"2d. Have any of your patients had the smallpox after vaccination? In the case of every such occurrence, at what period was the vaccine matter taken from the vesicle? How was it preserved? How long before it was inserted? What was the appearance of the inflammation? And what the interval between vaccination and the variolous eruption?

"3d. Have any bad effects occurred in your experience in consequence of vaccination? And if so, what were they?

"4th. Is the practice of vaccination increasing or decreasing in your neighbourhood; if decreasing, to what cause do you impute it?"

To such letters the board have received 426 answers: and the following are the results of their investigation:

The number of persons, stated in such letters to have been vaccinated, is 164,381.

The number of cases in which smallpox had followed vaccination is 56.

The board think it proper to remark under this head, that, in the enumeration of cases in which smallpox has succeeded vaccination, they have included none but those in which the subject was vaccinated by the surgeon reporting the facts.

The bad consequences which have arisen from vaccination are, eruptions of the skin in 66 cases, and inflammation of the arm in 24 instances, of which three proved fatal.

Vaccination, in the greater number of counties from which reports have been received, appears to be increasing; it may be proper however to remark, that, in the metropolis, it is on the decrease.

The principal reasons assigned for the decrease are,

Imperfect vaccination,
Instances of smallpox after vaccination,
Supposed bad consequences,
Publications against the practice,
Popular prejudices.

And such report having been considered, it was moved, seconded, and

Resolved, That the report now read, be adopted by this court, as the answer of the court to the letter of the Royal College of Physicians, of the 23d day of October last, on the subject of vaccination.

Resolved, That a copy of these minutes and resolutions, signed by Mr Governor Lucas (presiding at this court in the presence of the master) be transmitted by the secretary to the register of the Royal College of Physicians.

(Signed) WM LUCAS.

N°. IV.

N°. IV.

Sir, *Edinburgh, March* 3. 1807.

I mentioned in my former letter, that I would take the earliest opportunity of laying before the Royal College of Surgeons of Edinburgh, the communication with which the Royal College of Physicians of London had honoured them, on the 23d of October last:

I am now directed by the Royal College to send the following answer on that important subject.

The practice of vaccine inoculation, both in private, and at the vaccine institution established here in 1801, is increasing so rapidly, that for two or three years past, the smallpox has been reckoned rather a rare occurrence, even among the lower orders of the inhabitants of this city, unless in some particular quarters about twelve months ago; and, among the higher ranks of the inhabitants, the disease is unknown.

The members of the Royal College of Surgeons have much pleasure in reporting, that, as far as their experience goes, they have no doubt of the permanent security against the smallpox which is produced by the constitutional affection of the cowpox; and that such has hitherto been their success in vaccination, as also to gain for it the confidence of the public, insomuch that they have not been required, for some years past, to inoculate any person with smallpox who had not previously undergone the inoculation with the cowpox.

The members of the Royal College have met with no occurrence in their practice of cowpox inoculation which could operate in their minds to tis disadvantage; and they beg leave particularly to notice, that they have seen no instance of obstinate eruptions, or of new and dangerous diseases, which they could attribute to the introduction among mankind this of mild preventive of smallpox. The Royal College of Surgeons know of no causes which have hitherto retarded the adoption of vaccine inoculation here; on the contrary, the practice has become general within this city; and from many thousand packets of vaccine matter having been sent by the members of the Royal College, and the vaccine institution here, to all parts of the country, the Royal College have reason to believe that the practice has been as generally adopted throughout this part of the united kingdom as could have been expected from the distance of some parts of the country from proper medical assistance, and other circumstances of that nature.

I have the honour to be,
Sir,
Your most obedient servant,
Wm Farquharson,
President of the Royal College and Incorporation of Surgeons of Edinburgh.

N°. V.

Royal College of Surgeons in Ireland,
Sir, *Dublin, February 4th,* 1807.

I am directed to transmit to you the inclosed report of a committee of the College of Surgeons in Ireland, to whom was referred a letter from the Royal College of Physicians in London, relative to the present state of vaccination in this part of the united kingdom; and to state, that the College of Surgeons will be highly gratified by more frequent opportunities of corresponding with the English College of Physicians on any subject which may conduce to the advancement of science, and the welfare of the public.

I have the honour to be,
Sir,
Your most obedient humble servant,
James Henthorn, *Secretary.*

At a meeting of the Royal College of Surgeons in Ireland, holden at their Theatre, on Tuesday the 13th day of January 1807.

Francis M'Evoy, Esq. *President.*

Mr Johnson reported from the committee, to whom was referred a letter from the College of Physicians, London, relative to the present state of vaccination in the united kingdom, &c. &c. that they met, and came to the following resolutions:

That it appears to this committee, That inoculation with vaccine infection is now very generally adopted by the surgical practitioners in this part of the united kingdom, as a preventive of smallpox.

That it appears to this committee, that from the 25th day of March 1800 to the 25th of November 1806, 11,504 persons have been inoculated with vaccine infection at the dispensary for infant poor, and 2831 at the cowpox institution, making a total of 14,335, exclusive of the number inoculated at hospitals and other places, where no registry is made and preserved.

That it is the opinion of this committee, that the cowpox has been found to be a mild disease, and rarely attended with danger, or any alarming symptom, and that the few cases of smallpox which have occurred in this country, after supposed vaccination, have been satisfactorily proved to have arisen from accidental circumstances, and cannot be attributed to the want of efficacy in the genuine vaccine infection as a preventive of smallpox.

That it is the opinion of this committee, that the causes which have hitherto retarded the more general adoption of vaccination in Ireland, have, in a great measure, proceeded from the prejudices of the lower classes of the people, and the interest of some irregular practitioners.

To which report the College agreed.

Extract from the minutes,
James Henthorn, *Secretary.*

After this report, we cannot help thinking that the British legislature would be fully warranted for passing an act prohibiting the inoculation of smallpox under very severe penalties, and ordering all those who may be subjected to smallpox by accidental contagion to be confined to lazarettos, or at least to their own houses, under a proper guard, to prevent the communication of infection, till their complete recovery. By such an act, there is good ground to believe, that the loathsome and dangerous disease of smallpox would in a few years be exterminated in Britain.

But

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But although providence has thus furnished mankind with an easy mode of preserving their offspring from the danger of smallpox, by the inoculation of the cow pox at an early period of life, yet not a few deaths from the natural smallpox have occurred in Britain even during the course of the present year.

When the preventive has not been duly employed, after the contagion of variola is introduced into the body, nothing yet known will prevent the disease from running its course, either under the mild or confluent form; and the endeavours of the medical practitioner are altogether to be employed in rendering that course as favourable as possible by mitigating symptoms.

In the mild or distinct smallpox, the strictest antiphlogistic regimen is to be enjoined. Gentle refrigerant cathartics are often useful, and mild diluents should be copiously employed. Under these remedies the disease will generally run its course without much inconvenience. But it will sometimes be necessary to employ remedies for obviating particular urgent symptoms, such as gargarisms or blisters for affections of the throat.

In the malignant smallpox, besides the same refrigerant plan of cure which is best accommodated to the mild, as the secondary fever shews evident marks of a putrid tendency, it is necessary to employ those remedies which are accommodated to typhus, and accordingly recourse is not only had to opiates and cardiacs, but to wine, cinchona, and the mineral acids.

Genus XXIX. VARICELLA.

226 *Chickenpox.*

Varicella, *Vog.* 42.
Variola lymphatica, *Sauv.* sp. 1.
Anglis, *The Chickenpox*, Edin. Med. Essays, vol. ii. art. 2. near the end. *Heberden*, Med. Transact. art. 17. *The Watery-Pox.*

This is in general a very slight disease; and is attended with so little danger, that it would not merit any notice, if it were not apt to be confounded with the smallpox, and thus give occasion to an opinion that a person might have the smallpox twice in his life; or they are apt to deceive into a false security those who have never had the smallpox, and make them believe that they are safe when in reality they are not. This eruption breaks out in many, according to Dr Heberden, without any illness or previous sign; in others it is preceded by a slight degree of chilness, lassitude, cough, broken sleep, wandering pains, loss of appetite, and feverish state for three days.

In some patients the chickenpox make their first appearance on the back; but this perhaps is not constant. Most of them are of the common size of the smallpox, but some are less. Dr Heberden never saw them confluent, nor very numerous. The greatest number was about 12 on the face, and 200 over the rest of the body.

On the first day of the eruption they are reddish. On the second day there is at the top of most of them a very small bladder, about the size of a millet seed. This is sometimes full of a watery and colourless, sometimes of a yellowish liquor, contained between the cuticle and skin. On the second, or, at the farthest, on the third day from the beginning of the eruption, as many of these pocks as are not broken seem arrived at their full maturity; and those which are fullest of that yellow liquor very much resemble what the genuine smallpox are on the fifth or sixth day, especially where there happens to be a larger space than ordinary occupied by the extravasated serum. It happens to most of them, either on the first day that this little bladder arises, or on the day after, that its tender cuticle is burst by the accidental rubbing of the clothes, or by the patient's hands to allay the itching which attends this eruption. A thin scab is then formed at the top of the pock, and the swelling of the other part abates, without its ever being turned into pus, as it is in the smallpox. Some few escape being burst; and the little drop of liquor contained in the vesicle at the top of them, grows yellow and thick, and dries into a scab. On the fifth day of the eruption they are almost all dried and covered with a slight crust. The inflammation of these pocks is very small, and the contents of them do not seem to be owing to suppuration, as in the smallpox, but rather to what is extravasated under the cuticle by the serous vessels of the skin, as in a common blister. It is not wonderful, therefore, that this liquor appears so soon as on the second day; and that, upon the cuticle being broken, it is presently succeeded by a slight scab: hence too, as the true skin is so little affected, no mark or scar is likely to be left, unless in one or two pocks, where, either by being accidentally much fretted, or by some extraordinary sharpness of the contents, a little ulcer is formed in the skin.

Varicella.

The patients scarce suffer any thing throughout the whole progress of this illness, except some languidness of strength, spirits, and appetite; all which is probably owing to the confining of themselves to their chamber.

Remedies are not likely to be much wanted in a disease attended with hardly any inconvenience, and which in so short a time is certainly cured of itself.

The principal marks by which the chickenpox may be distinguished from the smallpox are,

1. The appearance, on the second or third day from the eruption, of that vesicle full of serum upon the top of the pock.

2. The crust, which covers the pocks on the fifth day; at which time those of the smallpox are not at the height of their suppuration.

Foreign medical writers hardly ever mention the name of this distemper: and the writers of our own country scarce mention any thing more of it than its name. Morton speaks of it as if he supposed it to be a very mild genuine smallpox. But these two distempers are certainly totally different from one another, not only on account of their different appearances above mentioned, but because those who have had the smallpox are capable of being infected with the chickenpox; but those who have once had the chickenpox are not capable of having it again, though to such as have never had this distemper, it seems as infectious as the smallpox. Dr Heberden wetted a thread in the most concocted pus-like liquor of the chickenpox which he could find; and after making a slight incision,

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ſion, it was confined upon the arm of one who had formerly had it; the little wound healed up immediately, and ſhowed no ſigns of any infection.

From the great ſimilitude between the two diſtempers, it is probable, that inſtead of the ſmallpox, ſome perſons have been inoculated from the chickenpox; and that the diſtemper which has ſucceeded, has been miſtaken for the ſmallpox by haſty or unexperienced obſervers.

There is ſometimes ſeen an eruption, concerning which Dr Heberden is in doubt whether it be one of the many unnoticed cutaneous diſeaſes, or only a more malignant ſort of chickenpox.

This diſorder is preceded for three or four days by all the ſymptoms which forerun the chickenpox; but in a much higher degree. On the fourth or fifth day the eruption appears, with a very little abatement of the fever: the pains likewiſe of the limbs and back ſtill continue, to which are joined pains of the gums. The pox are redder than the chickenpox, and ſpread wider; and hardly riſe ſo high, at leaſt not in proportion to their ſize. Inſtead of one little head or veſicle of a ſerous matter, theſe have from four to ten or twelve. They go off juſt like the chickenpox, and are diſtinguiſhable from the ſmallpox by the ſame marks; beſides which, the continuance of the pains and fever after the eruption, and the degree of both theſe, though there be not above 20 pocks, are circumſtances never happening in the ſmallpox.

227 Genus XXX. RUBEOLA.

Measles.

Rubeola, *Sauv.* gen. 94. *Lin.* 4. *Sag.* 293.
Febris morbilloſa, *Vog.* 36. *Hoffm.* II. 62.
Morbilli, *Junck.* 76.

Sp. I. The *Regular Measles.*

Rubeola vulgaris, *Sauv.* ſp. 1.
Morbilli regulares, *Sydenh.* ſect. iv. cap. 5.

Var. 1. The *Anomalous Measles.*

Rubeola anomala, *Sauv.* ſp. 2.
Morbilli anomali, *Sydenh.* ſect. v. cap. 3.

Var. 2. The *Measles* attended with *Quinſy.*

Var. 3. The *Measles*, with *Putrid Diatheſis* of the Blood.

28 Sp. II. The *Variolodes.*
In Scotland commonly called the *Nirles.*

Rubeola variolodes, *Sauv.* ſp. 3.

Deſcription. This diſeaſe begins with a cold ſtage, which is ſoon followed by a hot, with the ordinary ſymptoms of thirſt, anorexia, anxiety, ſickneſs, and vomiting; and theſe are more or leſs conſiderable in different caſes. Sometimes from the beginning the fever is ſharp and violent: often, for the firſt two days, it is obſcure and inconſiderable; but always becomes violent before the eruption, which commonly happens on the fourth day. This eruptive fever, from the beginning of it, is always attended with hoarſeneſs, a frequent hoarſe dry cough, and often with ſome difficulty of breathing. At the ſame time, the eyelids are ſomewhat ſwelled; the eyes are a little inflamed, and pour out tears; and with this there is a coryza, and frequent ſneezing. For the moſt part, a conſtant drowſineſs attends the beginning of this diſeaſe. The eruption, as we have ſaid, commonly appears upon the fourth day, firſt on the face, and ſucceſſively on the lower parts of the body. It appears firſt in ſmall red points; but, ſoon after, a number of theſe appear in cluſters, which do not ariſe in viſible pimples, but, by the touch, are found to be a little prominent. This is the caſe on the face; but, in other parts of the body, the prominency, or roughneſs, is hardly to be perceived. On the face, the eruption retains its redneſs, or has it increaſed for two days; but on the third, the vivid redneſs is changed to a browniſh red; and in a day or two more the eruption entirely diſappears, while a mealy deſquamation takes place. During the whole time of the eruption, the face is ſomewhat turgid, but ſeldom conſiderably ſwelled. Sometimes, after the eruption has appeared, the fever ceaſes entirely: but this is ſeldom the caſe; and more commonly the fever continues or is increaſed after the eruption, and does not ceaſe till after the deſquamation. Even then the fever does not always ceaſe, but continues with various duration and effect. Though the fever happen to ceaſe upon the eruption's taking place, it is common for the cough to continue till after the deſquamation, and ſometimes much longer. In all caſes, while the fever continues, the cough alſo continues, generally with an increaſe of the difficulty of breathing; and both of theſe ſymptoms ſometimes ariſe to a degree which denotes a pneumonic affection. This may happen at any period of the diſeaſe; but very often it does not come on till after the deſquamation of the eruption.

Rubeola.

After the ſame period, alſo, a diarrhœa frequently comes on, and continues for ſome time.

It is common for meaſles, even when they have not been of a violent kind, to be followed by inflammatory affections, particularly ophthalmia and phthiſis. If blood be drawn from a vein in the meaſles, with circumſtances neceſſary to favour the ſeparation of the fibrine, this always appears ſeparated, and lying on the ſurface of the craſſamentum, as in inflammatory diſeaſes. For the moſt part, the meaſles, even when violent, are without any putrid tendency; but in ſome caſes, ſuch a tendency appears both in the courſe of the diſeaſe, and eſpecially after the ordinary courſe of it is finiſhed.

Cauſes. The meaſles are occaſioned by a peculiar kind of contagion, the nature of which is not underſtood; and which, like that of the ſmallpox, affects a perſon only once in his life.

Prognoſis. From the deſcription of this diſtemper already given, it appears that the meaſles are attended with a catarrhal affection, and with an inflammatory diatheſis to a conſiderable degree; and therefore the danger of them is to be apprehended chiefly from the coming on of a pneumonic inflammation.

Cure. In meaſles, as well as in ſmallpox, the diſeaſe from its nature muſt neceſſarily run a determined courſe; and therefore the ſole aim of a practitioner is to conduct this courſe in the eaſieſt manner, by preventing and obviating urgent ſymptoms.

From the conſideration mentioned in the prognoſis, it

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it will be obvious, that the remedies eſpecially neceſſary are thoſe which may obviate and diminiſh the inflammatory diatheſis; and therefore, in a particular manner, blood-letting. This remedy may be employed at any time in the courſe of the diſeaſe, or after the ordinary courſe of it is finiſhed. It is to be employed more or leſs, according to the urgency of the ſymptoms of fever, cough, and dyſpnœa; and generally may be employed very freely. But as the ſymptoms of pneumonic inflammation ſeldom come on during the eruptive fever, and as this is ſometimes violent immediately before the eruption, though a ſufficiently mild diſeaſe be to follow; bleeding is ſeldom very neceſſary during the eruptive fever, and may often be reſerved for the times of greater danger which are perhaps to follow.

In all caſes of meaſles, where there are no marks of putreſcency, and where there is no reaſon, from the known nature of the epidemic, to apprehend putreſcency, bleeding is the remedy moſt to be depended upon: but aſſiſtance may alſo be drawn from cooling purgatives; and from bliſtering on the ſides or between the ſhoulders. The dry cough may be alleviated by the large uſe of demulcent pectorals, mucilaginous, oily, or ſweet. It may, however, be obſerved, with reſpect to theſe demulcents, that they are not ſo powerful in involving and correcting the acrimony of the maſs of blood as has been imagined; and that their chief operation is by lubricating the fauces, and thereby defending them from the irritation of acrids, either ariſing from the lungs or diſtilling from the head. For moderating and quieting the cough in this diſeaſe, opiates certainly prove the moſt effectual means, whenever they can be ſafely employed. In the meaſles, in which an inflammatory ſtate prevails in a conſiderable degree, opiates have indeed by ſome been ſuppoſed to be inadmiſſible: but experience abundantly demonſtrates, that the objection made to their uſe is merely hypothetical: and even in caſes where, from a high degree of pyrexia and of dyſpnœa, there is reaſon to fear the preſence, or at leaſt the danger, of pneumonic inflammation, opiates are highly uſeful, after bleeding, to obviate or abate the inflammatory ſtate, has been duly employed: in ſuch caſes, while the cough and watchfulneſs are the urgent ſymptoms, opiates may be ſafely exhibited, and with great advantage. In all the exanthemata, there is an acrimony diffuſed over the ſyſtem, which gives a conſiderable irritation; and, for obviating the effects of this, opiates are uſeful, and always proper, when no particular contraindication prevails.

When the deſquamation of the meaſles is finiſhed, though then there ſhould be no diſorder remaining, phyſicians have thought it neceſſary to purge the patient ſeveral times, with a view to draw off what have been called the *dregs of this diſeaſe;* that is, a portion of the morbific matter which is ſuppoſed to remain long in the body. Dr Cullen does not reject this ſuppoſition; but at the ſame time cannot believe that the remains of the morbific matter, diffuſed over the whole maſs of blood, can be wholly drawn off by purging; and therefore thinks, that, to avoid the conſequence of the meaſles, it is not the drawing off the morbific matter which we need to ſtudy, ſo much as to obviate and remove the inflammatory ſtate of the ſyſtem which had been induced by the diſeaſe. With this laſt view, indeed, purging may ſtill be a proper remedy; but bleeding, in proportion to the ſymptoms of inflammatory diſpoſition, is ſtill more ſo.

Miliaria.

From our late experience of the uſe of cold air in the eruptive fever of the ſmallpox, ſome phyſicians have been of opinion that the practice may be transferred to the meaſles; but this point has not yet been determined by ſufficiently extenſive experience. We are certain, that external heat may be very hurtful in the meaſles, as in moſt other inflammatory diſeaſes; and therefore, that the body ought to be kept in a moderate temperature during the whole courſe of the diſeaſe: but how far, at any period of the diſeaſe, cold air may be applied with ſafety, is ſtill uncertain. Analogy, though ſo often the reſource of phyſicians, is frequently fallacious; and further, though the analogy with the ſmallpox might lead to the application of cold air during the eruptive fever of the meaſles, the analogy with catarrh ſeems to be againſt the practice.

When the eruption is upon the ſkin, there are many inſtances of cold air making it diſappear, and thereby producing much diſorder in the ſyſtem; and there are alſo frequent inſtances of theſe ſymptoms being removed by reſtoring the heat of the body, and thereby again bringing out the eruption.

Upwards of 20 years ago, inoculation for the meaſles was propoſed, and practiſed in ſeveral inſtances with ſucceſs, by Dr Home of Edinburgh. His method of communicating the infection was, by applying to an inciſion in each arm cotton moiſtened with the blood of a patient labouring under the meaſles; but with others who have made ſimilar trials, the attempt has not yet ſucceeded. Attempts have been made to inoculate this diſeaſe by means of the fluid diſcharged under the form of tears, the ſquamæ falling from the ſurface, and the like; but there is reaſon to believe, that where it was imagined the infection had thus been communicated, the contagion was only carried about the perſon inoculating and communicated in the ordinary way.

From inoculation of the meaſles, it is imagined that ſeveral advantages may be obtained; and among others, it is thought the ſoreneſs of the eyes may be mitigated, the cough abated, and the fever rendered leſs ſevere. But the practice was never much employed, and now is ſcarce ever heard of.

Genus XXXI. MILIARIA. 229

The *Miliary Fever.*

Miliaria, *Lin.* 7.
Miliaris, *Sauv.* gen. 95. *Sag.* gen. 295.
Febris miliaris, *Vog.* 37.
Febris purpurata rubra et alba miliaris, *Hoffm.* II. 68.
Febris purpurea ſeu miliaris, *Junck.* 75.
Germanis der Frieſel. *God. Welſch.* Hiſt. Med. de novo puerperarum morbo, qui der *Frieſel* dicitur, Lipſ. 1655.
Hamilton, de febr. miliar. 1710. *Fontanus*, de febr. mil. 1747. *Allioni* de miliar. 1758. *Fordyce*, de febr. mil. 1748. *Fiſcher*, de febr. mil. 1767. De *Haen*, de diviſ. febr. 1760, et in Ration. med. paſſim. *Matt. Collin* ad *Baldinger* de miliar. 1764.

Miliaris

Exanthemata.

Miliaris benigna, *Sauv.* fp. 1.
Miliaris maligna, *Sauv.* fp. 2.
Miliaris recidivans, *Sauv.* fp. 3.
Miliaris Germanica, *Sauv.* fp. 5.
Miliaris Boia, *Sauv.* fp. *a.*
Miliaris Britannica, *Sauv.* fp. *i.*
Miliaris nova febris, *Sydenh.* Sched. monit. *Sauv.* fp. *d.*
Miliaris fudatoria, *Sauv.* fp. *e.*
Miliaris nautica, *Sauv.* fp. *g.*
Miliaris purpurata, *Sauv.* fp. *h.*
Miliaris lactea, *Sauv.* fp. *c.*
Miliaris puerperarum, *Sauv.* fp. *k.*
Miliaris fcorbutica, *Sauv.* fp. *l.*
Miliaris critica, *Sauv.* fp. *b.*

Hiftory and Defcription. This difeafe is faid to have been unknown to the ancients, and that it appeared for the firft time in Saxony about the middle of the laft century. It is faid to have fince fpread from thence into all the other countries of Europe; and fince the period mentioned, to have appeared in many countries in which it had never appeared before.

From the time of its having been firft taken notice of, it has been defcribed and treated of by many different writers; and by all of them, till very lately, has been confidered as a peculiar idiopathic difeafe. It is faid to have been conftantly attended with peculiar fymptoms. It comes on with a cold ftage, which is often confiderable. The hot ftage, which follows, is attended with great anxiety, and frequent fighing. The heat of the body becomes great, and foon produces profufe fweating, preceded, however, with a fenfe of pricking, as of pin points in the fkin; and the fweat is of a peculiar rank and difagreeable odour. The eruption appears fooner or later in different perfons, but at no determined period of the difeafe. It feldom or never appears upon the face; but appears firft upon the neck and breaft, and from thence often fpreads over the whole body.

The eruption named *miliary*, is faid to be of two kinds; the one named the *red*, the other the *white miliary.* The former, which in Englifh is ftrictly named a *rufh*, is commonly allowed to be a fymptomatic affection; and as the latter is the only one that has any pretenfions to be confidered as an idiopathic difeafe, it is this only that we fhall more particularly defcribe and treat of under this genus.

What is then called the *white miliary eruption*, appears at firft like the red, in very fmall red pimples, for the moft part diftinct, but fometimes clustered together. Their little prominence is better diftinguifhed by the finger than by the eye. Soon after the appearance of this eruption, and, at leaft, on the fecond day, a fmall veficle is vifible upon the top of the pimples. At firft the veficle is whey-coloured: but foon becomes white, and ftands out like a little globule. In two or three days, thefe globules break, or are rubbed off; and are fucceeded by fmall crufts, which foon after fall off in fmall fcales. While one fet of pimples takes this courfe, another fet arifes to run the fame; fo that the difeafe often continues upon the fkin for many days together. Sometimes when one crop of this eruption has difappeared, another, after fome interval, is produced. And it has been further obferved, that in fome perfons there is fuch a difpofition to this difeafe, that they have been affected with it feveral times in the courfe of their lives.

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This difeafe is faid to affect both fexes, and perfons of all ages and conftitutions: but it has been obferved at all times, to affect efpecially, and moft frequently, lying-in women.

It is often accompanied with violent fymptoms, and has frequently proved fatal. The fymptoms, however, attending it are very various; but no fymptom, or concourfe of fymptoms, are fteadily the fame in different perfons, fo as to give any fpecific character to the difeafe. When the difeafe is violent, the moft common fymptoms are phrenetic, comatofe, and convulfive affections, which are alfo fymptoms of all fevers treated by a very warm regimen.

While there is fuch a variety of fymptoms appearing in this difeafe, it is not to be expected that any one particular method of cure can be propofed; and, accordingly, we find in different writers different methods and remedies prefcribed; frequent difputes about the moft proper; and thofe received and recommended by fome oppofed and deferted by others.

It appears, however, to Dr Cullen, very improbable, that this was really a new difeafe, when it was firft confidered as fuch. There are very clear traces of it in authors who wrote long before that period; and though there were not, we know that ancient defcriptions were often inaccurate and imperfect, particularly with refpect to cutaneous affections; and we know alfo that thofe affections which commonly appeared as fymptomatic only, were often neglected, or confounded together under a general appellation.

The antecedent fymptoms of anxiety, fighing, and pricking of the fkin, which have been fpoken of as peculiar to this difeafe, are, however, common to many others; and perhaps to all thofe in which fweatings are forced out by a warm regimen. Of the fymptoms faid to be concomitant of this eruption, there are none which can be affirmed to be conftant and peculiar but that of fweating. This, indeed, always precedes and accompanies the eruption: and, while the miliary eruption attends many different difeafes, it never, however, appears in any of thefe but after fweating; and in perfons labouring under the fame difeafes it does not appear, if in fuch perfons fweating be avoided. It is therefore probable, that the eruption is the effect of fweating: and that it is the effect of a matter not before prevailing in the mafs of blood, but generated under particular circumftances in the fkin itfelf. That it depends upon particular circumftances of the fkin, is alfo probable from its being obferved that the eruption feldom or never appears upon the face, although it affects the whole of the body befides; and that it comes upon thofe places efpecially which are more clofely covered; and that it can be brought out upon particular places by external applications.

It is to be obferved, that this eruptive difeafe differs from the other exanthemata in many circumftances, efpecially the following; that it is not contagious, and therefore never epidemic; that the eruption appears at no determined period of the difeafe; that the eruption has no determined duration; that fucceffive eruptions frequently appear in the courfe of the fame

fever,

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fever, and that such eruptions frequently recur in the course of the same person's life. All this renders it very probable, that, in the miliary fever, the morbific matter is not a subsisting contagion communicated to the blood, and thence, in consequence of fever and assimilation, thrown out upon the surface of the body, but a matter occasionally produced in the skin itself by sweating.

This conclusion is further rendered probable from hence, that, while the miliary eruption has no symptoms or concourse of symptoms peculiar to itself, it, upon occasions, accompanies almost every febrile disease, whether inflammatory or putrid, if these happen to be attended with sweating; and from thence it may be presumed, that the miliary eruption is a symptomatic affection only, produced in the manner we have said.

But as this symptomatic affection does not always accompany every instance of sweating, it may be proper to inquire, what are the circumstances which especially determine this eruption to appear? And to this Dr Cullen gives no full and proper answer. He cannot say that there is any one circumstance which in all cases gives occasion to this eruption; nor can he say what different causes, in different cases, may give occasion to it. There is only one observation that can be made to the purpose; and it is, that these persons, sweating under febrile diseases, are especially liable to the miliary eruption, who have been previously weakened by large evacuations, particularly of blood. This will explain why it happens to lying-in women more frequently than to any other persons; and to confirm this explanation, he has observed, that the eruption has happened to other women, though not in childbed, but who had been much subjected to a frequent and copious menstruation, and to an almost constant *fluor albus*. He has also observed it to have happened to men in fevers, after wounds from which they had suffered a great loss of blood.

Further, That this eruption is produced hy a certain state of debility, is, he thinks, probable, from its so often attending fevers of the putrid kind, which are always accompanied with great debility. It is true, that it also sometimes attends inflammatory diseases, when it cannot be accounted for in the same manner; but he believes it may be observed, that it especially attends those inflammatory diseases in which the sweats have been long protracted, or frequently repeated, and which have thereby produced a debility, and perhaps a debilitating putrid diathesis.

That, however, the miliary eruption is not necessarily or even generally connected with a certain state of debility, is abundantly evident from its being entirely wanting in by much the greater number of instances of typhoid fever, and in a variety of other diseases where every possible degree of debility occurs: And that it is not connected with any certain state of debility, still farther appears, both from the condition of those affected with it in different instances, which in point of strength is very various; and likewise from the continuance of fresh eruptions with the same individual, although during that time in very different states with respect to debility. It appears, therefore, much more probable, that it depends on some peculiar state of the surface, induced by the concurring influence of certain predisposing and occasional causes.

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It appears so clearly that this eruption is always a symptomatic and factitious affection, that Dr Cullen is persuaded it may be, in most cases, prevented merely by avoiding sweats. Spontaneous sweatings, in the beginning of diseases, are very rarely critical; and all sweatings not evidently critical should be prevented, or at least moderated; and the promoting them, by increasing external heat, is commonly very pernicious. Even critical sweats should hardly be encouraged by such means. If, therefore, spontaneous sweats arise, they are to be checked by the coolness of the chamber; by the lightness and looseness of the bedclothes; by the persons laying out their arms and hands; and by their taking cold drink: and in this way Dr Cullen thinks he has frequently prevented miliary eruptions, which were otherwise likely to have appeared, particularly in puerperal women.

But it may happen, when these precautions have been neglected, or from other circumstances, that a miliary eruption does actually appear; and the question will then be put, how the case is to be treated? This is a question of consequence; as there is reason to believe that the matter here generated is often of a virulent kind; it is often the offspring of putrescency; and, when treated by increasing the external heat of the body, it seems to acquire a virulence which produces those symptoms mentioned above, and proves certainly fatal.

It has been an unhappy opinion with most physicians, that eruptive diseases were ready to be hurt by cold; and that it was therefore necessary to cover up the body very closely, and thereby increase the external heat. We now know that this is a mistaken opinion; that increasing the external heat of the body is very generally mischievous; and that several eruptions not only admit, but require the application of cold air. Dr Cullen is persuaded, therefore, that the practice which formerly prevailed in the case of miliary eruptions, of covering up the body closely, and both by external means and internal remedies encouraging the sweatings which accompany this eruption, was highly pernicious, and commonly fatal. He is therefore of opinion, that even when a miliary eruption has appeared, in all cases in which the sweating is not manifestly critical, we should employ all the means of stopping the sweating that are mentioned above; and he has sometimes had occasion to observe, that even the admission of cool air was safe and useful.

This is, in general, the treatment of miliary eruptions: but at the same time, the remedies suited to the primary disease are to be employed; and therefore when the eruption happens to accompany inflammatory affections, and the fulness and hardness of the pulse or other symptoms show an inflammatory state present, the case is to be treated by blood-letting, purging, and other antiphlogistic remedies.

On the other hand, when the miliary eruption attends diseases, in which debility and putrescency prevail, it will be proper to avoid all evacuations, and to employ tonic and antiseptic remedies, particularly the cinchona, cold drink, and cold air.

The most distressing circumstance attending this affection, is the almost unsupportable sickness at stomach which frequently occurs, and which is often observed to precede fresh eruptions taking place during the

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the courſe of the diſeaſe. With the view of counteracting and alleviating this ſymptom, recourſe is had to wine and other cordial medicines. But with many patients nothing is found to have ſo much influence as the uſe of camphor, particularly when introduced gradually in ſmall doſes, under the form of the *miſtura camphorata* of the London Pharmacopœia, or of the *emulſio camphorata* of that of Edinburgh.

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Genus XXXII. SCARLATINA.

Scarlet fever.

Scarlatina, *Sauv.* gen. 98. *Vog.* 39. *Sag.* 294. *Junck.* 75.

Sp. I. The Mild *Scarlet fever.*

Scarlatina febris, *Sauv.* ſp. 1. *Sydenham*, ſect vi. cap. 2.

Sp. II. The *Scarlet Fever* with *Ulcerated Sore Throat.*

Scarlatina anginoſa. *Withering* on the Scarlet Fever.

The mild ſcarlet fever is deſcribed by Sydenham, who tells us that he can ſcarce account it a diſeaſe; and indeed nothing more ſeems to be neceſſary in the treatment of it than an antiphlogiſtic regimen, avoiding the application of cold air and cold drink. The diſeaſe, however, often rages epidemically, and is attended with very alarming ſymptoms, in which caſe it is called *ſcarlatina anginoſa.*—The beſt deſcription of this diſtemper has been publiſhed by Dr Withering in the year 1778. This diſeaſe made its appearance, we are told, at Birmingham and the neighbouring villages, about the middle of May 1778. It continued in all its force and frequency to the end of October; varying, however, in ſome of its ſymptoms, as the air grew colder. In the beginning of November it was rarely met with; but towards the middle of that month, when the air became warmer, it increaſed again, and in ſome meaſure reſumed thoſe appearances it poſſeſſed in the ſummer months, but which it had loſt during the cold winds in October.

It affected children more than adults; but ſeldom occurred in the former under two years of age, or in the latter if they had paſſed their fiftieth year.

Deſcription. With various general ſymptoms of fever, the patient at firſt complains of a dejection of ſpirits, a ſlight ſoreneſs or rather ſtiffneſs in the neck, with a ſenſe of ſtraitneſs in the muſcles of the neck and ſhoulders, as if they were bound with cords. The ſecond day of the fever this ſoreneſs in the throat increaſes, and the patients find a difficulty in ſwallowing: but the difficulty ſeems leſs occaſioned by the pain excited in the attempt, or by the ſtraitneſs of the paſſage, than by an inability to throw the neceſſary muſcles into action. The ſkin feels hot and dry, but not hard; and the patients experience frequent, ſmall, pungent pains, as if touched with the point of a needle. The breath is hot and burning to the lips, and thirſt makes them wiſh to drink; but the tendency to ſickneſs, and the exertions neceſſary in deglutition, are ſo unpleaſant, that they ſeldom care to drink much at a time. They have much uneaſineſs alſo from want of reſt during the night. In the morning of the third day, the face, neck and breaſt, appear redder than uſual: in a few hours this redneſs becomes univerſal; and increaſes to ſuch a degree of intenſity, that the face, body, and limbs, reſemble a boiled lobſter in colour, and are evidently ſwollen. Upon preſſure the redneſs vaniſhes, but ſoon returns again. The ſkin is ſmooth to the touch, nor is there the leaſt appearance of pimples or puſtules. The eyes and noſtrils partake more or leſs of the general redneſs; and in proportion to the intenſity of this colour in the eyes, the tendency to delirium prevails.

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Things continue in nearly this ſtate for two or three days longer, when the intenſe ſcarlet gradually abates, a brown colour ſucceeds, and the ſkin becoming rough, peels off in ſmall ſcales. The tumefaction ſubſides at the ſame time, and the patients gradually recover their ſtrength and appetite.

During the whole courſe of the diſeaſe, the pulſe is quick, ſmall, and uncommonly feeble, the urine ſmall in quantity; the ſub-maxillary glands ſomewhat enlarged and painful to the touch. The velum pendulum palati, the uvula, the tonſils, and gullet, as far as the eye can reach, partake of the general redneſs and tumefaction; but although collections of thick mucus, greatly reſembling the ſpecks or ſloughs in the putrid ſore throat, ſometimes occur, yet thoſe are eaſily waſhed off; and real ulcerations of thoſe parts were never obſerved.

Theſe are the moſt uſual appearances of this diſorder; but it too frequently aſſumes a much more fatal form. In ſome children the delirium commences in a few hours after the firſt attack; the ſkin is intenſely hot; the ſcarlet colour appears on the firſt or ſecond day, and they die very early on the third. Others again, who ſurvive this rapid termination, inſtead of recovering, as is uſual, about the time the ſkin begins to get its natural colour, fall into a kind of lingering, and die at laſt in the courſe of ſix or eight weeks.

In adults, circular livid ſpots were frequently obſerved about the breaſt, knees, and elbows; alſo large blotches of red, and others of white intermixed, and often changing places.

In the month of October, when the air became colder, the ſcarlet colour of the ſkin was both leſs frequent and leſs permanent. Many patients had no appearance of it at all; while others, eſpecially adults, had a few minute red pimples, crowned with white pellucid heads. The inſide of the throat was conſiderably tumefied, its colour a dull red, ſometimes tending to a livid. The pulſe beat in general 130 or 140 ſtrokes in a minute; was ſmall, but hard, and ſometimes ſufficiently ſo to juſtify the opening of a vein; and the blood thus taken away, in every inſtance, when cool, appeared ſizy, and the whole craſſamentum firm.

Happy would it be, Dr Withering obſerves, if the baneful influence of this diſorder terminated with the febrile ſymptoms. But in ten or fifteen days from the ceſſation of the fever, and when a complete recovery might be expected, another train of ſymptoms occurs, which at laſt frequently terminate fatally. The patients, after a few days amendment, feel a ſomething that prevents their farther approach to health;

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health; an unaccountable languor and debility prevails, a ſtiffneſs in the limbs, an accelerated pulſe, diſturbed ſleep, diſreliſh to food, and a ſcarcity of urine. Theſe ſymptoms, we are told, are ſoon ſucceeded by ſwellings of a real dropſical nature, forming ſometimes an anaſarca, and on other occaſions an aſcites; and not unfrequently ſcarlatina has proved fatal, from ſupervening hydrothorax in conſequence of the effuſion of water into the cheſt. It is unneceſſary to remark, that when this happens, a fatal termination is more ſudden than from any other modification of dropſy.

Dr Withering, after examining the accounts given of this diſeaſe by different authors, proceeds to the diagnoſis. It may be diſtinguiſhed, he obſerves, from the petechial fever, by the eruption in the latter appearing ſeldom before the fourth day, by the regularity and diſtinctneſs of the ſpots, and by its principally occupying the neck, the back, and the loins. On the other hand, in the ſcarlet fever, the eruption generally appears about the third day; and conſiſts either of broad blotches, or elſe one continued redneſs, which ſpreads over the face and the whole body.

In the fever called *purpura*, the puſtules are prominent, keep their colour under preſſure, and never appear early in the diſeaſe; whereas in the ſcarlet fever, the eruption appears more early, is not prominent, but perfectly ſmooth to the touch, and becomes quite white under preſſure.

Although the *purple fever* and *ſcarlatina* may be connected by ſome general cauſe, yet our author takes occaſion to obſerve, that they cannot be mere modifications of the ſame eruption: for examples occur, he ſays, of the ſame perſon being firſt ſeized with one of theſe diſorders, and afterwards with the other; but he never met with an inſtance of the ſame perſon having the ſcarlet fever twice; and he believes it to be as great an improbability as a repetition of the ſmallpox.

This diſorder is particularly diſtinguiſhed from the *meaſles*, we are told, by the want of that cough, watery eye, and running at the noſe, which are known to be the predominant ſymptoms in the early ſtate of the meaſles, but are never known to exiſt in the ſcarlatina.

From the *eryſipelas* this diſeaſe is diſtinguiſhable, by the limited ſeat of the former, together with its not being contagious.

The *cynanche maligna*, however, is according to Dr Withering more difficult to diſtinguiſh from this diſeaſe than any other; and yet the diſtinction is, he thinks, a matter of the greateſt importance, as the method of treatment, according to him, ought to be extremely different.—Although, in a number of circumſtances, theſe two diſeaſes bear a very great reſemblance, yet, with a little attention, the one may in general, he thinks, be diſtinguiſhed from the other. From Dr Fothergill's account of the ſore throat attended with ulcers, our author has made out the following characteriſtical circumſtances of the two diſeaſes, contraſted to one another.

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Scarlatina Anginoſa.	Angina Gangrenoſa.
Seaſon. . Summer . . Autumn.	*Seaſon*. . Spring . . Winter.
Air. . Hot . . . Dry.	*Air*. . Warm . . Moiſt.
Places. High . . Dry . . . Gravelly.	*Places*. Cloſe. . Low . . Damp. . Marſhy.
Subjects. Vigorous. Both ſexes alike. . Robuſt in moſt danger. . . .	*Subjects*. Delicate . . Women and female children. Robuſt adults not in danger.
Skin. Full ſcarlet . . . . ſmooth . . If pimply, the pimples white at the top . . Always dry and hot.	*Skin*. Red tinct . . pimply. . The pimples redder than the interſtices . . bedewed with ſweat towards morning.
Eyes. Shining, equable, intenſe redneſs, rarely watery.	*Eyes*. Inflamed and watery, or ſunk and dead.
Throat. In ſummer, tonſils, &c. little tumefied; no ſlough . . In autumn, more ſwelled. Integuments ſeparating . . Sloughs white.	*Throat*. Tonſils, &c. conſiderably ſwelled and ulcerated . . . Sloughs dark brown.
Breath. Very hot, but not fetid.	*Breath*. Offenſive to the patients and aſſiſtants.
Voice. In ſummer, natural.	*Voice*. Flat and rattling.
Bowels. Regular at the acceſſion.	*Bowels*. . Purging at the acceſſion.
Blood. Buffy. . Firm.	*Blood*. . Florid . . Tender.
Termination. The 3d, 5th, 8th, or 11th day.	*Termination*. No ſtated period.
Nature. Inflammatory.	*Nature*. Putrid.

It is not pretended, Dr Withering remarks, that all the above-contraſted ſymptoms will be met with in every caſe. It is enough, he obſerves, that ſome of them appear; and that if, conjoined with the conſideration of the prevailing conſtitution, they enable us to direct that mode of treatment which will moſt contribute to the relief of the ſick.

But notwithſtanding the attention which Dr Withering has beſtowed upon this ſubject, we are ſtill decidedly of opinion, that the diſeaſe which he has ſo accurately deſcribed under the title of *ſcarlatina anginoſa*, is in reality the ſame affection with the malignant ulcerous ſore throat of Huxham and Fothergill. During different epidemics, this diſeaſe, like ſmallpox and meaſles in different ſeaſons, is conſiderably varied in its appearance. But ſtill there occurs ſuch a ſimilarity as clearly marks the ſameneſs of the affection. And indeed this, as in the caſe of the ſmallpox, is abundantly demonſtrated by infection from one contagion giving protection againſt ſucceeding ones, although the appearances be much varied. This has particularly appeared at Edinburgh, where the diſeaſe has of late prevailed as an epidemic on five different years, viz. 1774-75, 1782-83, 1789-90, 1797-98, and 1804-5. During the firſt of theſe occaſions, in the greater part of patients, the ſore throats were of a very gangrenous and malignant nature: during the ſecond, the diſeaſe more commonly appeared under the form of what might be called *ſimple ſcarlatina*: and during the other epidemics, the contagion was, if we may be allowed the expreſſion, of an intermediate nature. But it is farther to be remarked, that during every one of thoſe epidemics, when ſeveral children of a family were at the ſame time

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subjected to the infection, in one the disease would have been attended with almost all the symptoms mentioned in the column of *scarlatina anginosa*, with respect to skin, eyes, throat, breath, bowels, termination of the affections, &c. In another, would have occurred all the symptoms with respect to those particulars which he has mentioned under the column of *angina gangrenosa*. While at the same time, in numberless instances, even in the same patient, the disease at its commencement has shown evident marks of an inflammatory, and at its termination of a putrid tendency. And there cannot be a doubt, that both the scarlatina anginosa of Withering, and the cynanche maligna, as described by Fothergill and Huxham, have occurred in every season and situation, and have affected persons of every age and constitution not before subjected to either disease.

Causes. Dr Withering affirms, that the immediate cause of this disease is a poison of a peculiar kind communicable by contagion.

2. That this poison first takes possession of the mucous membrane lining the fauces and the nose; and either by its action upon the secretory glands, or upon the mucus itself, assimilates that mucus to its own nature.

3. That it is from this beginning, and from this only, that it spreads to the stomach, &c. and at length acts upon the system at large.

4. That its first action upon the nerves is of a sedative or debilitating nature.

5. That in consequence of certain laws of the nervous system, when the debilitating effects operate upon the sensorium commune, a reaction takes place; and that this reaction is, *cæteris paribus*, proportioned to the debilitating power.

6. That, in consequence of this reaction of the nervous system, the vibratory motion of the capillary blood-vessels dependant thereon is greatly increased; an unusually large quantity of blood is accumulated in those vessels; the heart and large blood-vessels are deprived of their customary proportion; and hence, though stimulated to more frequent contraction, the pulse must necessarily be feeble.

7. That as violent exertions are followed by debility, upon the cessation of the fever, the capillary vessels, which had acted with such unusual violence, are left in a state of extreme debility, and are long in recovering their tone; hence it is that so many patients afterwards become dropsical.

Dr Withering next proceeds to the consideration of the different remedies, which either are at present in common use, or have been recommended as proper in this disease.

Cure. Blood-letting has been recommended by authors; but such was the state of the pulse in this disorder, at least during the summer months, that it was not in any instance thought advisable to take away blood. In some cases, indeed, where the fiery redness of the eyes seemed to demand the use of leeches, they were had recourse to, but never with any advantage. In the harvest months, when the pulse was more firm, and when suffocation seemed to be threatened from the swelling in the fauces, blood-letting was sometimes advised; but still with less advantage than one would have expected in almost any other situation.

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Vomiting.] This, Dr Withering observes, seems to be the remedy of nature; and he is surprised how it should have been omitted by several authors who have gone before him. Vomiting, he says, most amply fulfils the indications arising both from a consideration of the cause and of the effects; and a liberal use of the remedy he holds forth as the true foundation for successful practice in scarlet fever and sore throat. His common form of emetic is a combination of tartar emetic and ipecacuanha, given in pretty smart doses; and these are to be repeated at least once in 48 hours, and in the worst cases so often as twice in 24 hours.

Purging.] The action of purgatives is considered by Dr Withering as altogether repugnant to the curative indications in this disease: for the poisons, as formerly remarked, being received into the system by the fauces, the operation of a purge, instead of discharging it, can only promote its diffusion along the alimentary canal; and in fact, we are told, that when even a a spontaneous purging supervenes in this disease, the patients sink so amazingly fast, that it is not within the reach of art to support them. When, however, a considerable quantity of acrid matter passing from the fauces into the stomach, makes its way to the rectum, a considerable degree of looseness often takes place. And although evacuations from the system in general by means of cathartics may be hurtful, yet patients often obtain great relief from a free discharge of this matter; and by discharging it, purgatives have the effect even of preventing an evacuation from the system, which would otherwise take place.

Sudorifics. Cordials. Alexipharmics.] None of these remedies were found beneficial. With respect to cordials, Dr Withering observes, that although they seem to be indicated by the great loss of strength and feeble pulse, yet the certain consequence of their use always was, an increase of restlessness, of the delirium, and of the heat.

Diuretics.] These were found very beneficial. The vegetable fixed alkali is recommended as the most proper article of this kind: a dram or two may be easily swallowed every 24 hours, by giving a small quantity in every thing the patient drinks. Diuretics, however, have been found principally serviceable, by practitioners in general, in those cases where the urine is observed to be scanty, and where dropsical symptoms have taken place.

Cinchona.] No medicine, we are told, ever had a fairer trial in any disease than the Peruvian bark had in this epidemic; for the feeble pulse, great prostration of strength, with here and there a livid spot, were thought to be such undeniable evidences of a putrid tendency, that cinchona was poured down not with a sparing hand. But this was only at first; for these livid spots and the sloughs in the throat being found to be the effects of inflammation instead of putrefaction, and the bark instead of diminishing, rather increasing these symptoms, it was at last entirely laid aside by Dr Withering in his practice. But although cinchona may not have been successful with a particular epidemic at a particular place; yet from the concurring testimony of many practitioners, it is very commonly

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monly found to be productive of good effects: And there is perhaps no remedy on which greater dependance is in general put, particularly in the advanced periods of the diſeaſe, where the fœtor is conſiderable.

Upon the ſame principles that cinchona was preſcribed, fixable air was at firſt likewiſe adviſed, but with no evident effects either one way or another. Dulcified acids were alſo had recourſe to, but with no advantage.

Opiates.] Theſe, although recommended by ſome authors for the removal of inquietude and watchfulneſs, yet in this epidemic, inſtead of effecting theſe purpoſes, always increaſed the diſtreſs of the patient.

Bliſters.] In the ſummer appearance of the diſeaſe, bliſters were univerſally detrimental; they never failed to haſten the delirium; and if the caſe was of the worſt kind, they too often confirmed its fatal tendency. But although this may have been the caſe during the epidemic which Dr Withering deſcribes, it has by no means been generally obſerved. On the contrary, by the early application of bliſters to the external fauces, both the glandular ſwellings and likewiſe the diſcharge from the mouth and fauces have been much diminiſhed; and practitioners have believed, not without probable reaſon, that the after-affections of the throat were leſs conſiderable than would otherwiſe have been the caſe.

Injected gargles of contrayerva decoction, ſweetened with oxymel of ſquills, &c. were found very beneficial in bringing always large quantities of viſcid ropy ſtuff from the fauces.

The immerſion of the feet and legs in warm water, although it did no harm, yet did not either procure ſleep or abate the delirium, as it frequently does in other kinds of fever.

As in ſummer it was found difficult to keep the patients ſufficiently cool, they were ordered to lie upon a mattreſs inſtead of a feather-bed; a free circulation of air was kept up; and where the patients ſtrength would admit of it, they were ordered frequently out of doors. Animal food and fermented liquors were denied them, and nothing allowed but tea, coffee, chocolate, milk and water, gruel, barley-water, and ſuch articles.

With reſpect to the dropſical diſorder which ſo frequently ſucceeds to this complaint, it was never obſerved, Dr Withering remarks, when the preceding ſymptoms had been properly treated.

When called upon to patients in the dropſical ſtate, he began his practice by a doſe of calomel at night, and a purgative in the morning. When a febrile pulſe attended the other ſymptoms, emetics were uſeful, as well as the ſaline draughts and other neutral ſalts. When great debility, comatoſe or peripneumonic ſymptoms occurred, bliſters were found very ſerviceable: but when dropſical ſymptoms were the principal cauſe of complaint, ſmall doſes of rhubarb and calomel were adviſed; recourſe was alſo had to diluted ſolutions of fixed alkalies, ſquills, Seltzer waters, and and other diuretics.

When the urine flows freely, ſteel and other tonics are recommended; together with gentle exerciſe, highſeaſoned food, wine, and the wearing of flannel in contact with the ſkin.

Dr Withering concludes his eſſay with an enumeration of ſeveral caſes, treated according to the principles above laid down. The ſucceſsful termination of theſe caſes demonſtrates the propriety of the practice which he has recommended; at leaſt for the epidemic under the form in which it then appeared.

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Since Dr Withering's publication, two other practices have obtained conſiderable celebrity in this diſeaſe. The one is daſhing cold water on the ſurface of the body in the manner recommended by Dr Currie in proper fevers. It is, however, very certain that although this may obviate ſymptoms, and particularly diminiſh the heat when very urgent, yet it never produces an artificial termination of the diſeaſe as ſome have alleged. When the contagion of ſcarlatina is introduced into a human body, never before ſubjected to the diſeaſe, it muſt, like ſmallpox and meaſles, run a certain courſe, and the attention of the practitioner muſt merely be employed in endeavouring to render that courſe as mild as he can, principally by obviating urgent ſymptoms.

The other remedy, lately introduced, and highly commended in ſcarlatina anginoſa, is the oxygenated muriatic lead. This has been particularly extolled by Mr John Ayrey Braithwaite, ſurgeon at Lancaſter. One dram of the oxygenated muriatic acid is mixed with eight ounces of diſtilled water. This quantity he directs to be taken by a patient at the age of puberty every day. But the quantity muſt be regulated by the age and ſituation of the patient. This remedy alſo is only uſeful as obviating ſymptoms, particularly the affection of the throat. But with this intention we have often employed it with great advantage.

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Nettle-rash.

Febris urticata, *Vog.* 40.
Uredo, *Lin.* 8.
Purpura urticata, *Junck.* 75.
Scarlatina urticata, *Sauv.* ſp. 2.
Eryſipelatis ſpecies altera, *Sydenham*, ſect. vi. cap. 6.
Febris ſcarlatina, et febris urticata, *Meyſerey*, Mal. des armées, 291 et ſeq.

Deſcription. This diſeaſe has its Engliſh name of nettle-raſh from the reſemblance of its eruption to that made by the ſtinging of nettles. Theſe little elevations upon the ſkin in the nettle-raſh often appear inſtantaneouſly, eſpecially if the ſkin be rubbed or ſcratched, and ſeldom ſtay many hours in the ſame place, and ſometimes not many minutes. No part of the body is exempt from them; and where many of them riſe together, and continue an hour or two, the parts are often conſiderably ſwelled; which particularly happens in the face, arms, and hands. Theſe eruptions will continue to infeſt the ſkin, ſometimes in one place and ſometimes in another, for one or two hours at a time, two or three times every day, or perhaps for the greateſt part of the 24 hours.—In ſome perſons they laſt only a few days, in others many months; nay, ſometimes the diſeaſe has laſted for years with very ſhort intervals.

But though the eruption of the urticaria reſembles, as already obſerved, that produced by the ſtinging of nettles,

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nettles, it is sometimes accompanied with long weals, as if the part had been struck with a whip. Whatever be the shape of these eminences, they always appear solid, without having any cavity or head containing either water or any other liquor: and this affords an easy mark whereby this disease may be distinguished from the itch. For it often happens, that the insufferable itching with which this eruption is attended, provokes the patient to scratch the parts so violently, that a small part of the cuticle on the top of these little tumors is rubbed off; a little scab succeeds; and, when the swelling is gone down, there is left an appearance hardly to be distinguished from the itch, but by the circumstance just now mentioned. The nettle-rash also further differs from the itch, in not being infectious.

Causes, &c. Dr Heberden is inclined to ascribe this distemper to some mechanical cause outwardly applied to the skin. He observes, that most people suffer in a similar manner from the real stinging of nettles. Cowhage, or, as it is corruptly called, *cow-itch*, a sort of phaseolus, or French bean, the pod of which is covered over with a kind of down or hair, and the effect of which upon the skin is much the same as that of nettles; and almost any hairs cut equally short, and sprinkled upon the skin, whenever they happen to stick in it, will make the part itch or smart in such a manner as to give great uneasiness; it is also a considerable time before the skin can be cleared of the finer ones, when once they are strewed upon it.

Reaumur, in the fourth memoir of his History of Insects, describes a species of caterpillars to which belong a sort of hairs almost invisible to the naked eye, which are easily detached, and frequently float in the air round their nest, though it have not been at all disturbed. The touch of these hairs has a similar effect with the cow-itch; that is, they occasion intolerable itchings, with little bumps and redness, arising sometimes to a slight inflammation. These he found would continue four or five days, if the animal or the nest had been much handled; and though they had not been touched at all, yet, by only walking near their nests, the same effects would be brought on, but for a shorter time. These hairs affect the skin in this manner by sticking in it, as he could perceive with a glass of a great magnifying power; for with one of a small power they were not visible. The uneasy sensations caused by these small wounds, not only, as he says, last several days, but move from one part of the body to another; so that they will cease upon one wrist, and immediately begin on the other; from the wrist they will go to the fingers or the face, or even to the parts of the body which are covered. He supposes, that the motions of the body, when much of this fine down lies near or upon the skin, may drive it from one part to another, or change what was lying there inoffensively to a situation fit to make it penetrate into the skin. Neither cold water, nor oil, nor spirit of wine, with which the parts affected were bathed, had any effect in removing the itching. He thinks the most efficacious remedy which he tried for this complaint was, to rub the parts strongly with parsley, which instantly lessened the sensations, and after two or three hours, entirely freed the patient from them. It is also well known, that many species of caterpillars, by only walking over the hands, will produce something like this effect on the parts which they touch, and undoubtedly from the same cause.

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Dr Heberden asks, Is it impossible that the nettle-rash should arise from the same causes, or from others similar, which we miss by looking too deeply for them in the blood and humours? Such, says he, may have been its origin in some instances, where it has lasted only a few days; but where this affection has continued for some years, in persons who change their linen every day, and who bathe frequently all the time, it can hardly be ascribed to such an external cause. He has observed it frequently to arise from cantharides: but though it has continued many weeks after the removal of the blister, yet it might be suspected that this arose from the fine spiculæ of the cantharides sticking all this time about the skin; it being customary to strew much of the dry powder of the cantharides over the blister-plaster, whence it may readily be carried to other parts of the body. But it is certain that similar effects will sometimes follow the internal use of wild valerian root, or the eating of fish not sufficiently dressed; muscles, shrimps, and even honey, and the kernels of fruits, will also sometimes produce symptoms of a similar kind. But whatever be its cause, Dr Heberden never saw any reason to suppose that the nettle-rash had in any way vitiated the humours to such a degree as to require the use of internal remedies; and if the itching could be certainly and expeditiously allayed, there would be no occasion for any farther cure. He concludes this history of the disorder with a case communicated to him by Dr Monsey, physician of Chelsea College, and in which the disease appeared with uncommon violence.

W. A. aged near 30, of a thin spare habit, was seized with a disorder attended with symptoms of a very uncommon kind. Whenever he went into the air, if the sun shined bright, he was seized with a tickling of his flesh on those parts exposed to the sun: this tickling, by his continuing in the air, increased to a violent itching, attended with great heat and pain: the skin would then be almost as red as vermilion, and thicken like leather; and this remained till he went out of the open air, and then abated in about 15 or 20 minutes. This happened only when the sun was above the horizon; at other times he was what he called *quite well*.—But it was not owing to the heat of the sun; for the sun in winter affected him full as much, if not more, and the heat of the fire had no such effect. Thus he was confined to the house for 10 years. He tried several hospitals, and had advices from many physicians, without the least abatement of his complaints. At last it was agreed by a consultation of physicians, that he should try dipping in salt water; which he did at Yarmouth for 13 weeks, without any visible amendment. One hot day, having pulled off his clothes and gone into the sea in the middle of the day, the heat diffused itself so violently all over his body, that, by the time he had put on his clothes, his eyesight began to fail, and he was compelled to lie down upon the ground to save himself from falling. The moment he lay down, the faintness went off: upon this he got up again; but had no sooner arisen, than he found himself in the former condition: he therefore lay down

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down again, and immediately recovered. He continued alternately getting up and lying down, till the disorder began to be exhausted, which was in about half an hour; and he was frequently obliged to have recourse to the same expedient.

Having at last accidentally met with Dr Monsey, this physician questioned him concerning the cause of the disorder; but nothing could be guessed at, excepting that the patient owned he had one winter lived entirely upon bullock's liver and porter, from inability to purchase better victuals. A comrade lived with him at that time, on the same provisions; and he also was affected in a similar manner, though in a less degree, and had recovered. This patient was then first put upon a course of Dover's sweating powder without any effect, and afterwards tried a course of nitrous ones with the same bad success. At last Dr Monsey determined to try the effect of mercury, which happily proved effectual in removing this obstinate and uncommon distemper. The patient began with taking five grains of calomel for three nights running, and a cathartic next morning. In this course he went on for near a fortnight, at the end of which he found himself very sensibly relieved. This encouraged him to go on rather too boldly, by which means a slight salivation ensued; however, that went off soon, and in about six weeks he was quite well.—Some time after, he was threatened with a return of his disorder; but this was effectually relieved by a dose of calomel, which he had afterwards occasion to repeat for the same reason, and with the same success; but at last the disorder seemed to be radically cured, by his having no further symptoms of a relapse.

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Genus XXXIV. PEMPHIGUS.

Pemphigus, *Sauv.* gen. 93. *Sag.* 291.
Morta, *Lin.* 1.
Febris bullosa, *Vog.* 41.
Pemphigus major, *Sauv.* sp. 1.
Exanthemata serosa, *C. Pison.* Obs. 150.
Febris pemphygodes, *Ephem. Germ.* D. I. A. viii. Obs. 56.
Pemphigus castrensis, *Sauv.* sp. 2.
Febres syneches, cum vesiculis per pectus et collum sparsis, *Morton.* App. ad Exerc. II.
Pemphigus Helveticus, *Sauv.* sp. 3. *Langhans* in Act. Helvet. vol. ii. p. 260. et in *Beschreibung* des Siementhals, Zurich 1753.

This is a very rare disease, insomuch that Dr Cullen declares he never saw it. He declines taking the descriptions of foreign physicians: we shall therefore content ourselves with giving an instance of this very uncommon distemper, as it was observed in the Infirmary at Aberdeen, and was treated by the late Dr David Stuart, then physician to that hospital, who soon after published an account of it in the Edinburgh Medical Commentaries. A private soldier of the 73d regiment, aged eighteen years, formerly a pedlar, and naturally of a healthy constitution, was received into the hospital at Aberdeen on the 25th of April. About twenty days before that, he had been seized with the measles when in the country; and, in marching to town, on the second day of their eruption, he was exposed to cold; upon which they suddenly disappeared.

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Having arrived at Aberdeen, he was quartered in a damp, ill-aired, under-ground apartment. He then complained of sickness at stomach, great oppression about the præcordia, headach, lassitude, and weariness, on the least exertion; with stiffness and rigidity of his knees and other joints. The surgeon of the regiment visited him: he was purged, but with little benefit. About ten days before, he observed on the inside of his thighs a number of very small, distinct, red spots, a little elevated above the surface of the skin, and much resembling the first appearance of small-pox. This eruption gradually spread itself over his whole body, and the pustules continued every day to increase in size.

Upon being received into the hospital, he complained of headach, sickness at stomach, oppression about the præcordia, thirst, sore throat, with difficulty of swallowing; his tongue was foul, his skin felt hot and feverish; pulse from 110 to 120, rather depressed; belly costive; eyes dull and languid, but without delirium. The whole surface of his skin was interspersed with vesicles, or phlyctænæ, of the size of an ordinary walnut; many of them were larger, especially on the arms and breast. In the interstices, between the vesicles, the appearance of the skin was natural, nor was there any redness round their base; the distance from one to another was from half an inch to a hand-breadth or more. In some places two or three were joined together, like the pustules in the confluent small-pox. A few vesicles had burst of themselves, and formed a whitish scab or crust. These were chiefly on the neck and face; others showed a tolerably laudable pus. However, by far the greatest number were perfectly entire, turgid, and of a bluish colour. Upon opening them, it was evident that the cuticle elevated above the cutis, and distended with a thin, yellowish, semi-pellucid serum, formed this appearance. Nor was the surface of the cutis ulcerated or livid; but of a red florid colour, as when the cuticle is separated by a blister, or superficial burning. No other person laboured under a similar disease, either in the part of the country from which he came, or when he resided in Aberdeen.

This case was treated in the following manner. The largest of the vesicles were snipped, and dressed with *unguent. è lap. calaminari.* In the evening he was vomited with a solution of tartar emetic, given in small quantities and at intervals. This also procured two loose stools. And he was ordered for drink, water-gruel acidulated with lemon juice.

"April 16. He still complained of sickness, some oppression about his breast, and sore throat; he had slept little during the night; his tongue was foul and blackish; his skin, however, was not so hot as the preceding day; his urine was high-coloured, but had the appearance of separation; his pulse 90, and soft; most of the sores on the trunk of the body looked clean. Others, particularly where the vesicles were confluent, seemed beginning to ulcerate, and to have a bluish sub-livid appearance. They were dressed afresh with cerate, and he was ordered the following medicines:

℞ Decoct, Cort. Peruvian. ℥vj. Vini rubr. Lusitan. ℥iij. M. Hujus mixturæ capiat ℥ß. tertia quaque hora.

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"His acidulated drink was continued; and on account of the very offensive smell on approaching near him, some vinegar was placed in a bason before the bed, and sprinkled on the floor; and the room was kept properly aired.

"April 17. His sores looked tolerably clean, unless on his arms and thighs; where they were livid, a little ulcerated, and discharged a bloody ichor.

"His headach, sickness, &c. were almost gone; his tongue was rather cleaner; pulse 68, and soft. As the decoction of the bark sat easily on his stomach, the following prescription was ordered:

℞ Pulv. subtiliss. Cort. Peruv. ʒß. Vini rubri Lusitan. Aquæ fontan. āā ℥ss. M. ft. Haust. tertia quaque hora repetend.

The acidulated drink was continued, and fresh dressings applied to the sores.

"April 18. The little ulcers in his arms and thighs still discharged a bloody ichor, and looked ill; his other complaints were better; pulse 82. The bark had not nauseated him, and it was continued as well as his former drink.

"April 19. His sores looked much cleaner and better; the fever was gone, his pulse natural, and he had no complaint but weakness and a troublesome itching of the skin: The Peruvian bark, &c. were continued.

"April 20. Some of the ulcers still poured forth a bloody ichor; most of them, however, looked well, and had begun to heal—fever gone—medicines continued.

"From the 21st of April, he went on gaining strength, and his sores appeared to heal fast; he was desired to take only four doses every day; and by the 27th his sores, &c. were totally dried up—he had no complaint, and was dismissed cured."

Since the publication of this case of pemphigus by Dr Stuart, observations on this disease have been published by Dr Stephen Dickson of Dublin, in the Transactions of the Royal Irish Academy. In these observations, an account is given of six different cases which Dr Dickson has had an opportunity of seeing. Judging from these, Dr Dickson thinks that Dr Cullen's definition of this disease requires correction; and that it ought to be defined, "a fever accompanied with the successive eruption, from different parts of the body, internal as well as external, of vesicles about the size of an almond, which become turgid with a faintly yellowish serum, and in three or four days subside."

From the cases which have fallen under Dr Dickson's observation, he concludes, that the disease varies considerably as to its mildness or malignity. In three of the cases which he has seen, the symptoms were extremely mild, but in the other three strong symptoms of putrescency were manifested, and the life of the patient was in great danger. With respect to the method of cure, he is of opinion, that the general symptoms of weakness, and tendency to putrefaction, obviously point out the proper treatment. Nourishment must be supplied, and the Peruvian bark and wine carefully administered; and when vesicles appear on internal parts, irritation must be guarded against by opiates, demulcents, and gentle laxatives.

Some additional observations on the subject of pemphigus have lately been published in the London Medical Journal by Mr Thomas Christie. From a case which Mr Christie describes, he is disposed to agree with Dr Dickson in thinking that sometimes at least pemphigus is not contagious. He remarks, however, that the pemphigus described by some foreign writers was extremely infectious; which he thinks may lead to a division of the disease into two species, the pemphigus simplex and complicatus; both of which, but especially the last, seem to vary much with respect to mildness and malignity.

Aphtha.

GENUS XXXV. APHTHA. 233

The *Thrush*.

Aphtha, *Sauv.* gen. 100. *Lin.* 9. *Sag.* 298. *Boerh.* 978. *Hoffm.* II. 478. *Junck.* 137.
Febris aphthosa, *Vog.* 44.

The only idiopathic species is the thrush to which infants are subject; (Aphtha lactucimen, *Sauv.* sp. 1.)

The aphthæ are whitish or ash-coloured pustules, invading the uvula, fauces, palate, tonsils, inside of the cheeks, gums, tongue, and lips. They for the most part begin at the uvula, sending forth a glutinous mucus, and the pustules covering all or the greatest number of the parts above mentioned, with a thick whitish crust adhering most tenaciously. This crust does not induce an eschar on the parts on which it lies by eating into them, but comes off in whole pieces after the pustules have arrived at maturity. This will often happen in a short time, so that the throat and internal parts of the mouth are frequently observed to be clean, which a few years before were wholly covered with white crusts. Neither is this disease confined to the throat and fauces, but is said to affect the œsophagus, stomach, and all parts of the alimentary canal. Of this indeed there is no other proof, than that, after a great difficulty of swallowing, there is sometimes an immense quantity of aphthæ evacuated by stool and vomiting, such as the mouth could not be thought capable of containing.

Causes, &c. The aphthous fever seems to be produced by cold and moisture, as it is found only in the northern countries, and especially in marshy places; and in them the aphthæ often appear without any fever at all.

Prognosis. There is no symptom by which the coming out of aphthæ can be foretold, though they are common in many fevers; but they themselves are in general a bad symptom, and always signify a very tedious disorder: the danger denoted by them is in proportion to the difficulty of deglutition; and a diarrhœa accompanying them is likewise bad. This indeed generally carries off old people when they become affected with aphthæ. The dark-coloured aphthæ also are much more dangerous than such as are of a brown or ash colour; but it is a good sign when the appetite returns, and the dark-coloured ones are succeeded by others of a whiter colour. Neither are those which are unaccompanied with fever so dangerous as the other kind.

Cure. As the aphthæ are seldom a primary disease, we must generally endeavour to remove the disorder upon which they depend, after which they will fall off;

off; but in the mean time we are not to neglect applications to the aphthæ themſelves, ſuch as detergent and ſoftening gargles made of the decoction of figs, with the addition of honey of roſes, a little vinegar, and ſome tincture of myrrh.

234 ORDER IV. HÆMORRHAGIÆ.

HÆMORRHAGES.

Hæmorrhagiæ, *Vog.* Claſs II. Ord. I. *Hoffm.* II. 194. *Junck.* 5.
Sanguifluxus, *Sauv.* Claſs IX. Ord. I. *Sag.* Claſs V. Order I.

235 GENUS XXXVI. EPISTAXIS.

BLEEDING at the *NOSE.*

Hæmorrhagia, *Sauv.* gen. 239. *Lin.* 173. *Sag.* gen. 174.
Hæmorrhagia narium, *Hoffm.* II. 196. *Junck.* 6.
Hæmorrhagia plethorica, *Sauv.* ſp. 22. *Hoffm.* II. 198.

The other ſpecies enumerated by authors are all ſymptomatic.

Deſcription. The milder ſpecies of this hæmorrhage comes on more frequently in ſummer than in winter, and for the moſt part without giving any warning, or being attended with any inconvenience; but the leſs benign kind is preceded by ſeveral remarkable ſymptoms. Theſe are, congeſtions of the blood ſometimes in one part, and ſometimes in another, and which are often very troubleſome in the ſides of the head: there is a redneſs of the cheeks; an inflation of the face, and of the veſſels of the neck and temples; a *tinnitus aurium;* a heavy pain of the eyes, with a prominence, dryneſs, and ſparks; there is a vertiginous affection of the head, with an itching of the noſtrils, and a ſenſe of weight, eſpecially about the root of the noſe. In ſome the ſleep is diſturbed with dreams about blood, fire, &c. Frequently the belly is coſtive, there is a diminution of the quantity of urine, a ſuppreſſion of ſweat, coldneſs of the lower extremities, and tenſion of the hypochondria, eſpecially the right one.

Cauſes, &c. This hæmorrhage may occur at any time of life; but moſt commonly happens to young perſons, owing to the peculiar ſtate of the ſyſtem at that time. Sometimes, however, it happens after the ακμη and during the ſtate of manhood, at which time it is to be imputed to a plethoric ſtate of the ſyſtem; to a determination of the blood, by habit, to the veſſels of the noſe; or to the particular weakneſs of theſe veſſels.

In all theſe caſes the diſeaſe may be conſidered as an arterial hæmorrhage, and depending upon an arterial plethora; but it ſometimes occurs in the decline of life, and may then be conſidered as the ſign of a venous plethora in the veſſels of the head. It often happens at any period of life in certain febrile diſeaſes, which are altogether or partly of an inflammatory nature, and which ſhow a particular determination of the blood to the veſſels of the head. As by this evacuation, other diſeaſes are often removed, it may on theſe occaſions be deemed truly *critical.* It happens to perſons of every conſtitution and temperament; but moſt frequently to the plethoric and ſanguine, and more commonly to men than women.

Prognoſis. In young people, the bleeding at the noſe may be conſidered as a ſlight diſeaſe, and ſcarce worth notice. But, even in young perſons, when it recurs very frequently and in great quantity, it is alarming; and is to be conſidered as a mark of an arterial plethora, which in the decline of life may give the blood a determination to parts from which the hæmorrhage would be more dangerous; and this will require more particular attention, as the marks of plethora and congeſtion preceding the hæmorrhage are more conſiderable, and as the flowing of the blood is attended with a more conſiderable degree of febrile diſorder. Theſe conſequences are more eſpecially to be dreaded, when the epiſtaxis happens to perſons after their ακμη, returning frequently and violently. Even in the decline of life, however, it may be conſidered as in itſelf very ſalutary; but at the ſame time it is a mark of a dangerous ſtate of the ſyſtem, i. e. of a ſtrong tendency to a venous plethora in the head, and it has accordingly been often followed by apoplexy, palſy, &c. When it happens in febrile diſeaſes, and is in pretty large quantity, it may be generally conſidered as critical and ſalutary; but it is very apt to be too profuſe, and thus becomes dangerous. It ſometimes occurs during the eruptive fever of ſome exanthemata, and is in ſuch caſes ſometimes ſalutary; but if theſe exanthemata be accompanied with any putrid diſpoſition, this hæmorrhage, as well as artificial bloodlettings, may have a very bad tendency.

Cure. The treatment in caſes of epiſtaxis may be referred to two heads. 1ſt, The treatment during the time of the diſcharge; and, 2dly, The treatment after the diſcharge is ſtopt, with the view of preventing the return of it. During the former of theſe periods, it is neceſſary in the firſt place to conſider whether the diſcharge ſhould be left to its natural courſe or ſtopped by artificial means. In determining this queſtion, regard muſt be paid to the quantity of the diſcharge; the appearance of the blood; the conſtitution with which epiſtaxis occurs; the former habit of the patient; and the conſequences which reſult from the diſcharge. When, from due conſideration of theſe circumſtances, there is reaſon to fear that further evacuation would be attended with bad conſequences, though this diſeaſe has been generally thought very ſlight, it ſhould ſeldom be left to the conduct of nature; and in all caſes it ſhould be moderated by keeping the patient in cool air, by giving cold drink, by keeping the body and head erect, by avoiding any blowing of the noſe, ſpeaking, or other irritation; and if the blood has flowed for ſome time without ſhowing any tendency to ſtop, we are to attempt the ſuppreſſion of the hæmorrhage, by preſſing the noſtril from which the blood flows, waſhing the face with cold water, or applying this to ſome other parts of the body. Theſe meaſures Dr Cullen judges to be proper even on the firſt attacks, and even in young perſons where the diſeaſe is in the leaſt hazardous: but they will ſtill be more requiſite if the diſeaſe frequently recurs without any external violence; if the returns happen to perſons not diſpoſed

diſpoſed to a plethoric habit; and more particularly if no ſigns of plethora appear in the ſymptoms preceding the diſcharge.

When the bleeding is ſo profuſe that the pulſe becomes weak and the face pale, every means muſt be uſed to put a ſtop to it, and that whether the patient be young or old. Beſides thoſe methods above mentioned, we muſt uſe aſtringents both internal and external; but the latter are the moſt powerful, and the choice of theſe may be left to the ſurgeon. The internal aſtringents are either vegetable or foſſil; but the vegetable aſtringents are ſeldom powerful in the cure of any hæmorrhages except thoſe of the alimentary canal. The foſſil aſtringents are more active, but differ conſiderably in ſtrength from one another.—The chalybeates appear to have little ſtrength: the preparations of lead are more powerful; but cannot be employed, on account of their pernicious qualities, unleſs in caſes of the utmoſt danger. The *tinctura ſaturnina*, or *antiphthiſica*, is a medicine of very little efficacy, either from the ſmall quantity of lead it contains, or from the particular ſtate in which it is. The ſafeſt, and at the ſame time the moſt powerful aſtringent, ſeems to be alum.

For ſuppreſſing this and other hæmorrhages, many ſuperſtitious remedies and charms have been uſed, and ſaid to have been employed with ſucceſs. This has probably been owing to the miſtake of the by-ſtanders, who have ſuppoſed that the ſpontaneous ceſſation of the hæmorrhage was owing to their remedy. At the ſame time Dr Cullen is of opinion, that ſuch remedies have ſometimes been uſeful, by impreſſing the mind with horror or dread. Opiates have ſometimes proved ſucceſsful in removing hæmorrhages; and when the fulneſs and inflammatory diatheſis of the ſyſtem have been previouſly taken off by bleeding, they may, in Dr Cullen's opinion, be uſed with ſafety and advantage. Ligatures have been applied upon the limbs, for retarding the return of the venous blood from the extremities; but their uſe ſeems to be ambiguous. In the caſe of profuſe hæmorrhages, no care is to be taken to prevent the patient from fainting, as this is often the moſt certain means of ſtopping them.

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Genus XXXVII. HÆMOPTYSIS.

Spitting *of* Blood.

Hæmoptyſis, *Sauv.* gen. 240. *Lin.* 179. *Vog.* 84. *Sag.* gen. 175. *Junck.* 8.
Hæmoptoë, *Boerh.* 1198.
Sanguinis fluxus ex pulmonibus, *Hoffm.* II. 202.

Sp. I. *Hæmoptysis* from *Plethora.*

Sp. II. *Hæmoptysis* from *External Violence.*

Hæmoptyſis accidentalis, *Sauv.* ſp. 1.
Hæmoptyſis habitualis, *Sauv.* ſp. 2.
Hæmoptyſis traumatica, *Sauv.* ſp. 12.

Sp. III. *Hæmoptysis* with *Phthiſis.*

Hæmoptyſis phthiſica, *Sauv.* ſp. 9.
Hæmoptyſis ex tuberculo pulmonum, *Sauv.* ſp. 10.

Sp. IV. *The Calculous Hæmoptysis.*

Hæmoptyſis calculoſa, *Sauv.* ſp. 14.

Sp. V. *The Vicarious Hæmoptysis.*

Hæmoptyſis catamenialis, *Sauv.* ſp. 4.
Hæmoptyſis periodica, *Sauv.* ſp. 5.

Deſcription. This hæmorrhage commonly begins with a ſenſe of weight and anxiety in the cheſt, ſome uneaſineſs in breathing, pain of the breaſt or other parts of the thorax, and ſome ſenſe of heat under the ſternum: and very often it is preceded by a ſaltiſh taſte in the mouth. Immediately before the appearance of blood, a degree of irritation is felt at the top of the larynx. The perſon attempts to relieve this by hawking, which brings up a little florid and ſomewhat frothy blood. The irritation returns; and in the ſame manner blood of a ſimilar kind is brought up, with ſome noiſe in the windpipe, as of air paſſing through a fluid. Sometimes, however, at the very firſt, the blood comes up with coughing, or at leaſt ſomewhat of coughing, and accompanies the hawking above mentioned.

The blood is often at firſt in very ſmall quantity, and ſoon diſappears; but in other caſes, eſpecially when it frequently recurs, it is in greater quantity, and often continues to appear at times for ſeveral days together. It is ſometimes profuſe, but rarely in ſuch quantity as either by its exceſs or by a ſudden ſuffocation to prove immediately mortal.

It is not always eaſy to diſcover whether the blood evacuated by the mouth proceeds from the internal ſurface of the mouth itſelf, from the fauces or adjoining cavities of the noiſe, from the ſtomach, or from the lungs. It is, however, very neceſſary to diſtinguiſh theſe different caſes; and for this Dr Cullen offers the following conſiderations.

1. When the blood proceeds from ſome part of the internal ſurface of the mouth, it comes out without any hawking or coughing; and generally, upon inſpection, the cauſe is evident.

2. When blood proceeds from the fauces, or adjoining cavities of the noſe, it may be brought out by hawking, and ſometimes by coughing. In this caſe, there may be a doubt concerning its real ſource, and the patient may be allowed to pleaſe himſelf with the thoughts that the blood does not come from the lungs. But the phyſician muſt remember that the lungs are much more frequently the ſource of a hæmorrhage than the fauces. The latter ſeldom happens but to perſons who have before been liable to a hæmorrhage from the noſe, or to ſome evident cauſe of eroſion; and in moſt caſes, by looking into the fauces, the diſtillation of the blood from thence will be perceived.

3. When blood proceeds from the lungs, the manner in which it is brought up will commonly ſhow from whence it comes; but, independent of that, it may alſo be known from the cauſes of hæmoptyſis from the lungs, to be afterwards mentioned, having preceded.

4. When vomiting accompanies the throwing out of blood from the mouth, we may generally know the ſource from whence it proceeds, by conſidering that blood does not proceed ſo frequently from the ſtomach as from the lungs: that blood proceeding from the ſtomach commonly appears in greater quantity than from the lungs. The pulmonary blood alſo is uſually of a florid colour, and mixed with a little frothy mucus

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mucus only; but the blood from the ſtomach is of a darker colour, more grumous, and mixed with the other contents of the ſtomach. The coughing or vomiting, as the one or the other happens firſt to ariſe, may ſometimes point out the ſource of the blood; and this has alſo its peculiar antecedent ſigns and cauſes.

Cauſes, &c. A hæmoptyſis may be produced at any time of life by external violence; and, in adult perſons, while the arterial plethora prevails in the ſyſtem, i. e. from the age of 16 to 35, a hæmoptyſis may at any time be produced merely by a plethoric ſtate of the lungs. More frequently, however, it ariſes from a faulty proportion between the capacity of the lungs and that of the reſt of the body. Thus it is often an hereditary diſeaſe, which implies a peculiar and faulty conformation.

This diſeaſe eſpecially happens to perſons, who diſcover the ſmaller capacity of their lungs by the narrowneſs of their cheſt, and by the prominence of their ſhoulders; which laſt is a mark of their having been long liable to a difficulty of reſpiration. In ſuch caſes, too, the diſeaſe very frequently happens to perſons of a ſanguine temperament, in whom particularly the arterial plethora prevails. It happens alſo to perſons of a ſlender delicate make, of which a long neck is a mark; to perſons of much ſenſibility and irritability, and therefore of quick parts; to perſons who have formerly been liable to hæmorrhages from the noſe; to thoſe who have ſuffered a ſuppreſſion of any uſual hæmorrhage, the moſt frequent inſtance of which is in females who have ſuffered a ſuppreſſion of their menſtrual flux; and, laſtly, to perſons who have ſuffered the amputation of a limb.

All this conſtitutes the prediſponent cauſe of hæmoptyſis; and the diſeaſe may happen merely from the prediſponent cauſe ariſing to a conſiderable height. But in thoſe who are already prediſpoſed, it is often brought on by the concurrence of various occaſional and exciting cauſes. One of theſe, and perhaps a frequent one, is external heat; which, even when in no great degree, brings on the diſeaſe in ſpring, and the beginning of ſummer, while the heat rarefies the blood more than it relaxes the ſolids, which had before been contracted by the cold of winter. Another exciting cauſe is a ſudden diminution of the weight of the atmoſphere, eſpecially when concurring with any effort in bodily exerciſe. The effort alone, may often be the exciting cauſe in thoſe who are already prediſpoſed; and more particularly any violent exerciſe of reſpiration. In the prediſpoſed, alſo, the diſeaſe may be occaſioned by any degree of external violence.

Prognoſis. Hæmoptyſis may ſometimes be no more dangerous than a hæmorrhage from the noſe; as when it happens to females, in conſequence of a ſuppreſſion of their menſes; when, without any marks of prediſpoſition, it ariſes from external violence; or, from whatever cauſe it may proceed, when it leaves no cough, dyſpnœa, or other affection of the lungs, behind it. But, even in theſe caſes, a danger may ariſe from too large a wound being made in the veſſels of the lungs, from any quantity of red blood being led to ſtagnate in the cavity of the bronchiæ, and particularly from any determination of the blood being made into the veſſels of the lungs, which by renewing the hæmorrhage may have theſe conſequences.

Hæmoptyſis.

Cure. In the treatment of this diſeaſe, with a view of ſtopping the diſcharge, it is firſt neceſſary to have recourſe to thoſe meaſures which tend to diminiſh the impetus by which the blood is expelled. This is to be effected by a removal of plethora when it exiſts; by diminiſhing the general impetus of circulation; by diminiſhing local increaſed action when it takes place in the veſſels of the lungs; and by producing a determination of blood to other parts of the ſyſtem remote from the lungs. But beſides practices diminiſhing impetus, it is often alſo neceſſary to employ ſuch as augment the reſiſtance to the paſſage of blood through the ruptured veſſels of the lungs. With theſe views a variety of practices may be employed, particularly blood-letting, refrigerants, ſedatives, aſtringents, and the like.

On this ſubject Dr Cullen differs from thoſe who preſcribe chalybeates and cinchona in the cure of hæmoptyſis. Both of theſe, he obſerves, contribute to increaſe the phlogiſtic diatheſis then prevailing in the ſyſtem, and the hæmoptyſis from prediſpoſition is always accompanied with ſuch a diatheſis. Inſtead of theſe, therefore, he recommends blood-letting in greater or ſmaller quantity, and more or leſs frequently repeated as the ſymptoms ſhall direct. At the ſame time cooling purgatives are to be employed, and every part of the antiphlogiſtic regimen is to be ſtrictly enjoined. In the London Medical Obſervations, the uſe of nitre is greatly recommended by Dr Dickſon, to whom its efficacy was made known by Dr Letherland, phyſician to St Thomas's Hoſpital. The moſt commodious method of exhibiting it he found was in an electuary. Four ounces of conſerve of roſes were made into an electuary with half an ounce of nitre; of which the bulk of a large nutmeg was directed to be given, four, ſix, or eight times a day, according to the urgency of the caſe. The good effects of this, he tells us, have often aſtoniſhed him: and when given early in the diſeaſe, he ſays he can depend as much upon it for the cure of an hæmoptyſis, as on cinchona for the cure of an intermittent. He agrees with Dr Cullen, however, that in thoſe caſes where there is any hardneſs in the pulſe, and which almoſt always happens, there is a neceſſity for veneſection. A cool regimen, and quiet of body and mind, are certainly uſeful; but Dr Cullen obſerves that ſome kinds of geſtation, ſuch as ſailing, and travelling in an eaſy carriage on ſmooth roads, have often proved a remedy. When the cough is very troubleſome, it is abſolutely neceſſary to exhibit frequently a ſmall doſe of an opiate. Dr Dickſon alſo informs us, that the nitre joined with ſpermaceti, or *pulv. è tragacanth. comp.* has produced equally good effects with the electuary above mentioned; in the compoſition of which he at firſt conſidered the conſerve only as a vehicle for the nitre, though he means not to inſinuate that the former is totally deſtitute of efficacy.

When this hæmorrhage has reſiſted other modes of cure, and there is reaſon to apprehend, even from the mere quantity of blood evacuated, that the patient may ſink under the diſcharge, bliſters, particularly when applied to the breaſt, are often had recourſe to with great advantage; and the ſulphuric acid, properly diluted, Hæmorrhagiæ. luted, both as an astringent and refrigerant, is often employed with very good effects.

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Pulmonary Consumption.

Phthisis, *Sauv.* gen. 276. *Lin.* 208. *Vog.* 319. *Sag.* 101. *Junck.* 33.
Phthisis pulmonis, *Boerh.* 1196.
Affectio phthisica, sive tabes pulmonalis, *Hoffm.* II. 284.

238 Sp. I. The *Incipient Phthisis*, without expectoration of *Pus*.

Phthisis incipiens, *Morton* Physiolog. L. II. cap. 3.
Phthisis sicca, *Sauv.* sp. 1.

239 Sp. II. The *Confirmed Phthisis*, with an expectoration of *Pus*.

Phthisis confirmata *auctorum*.
Phthisis humida, *Sauv.* sp. 2.

Sometimes, notwithstanding all the care that can be taken, the hæmoptysis will degenerate into a phthisis pulmonalis, or consumption of the lungs; and sometimes hæmoptysis will be the consequence of this dangerous disorder. It has indeed been supposed, that an ulceration of the lungs, or phthisis, was the natural and almost necessary consequence of hæmoptysis: but according to Dr Cullen, this is in general a mistake; for there are many instances of a hæmoptysis from external violence without being followed by any ulceration. The same thing has often been observed where the hæmoptysis arose from an internal cause; and this not only in young persons, when the disease returned for several times, but when it has often recurred during the course of a long life; and it may easily be conceived, that a rupture of the vessels of the lungs, as well as of the vessels of the nose, may be sometimes healed. The causes of phthisis, therefore, Dr Cullen reduces to five heads. 1. A hæmoptysis. 2. A suppuration of the lungs in consequence of a pneumonia. 3. A catarrh. 4. An asthma; and 5. Tubercles.

1. When a phthisis arises from a hæmoptysis, it is probable that it is occasioned by particular circumstances; and what these circumstances are, may not always be easily known. It is possible, that merely the degree of rupture, or frequently repeated rupture, preventing the wound from healing, may occasion an ulcer; or it is possible, that red blood effused, and not brought up entirely by coughing, may, by stagnating in the bronchiæ, become acrid, and erode the parts. But these hypotheses are not supported by any certain evidence; and from many observations we are led to think, that several other circumstances must concur in producing the disease from hæmoptysis.

2. The second cause of an ulceration of the lungs mentioned above is a suppuration formed in consequence of pneumonia. When a pneumonia, with symptoms neither very violent nor very slight, has continued for many days, it is to be feared it will end in a suppuration; but this is not to be determined by the number of days; for, not only after the fourth, but even after the tenth day, there have been examples of a pneumonia ending by a resolution; and if the disease has suffered some intermission, and again recurred, there may be instances of a resolution happening at a much later period from the beginning of the disease than that now mentioned. But if a moderate disease, in spite of proper remedies employed, be protracted to the 14th day without any considerable remission, a suppuration is pretty certainly to be expected; and it will be more certain still, if no signs of resolution have appeared, or if an expectoration which had appeared shall have again ceased, and the difficulty of breathing has continued or increased, while the other symptoms have been rather abated.

That in a pneumonia, the effusion is made which may lay the foundation of a suppuration, may be concluded from the difficulty of breathing becoming greater when the patient is in a horizontal posture, or when the patient can lie more easily on the affected side. That, in such cases, a suppuration is actually begun, may be inferred from the patient's being frequently affected with slight cold shiverings, and with a sense of cold felt sometimes in one sometimes in another part of the body. We form the same conclusion also from the state of the pulse, which is commonly less frequent and softer, but sometimes quicker than before. That a suppuration is already formed, may be inferred from there being a considerable remission of the pain which had before subsisted; while with this the cough, and especially the dyspnœa, continue, and are rather increased. At the same time the frequency of the pulse is rather increased, the feverish state suffers considerable exacerbations every evening, and by degrees a hectic fever in all its circumstances comes to be formed.

In this state of symptoms, we conclude very confidently, that an abscess, or, as it is called, a *vomica*, is formed in some part of the pleura, and most frequently in that portion of it investing the lungs. Here purulent matter frequently remains for some time, as if enclosed in a cyst; but commonly not long before it comes to be either absorbed and transferred to some other part of the body, or breaks through into the cavity of the lungs, or into that of the thorax. In the latter case it produces the disease called *empyema;* but it is when the matter is poured into the cavity of the bronchiæ that it properly constitutes the phthisis pulmonalis. In the case of empyema, the chief circumstances of a phthisis are indeed also present: but we shall here consider only that case in which the abscess of the lungs gives occasion to purulent expectoration.

An abscess of the lungs, in consequence of pneumonia, is not always followed by a phthisis: for sometimes a hectic fever is not formed; the matter poured into the bronchiæ is a proper and benign pus, which frequently is coughed up very readily, and spit out; and though this purulent expectoration should continue for some time, if it be without hectic fever, the ulcer soon heals, and every morbid symptom disappears. This has so frequently happened, that we may conclude, that neither the access of the air, nor the constant motion of the lungs, will prevent an ulcer of these parts from healing, if the matter of it be well-conditioned. An abscess of the lungs, therefore, does not necessarily produce phthisis pulmonalis; and if it be followed by such a disease, it must be in consequence of particular circumstances which corrupt the purulent

purulent matter produced, render it unsuitable to the healing of the ulcer, and at the same time make it afford an acrimony, which, absorbed, produces a hectic fever and its consequences.

The corruption of the matter of such abscesses may be owing to several causes; as, 1. That the matter effused during the inflammation had not been a pure serum fit to be converted into a laudable pus, but had been joined with other matters which prevented that, and gave a considerable acrimony to the whole. Or, 2. That the matter effused and converted into pus, merely by long stagnation in a vomica, or by its connexion with an empyema, had been so corrupted as to become unfit for the purpose of pus in the healing of the ulcer. These seem to be possible causes of the corruption of matter in abscesses, so as to make it the occasion of a phthisis in persons otherwise sound; but it is probable that a pneumonic abscess especially produces phthisis when it happens to persons previously disposed to that disease, and therefore only as concurring with some other causes of it.

3. The third cause supposed to produce a phthisis is a catarrh; which, in many cases, seems in length of time to have the expectoration of mucus proper to it gradually changed to an expectoration of pus; and at the same time, by the addition of a hectic fever, the disease, which was at first a pure catarrh, is changed into a phthisis. But this supposition is, in the opinion at least of some physicians, liable to several difficulties. The catarrh is properly an affection of the mucous glands of the trachea and bronchiæ, analogous to the coryza and less violent kinds of cynanche tonsillaris, which very seldom end in suppuration. And although a catarrh should be disposed to do so, the ulcer produced might readily heal up, as it does in the case of a cynanche tonsillaris; and therefore should not produce a phthisis.

Farther, The catarrh, as purely the effect of cold, is generally a mild disease as well as of short duration; and, according to Dr Cullen, there are at most but very few of the numerous cases of it, which can be said to have ended in a phthisis. In all these cases in which this seems to have happened, he thinks it probable that the persons affected were peculiarly predisposed to phthisis; and the beginning of phthisis so often resembles a catarrh, that it may have been mistaken for such a disease. It often happens also, to increase the fallacy, that the application of cold, which is the most frequent cause of catarrh, is also frequently the exciting cause of the cough, which proves to be the beginning of a phthisis.

Many physicians have supposed that an acrimony of the fluids eroding some of the vessels of the lungs is a frequent cause of ulceration and phthisis; but this appears to Dr Cullen to be a mere supposition. He acknowledges, that in many cases an acrimony subsisting in some part of the fluids is the cause of the disease; but observes that it is at the same time probable, that this acrimony operates by producing tubercles, rather than by any direct erosion.

But notwithstanding these objections, experience affords numerous examples of cases in which a disease long subsisting under the form of catarrh has at last degenerated into phthisis, and proved fatal from supervening hectic fever. It must, however, at the same time be allowed, that catarrh, degenerating into a chronic state after subsisting for many years, has of itself often proved fatal without inducing phthisis.

4. If phthisis does not frequently follow catarrh, it is still more rarely a consequence of asthma. Innumerable examples are unquestionably afforded of that disease subsisting for many years without any symptom whatever of phthisis as a consequence of it. But at the same time, there are unquestionable examples of phthisis deriving its origin from asthma; which, however, probably happens only in cases where a peculiar state of the lungs at the same time takes place: But without the concurrence of asthma, this state would not of itself have been sufficient for inducing the affection.

5. Of all the causes formerly mentioned, phthisis most frequently arises from tubercles. Dr Simmons informs us, that he has had opportunities of inspecting the bodies of many people who died in this way, and never found them totally absent. He has likewise seen them in subjects of different ages, who had been troubled with no symptoms of an affection of the breast during their lifetime. In these, however, they were small, and few in number. This proves that they may exist without inconvenience till they begin to disturb the functions of the lungs by their size and number; or till some degree of inflammation be excited, either by accidental causes, or by certain changes that take place within their substance; for as yet we know but little of their true nature. These little tumors vary in their consistence; in some they are composed of a pulpy substance, and in others approach more to the nature of scirrhus. They are most commonly formed in consequence of a certain constitutional predisposition; but whatever is capable of occasioning a morbid irritability of the lungs seems also to be capable of generating them. Thus the spasmodic asthma frequently ends in tubercles and consumption; and it is not unusual for millers, stone-cutters, and others, to die consumptive, from their being so constantly exposed to dust, which in these cases probably acts by producing similar concretions: Dr Kirkland observes, that scythe-grinders are subject to a disease of the lungs, from particles of sand mixing with iron dust, which among themselves they call the *grinders rot*. Tubercles, however, in by much the greater number of instances, have their source from a scrophulous disposition; and some eminent physicians have supposed that the generality of pulmonary consumptions are of this kind. This notion, however, they have perhaps carried too far: they have probably been misled by those tuberculous concretions which, without good reason, have been supposed to be diseased glands, and of course analogous to the glandular affections we meet with in the scrophula. Tubercles may likewise sometimes be owing to the sudden repulsion of cutaneous eruptions, or of the matter of exanthemata, &c. or to other causes.

The persons who are most liable to consumption are those of a fair complexion, fine and soft skin, florid cheeks, and a slender make; with high cheek-bones, hollow temples, long neck, shoulders standing out like wings, narrow chest, and a remarkable prominence of the processes of the os sacrum. To these marks we may add, that of *sound teeth*, which, as the disease advances, Hæmorrhagiæ. vances, usually become of a milky white colour, and more or less transparent. Of those who are carried off by this disease, Dr Simmons asserts, the greater number will be found never to have had a carious tooth. This circumstance, however, does not seem to us to hold so generally as Dr Simmons is disposed to imagine: and instances not unfrequently occur of patients dying of phthisis, although they have had many teeth subjected to caries; and some of these beginning even at an early period of life.

Persons of the above description often remain for a long time without feeling any other inconvenience than some oppression at the breast in moist weather, or in hot apartments. Their breathing is easily hurried, sometimes by the slightest motion; and they become languid, paler, and thinner. All this time, however, they feel no heat or painful sensation in the breast. As the evil increases, the patient begins to be attacked with a slight, frequent, and dry cough, which is most troublesome in the night-time. But this, by proper care, is often relieved; and the patient remains in this state for a considerable time, and even for many years, if he be sensible of his danger, and careful to guard against it by a suitable manner of living. More commonly, however, we find the cough increasing, and sometimes accompanied with more or less catarrh. This is usually ascribed to cold; and but too generally neglected, till the disease become alarming by its obstinacy and its effects. This may be considered as the *beginning*, or first period, of the disease. During this stage, the cough is sometimes dry from the first; and sometimes, when it begins in the form of a catarrh, is attended with more or less expectoration of mucus.

When the cough begins in the form of a catarrh, and appears to be occasioned by an increased secretion of a thin saltish mucus irritating the membrane of the trachea, all judicious practitioners agree in recommending an attention to regimen, the free use of diluting liquors, bland emulsions, small doses of nitre, the taking away a few ounces of blood if there be much inflammation, the inhaling the steams of warm water by means of the machine contrived for that purpose, and the occasional use of such a dose of elixir paregoricum as will be sufficient to allay the irritation of the bronchiæ, and to promote a gentle moisture on the skin. These methods will generally be found to be efficacious, especially if the patient's chamber be of a moderate temperature, and he carefully avoid exposure to a cold, damp, or raw air, till the complaint be removed. In cases in which the cough has been obstinate, and the inflammatory symptoms considerable, Dr Simmons has often experienced the great advantages of the warm bath, the heat of which did not exceed 92°. When this is had recourse to, the patient should remain in it only a very few minutes, and go soon afterwards to bed; but not with a view to force a sweat by an increased weight of bedclothes, as is too often injudiciously practised.

Patients of a consumptive habit, who have had an attack of this kind at the beginning of winter, are particularly liable to a return of the complaint during the continuance of the cold season, on the slightest occasion and with greater violence. A relapse is therefore to be carefully guarded against; and nothing will be found to do this more effectually than the use of socks and a flannel under-waistcoat. The use of flannel has been condemned by several medical writers as increasing the insensible perspiration; but in the present case, to say nothing of some others in which it may be useful, it will in general be found to have the best effects. It will prevent a too great determination to the lungs, and should not be left off till the approach of summer. In some few instances in which flannel was found to have a disagreeable effect, a piece of dimity, worn over the breast next the skin, will prevent the return of colds and coughs in persons of a delicate habit, who had before been liable to them on the slightest occasions. Shirts made of cotton cloth are much more effectual than linen in preserving an equable temperature of the surface, and guarding against the action of external cold; while at the same time they are much more pleasant to most people than even the finest flannel. In these cases, circumstances that are seemingly of the most trifling nature become of importance.

Phthisis. Sometimes the cough is occasioned by an immediate inflammation of some part of the lungs, from some of the usual causes of inflammation; and when this happens, no time is to be lost in removing it. To do this will perhaps require more than one bleeding, together with a strict attention to a cooling plan of diet, diluting drinks, the inhalation of warm steams, and if convenient, the use of the warm bath; but above all, the speedy application of a large blister as near as may be to the supposed seat of the inflammation. The cough, in this case, will often remain after the original complaint is abated. A prudent use of opiates at bedtime, either by themselves or combined with gummy and mucilaginous medicines, will then generally be useful as a sedative and antispasmodic.

In this, as well as in the catarrhal cough just now mentioned, many practitioners are too eager to administer cinchona, with the view, as they term it, of *bracing* up the patient: but this never fails to increase the cough, and of course to do great and very irreparable mischief.

And here it will not be foreign to our subject to observe, that a symptomatic cough, which has its rise not from catarrh, or from an immediate inflammation of the lungs, but from their sympathy with the stomach, has sometimes laid the foundation of phthisis, from its having been mistaken, and of course improperly treated. It seems to be owing to a redundancy or vitiated state of the bile, or to some affection of the stomach, which it is perhaps not easy to define. It is sometimes a concomitant of other bilious symptoms; and when this happens to be the case, it cannot easily be mistaken; but we sometimes find it occurring singly, and in general attacking persons of a sedentary life. Dr Stoll of Vienna, who has noticed this cough, has very properly given it the name of *tussis stomachica*. This complaint is so far from being relieved by bleeding, that it constantly grows worse after it, especially if the evacuation be in any considerable quantity. The oily remedies seldom fail to exasperate this cough, which at first is dry, frequent, and often extremely violent, but which seldom fails to give way to one or two gentle pukes, and the occasional use of mild cathartics. The cough, as in other cases, often continues from habit after the cause that

that gave riſe to it has been removed, and may then be checked by opiates.

When the diſeaſe has been neglected, or our attempts to remove it in the beginning have failed, both of which circumſtances but too frequently happen, the patient begins to complain of a ſoreneſs, and of ſlight lancinating pains ſhooting through the breaſt, ſometimes in the direction of the mediaſtinum, and ſometimes confined chiefly to one ſide. The ſoreneſs is pretty conſtant, and much increaſed by the cough. The pain in the ſide often prevents the patient from lying on the ſide affected; and this inability of lying, except on one ſide, frequently occurs even when no ſuch pain is felt. In this ſtage of the diſeaſe, fluſhing heats are felt in the palms of the hands and ſoles of the feet: the breathing is ſhort and laborious; and it is not long before the patient begins to expectorate a thin and frothy phlegm, at firſt in ſmall quantities, coughed up with difficulty, and ſome pain of the breaſt, and now and then ſtreaked with blood: this may be conſidered as the *inflammatory period* of the diſeaſe, to which ſucceeds the *ſuppurative ſtage*. In the latter, the expectoration becomes more copious and purulent, the breath proportionably offenſive, and the exacerbations of the hectic fever more conſiderable: an increaſed quickneſs of the pulſe comes on about the middle of the day; but the moſt conſiderable paroxyſm of the fever is at night, and at firſt continues till towards morning, commonly till three or four o'clock, when it terminates in a ſweat, which uſually begins upon the breaſt. As the diſeaſe advances, theſe ſweats become more profuſe, and ſometimes come on almoſt as ſoon as the pulſe begins to quicken, but without affording any relief to the patient. During the exacerbations, we obſerve a circumſcribed redneſs of the cheeks, while the reſt of the face is pale, and appears as if it were not clean waſhed. The coſtiveneſs that commonly accompanies the beginning of the diſeaſe is uſually ſucceeded by a diarrhœa; the ſpitting leſſens, and all the purulent matter ſeems to be carried downwards. The waſting of the fat and the loſs of nouriſhment occaſion the nails to curve inwards, the hair to fall off, and the eyes to ſink in their ſockets. In the mean time, the legs commonly ſwell; till at length death cloſes a ſcene which is melancholy to all but the patient himſelf, who in general continues ſenſible to the laſt moment, and even then indulges a vain hope of prolonging a miſerable exiſtence. In ſome caſes, and that not unfrequently, a delirium comes on towards the cloſe of the diſeaſe.

The hectic fever that attends this and ſome other chronic diſeaſes, is evidently the effect of acrimony, and moſt commonly of pus abſorbed and carried into the circulation. The nature of this acrimony, and the different irritability of different patients, are probably the ſources of the variety we obſerve in fevers of this denomination; a variety which is doubtleſs much greater than we are aware of. Thus we find that the matter of the ſmallpox excites a fever of this kind; but this *ſecondary fever*, as it is called, differs from the hectic attendant on conſumptions; nor does the latter correſpond with that which ſometimes accompanies the ſuppuration of a cancerous ulcer. In the pulmonary conſumption, or at leaſt in the third ſtage of it, the fever induced often appears to be of the putrid kind, and has been denominated *febris hectica putrida* by the judicious Morton, who conſiders it as being combined with a peripneumonic or inflammatory fever, which recurs as often as freſh tubercles begin to inflame. For although we have named one period of the diſeaſe the *inflammatory*, and another the *ſuppurative period*, yet we are not to ſuppoſe that the latter is exempt from inflammation. While matter is poured into the bronchiæ, or abſorbed and carried into the ſyſtem from one part of the lungs, other parts are in a crude ſtate of inflammation, or advancing towards ſuppuration; ſo that, on examining the lungs of perſons who die conſumptive, we find ſome tubercles that are ſmall and juſt formed, ſome that are large and full of matter, and others that are in a ſtate of ulceration. This eaſily accounts for the occaſional combination of inflammatory ſymptoms with thoſe of the putrid hectic. When the matter abſorbed is a laudable pus, as in the caſe of the pſoas abſceſs, we find the form of the hectic fever differing from either of thoſe we have mentioned.

Cure. In theſe different periods of the diſeaſe, the curative indications are ſufficiently obvious. To prevent the formation of freſh tubercles; to obviate the inflammation of thoſe already formed; to promote their reſolution; to allay morbid irritability, the cough, and other troubleſome ſymptoms; and, above all, to check the tendency to the hectic ſtate, are the views that every rational phyſician propoſes to himſelf in the treatment of the genuine conſumption. We know of no medicines that can exert their ſpecific effects upon the lungs by diſſolving tuberculous concretions; nor is it probable, from what we know of the animal economy, that any ſuch will ever be diſcovered. Yet medicines that operate in a general manner upon the ſyſtem, may, by promoting abſorption, and diminiſhing the determination to the lungs, tend to diſperſe tubercles, or to prevent their formation. There are not wanting inſtances of wonderful recoveries, in caſes where the evil was ſuppoſed to be beyond the power of phyſic; and in ſome, where nature was left to herſelf; ſo that a phyſician who has obſerved the various and powerful reſources nature has within herſelf, will be very cautious how he aſſerts that a diſeaſe is incurable.

The moſt formidable effects of ulcerated lungs are the abſorption and conſequent hectic. It ſeems evident, that, in many caſes, death is brought on by this, rather than by the lungs themſelves being rendered unfit for the purpoſes of reſpiration. So that if we can obviate the effects of the abſorption, diminiſh the preternatural determination to the lungs, and fulfil the other general indications juſt now mentioned, we may very often enable nature to recover herſelf. It may be alleged indeed, that the phyſicians art has hitherto proved very unſucceſsful in theſe caſes; but may not this be owing to the remedies that are employed being very often ſuch as are inimical to the cure?

The cinchona is, perhaps, the moſt commonly employed of any, and often confided in as an ultimate reſource in theſe caſes. But beſides this, the ſulphuric acid, the balſams, and frequent bleedings, have each had their partizans. The uſe of bliſters and iſſues, opiates, a milk and vegetable diet, exerciſe, and change of air, are pretty generally recommended by all. Concerning cinchona, Deſſault long ago obſerved, that it had been productive

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productive of great mischief in consumptive cases; and Dr Fothergill, in a paper lately published by him on this subject, very judiciously remarks, that it is so far from curing the hectic fever arising from distempered lungs, that according to the best of his observations, it not only takes up that time which might probably have been better employed in the use of other medicines, but for the most part aggravates the disease beyond remedy. Indeed it has been the opinion of several attentive observers, that, whenever pus or any kind of matter excites an hectic fever, by being absorbed and carried into the circulation, the cinchona will never fail to exasperate the complaint, especially if it be accompanied with any degree of inflammatory diathesis, unless the matter has a free outlet from the system; as in the case of abscesses, for instance, in which we often find it productive of excellent effects. It is likewise well known to be used as a tonic, to obviate the effects of fluor albus, or any other immoderate evacuation in delicate persons, which, by enfeebling the system, very often lays the foundation of phthisis: but the moment we have reason to suspect that the lungs are ulcerated, especially if this ulceration be attended with an inflammatory disposition; or if the separation of vitiated pus be the consequence of a peculiar increased morbid action of the vessels at the part, it ought to be laid aside; and in the genuine tuberculous consumption, perhaps, it is rarely admissible.

Dr Fothergill, however, observes, that there are two causes of consumption, which often produce symptoms so similar to those of the genuine phthisis, as sometimes to have led him to make use of cinchona, in apparent tendencies to a genuine pulmonary consumption, with advantage.

One of the causes is, the suckling of children longer than is consistent with the mother's ability. This case frequently occurs among the middling and lower classes of females, of constitutions naturally delicate and tender. In such a state of weakness, some slight cold brings on a cough, which increases gradually, till at length it produces the true pulmonary consumption. Here cinchona given early, in moderate doses, and merely as a tonic remedy, is often of excellent use.

Another cause, is any weakening discharge, either from abscesses, the greater operations of surgery, a copious and constant *fluor albus*, or similar enfeebling evacuations. That cinchona is, for the most part, of use in these cases, when the lungs are not inflamed, is indubitable; and if they be so affected, but not beyond a certain degree, it is also efficacious in preventing the progress of the consumption.

In phthisical complaints succeeding such situations, a prudent trial of cinchona seems necessary. Small doses of the decoction, either alone, or joined with the saline mixture or such other additions as the physician thinks proper, may be given. But if the breath becomes more tight and oppressed, the cough dry, the pulse more quick and hard, and especially if slight transitory pains or stitches about the thorax are more frequently complained of, a perseverance in the use of cinchona will increase the disease. If such also should be the appearances in the progress of the disease, or, from whatever cause, if cinchona be accompanied with such effects, the use of it ought to be withheld.

If, on the other hand, no pain, tightness, or oppression, is perceived, and there appear a manifest abatement of the symptoms, it will be advisable to proceed. The administration of this medicine, however, requires a judicious observer; and it ought neither to be given in the early inflammatory stage of this disease, nor be continued in any subsequent period, if it produce the effects above mentioned.

By its tonic virtues it will often enable nature to conquer many difficulties. In confirmation of this remark, Dr Fothergill farther observes, that he has seen it of use in promoting expectoration, when this became deficient from want of strength towards the end of peripneumonic fevers; but that it stops this discharge, changes slight wandering pains into such as are fixed, and increases them with all their consequences, in a variety of cases.

The elixir of vitriol, or the sulphuric acid properly diluted, though in many instances a highly useful remedy, is often exhibited in consumptive cases with no less impropriety than cinchona. This medicine, from its astringency, is obviously improper in the inflammatory state of the disease. But in the latter stage, when a general tendency to putrefaction takes place, it is serviceable in resisting the effect; it restrains the colliquative sweats; and if the lungs be not injured past reparation, it is allowed to be a very useful auxiliary.

Various are the opinions concerning the efficacy of Bristol water in this disease. The experienced author last mentioned informs us, that he has seen many persons recover from pulmonary diseases after drinking these waters, whose cure seemed to be doubtful from any other process; and he thinks this circumstance, added to the general reputation of Bristol waters in phthisical cases, affords sufficient inducement to recommend the trial of them in the early stages of such complaints. It is, however, before the approach of a confirmed phthisis that patients ought to repair to Bristol; otherwise a journey thither will not only be without benefit, but may even prove detrimental.

Some have imagined, that the journey, a better air, change of situation and of objects, have contributed to the patient's recovery; and these may doubtless be of advantage. It seems, however, that the water drank fresh at the pump, actually contains principles conducive to the recovery of patients affected with phthisical complaints. It seems to possess a slight calcareous stypticity, and perhaps the air it contains may also have an antiseptic quality. On the whole, it appears to be an efficacious medicine, and is often found of remarkable benefit to consumptive patients.

Change of air, particularly from bad to good, is of great consequence to all chronic diseases of the lungs. In consumptive cases, the air of all large cities is found to be particularly injurious.

A sea voyage has been much recommended in the cure of this disease. The benefit of exercise has also been strongly urged by many writers; but, however salutary when properly used, it certainly ought to be regulated with discretion. Dr Dickson declares himself of opinion, that riding on horseback in consumptive cases is most commonly hurtful, without such regulations as

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Exercife on horfeback feems to be chiefly beneficial in thofe cafes where confumption is a fecondary difeafe. For example, in the nervous atrophy; in the hypochondriacal confumption; or when it is the effect of long-continued intermittents, or of congeftions in any of the abdominal vifcera; or, in a word, whenever the confumption is not attended with an inflamed or ulcerated ftate of the lungs, long journeys on horfeback will be beneficial. Such a practice may likewife be highly ufeful in obviating an attack of phthifis, or in carrying off a dry hufky cough in a perfon of a confumptive habit, when there is reafon to fuppofe that no tubercles are as yet formed. On the other hand, in the confirmed phthifis, when the lungs are inflamed or ulcerated, much or violent exercife will be improper; and there have been inftances where the death of the patient was evidently accelerated by it. The exercife therefore fhould be gentle, proportioned to the ftrength of the patient, and employed only in the morning. In fine weather, an eafy open carriage is perhaps the moft eligible, not only on account of its being open to the air, but becaufe it affords that kind of agitation which is moft wanted in thefe cafes. For if we confider the different modes of exercife, we fhall find that walking, though the beft exercife in health, as it employs the moft mufcles, is the worft for the fickly, who fhould have the benefit of exercife without fatigue. Riding on horfeback agitates the vifcera more than walking, and is therefore preferable to it in many chronic difeafes; but when a preternatural determination to the lungs has taken place, it will be liable to increafe the evil, and may likewife be hurtful by the fatigue that attends it. For thefe reafons it will be prudent to begin with a carriage; and if the patient gain ftrength, and the difeafe abates, recourfe may afterwards be had to horfe-exercife.

The gentle motion of a coach has been often found of great utility in pulmonary complaints. Its efficacy feems to depend chiefly on its increafing the determination to the furface of the body. The naufea which this motion excites in fome perfons is an effect of this increafed determination. It has therefore been found beneficial in hæmoptyfis; and Dr Simmons mentions the cafe of a lady, who, after trying various remedies to no purpofe, was cured of this complaint by travelling feveral hundred miles through different parts of England in her own coach. At firft, whenever fhe remained three or four days in any place, the diforder began to return again; but at length by perfevering in her journeys, it gradually went off. Deffault, who practifed at Bourdeaux about 40 years ago, tells us, he fent feveral confumptive patients to Bareges, and with good fuccefs; but that in thefe cafes his reliance was not fo much upon the Bareges waters, as upon the motion of the carriage and the change of air in a journey of more than 100 leagues.

Phthifis. It is now pretty generally acknowledged, that the good effects of fea voyages in confumptive cafes depend more upon the conftant and uniform motion of the fhip, than upon any particular impregnation of the fea air; although this from its coolnefs and purity may likewife be of great ufe, efpecially in the hot months, when fea voyages are generally undertaken by confumptive patients. The ancients were no ftrangers to this remedy; and amongft the Romans it was no unufual thing for confumptive perfons to fail to Egypt. Pliny obferves, that this was done not for the fake of the climate, but merely on account of the length of the voyage.

Many of our Englifh phyficians have recommended a voyage to Lifbon in thefe cafes. When this is done, the proper feafon of the year fhould be carefully attended to. Dr Simmons knew a gentleman who went thither with fymptoms of incipient phthifis, and who experienced fome relief during the courfe of the voyage; but happening to arrive at Lifbon at the beginning of the rainy feafon, the difeafe was foon greatly increafed, and terminated fatally.

Another fpecies of motion has of late been extolled as highly ufeful in confumptive cafes. Dr James Carmichael Smyth of London, has lately publifhed an account of the effects of fwinging, employed as a remedy in the pulmonary confumption and hectic fever. In this treatife Dr Smyth contends, that fea air, in place of being of advantage, is conftantly prejudicial to hectic and confumptive patients, and even to thofe who have a tendency to fuch complaints. He thinks, therefore, that the benefit derived from fea voyages muft certainly be referred to fome other caufe. In ftating his fentiments on this fubject, he attempts to eftablifh a diftinction between exercife and motion. By exercife, he underftands mufcular action, or the exertion of the locomotive powers of the body either alone or combined. This he reprefents as increafing the force and frequency of the heart's contraction, the velocity and momentum of the blood, the quicknefs of breathing, the heat, the irritability, and the tranfpiration of the whole body. By motion, in contradiftinction to exercife, he means fuch motion as is not neceffarily accompanied with any agitation or fucceffion of the body, and which is totally independent of any mufcular exertion. The effects of this, both on the heart, the lungs, and indeed on the fyftem in general, he confiders as of the fedative kind; thus it fufpends the action of coughing, and leffens the frequency of the pulfe. He is, therefore, led to refer the good effects of fea voyages entirely to this caufe. And on thefe grounds he was led to conclude, that the motion given by fwinging might be of equal if not greater fervice. This conclufion, we are told, in the treatife above alluded to, experience in many cafes

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cases has fully confirmed; and he recommends it as a mode of cure which may be employed with advantage in every ſtage of phthiſis. While, however, the reaſoning of Dr Smyth on this ſubject ſeems to be liable to many objections, we are ſorry to add, that his obſervations in practice have by no means been confirmed by thoſe of others, who have had recourſe to this mode of cure.

The beſt adapted diet in conſumptive caſes is milk; the milk of aſſes, both as an article of diet and as a medicine, has in particular been highly extolled. It may however be remarked, that there are conſtitutions in which this ſalutary nutriment ſeems to diſagree. A propenſity to generate bile, or too ſtrong a diſpoſition to aceſcency from a weakneſs of the digeſtive organs, both merit attention. Whey, either from cows or goats milk, appears to be more ſuitable in the former caſe; and for correcting acidity, lime water may be added to the milk. The method of adding rum or brandy to aſſes or cows milk, ſhould be uſed with great caution: for when added beyond a certain quantity, as is often the caſe, they not only coagulate the milk, but heat the body; by which means the milk diſagrees with the patient, and the ſpirit augments the diſeaſe.

In conſumptive caſes, Dr Simmons obſerves, that the patient's taſte ſhould be conſulted; and ſays that a moderate uſe of animal food, where the ſalted and high-ſeaſoned kinds are avoided, is not to be denied. Shell-fiſh, particularly oyſters, are uſeful, as well as ſnails ſwallowed whole, or boiled in milk.

Repeated bleedings, in ſmall quantities, are by ſome conſidered in conſumptive caſes as highly advantageous: and in particular circumſtances they undoubtedly are ſo; for inſtance, when the conſtitution apparently abounds with blood; when the fluid drawn off is extremely ſizy; when there is much pain in the breaſt; and when veneſection is followed by an abatement of every ſymptom. In theſe caſes, bleeding is certainly proper, and ought to be repeated ſo long as it ſeems to be attended with advantage. In very delicate conſtitutions, however, even where the pulſe is quick, with ſome degree of fulneſs, and the blood laſt drawn conſiderably ſizy, it may not prove ſerviceable.

It deſerves to be remarked, that the inflammatory appearance of the blood is not alone a ſufficient reaſon for bleeding; but, in determining the propriety of this evacuation, all other circumſtances ſhould be conſidered; ſuch as the patient's age, ſtrength, habit, and the ſtate of the diſeaſe.

A remark which has been judiciouſly made by Dr Fothergill, ought not to be omitted in the account of this diſeaſe. It is, that young delicate females, about the age of 15 or 16, and upwards, are often ſubject to conſumptions. When the diſeaſe has advanced conſiderably, the *menſes*, if they have made their appearance, moſt generally ceaſe. This alarms their female friends, and they call upon the phyſician to uſe his utmoſt endeavours for reſtoring the diſcharge; believing the ceſſation of it to be the immediate cauſe of the phthiſical complaint. Induced by their ſolicitations, medicines have ſometimes been adminiſtered, which, without obtaining this end, have tended to aggravate the diſtemper. This deficiency is often of no real diſadvantage in thoſe caſes; and in many the evacuation would prove injurious, by diminiſhing the ſtrength, which is already too much impaired. Even ſmall bleedings at the regular periods have often done more harm than good. A ſudden ſuppreſſion may require bleeding; but when the evacuation fails through want of ſtrength, and from poverty of blood, the renewal of it increaſes the diſeaſe.

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Beſides theſe remedies, Dr Simmons ſtrongly recommends a frequent repetition of vomits. Many phyſicians have ſuppoſed, that where there is any increaſed determination to the lungs, vomits do miſchief: but Dr Simmons is perſuaded, that inſtead of augmenting, they diminiſh this determination; and that much good may be expected from a prudent uſe of this remedy, than which none has a more general or powerful effect on the ſyſtem. If any remedy be capable of diſperſing a tubercle, he believes it to be emetics. The affections of the liver, that ſometimes accompany pulmonary complaints, give way to repeated emetics ſooner than to any other remedy. In ſeveral caſes where the cough and the matter expectorated, the fluſhing heats, loſs of appetite, and other ſymptoms, threatened the moſt fatal event; the complaints were greatly relieved, and in others wholly removed, by the frequent uſe of emetics. Other ſuitable remedies were indeed employed at the ſame time; but the relief the patients generally experienced after the emetic, was a ſufficient proof of its ſalutary operation. By this, however, he does not mean that vomits will be uſeful in every period of the diſeaſe, or in every patient. In general, it will be found that the earlier in the diſeaſe emetics are had recourſe to, the more likely they will be to do good, and the leſs likely to do harm. The caſes in which emetics may be reckoned improper, are commonly thoſe in which the diſeaſe is rapid in its progreſs; or in that ſtage of it when there is great debility, with profuſe colliquative ſweats.

In theſe caſes, when an emetic has been adminiſtered twice a-week, and the cough is mitigated, the expectoration facilitated, and the other ſymptoms relieved, both the patient and the phyſician will be encouraged to proceed, and to repeat the vomit every ſecond day, or even every day, for ſeveral days together, as Dr Simmons has ſometimes done when the good effects of it were obvious.

The choice of emetics to be employed in theſe caſes is by no means a matter of indifference. Carduus tea, chamomile tea, warm water, and others that act by their bulk, and by exciting nauſea, relax the tone of the ſtomach when they are frequently repeated, and of courſe will be improper. More active emetics are therefore to be preferred; and here ſome of the preparations of antimony might naturally be thought of. But the operation of theſe is not confined to the ſtomach. They produce evacuations by ſtool, and a diſpoſition to ſweat; and are therefore improper in the pulmonary hectic. The mildneſs and excellence of ipecacuanha as an emetic, are well known; but in theſe caſes, Dr Simmons has often employed the ſulphate of copper, concerning the effects of which we meet with ſome groundleſs aſſertions in ſeveral medical books. Its operation is confined to the ſtomach; it acts almoſt inſtantaneouſly; and its aſtringency ſeems to obviate the relaxation that is commonly ſuppoſed to attend the frequent uſe of emetics. In two caſes

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he experienced its good effects, after vomits of ipecacuanha had been given ineffectually. It should be administered in the morning, and in the following manner:

Let the patient first swallow about half a pint of water, and immediately afterwards sulphate of copper dissolved in a cupful of water. The dose of it must be adapted to the age and other circumstances of the patient, and may be varied from two grains to ten, fifteen, or twenty. As some persons are much more easily puked than others, it will be prudent to begin with a small dose: not that any dangerous effects will be produced by a large one, for the whole of the medicine is instantly rejected; but if the nausea be violent, and of long continuance, the patient may perhaps be discouraged from repeating it. In general, the moment the emetic has reached the stomach it is thrown up again. The patient must then swallow another half pint of water, which is likewise speedily rejected; and this is commonly sufficient to remove the nausea.

Dr Marryat, in his *New Practice of Physic*, prescribes with great freedom what he calls the *dry vomit*, from its being directed to be taken without drinking. This medicine consists of sulphate of copper and tartrite of antimony. It has the benefit also of producing instantaneous operation; but it is more apt to excite nausea than the sulphate of copper alone, and is liable to some of the objections stated to antimonial emetics.

Another remedy which Dr Simmons strongly recommends in consumptive cases, both from his own observation, and on the authority also of many other eminent practitioners, is gum-myrrh. This given by itself to the extent of a scruple or half a drachm for a dose, two or three times a-day, or, if there be much inflammatory tendency, combined with a proportion of nitre or of cream of tartar, has often been serviceable in cases which were apparently instances of incipient phthisis even of the tuberculous kind. But when the disease is far advanced, or even decidedly marked, as far as our experience goes it has rarely been productive of any benefit.

Besides the use of internal remedies in pulmonary affections, physicians have often prescribed the smoke of resinous and balsamic substances to be conveyed into the lungs. The vapour of sulphuric ether, dropt into warm water, has likewise been used in these cases. The inhaling of fixed air has also been spoken of as an useful practice. Dr Simmons has seen all these methods tried at different times; but without being able to perceive any real advantages from them in the suppurative stage of the disease, where they might be expected to be of the greatest use; and in the beginning he has often found the two first to be too stimulating. He therefore preferred the simple vapour of warm water, and has experienced its excellent effects in several instances; but when the complaint has made any considerable progress, its utility is less obvious; and when the patients have been much weakened, he has seen it bring on profuse sweats, especially when used in bed, and therefore he generally recommended it to be used in the day time. Formerly he made use of a fumigating machine, described in the Gentleman's Magazine for 1748, in which the air, inspired by the patient, is made to pass through hot water by means of a tube that communicates with the external air, and with the bottom of the vessel: but we have now a more elegant, and, on account of the valve and mouth-piece, a more useful instrument of this kind, the inhaler, invented by the ingenious Dr Mudge.

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Another remedy recommended by some as a specific in consumptions is the earth-bath. Van Swieten, in his Commentaries on Boerhaave, tells us, from the information of a person of credit, that in some parts of Spain they have a method of curing the phthisis pulmonalis by the use of this remedy; and he quotes the celebrated Solano de Luque in confirmation of this practice. Solano speaks of the *banos de tierra*, or earth-baths, as a very old and common remedy in Granada and some parts of Andalusia, in cases of hectic fever and consumptions; and relates several instances of their good effects in his own practice. The method he adopted on these occasions was as follows: He chose a spot of ground on which no plants had been sown, and there he made a hole large and deep enough to admit the patient up to the chin. The interstices of the pit were then carefully filled up with the fresh mould, so that the earth might everywhere come in contact with the patient's body. In this situation the patient was suffered to remain till he began to shiver or felt himself uneasy; and during the whole process, Solano occasionally administered food or some cordial medicine. The patient was then taken out, and, after being wrapped in a linen cloth, was placed upon a mattress, and two hours afterwards his whole body was rubbed with an ointment, composed of the leaves of the *solanum nigrum* and hog's lard. He observes, that a new pit must be made every time the operation is repeated; and advises the use of these baths only from the end of May to the end of October. Dr Fouquet, an ingenious French physician, has tried this remedy in two cases. In one, a confirmed phthisis, he was unsuccessful; but the remedy had not a fair trial. The patient, a man 30 years of age, had been for several months afflicted with cough, hectic fever, and profuse colliquative sweats. He was first put into the earth in the month of June; but soon complained of an uneasy oppression at his stomach, and was removed at the end of seven minutes. The second time he was able to remain in it half an hour, and when taken out was treated in the way prescribed by Solano. In this manner the baths were repeated five times, and the patient was evidently relieved; but having conceived a dislike to the process, he refused to submit to any further trials, and died some months afterwards. In the second case he was more fortunate: the patient, a girl 11 years of age, had been for three months troubled with a cough brought on by the measles, which was at length attended with a purulent expectoration, hectic fever, and night sweats. She began the use of the earth-bath in August, and repeated it eight times in the space of 20 days. At the end of that time the fever and disposition to sweat had entirely ceased, and by the use of the common remedies the patient was perfectly restored. A physician at Warsaw has likewise prescribed the earth-bath with good success in cases of hectic fever. The Spaniards confine it entirely to such cases; but in some other parts of the world we find a similar method employed as a remedy for other diseases, and particularly for the sea-scurvy. Dr Priestley observes, that the Indians, he has been told, have

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a custom of burying their patients labouring under putrid diseases up to the chin in fresh mould, which is also known to take off the fœtor from flesh meat beginning to putrefy. The rancidity of a ham, for example, may be corrected by burying it for a few hours in the earth. The efficacy of this remedy in the sea scurvy has, it is said, frequently been experienced by the crews of our East India ships.

Solano, who is fond of philosophizing in his writings, is of opinion, that the earth applied in this way absorbs the morbid taint from the system; but does it not seem more probable, that the effluvia of the earth, by being absorbed and carried into the circulation, correct the morbid state of the fluids, and thus are equally useful in the sea scurvy and in the pulmonary hectic? That the earth when moistened does emit a grateful odour is a fact generally known; and Baglivi long ago gave his testimony in favour of the grateful effects of the effluvia of fresh earth. He ascribes these good effects to the nitre it contains.

The earth-bath, both in consumptive cases and likewise in a variety of other affections, has of late been extensively employed in Britain by a celebrated empiric. But, as far as we can learn, in most cases it produced to the patient a very distressing sensation of cold; in some, it seemed to be productive of bad effects, probably in consequence of this cold; and we have not heard of any consumptive cases in which good effects were decidedly obtained from it.

With regard to the drains, such as blisters, issues, and setons, which are so frequently recommended in pulmonary complaints, there is less danger of abuse from them than from the practice of venesection. The discharge they excite is not calculated to weaken the patient much; and the relief they have so often been found to afford, is a sufficient reason for giving them a trial. Blisters, as is well known, act in a twofold manner; by obviating spasm, and producing revulsion: Issues and setons act chiefly in the latter of these two ways; and in this respect their effects, though less sudden and less powerful at first, are more durable from the continuance of the discharge they occasion. It is perhaps hardly necessary to remark, that, if much service is to be expected from either of these remedies, they should be applied early in the disease. The ingenious Dr Mudge, who experienced the good effects of a large scapulary issue on his own person, very properly observes, that the discharge in these cases ought to be considerable enough to be felt. But it is seldom possible for us to prevail on the delicate persons, who are most frequently the victims of this disease, to submit to the application of a caustic between the shoulders. The discharge produced by a seton is by no means inconsiderable; and as in these cases there is generally some part of the breast that is more painful or more affected by a deep inspiration than the rest, a seton in the side, as near as can be to the seat of the pain, will be an useful auxiliary. Dr Simmons has seen it evidently of great use in several cases.

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GENUS XXXVIII. HÆMORRHOIS.

HÆMORRHOIDS, or *PILES*.

Hæmorrhois, *Sauv.* gen. 217. *Lin.* 192. *Sag.* gen. 182.
Hæmorrhoidalis fluxus, *Hoffm.* 219.
Hæmorrhoides, *Junck.* 11. et 12.
Leucorrhois, *Vog.* 112.

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Sp. I. *External PILES.* 241

Var. A. *Bloody PILES.*

Hæmorrhois moderata, *Sauv.* sp. 1.
Hæmorrhoides ordinatæ, *Junck.* 11.
Hæmorrhoides nimiæ, *Junck.* 11.
Hæmorrhois immodica, *Sauv.* sp. 2.
Hæmorrhoides excedentes, *Alberti* de hæmorrhoid. p. 179.
Hæmorrhois polyposa, *Sauv.* sp. 3.

Var. B. *Mucous PILES.*

Hæmorrhoides decoloratæ, albæ, et mucidæ, *Junck.* 13. *Alberti*, p. 248.

Sp. II. The *PILES* from a *Procidentia Ani.* 242

Hæmorrhois ab exania, *Sauv.* sp. 4.

Sp. III. The *Running PILES.* 243

Sp. IV. The *Blind PILES.* 244

Hæmorrhoides cœcæ, *Junck.* 12. *Alberti*, p. 274.

Description. The discharge of blood from small tumors on the verge of the anus constitutes what is called the *hæmorrhoids* or *piles*. They are distinguished into the *external* and *internal*, according to the situation of the tumors, either without or within the anus. Sometimes, however, these tumors appear without discharging any blood; and in this case they are called the *hæmorrhoides cœcæ*, or *blind piles*. Sometimes the disease appears without the verge of the anus in distinct separate tumors; but frequently only one tumid ring appears, seeming as it were the anus pushed without the body. Sometimes these tumors appear without any previous disorder of the body: but more frequently, before the blood begins to flow, and sometimes even before the tumors are formed, various affections are perceived in different parts of the body; as headach, vertigo, stupor, difficulty of breathing, sickness, colic pains, pain of the back and loins, and frequently a considerable degree of pyrexia; while along with these symptoms there is a sense of fulness, heat, itching, and pain, in and about the anus. Sometimes the disease is preceded by a serous discharge from the anus; and sometimes this serous discharge, accompanied with swelling, seems to come in place of the discharge of blood, and to relieve the above-mentioned disorders of the system. This serous discharge hath therefore been named the *hæmorrhois alba*.

In this disease the quantity of blood discharged is different upon different occasions. Sometimes it flows only when the person goes to stool, and commonly follows the discharge of fæces. In other cases it flows without any discharge of fæces; and then generally in consequence of the disorders above mentioned, when it is also commonly in larger quantity. This is often very considerable; and, by the repetition, so great, that we could hardly suppose the body to bear it but with the

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the hazard of life. Indeed, though rarely, it has been so great as to prove suddenly fatal. These considerable discharges occur especially to persons who have been frequently liable to the disease. They often induce great debility, and frequently a leucophlegmatia or dropsy which proves fatal. Sometimes the tumors and discharges of blood in this disease recur exactly at stated periods. In the decline of life it frequently happens that the hæmorrhoidal flux, formerly frequent, ceases to flow; and in that case it generally happens that the persons are affected with apoplexy or palsy. Sometimes hæmorrhoidal tumors are affected with inflammation, which ends in suppuration, and gives occasion to the formation of fistulous ulcers in those parts.

The hæmorrhoidal tumors have often been considered as varices or dilatations of the veins; and in some cases varicous dilatations have appeared upon dissection. These, however, do not appear in the greater part of cases; and Dr Cullen is of opinion that they are usually formed by an effusion of blood into the cellular texture of the intestine near to its extremity. When recently formed, they contain fluid blood; but after they remain for some time they are usually of a firmer consistence, in consequence of the blood being coagulated.

Causes, &c. It would seem probable, that the hæmorrhoidal tumors are produced by some interruption of the free return of the blood from the rectum, by which a rupture of the extremities of the veins is occasioned. But considering that the hæmorrhage occurring here is often preceded by pain, inflammation, and a febrile state, and with many other symptoms which show a connection of the topical affection with the state of the whole system, it is probable that the interruption of the blood in the veins produces a considerable resistance to the motion of the blood through the arteries, and consequently that the discharge of blood is commonly from the latter. Some have thought, that a difference of the hæmorrhois, and of its effects upon the system, might arise from the difference of the hæmorrhoidal vessels from whence the blood issued. But Dr Cullen is of opinion, that we can scarce ever distinguish the vessels from which the blood flows, and that the frequent inosculations of both arteries and veins belonging to the lower extremity of the rectum, will render the effects of the hæmorrhage much the same, from whatever source it proceeds.

With regard to the hæmorrhoids, however, he is of opinion, that they are, for the most part, merely a topical affection. They take place before the period of life at which a venous plethora happens. They happen to females, in whom a venous plethora determined to the hæmorrhoidal vessels cannot be supposed to occur; and they happen to both sexes, and to persons of all ages, from causes which do not affect the system, and are manifestly suited to produce a topical affection only.

These causes are, in the first place, the frequent voiding of hard and bulky fæces, which, by their long stagnation in the rectum, and especially when voided, must necessarily press upon the veins of that part, and interrupt the course of the blood in them. For this reason the disease so frequently happens to those who are habitually costive. From the same causes, the disease happens frequently to those who are subject to a prolapsus ani. In voiding the fæces, it almost always happens that the internal coat of the rectum is more or less protruded; and, during this protrusion, it sometimes happens that the sphincter ani is contracted: in consequence of this, a strong constriction is made, which preventing the protruded gut from being replaced, and at the same time preventing the return of blood from it, occasions a considerable swelling, and the formation of a tumid ring round the anus.

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Upon the sphincter's being a little relaxed, as it is immediately after its strong contraction, the portion of the gut which had fallen out is commonly taken into the body again; but by the frequent repetition of the accident, the size and fulness of the ring formed by the prolapsed intestine is much increased. It is therefore more slowly and difficultly replaced; and in this consists the chief uneasiness of hæmorrhoidal persons. As the internal edge of this ring is necessarily divided by clefts, the whole often puts on the appearance of a number of distinct swellings; and it also frequently happens, that some portions of it are more considerably swelled, become more protuberant, and form those small tumors more strictly called *hæmorrhoids* or *piles*.

From considering that the pressure of the fæces, and other causes interrupting the return of venous blood from the lower extremity of the rectum, may operate a good deal higher up than that extremity, we may understand how tumors may be formed within the anus; and probably it also happens, that some of the tumors formed without the anus may continue when taken within the body, and even be increased by the causes just mentioned. Thus may the production of internal piles be explained, which, on account of their situation and bulk, are not protruded on the person's going to stool, and are therefore more painful.

The production of piles is particularly illustrated by this, that pregnant women are frequently affected with the disease.—This is to be accounted for, partly from the pressure of the uterus upon the rectum, and partly from the costive habit to which pregnant women are liable. Dr Cullen has known many instances of piles happening for the first time during the state of pregnancy; and there are few women who have born children, that are afterwards entirely free from piles.—Purgatives also, especially those of the more acrid kind, and particularly aloetics, are apt to produce the piles when frequently used; and as they stimulate particularly the larger intestines, they may be justly reckoned among the exciting causes of this disease.

Prognosis. Though the hæmorrhoids are commonly, as we have said, to be esteemed a topical disease, they may, by frequent repetition, become habitual and connected with the state of the whole system; and this will more readily happen in persons who have been once affected with the disease, if they be frequently exposed to a renewal of the causes which occasioned it. It happens also to persons much exposed to a congestion in the hæmorrhoidal vessels, in consequence of their being often in an erect position of the body, and in an exercise which pushes the blood into the depending vessels, while at the same time the effects of these circumstances are much favoured by the abundance and

and laxity of the cellular texture about the anus. It is to be particularly obferved, that when an hæmorrhoidal affection has either been originally or has become a difeafe of the fyftem, it then acquires a particular connexion with the ftomach; fo that certain affections of the ftomach excite the hæmorrhoidal difeafe, and certain ftates of this difeafe excite the diforders of the ftomach.

It has been an almoft univerfally received opinion, that the hæmorrhoidal flux is a falutary evacuation, which prevents many difeafes which would otherwife have happened; and that it even contributes to give long life: and as this opinion has been ftrenuoufly adopted by Dr Stahl, it has had a very confiderable influence on the practice of phyfic in Germany. But Dr Cullen maintains that we can never expect to reap much benefit from this flux, which at firft is purely topical; and, granting that it fhould become habitual, it is never, he thinks, proper to be encouraged. It is a difagreeable difeafe; ready to go to excefs, and thereby to prove hurtful, and fometimes even fatal: at beft it is liable to accidents, and thus to unhappy confequences. He is therefore of opinion, that even the firft approaches of the difeafe are to be guarded againft; and that, though it fhould have proceeded for fome time, it ought always to be moderated, and the neceffity of it fuperfeded.

Cure. The general intentions of cure in cafes of hæmorrhois are much varied, according to the circumftances of the affection at the time. When hæmorrhois exifts in the ftate of tumor, the principal objects are to counteract inflammation, and to promote a difcharge of blood from the part. When it is in the ftate of evacuation, the chief intentions of cure are, to diminifh the impetus of blood at the part affected, and to increafe the refiftance to the paffage of blood through the ruptured veffels. And finally, when the difeafe exifts in the ftate of fuppreffion, the aims of the practitioner muft chiefly be, to obviate the particular affections which are induced in confequence of the fuppreffion; to reftore the difcharge, as a means of mitigating thefe and preventing others; or, when the difcharge cannot with propriety or advantage be reftored, to compenfate the want of it by vicarious evacuations.

With thefe various intentions in different cafes, a variety of different remedies may be employed with advantage.

When any evident caufe for this difeafe is perceived, we ought immediately to attempt a removal of that caufe. One of the moft frequent remote caufes is an habitual coftivenefs; which muft be obviated by a proper diet, fuch as the perfon's own experience will beft direct; or if the management of diet be not effectual, the belly muft be kept open by medicines, which may prove gently laxative, without irritating the rectum. In moft cafes it will be of advantage to acquire a habit with regard to the time of difcharge, and to obferve it exactly. Another caufe of the hæmorrhois to be efpecially attended to is the prolapfus ani, which is apt to happen on a perfon's having a ftool. If this fhall occur to any confiderable degree, and be not at the fame time eafily and immediately replaced, it moft certainly produces piles, or increafes them when otherwife produced. Perfons therefore who are liable to

this prolapfus, fhould, after having been at ftool, take great pains to have the inteftine immediately replaced, by lying down in a horizontal pofture, and preffing gently upon the anus, till the reduction fhall be completely obtained. When this prolapfus is occafioned only by the voiding of hard and bulky fæces, it is to be removed by obviating the coftivenefs which occafions it. But in fome perfons it is owing to a laxity of the rectum; and in thofe it is often moft confiderable on occafion of a loofe ftool. In thefe cafes, it is to be treated by aftringents, and proper artifices are to be employed to keep the gut in its place.

When the difeafe has frequently recurred from neglect, and is thus in fome meafure eftablifhed, the methods above mentioned are no lefs proper; but in this cafe fome other meafures muft alfo be ufed. It is efpecially proper to guard againft a plethoric ftate of the body; and therefore to avoid a fedentary life, full diet, and intemperance in the ufe of ftrong liquor, which in all cafes of hæmorrhage is of the moft pernicious confequence.

Exercife of all kinds is of great fervice in obviating and removing a plethoric ftate of the body; but upon occafion of the hæmorrhoidal flux, when this is immediately to come on, both walking and riding, as increafing the determination of the blood into the hæmorrhoidal veffels, are to be avoided. At other times, when no fuch determination is already formed, thefe modes of exercife may be very properly employed.

Another method of removing plethora is by cold bathing; but this muft be employed with caution. When the hæmorrhoidal flux is approaching, it may be dangerous to divert it; but during the intervals of the difeafe, cold bathing may be employed with fafety and advantage; and in thofe who are liable to a prolapfus ani, the frequent wafhing of the anus with cold water may be ufeful.

Befides general antiphlogiftic regimen, in fome cafes where the inflammation runs high, recourfe may be had with great advantage both to general blood-letting and to leeches applied at the anus. Relief is alfo often obtained from the external application of emollients, either alone or combined with different articles of the fedative kind, as acetite of lead or opium, by which it is well known that pain in general, particularly when depending on increafed fenfibility, or augmented action of the veffels, is powerfully allayed.

When the flux has actually come on, we are to moderate it as much as poffible, by caufing the patient lie in a horizontal pofture on a hard bed; by avoiding exercife in an erect pofture, ufing a cool diet, and avoiding external heat. But with refpect to the further cure of this difeafe, we muft obferve, that there are only two cafes in which it is common for hæmorrhoidal perfons to call for medical affiftance. The one is, when the affection is accompanied with much pain; and the other, when the piles are accompanied with exceffive bleeding. In the firft cafe, we muft confider whether the piles be external or internal. The pain of the external piles happens efpecially when a confiderable protrufion of the rectum has taken place; and while it remains unreduced, it is ftrangled by the conftriction of the fphincter; and at the fame time no bleeding happens to take off the fwelling of the pro-

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truded portion of the inteſtine; and ſometimes an inflammation ſupervenes, which greatly aggravates the pain. In this caſe, emollient fomentations and poultices are ſometimes of ſervice, but the application of leeches is generally to be preferred.

In caſe of exceſſive bleeding, we are on all occaſions to endeavour to moderate the flux, even where the diſeaſe has occurred as a critical diſcharge; for if the primary diſeaſe ſhall be entirely and radically cured, the preventing any return of the hæmorrhois ſeems perfectly ſafe and proper. It is only when the diſeaſe ariſes from a plethoric habit, and from a ſtagnation of blood in the hypochondriac region, or when, though originally topical, it has by frequent repetition become habitual, and has thereby acquired a connection with the ſyſtem, that any doubt can ariſe about curing it entirely. In any of theſe caſes, however, Dr Cullen is of opinion, that it will be proper to moderate the bleeding, leſt, by its continuance or repetition, the plethoric ſtate of the body, and the particular determination of the blood into the hæmorrhoidal veſſels, be increaſed, and the return of the diſeaſe be too much favoured. Dr Stahl is of opinion, that the hæmorrhoidal flux is never to be accounted exceſſive, excepting when it occaſions great debility or leucophlegmatia: but Dr Cullen thinks, that the ſmalleſt approach towards producing either of theſe effects ſhould be conſidered as an exceſs which ought to be prevented from going farther; and even in the caſes of congeſtion and plethora, if the plethoric habit and tendency can be obviated and removed, the hæmorrhoidal flux may then with ſafety be entirely ſuppreſſed. In all caſes therefore of exceſſive bleeding, or any approach to it, aſtringents both internal and external may be ſafely and properly applied; not indeed to induce an immediate and total ſuppreſſion; but to moderate the hæmorrhage, and by degrees to ſuppreſs it altogether; while at the ſame time meaſures are to be taken for the removing the neceſſity of its recurrence.

Genus XXXIX. MENORRHAGIA.

245 *Immoderate Flow* of the *Menses*.

Menorrhagia, *Sauv.* 244. *Lin.* 202. *Vog.* 96.
Menorrhagia, *Sag.* gen. 179.
Uteri hæmorrhagia, *Hoffm.* II. 224.
Hæmorrhagia uterina, *Junck.* 14.
Leucorrhœa, *Sauv.* gen. 267. *Lin.* 201. *Vog.* 119. *Sag.* gen. 202.
Cachexia uterina, ſive fluor albus, *Hoffm.* III. 348.
Fluor albus, *Junck.* 133.
Abortus, *Sauv.* gen. 245. *Lin.* 204. *Sag.* gen. 180. *Junck.* 92.
Abortio, *Vog.* 97.
Fluor uterini ſanguinis, *Boerh.* 1303.
Convulſio uteri, ſive abortus, *Hoffm.* III. 176.

246 Sp. I. The *Immoderate Flow* of the *Menses*, properly ſo called.

Menorrhagia rubra, *Cul.*
Menorrhagia immodica, *Sauv.* ſp. 3.
Menorrhagia ſtillatitia, *Sauv.* ſp. 2.

Deſcription. The quantity of the menſtrual flux is different in different women, and likewiſe in the ſame woman at different times. An unuſual quantity therefore is not always to be conſidered as morbid: but when a large flow of the menſes has been preceded by headach, giddineſs, or dyſpnœa; has been uſhered in by a cold ſtage; and is attended with much pain of the back and loins, with a frequent pulſe, heat, and thirſt, it may then be conſidered as preternaturally morbid. On the other hand, when the face becomes pale, the pulſe weak, an unuſual debility is felt in exerciſe, and the breathing is hurried by little labour; when the back becomes pained from any continuance in an erect poſture, when the extremities become frequently cold, and when at night the feet appear affected with œdematous ſwelling: from all theſe ſymptoms we may conclude, that the flow of the menſes has been immoderate, and has already induced a dangerous ſtate of debility. The debility, induced in this caſe, often appears alſo by affections of the ſtomach, an anorexia, and other ſymptoms of dyſpepſia; by a palpitation of the heart, and frequent faintings; by a weakneſs of mind, liable to ſtrong emotions from ſlight cauſes, eſpecially thoſe preſented by ſurpriſe. A large flow of the menſes attended with barrenneſs in married women, may generally be conſidered as preternatural and morbid. Generally, alſo, that flow of the menſes may be conſidered as immoderate, which is preceded and followed by a leucorrhœa.

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Cauſes, &c. The proximate cauſe of the menorrhagia is either the effort of the uterine veſſels preternaturally increaſed, or a preternatural laxity of the extremities of the uterine arteries.—The remote cauſes may be, 1. Thoſe which increaſe the plethoric ſtate of the uterine veſſels; as a full and nouriſhing diet, much ſtrong liquor, and frequent intoxications. 2. Thoſe which determine the blood more copiouſly and forcibly into the uterine veſſels; as violent ſtrainings of the whole body; violent ſhocks from falls; ſtrokes or contuſions on the lower belly; violent exerciſe, particularly in dancing; and violent paſſions of the mind. 3. Thoſe which particularly irritate the veſſels of the uterus: as exceſs in venery; the exerciſe of venery in the time of menſtruation; a coſtive habit, giving occaſion to violent ſtraining at ſtool; and cold applied to the feet. 4. Thoſe which have forcibly overſtrained the extremities of the uterine veſſels; as frequent abortions, frequent childbearing without nurſing, and difficult or tedious labours. Or, laſtly, Thoſe which induce a general laxity; as living much in warm chambers, and drinking much of warm enervating liquors, ſuch as tea, coffee, &c.

Cure. The treatment and cure of the menorrhagia, muſt be different according to the different cauſes of the diſeaſe. The practices employed, however, are chiefly uſed with one of two intentions; either with the view of reſtraining the diſcharge when preſent, or of preventing the return of an exceſſive diſcharge at the ſucceeding period. The firſt is chiefly to be accompliſhed by employing ſuch practices as diminiſh the force occaſioning the diſcharge of blood, or as augment the reſiſtance to its paſſage through the veſſels by which it is to be diſcharged. The laſt is in ſome degree to be obtained by avoiding cauſes which either increaſe the general impetus of the blood, or the impetus at the uterus in particular; but princi-

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pally by giving additional vigour to the uterine veſſels.

In all caſes, the firſt attention ought to be given to avoiding the remote cauſes, whenever that can be done; and by ſuch attention the diſeaſe may be often entirely cured. When the remote cauſes cannot be avoided, or when the avoiding them has been neglected, and a copious menſtruation has come on, it ſhould be moderated as much as poſſible, by abſtaining from all exerciſe at the coming on or during the continuance of the menſtruation; by avoiding even an erect poſture as much as poſſible; by ſhunning external heat, and of courſe warm chambers and ſoft beds; by uſing a light and cool diet; by taking cold drink, at leaſt as far as former habits will allow; by avoiding venery; by obviating coſtiveneſs, or removing it by laxatives which give little ſtimulus. The ſex are commonly negligent, either in avoiding the remote cauſes, or in moderating the firſt beginnings of this diſeaſe. It is by ſuch neglect that it ſo frequently becomes violent and of difficult cure; and the frequent repetition of a copious menſtruation may be conſidered as a cauſe of great laxity in the extreme veſſels of the uterus.

When the coming on of the menſtruation has been preceded by ſome diſorder in other parts of the body, and is accompanied with pains of the back, ſomewhat like parturient pains, with febrile ſymptoms, and when at the ſame time the flow ſeems to be copious, a bleeding at the arm may be proper, but is not often neceſſary; and it will in moſt caſes be ſufficient to employ, with great attention and diligence, thoſe means already mentioned for moderating the diſcharge.

When the immoderate flow of the menſes ſhall ſeem to be owing to a laxity of the veſſels of the uterus, as may be concluded from the general debility and laxity of the perſon's habit; from the remote cauſes that have occaſioned the diſeaſe; from the abſence of the ſymptoms which denote increaſed action in the veſſels of the uterus; from the frequent recurrence of the diſeaſe; and particularly from this, that the female in the intervals of menſtruation is liable to a leucorrhœa: in ſuch a caſe, the diſeaſe is to be treated, not only by employing all the means above mentioned for moderating the hæmorrhage, but alſo by avoiding all irritation, every irritation having a greater effect in proportion as the veſſels are more lax and yielding. If, in ſuch a caſe of laxity, it ſhall appear that ſome degree of irritation occurs, opiates may be employed to moderate the diſcharge; but in uſing theſe much caution is requiſite. If, notwithſtanding theſe meaſures having been taken, the diſcharge ſhall prove very large, aſtringents both external and internal may be employed. In ſuch caſes, Dr Cullen aſks, May ſmall doſes of emetics be of ſervice?

When the menorrhagia depends on the laxity of the uterine veſſels, it will be proper, in the intervals of menſtruation to employ tonic remedies; as cold bathing and chalybeates. The exerciſes of geſtation alſo may be very uſeful, both for ſtrengthening the whole ſyſtem, and for taking off the determination of the blood to the internal parts.

Theſe remedies may be employed in all caſes of menorrhagia, from whatever cauſe it may have proceeded, if it ſhall have already induced a conſiderable degree of debility in the body.

Leucorrhœa.

Sp. II. *Abortion.* 247

Menorrhagia abortus, *Cul.*
Menorrhagia gravidarum, *Sauv.* ſp. 6.
Abortus effluxio, *Sauv.* ſp. 1.
a, Abortus ſubtrimeſtris.
b, Abortus ſubſemeſtris.
c, Abortus octimeſtris.
Abortus ab uteri laxitate, *Sauv.* ſp. 2.

Sp. III. *Immoderate Flux* of the *Lochia.* 248

Menorrhagia lochialis, *Sauv.* ſp. 8. *Cul.*

For the deſcription, treatment, and cure, of theſe two laſt diſeaſes, ſee Midwifery.

Sp. IV. *Immoderate Flow* of the *Menses* from ſome local diſorder. 249

Menorrhagia vitiorum, *Cul.*
Menorrhagia ex hyſteroptoſi, *Sauv.* ſp. 5.
Menorrhagia ulceroſa, *Sauv.* ſp. 9.

Sp. V. The *Leucorrhœa*, *Fluor Albus*, or *Whites.* 250

Menorrhagia alba, *Cul.*
Leucorrhœa, *Sauv.* gen. 267.
Menorrhagia decolor, *Sauv.* ſp. 7.
Leucorrhœa Americana, *Sauv.* ſp. 5.
Leucorrhœa Indica, *Sauv.* ſp. 6.
Leucorrhœa Nabothi, *Sauv.* ſp. 9.
Leucorrhœa gravidarum, *Sauv.* ſp. 8.

Deſcription. The *fluor albus*, female weakneſs, or *whites*, as it is commonly called, is a diſeaſe of the womb and its contiguous parts; from which a pale-coloured, greeniſh, or yellow fluid, is diſcharged, attended with loſs of ſtrength, pain in the loins, bad digeſtion, and a wan ſickly aſpect.

Cauſes, &c. The quantity, colour, and conſiſtence of the diſcharge, chiefly depend upon the time of its duration, the patient's habit of body, and the nature of the cauſe by which it was produced. Taking cold, ſtrong liquor, immoderate heat and moiſture, or violent exerciſe, are all obſerved to produce a bad effect, as to its quantity and quality.

Weakly women of lax ſolids, who have had many children, and long laboured under ill health, are of all the moſt ſubject to this diſagreeable diſeaſe; from which they unfortunately ſuffer more ſevere penance than others, as the niceſt ſenſations are often connected with ſuch a delicacy of bodily frame as ſubjects them to it.

In Holland it is very frequent, and in a manner peculiar to the place, from the dampneſs of its ſituation; the ſurrounding air being ſo overcharged with moiſture as to relax the body, ſtop perſpiration, and throw it upon the bowels or womb; producing in the firſt a diarrhœa or flux, in the laſt the *fluor albus* or female weakneſs.

The diſcharge often proceeds from the veſſels ſubſervient to menſtruation; becauſe, in delicate habits, where thoſe veſſels are weak, and conſequently remain too

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long uncontracted, the *fluor albus* sometimes immediately follows the menſes, and goes off by degrees as they gradually cloſe. It alſo comes from the mucous glands of the womb, as is particularly evident in very young females of eight and ten years old; in whom, though very rarely, it has been obſerved, and where it muſt then neceſſarily have eſcaped from thoſe parts, as the uterine veſſels are not ſufficiently enlarged for its paſſage at ſo early a period.

Sometimes, as in women with child, it proceeds from the paſſage to the womb, and not from the womb itſelf; which, during pregnancy, is cloſely ſealed up, ſo that nothing can paſs from thence till the time of labour. The application of thoſe inſtruments called *peſſaries*, from the pain and irritation they occaſion, is alſo apt to bring on this diſcharge. Hence we may conclude, that this diſeaſe may happen although the blood be in a pure ſtate. Here the fault ſeems to be placed in the veſſels at the part, by which the fluids are vitiated and changed from their natural qualities.

The *fluor albus* has been ſuppoſed to ſupply the want of the menſes; becauſe where the firſt prevails, the laſt is generally either irregular or totally wanting: but it might more properly be ſaid, that the preſence of the *fluor albus*, which is a preternatural evacuation, occaſions the abſence of that which is natural; as is evident from the return of the menſes after the *fluor albus* has been cured. Indeed, when this diſcharge appears about the age of 13 or 14, and returns once a month, with ſymptoms like thoſe of the menſes, then it may be deemed ſtrictly natural, and therefore ought not to be ſtopped.

Prognoſis. The *fluor albus* may be diſtinguiſhed into two kinds. The firſt ariſes from a ſimple weakneſs, or the relaxation of the ſolids; which may either be *general*, where the whole bodily ſyſtem is enervated and unſtrung; or *partial*, where the womb only is thus affected, in conſequence of hard labour, frequent miſcarriages, a ſuppreſſion or immoderate quantity of the menſes, or a ſprain of the back or loins.

In the firſt caſe, the diſcharge being generally mild, may be ſafely taken away. In the ſecond, it may proceed from a vitiated or impure blood, where the body, from thence, is loaded with groſs humours, which nature for her own ſecurity and relief thus endeavours to carry off. In ſuch caſes, the diſcharge is often of a reddiſh colour, like that from old ulcerous ſores; being ſometimes ſo ſharp as to excoriate the contiguous parts, and occaſion a ſmarting and heat of urine.

A deep ſeated, darting pain, with a forcing down, attending ſuch a diſcharge is a very dangerous and alarming ſign, and indicates an ulceration or cancerous ſtate of the womb. This malignant ſtate of the diſeaſe, if of long continuance, is extremely difficult to cure; and diſpoſes the patient to barrenneſs, a bearing down, dropſy, or conſumption.

Cure, &c. The cauſes of thoſe two kinds of this diſeaſe being different, ſo they will require a very different method of cure. For this purpoſe, in the firſt caſe, nothing will be more proper than nouriſhing ſimple food; ſuch as veal broths, jellies, freſh eggs, and milk diet. The acid fruits will alſo be proper; and the patient may take a reſtorative, ſtrengthening infuſion, which will give firmneſs to the body, and aſſiſt the weakened fibres of the womb in returning to their natural ſtate.

Leucorrhœa.

The ſame method may be uſed with ſucceſs, where the *fluor albus* follows the menſes, as already obſerved.

The Tunbridge or Spa waters may be drank at the ſame time; and if neceſſary, an infuſion of green tea, or pure ſmith's forge water, may be uſed with a womb-ſyringe as an injection twice a-day. Should the diſeaſe prove uncommonly obſtinate, the patient may go into the cold bath every ſecond day; and alſo drink lime-water with milk, which will expedite the cure, and prevent a relapſe. Volatile liniment, and afterwards a ſtrengthening plaſter, may be applied to the ſmall of the back.

By way of caution, the female ſhould abſtain from the immoderate uſe of tea; and be removed into a dry clear air; or if ſhe be obliged to remain in one leſs proper, ſhe may apply the fleſh-bruſh, and wear a flannel ſhift next her ſkin, impregnated with the fumes of burning frankincenſe or any of the grateful aromatic gums. Cold ſpring water pumped on the loins, or a bliſtering plaſter applied to the bottom of the ſpine or back, are both very powerful in their effects, and have ſometimes ſucceeded after other remedies had been tried in vain.

In the ſecond ſpecies of the diſeaſe, where the diſcharge is ſharp and of long ſtanding, it would be extremely dangerous to ſuppreſs it ſuddenly, either by aſtringents internally taken, or applied as injections, until the ſyſtem be reſtored to a more ſound and vigorous condition.

A purging potion may be taken twice a-week, and in the intervals an alterative pill night and morning. After this courſe has been continued a fortnight or three weeks, ſhe may begin with the ſtrengthening bitter infuſion, or ſome other tonic, in the quantity of a tea-cupful twice a-day, or to a greater extent if the ſtomach will allow.

The ſame ſort of food and regimen will here be proper as in the firſt kind of the diſeaſe. The patient ſhould abſtain from malt liquors, and drink rice-water, in each pint of which half an ounce of gum-arabic has been diſſolved; or if ſhe be weak, and of a cold bloated habit of body, a little French brandy may be added occaſionally.

When ſhe begins to take the bitter infuſion, it will be proper to uſe the Tunbridge or Pyrmont water for common drink; but if thoſe cannot conveniently be had, the *alkaline aërated water*, impregnated with iron, will make an excellent ſubſtitute. If it ſhould render her coſtive, and occaſion headach, ſhe may deſiſt, and drink a ſolution of cryſtals of tartar, or a little ſenna tea ſweetened with manna, till thoſe complaints be removed.

In ſhort, as this is a malady of the moſt diſagreeable kind, which by long continuance or neglect becomes difficult of cure, and often produces an *ulceration of the womb*, *bearing down*, *barrenneſs*, a *dropſy*, or *conſumption*; it were to be wiſhed that women, on ſuch occaſions, would be more attentive to their own ſafety, by uſing all poſſible means, in due time, to prevent thoſe diſorders.

Dr Leake ſays he has attended more patients labouring under the *fluor albus* in the autumn than at any other

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season of the year, especially when the weather was uncommonly moist and cold: most of them were cured by change of diet, an increased perspiration, and the proper use of cinchona with aromatics. He observed, that several about this time who escaped the disorder, were visited with bad colds, a defluxion on the throat, or a diarrhœa, which were removed by a similar treatment.

Among other remedies which have been recommended in leucorrhœa, recourse has lately been had to the internal use of cantharides. This remedy for leucorrhœa has, in particular, been highly extolled in a late publication on the powers of cantharides, when used internally, written by Mr John Roberton, surgeon in Edinburgh. The analogy between gleet and leucorrhœa, Mr Roberton tells us, suggested to him, that the cantharides which he had employed with such good effects in gleet, might also be useful in leucorrhœa. The event, he affirms, fully answered his expectations, and he has employed the remedy with very great success. The cantharides were used under the form of tincture: the *tinctura meloës vesicatorii* of the Edinburgh Pharmacopœia. This medicine he employed in much larger doses than is commonly prescribed. Thus a mixture containing an ounce of the tincture of cantharides, diffused in six ounces of water, was taken to the extent of half an ounce, four times a-day; nay, in some cases, the tincture was exhibited to the extent of half an ounce in a day, without any inconvenience, and with the best effects. As examples of the power of this remedy, Mr Roberton has given a detail of six cases, selected from a number which have been under his care. In three cases, as being the most inveterate, the effects of the cantharides were most evident. And we shall only observe, that if this remedy be found by other practitioners to be equally successful in the cure of leucorrhœa, it will be a very valuable acquisition in the practice of medicine, especially if it shall be found by others, as well as by Mr Roberton, that not only the general symptoms of leucorrhœa are removed, but that the tone and functions of the uterine system are completely restored by the use of cantharides.

As women are sometimes connected with those who do not conscientiously regard their safety, it is a circumstance of the utmost consequence *to distinguish a fresh venereal infection from the fluor albus or whites*: for if the first be mistaken for the last, and be either neglected or improperly treated, the worst consequences may arise.

The following signs will best inform the patient whether there be occasion for her doubts or not.

A fresh infection, called *gonorrhœa*, is malignant and inflammatory; the *fluor albus* most commonly arises from relaxation and bodily weakness: and therefore the remedies proper in the first disorder would render the last more violent, by locking up and confining the infectious matter.

In the gonorrhœa, the discharge chiefly proceeds from the parts contiguous to the urinary passage, and continues whilst the menses flow; but in the *fluor albus* it is supplied from the cavity of the womb and its passage, and then the menses are seldom regular.

In the gonorrhœa, an itching, inflammation, and heat of urine, are the forerunners of the discharge; the orifice of the urinary passage is prominent and painful, and the patient is affected with a frequent irritation to make water. In the *fluor albus*, pains in the loins, and loss of strength, attend the discharge; and if any inflammation or heat of urine follow, they happen in a less degree, and only after a long continuance of the discharge, which, becoming sharp and acrimonious, excoriates the surrounding parts.

Catarrhus.

In the gonorrhœa, the discharge suddenly appears without any evident cause; but in the *fluor albus*, it comes on more slowly, and is often produced by irregularities of the menses, frequent abortion, sprains, or long-continued illness.

In the gonorrhœa, the discharge is greenish or yellow, less in quantity, *and not attended with the same symptoms of weakness*. In the *fluor albus*, although sometimes of the same colour, especially in bad habits of body, and after long continuance, it is usually more offensive and redundant in quantity.

All the other kinds of hæmorrhage enumerated by medical writers, are by Dr Cullen reckoned to be symptomatic.

STOMACACE, *Sauv.* gen. 241. *Lin.* 175. *Vog.* 85. *Sag.* gen. 177.

Species: Scorbutica, Purulenta, &c.

HÆMATEMESIS, *Sauv.* gen. 242. *Lin.* 184. *Vog.* 89. *Sag.* gen. 177.

Species: Plethorica, Catamenialis, Scorbutica, &c.

HÆMATURIA, *Sauv.* gen. 233. *Lin.* 198. *Vog.* 92. *Sag.* gen. 178.

Species: Purulenta, Calculosa, Hæmorrhoidalis, &c.

ORDER V. PROFLUVIA.

GENUS XL. CATARRHUS. 251

The *CATARRH*.

Catarrhus, *Sauv.* gen. 186. *Vog.* 98. *Sag.* gen. 145.
Coryza, *Lin.* 174. *Vog.* 100. *Sag.* gen. 196.
Rheuma, *Sauv.* gen. 142.
Tussis, *Sauv.* gen. 142. *Lin.* 155. *Vog.* 205. *Sag.* gen. 245, 255. *Junck.* 30.
Tussis catarrhalis et rheumatica, *Hoffm.* III. 109.

Sp. I. *Catarrh* from COLD. 252

Catarrhus à frigore, *Cul.*
Catarrhus benignus, *Sauv.* sp. 1.
Catarrhus pectoreus, *Sauv.* sp. 6.
Coryza catarrhalis, *Sauv.* sp. 1.
Coryza phlegmatorrhagia, *Sauv.* sp. 2. *Salmuth.* Obs. cent. 1, 37. *Junck.* 28. *Morgagn.* de sed. xiv. 21.
Coryza febricosa, *Sauv.* sp. 6.
Tussis catarrhalis, *Sauv.* sp. 1. *N. Rosen* Diss. apud *Haller*, Disput. Pract. tom. ii.
Rheuma catarrhale, *Sauv.* sp. 1.
Amphimerina catarrhalis, *Sauv.* sp. 2.
Amphimerina tussiculosa, *Sauv.* sp. 13.
Cephalalgia catarrhalis, *Sauv.* sp. 10.

Sp. II.

Profluvia.

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Sp. II. *Catarrh* from Contagion.

Catarrhus à contagio, *Cul.*
Catarrhus epidemicus, *Sauv.* ſp. 3.
Rheuma epidemicum, *Sauv.* ſp. 2.
Synocha catarrhalis, *Sauv.* ſp. 5.

There are ſeveral ſymptomatic ſpecies: as, Catarrhus Rubeoloſus; Tuſſis Varioloſa, Verminoſa, Calculoſa, Phthiſica, Hyſterica, à dentitione, Gravidarum, Metallicolarum, &c.

Deſcription. The catarrh is an increaſed excretion of mucus from the mucous membrane of the noſe, fauces and bronchiæ, attended with pyrexia.

Practical writers and noſologiſts have diſtinguiſhed the diſeaſe by different appellations, according as it happens to affect different parts of the mucous membrane, one part more or leſs than the other: but Dr Cullen is of opinion that the diſeaſe in thoſe different parts is always of the ſame nature, and proceeds from the ſame cauſe in the one as in the other. Very commonly indeed, thoſe different parts are affected at the ſame time; and therefore there is little room for the diſtinction mentioned. The diſeaſe has been frequently treated of under the title of *tuſſis* or *cough;* and a cough, indeed, always attends the chief form of catarrh, that is, the increaſed excretion from the bronchiæ; but as it is ſo often alſo a ſymptom of many other affections, which are very different from one another, it is improperly uſed as a generic title.

The diſeaſe generally begins with ſome difficulty of breathing through the noſe, and with a ſenſe of ſome fulneſs ſtopping up that paſſage. This again is often attended with ſome dull pain and a ſenſe of weight in the forehead, as well as a ſtiffneſs in the motion of the eyes. Theſe feelings, ſometimes at their very firſt beginning, and always ſoon after, are attended with the diſtillation of a thin fluid from the noſe, and ſometimes from the eyes; and theſe fluids are often found to be ſomewhat acrid, both by their taſte and by their fretting the parts over which they paſs. Theſe ſymptoms conſtitute the coryza and gravedo of authors, and are commonly attended with a ſenſe of laſſitude over the whole body. Sometimes cold ſhiverings are felt; at leaſt the body is more ſenſible than uſual to the coldneſs of the air; and with all this the pulſe is more frequent than ordinary, eſpecially in the evenings.

Theſe ſymptoms have ſeldom continued long before they are accompanied with ſome hoarſeneſs, and a ſenſe of roughneſs and ſoreneſs in the trachea, with ſome difficulty of breathing, expreſſed by a ſenſe of ſtraitneſs in the cheſt, and with a cough which ſeems to ariſe from ſome irritation felt at the glottis. This cough is generally at firſt dry and painful, occaſioning pains about the cheſt, and more eſpecially in the breaſt; ſometimes, together with theſe ſymptoms, pains reſembling thoſe of the rheumatiſm are felt in ſeveral parts of the body, particularly about the neck and head. With all theſe ſymptoms, the appetite is impaired, ſome thirſt ariſes, and a feveriſh laſſitude is felt all over the body. Theſe ſymptoms mark the height and violence of the diſeaſe; but commonly it does not continue long. By degrees the cough

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Catarrhus.

comes to be attended with a more copious excretion of mucus; which is at firſt thin, but gradually becoming thicker, is brought up with leſs frequent and leſs laborious coughing. The hoarſeneſs and ſoreneſs of the trachea are alſo relieved or removed; and the febrile ſymptoms abating, the expectoration becomes again leſs conſiderable, and the cough leſs frequent, till at length they ceaſe altogether.

Such is generally the courſe of this diſeaſe, neither tedious nor dangerous; but it is ſometimes in both reſpects otherwiſe. The body ſubjected to catarrh ſeems to be more than uſually liable to be affected by cold air; and upon expoſure of the body to freſh cold, the diſeaſe, which ſeemed to be yielding, is often brought back with greater violence than before, and is rendered not only more tedious than otherwiſe it would be, but alſo more dangerous by the ſupervening of other diſeaſes. Some degree of the cynanche tonſillaris often accompanies the catarrh; and when this is aggravated by a freſh application of cold, the cynanche alſo becomes more violent and dangerous from the cough which is preſent at the ſame time. When a catarrh has been occaſioned by a violent cauſe, when it has been aggravated by improper management, and eſpecially when it has been rendered more violent by freſh and repeated applications of cold, it often paſſes into a pneumonic inflammation, attended with the utmoſt danger.

Unleſs, however, ſuch accidents as theſe happen, a catarrh, in ſound perſons not far advanced in life, is always a ſlight and ſafe diſeaſe: but, in perſons of a phthiſical diſpoſition, a catarrh may readily produce a hæmoptyſis, or perhaps form tubercles, in the lungs; and ſtill more readily in perſons who have tubercles already formed in the lungs, an accidental catarrh may occaſion the inflammation of theſe tubercles, and in conſequence produce a phthiſis pulmonalis.

In elderly perſons, a catarrh ſometimes proves a dangerous diſeaſe. Many perſons, as they advance in life, and eſpecially after they have arrived at old age, have the natural mucus of the lungs poured out in greater quantity, and requiring a frequent expectoration. If, therefore, a catarrh happen to ſuch perſons, and increaſe the afflux of fluids to the lungs, with ſome degree of inflammation, it may produce the peripneumonia notha, or more properly chronic catarrh, a diſeaſe continuing often for many years, or at leaſt returning regularly every winter; which in ſuch caſes is very often fatal.

Cauſes, &c. The proximate cauſe of catarrh ſeems to be an increaſed afflux of fluids to the mucous membrane of the noſe, fauces, and bronchiæ, along with ſome degree of inflammation affecting the ſame. The latter circumſtance is confirmed by this, that, in the caſe of catarrh, the blood drawn from a vein commonly exhibits the ſame inflammatory cruſt which appears in the caſe of phlegmaſiæ. The remote cauſe of catarrh is moſt commonly cold applied to the body. This application of cold producing catarrh is generally evident; and Dr Cullen is of opinion that it would always be ſo, were men acquainted with and attentive to the circumſtances which determine cold to act upon the body.

The application of cold which occaſions a catarrh probably operates by ſtopping the diſcharge uſually made

Profluvia. made by the ſkin, and which is therefore determined to the mucous membrane of the parts above-mentioned. As a part of the weight which the body daily loſes by inſenſible evacuation, is owing to an exhalation from the lungs, there is probably a connexion between this exhalation and the cutaneous perſpiration, ſo that the one may be increaſed according as the other is diminiſhed; and therefore we may underſtand how the diminution of cutaneous perſpiration, by the application of cold, may increaſe the afflux of fluids to the lungs, and thereby produce a catarrh.

Dr Cullen remarks that there are ſome obſervations of Dr James Keil which may render this matter doubtful; but ſays there is a fallacy in thoſe obſervations. The evident effects of cold in producing coryza, leave the matter, in general, without doubt; and there are ſeveral other obſervations which ſhow a connexion between the lungs and the ſurface of the body.

Whether from the ſuppreſſion of perſpiration, a catarrh be produced merely by an increaſed afflux of fluids, or whether in addition to this the matter of perſpiration be at the ſame time determined to the mucous glands, and there excites a particular irritation, may be uncertain; but Dr Cullen thinks the latter ſuppoſition is moſt probable.

Although in the caſe of a common catarrh, which is in many inſtances ſporadic, it may be doubtful whether any morbific matter be applied to the mucous glands; yet we are certain that the ſymptoms of a catarrh do frequently depend upon ſuch a matter being applied to theſe glands, as appears from the caſe of meaſles, chincough, and eſpecially from the frequent occurrence of contagious and epidemical catarrh.

The phenomena of contagious catarrhs have been much the ſame with thoſe of the others; and the diſeaſe has always been particularly remarkable for this, that it has been the moſt widely and generally ſpreading epidemic known. It has ſeldom appeared in any one country of Europe, without appearing ſucceſſively in almoſt every different part of it; and, in ſome inſtances, it has been alſo transferred to America, and has been ſpread there in like manner, ſo far as we have had opportunities of being informed.

The catarrh from contagion appears with nearly the ſame ſymptoms as thoſe above mentioned. It ſeems often to come on in conſequence of the application of cold. And indeed catarrh from cold and contagion are in every reſpect ſo ſimilar, that when this epidemic rages, it is impoſſible to determine with a perſon having ſymptoms of catarrh after expoſure to cold, whether the diſeaſe proceeds from the one cauſe or the other. In moſt inſtances, however, catarrh from contagion comes on with more cold ſhivering than the catarrh ariſing from cold alone; and the former does alſo not only ſooner ſhow febrile ſymptoms, but to a more conſiderable degree. Accordingly, it more ſpeedily runs its courſe, which is commonly finiſhed in a few days. It ſometimes ends by a ſpontaneous ſweat; and this, in ſome perſons, produces a miliary eruption. It is, however, the febrile ſtate of this diſeaſe eſpecially that is finiſhed in a few days; for the cough and other catarrhal ſymptoms do frequently continue longer, and often when they appear to be going off they are renewed by any freſh application of cold. Catarrhus.

Prognoſis. Conſidering the number of perſons who are affected with catarrh, of either the one ſpecies or the other, and eſcape from it quickly without any hurt, it may be allowed to be a diſeaſe commonly free from danger: but it is not always to be treated as ſuch; for in ſome perſons it is accompanied with pneumonic inflammation. In the phthiſically diſpoſed, it often accelerates the coming on of phthiſis; and in elderly perſons it often proves fatal in the manner we have explained above, viz. by degenerating into its chronic ſtate. But though chronic catarrh be often the termination of that ſpecies which ariſes from cold, we have not, in any caſe, obſerved it to ariſe as a conſequence of a catarrh from contagion. This ſpecies of catarrh, however, is not unfrequently followed by phthiſis; or rather, where a phthiſical tendency before exiſted, the affection has been begun and its progreſs accelerated from this cauſe.

Cure. The cure of catarrh is nearly the ſame, whether it proceeds from cold or contagion; only in the latter caſe remedies are commonly more neceſſary than in the former. In the caſes of a moderate diſeaſe, it is commonly ſufficient to avoid cold, or to abſtain from animal food for ſome days. In ſome caſes, where the febrile ſymptoms are conſiderable, it is proper for that length of time to lie in bed, and, by taking frequently ſome mild and diluent drink, a little warmed, to promote a very gentle ſweat; and after this to take care to return very gradually only to the uſe of the free air. When the diſeaſe is more violent, not only the antiphlogiſtic regimen, exactly obſerved, but various remedies alſo, become neceſſary. To take off the phlogiſtic diatheſis which always attends this diſeaſe, blood-letting, more or leſs, according as the ſymptoms ſhall require, is the proper remedy. After blood-letting, for reſtoring the determination of the fluids to the ſurface of the body, and at the ſame time for expediting the ſecretion of mucus in the lungs, which may take off the inflammation of its membrane, vomiting is the moſt effectual means. For the laſt-mentioned purpoſe, it has been ſuppoſed that ſquills, gum-ammoniac, the volatile alkali, and ſome other medicines, might be uſeful; but their efficacy has never been found conſiderable: and if ſquills have ever been very uſeful, it ſeems to have been rather by their emetic than by their expectorant powers. When the inflammatory affections of the lungs ſeem to be conſiderable, it is proper, beſides blood-letting, to apply bliſters to the back or ſides.

As a cough is often the moſt troubleſome circumſtance of this diſeaſe, ſo demulcents may be employed to alleviate it. But after the inflammatory ſymptoms are much abated, if the cough ſtill remains, opiates afford the moſt effectual means of relieving it; and, in the circumſtances juſt now mentioned, they may be very ſafely employed. Very conſiderable advantage is often derived from employing opiates in ſuch a manner as to act more immediately on the head of the wind-pipe. For this purpoſe, opium may often be advantageouſly conjoined with demulcents, melting ſlowly in the mouth. And perhaps no form is more convenient, or anſwers the purpoſe better, than the *trochiſci glycyrrhizæ cum opio* of the Edinburgh Pharmacopœia, Profluvia. macopœia, where purified opium is combined with extract of liquorice, gum arabic, and other demulcents, to the extent of about a grain in a dram of the composition. After the inflammatory and febrile states of this disease are very much gone, the most effectual means of discussing all remains of the catarrhal affection is by some exercise of gestation diligently employed.

Besides the remedies above mentioned, Dr Mudge, in a treatise on this disease, recommends the steam of warm water as a most efficacious and safe remedy for a catarrh, and which indeed he seems to consider as little less than *infallible*. The method of breathing in these steams is described under the word INHALER; but he gives a caution to people in health, who may accidentally see his machine, not to make the experiment of breathing through cold water with it, or they will be almost certain of catching a severe cold. His directions for those troubled with the catarrh are as follow:

"In the evening, a little before bedtime, the patient, if of adult age, is to take three drams, or as many tea-spoonfuls, of elixir paregoricum, in a glass of water: if the subject be younger, for instance under five years old, one tea-spoonful; or between that and ten years, two. About three quarters of an hour after, the patient should go to bed, and, being covered warm, the inhaler three parts filled with water nearly boiling (which, from the coldness of the metal, and the time it ordinarily takes before it is to be used by the patient, will be of a proper degree of warmth), and being wrapped up in a napkin, but so that the valve in the cover is not obstructed by it, is to be placed at the arm-pit, and the bedclothes being drawn up and over it close to the throat, the tube is to be applied to the mouth, and the patient should inspire and expire through it for about twenty minutes or half an hour.

"It is very evident, as the whole act of respiration is performed through the machine, that in inspiration the lungs will be filled with air which will be hot, and loaded with vapour, by passing through the body of water; and in exspiration, all that was contained in the lungs will, by mixing with the steam on the surface of the water, be forced through the valve in the cover, and settle on the surface of the body under the bedclothes.

"The great use of this particular construction of the inhaler is this: First, As there is no necessity, at the end of every inspiration, to remove the tube from the mouth, in order to expire from the lungs the vapour which had been received into them, this machine may therefore be used with as much ease by children as older people. And, secondly, As a feverish habit frequently accompanies the disorder, the valve in that respect also is of the utmost importance: for a sweat, or at least a free perspiration, not only relieves the patient from the restless anxiety of a hot, dry, and sometimes parched skin, but is also, of all evacuations, the most eligible for removing the fever; and it will be generally found, that, after the inhaler so constructed has been used a few minutes, the warm vapour under the clothes will, by settling upon the trunk, produce a sweat, which will gradually extend itself to the legs and feet.

"In a catarrhous fever, or any feverish habit attending this cough, it would be proper to take a draught of warm thin whey a few minutes before the inhaler be used; and after the process is over, the sweat which it has produced may be continued by occasional small draughts of weak warm whey or barley-water. The sweating is by no means so necessary to the cure of the catarrhous cough, as that the success of the inhaler against that complaint at all depends upon it. Catarrhus.

"After this respiratory process is over, the patient usually passes the night without the least interruption from the cough, and feels no farther molestation from it than once or twice in the morning to throw off the trifling leakage which, unperceived, had dripped into the bronchiæ and vesicles during the night; the thinner parts of which being evaporated, what remains is soon got rid of by a very gentle effort.

"I cannot, however, take leave of this part of my subject, without pointedly observing, that if the patient means not to be disappointed by my assurances or his own expectations, it is essentially necessary that the following remarks, with regard to the time and manner of using this process, should be strictly attended to.

"First, That as tender valetudinary people are but too well acquainted with the first notices of the disorder, the remedy must, or ought to be, used the same evening; which will, in an ordinary seizure, be attended with an immediate cure: but if the soreness of the respiratory organs, or the petulance of the cough, show the cold which has been contracted to have been very severe, the inhaler, without the opiate, should be again repeated for the same time the next morning.

"Secondly, if the use of the inhaler, &c. be delayed till the second night, it will be always right to repeat it again the next morning without the opiate, but with it if the seizure has been violent.

"And, lastly, If the cough be of some days standing, it will be always necessary to employ both parts of the process at night and the succeeding morning, as the first simple inflammatory mischief is now most probably aggravated by an additional one of a chronic tendency.

"But if, through the want of a timely application, or a total neglect of this or any other remedy, the cough should continue to harass the patient, it is, particularly in delicate and tender constitutions, of the utmost consequence to attempt the removal of it as soon as possible, before any floating acrimony in the constitution (from the perpetual irritation) receives an habitual determination to an organ so essential to life as the lungs.

"If the patient expectorate with ease and freedom a thick and well-digested inoffensive phlegm, there is generally but little doubt of his spitting off the disorder, with common care, in a few days; and till that be accomplished, a proper dose of elixir paregoricum for a few successive nights will be found very useful in suppressing the fatiguing irritation and ineffectual cough, occasioned by a matter which, dripping in the early state of the disease into the bronchiæ during the night, is commonly at that time too thin to be discharged by those convulsive efforts.

"If, however, notwithstanding a free and copious expectoration, the cough should still continue, and the discharge, Profluvia. discharge, instead of removing the complaint, should itself, by becoming a disease, be a greater expence than the constitution can well support, it is possible that a tender patient may spit off his life through a weak, relaxed pair of lungs, without the least appearance of purulence, or any suspicion of suppuration. In those circumstances, besides, as was mentioned before, increasing the general perspiration by the salutary friction of a flannel waistcoat, change of situation, and more especially long journeys on horseback, conducted as much as possible through a thin, sharp, dry air, will seldom fail of removing the complaint.

"But, on the contrary, if the cough should, at the same time that it is petulant and fatiguing to the breast, continue dry, husky, and without expectoration; provided there be reason to hope that no tubercles are forming, or yet actually formed, there is not perhaps a more efficacious remedy for it than half a dram of gum-ammoniacum, with 18 or 20 drops of liquid laudanum, made into pills, and taken at bedtime, and occasionally repeated. This excellent remedy Sir John Pringle did me the honour to communicate to me; and I have accordingly found it, in a great many instances, amazingly succesful, and generally very expeditiously so, for it seldom fails to produce an expectoration, and to abate the distressing fatigue of the cough. In those circumstances I have likewise found the common remedy of ℥ss or ℈ij of *balf. fulph. anisat.* taken twice a-day, in a little powdered sugar or any other vehicle, a very efficacious one. I have also, many times, known a salutary revulsion made from the lungs by the simple application of a large plaster, about five or six inches diameter, of Burgundy pitch, between the shoulders; for the perspirable matter, which is locked up under it, becomes so sharp and acrid, that in a few days it seldom fails to produce a very considerable itching, some little tendency to inflammation, and very frequently a great number of boils. This application should be continued (the plaster being occasionally changed), for three weeks or a month, or longer, if the complaint be not so soon removed.

"And here I cannot help observing, that, though seemingly a trifling, it is however by no means an useless caution to the tender patient, not to expose his shoulders in bed, and during the night, to the cold; but when he lies down, to take care they be kept warm, by drawing the bedclothes up close to his back and neck.

"If, however, notwithstanding these and other means, the cough, continuing dry or unattended with a proper expectoration, should persevere in harassing the patient; if, at last, it should produce, together with a soreness, shooting pains through the breast and between the shoulders, attended also with shortness of the breath; and if, added to this, flushes of the cheeks after meals, scalding in the hands and feet, and other symptoms of a hectic, should accompany the disorder; there is certainly no time to be lost, as there is the greatest reason to apprehend that some acrimony in the habit is determined to the tender substance of the lungs, and that consequently tubercular suppurations will follow. In this critical and dangerous situation, I think I can venture to say from long experience, that, accompanied with change of air and occasional bleedings, the patient will find his greatest security in a drain from a large scapulary issue, assisted by a diet of asses milk and vegetables." Dysenteria.

Genus XLI. DYSENTERIA.

The *Dysentery*. 254

Dysenteria, *Sauv.* gen. 248. *Lin.* 191. *Vog.* 107. *Sag.* 183. *Hoffm.* III. 151. *Junck.* 76.

Description. The dysentery is a disease in which the patient has frequent stools, accompanied with much griping, and followed by a tenesmus. The stools, though frequent, are generally in small quantity; and the matter voided is chiefly mucus, sometimes mixed with blood. At the same time, the natural fæces seldom appear; and when they do, it is generally in a compact and hardened form, often under the form of small hard substances known by the name of *scybala*. This disease occurs especially in summer and autumn, at the same time with autumnal intermittent and remittent fevers; and with these it is often complicated. It comes on sometimes with cold shiverings, and other symptoms of pyrexia; but more commonly the symptoms of the topical affection appear first. The belly is costive, with an unusual flatulence in the bowels. Sometimes, though more rarely, some degree of diarrhœa is the first appearance.—In most cases, the disease begins with griping, and a frequent inclination to go to stool. In indulging this, little is voided, but some tenesmus attends it. By degrees the stools become more frequent, the griping more severe, and the tenesmus more considerable.—With these symptoms there is a loss of appetite, and frequently sickness, nausea, and vomiting, also affecting the patient. At the same time there is always more or less of pyrexia present. It is sometimes of the remittent kind, and observes a tertian period.—Sometimes the pyrexia is manifestly inflammatory, and very often of a putrid kind. These febrile states continue to accompany the disease during its whole course, especially when it terminates soon in a fatal manner. In other cases, the febrile state almost entirely disappears, while the proper dysenteric symptoms remain for a long time after. In the course of the disease, whether for a shorter or a longer time, the matter voided by stool is very various. Sometimes it is merely a mucous matter, without any blood, exhibiting that disease which is named by some the *morbus mucosus*, and by others the *dysenteria alba*. For the most part, however, the mucus discharged is more or less mixed with blood. This sometimes appears only in streaks among the mucus; but at other times is more copious, giving a tinct to the whole; and upon some occasions a pure and unmixed blood is voided in considerable quantity. In other respects, the matter voided is variously changed in colour and consistence, and is commonly of a strong and unusually fetid odour. It is probable, that sometimes a genuine pus is voided, and frequently a putrid sanies, proceeding from gangrenous parts. There are very often mixed with the liquid matter some films of a membranous appearance, and frequently some small masses of a seemingly sebaceous matter. While the stools voiding these various matters are, in many instances, exceedingly frequent, Profluvia.

quent, it is ſeldom that natural fæces appear in them; and when they do appear, it is, as we have ſaid, in the form of ſcybala, that is, in ſomewhat hardened, ſeparate balls. When theſe are voided, whether by the efforts of nature or as ſolicited by art, they procure a remiſſion of all the ſymptoms, and more eſpecially of the frequent ſtools, griping, and teneſmus.

Accompanied with theſe circumſtances, the diſeaſe proceeds for a longer or ſhorter time. When the pyrexia attending it is of a violent inflammatory kind, and more eſpecially when it is of a very putrid nature, the diſeaſe often terminates fatally in a very few days, with all the marks of a ſupervening gangrene. When the febrile ſtate is more moderate, or diſappears altogether, the diſeaſe is often protracted for weeks, and even for months; but, even then, after a various duration, it often terminates fatally, and generally in conſequence of a return and conſiderable aggravation of the inflammatory and putrid ſtates. In ſome caſes, the diſeaſe ceaſes ſpontaneouſly; the frequency of ſtools, the griping, and teneſmus, gradually diminiſhing, while natural ſtools return. In other caſes, the diſeaſe, with moderate ſymptoms, continues long, and ends in a diarrhœa, ſometimes accompanied with lienteric ſymptoms.

Cauſes, &c. The remote cauſes of this diſeaſe have been variouſly repreſented. In general it ariſes in ſummer or autumn, after conſiderable heats have prevailed for ſome time, and eſpecially after very warm and at the ſame time very dry ſtates of the weather: and the diſeaſe is much more frequent in warm than in cooler climates. It happens, therefore, in the ſame circumſtances and ſeaſons which conſiderably affect the ſtate of the bile in the human body; but the cholera is often without any dyſenteric ſymptoms, and copious diſcharges of bile have been found to relieve the ſymptoms of dyſentery; ſo that it is difficult to determine what connexion the diſeaſe has with the ſtate of the bile.

It has been obſerved, that the effluvia from very putrid animal ſubſtances readily affect the alimentary canal, and, upon occaſion, they certainly produce a diarrhœa; but whether they ever produce a genuine dyſentery, is not certain.

The dyſentery does often manifeſtly ariſe from the application of cold, but the diſeaſe is always contagious; and, by the propagation of ſuch contagion, independent of cold, or other exciting cauſes, it becomes epidemic in camps and other places. It is, therefore, to be doubted if the application of cold ever produces the diſeaſe, unleſs where the ſpecific contagion has been previouſly received into the body; and, upon the whole, it is probable that a ſpecific contagion is to be conſidered as being always the remote cauſe of this diſeaſe.

Whether this contagion, like many others, be of a permanent nature, and only ſhows its effects in certain circumſtances which render it active, or if it be occaſionally produced, we cannot determine. Neither, if the latter ſuppoſition be received, can we ſay by what means it may be generated. As little do we know any thing of its nature, conſidered in itſelf; or at moſt, only this, that in common with many other contagions, it is very often ſomewhat of a putrid nature, and capable of inducing a putreſcent tendency in the human body. This, however, does not at all explain the peculiar effect of inducing thoſe ſymptoms which properly and eſſentially conſtitute dyſentery. Of theſe ſymptoms the proximate cauſe is ſtill obſcure.—The common opinion has been, that the diſeaſe depends upon an acrid matter thrown upon or ſomehow generated in the inteſtines, exciting their periſtaltic motion, and thereby producing the frequent ſtools which occur in this diſeaſe. But this ſuppoſition cannot be adopted; for, in all the inſtances known, of acrid ſubſtances applied to the inteſtines, and producing frequent ſtools, they at the ſame time produce copious ſtools, as might be expected from acrid ſubſtances applied to any length of the inteſtines. This, however, is not the caſe in dyſentery, in which the ſtools, however frequent, are generally in very ſmall quantity, and ſuch as may be ſuppoſed to proceed from the lower parts of the rectum only. With reſpect to the ſuperior portions of the inteſtines, and particularly thoſe of the colon, it is probable they are under a preternatural and conſiderable degree of conſtriction: for, as we have ſaid above, the natural fæces are ſeldom voided; and when they are, it is in a form which gives reaſon to ſuppoſe they have been long retained in the cells of the colon, and conſequently that the colon had been affected with a preternatural conſtriction. This is confirmed by almoſt all the diſſections which have been made of the bodies of dyſenteric patients; in which, when gangrene had not entirely deſtroyed the texture and form of the parts, large portions of the great guts have been found affected with a very conſiderable conſtriction.

Dyſenteria.

The proximate cauſe of dyſentery, or at leaſt the chief part of the proximate cauſe, ſeems to conſiſt in a preternatural conſtriction of the colon, occaſioning, at the ſame time, thoſe ſpaſmodic efforts which are felt in ſevere gripings, and which efforts, propagated downwards to the rectum, occaſion there the frequent mucous ſtools and teneſmus. But whether this explanation ſhall be admitted or not, it will ſtill remain certain, that hardened fæces, retained in the colon, are the cauſe of the griping, frequent ſtools, and teneſmus: for the evacuation of theſe fæces, whether by nature or by art, gives relief from the ſymptoms mentioned; and it will be more fully and uſefully confirmed by this, that the moſt immediate and ſucceſsful cure of dyſentery is obtained by an early and conſtant attention to the preventing the conſtriction, and the frequent ſtagnation of fæces in the colon.]

Cure. In the early periods of this diſeaſe, the objects chiefly to be aimed at are the following: The diſcharge of acrid matter depoſited in the alimentary canal; the counteracting the influence of this matter when it cannot be evacuated; the obviating the effects reſulting from ſuch acrid matter as can neither be evacuated nor deſtroyed; and, finally, the prevention of any further ſeparation and depoſition of ſuch matter in the alimentary canal. In the more advanced periods of the diſeaſe, the principal objects are, the giving a proper defence to the inteſtines againſt irritating cauſes; the diminution of the morbid ſenſibility of the inteſtinal canal; and the reſtoration of due vigour to the ſyſtem in general, but to the inteſtines in particular.

The moſt eminent of our late practitioners, and of

Profluvia. Dysenteria.

of greateſt experience in this diſeaſe, ſeem to be of opinion, that it is to be cured moſt effectually by purging, aſſiduouſly employed. The means may be various; but the moſt gentle laxatives are uſually ſufficient; and, as the medicine muſt be frequently repeated, theſe are the moſt ſafe, more eſpecially as an inflammatory ſtate ſo frequently accompanies the diſeaſe. Whatever laxatives produce an evacuation of natural fæces, and a conſequent remiſſion of the ſymptoms, will be ſufficient to effectuate the cure. But if the gentle laxatives ſhall not produce the evacuation now mentioned, ſomewhat more powerful muſt be employed; and Dr Cullen has found nothing more proper or convenient than tartar emetic, given in ſmall doſes, and at ſuch intervals as may determine its operation to be chiefly by ſtool. To the tartrite of antimony, however, employed as a purgative, the great ſickneſs which it is apt to occaſion, and the tendency which it has, notwithſtanding every precaution, to operate as an emetic, are certainly objections. Another antimonial, at one time conſidered as an almoſt infallible remedy for this diſeaſe, the vitrum antimonii ceratum, is no leſs exceptionable, from the uncertainty and violence of its operation; and perhaps the ſafeſt and beſt purgatives are the different neutral ſalts, particularly thoſe containing foſſil alkali, ſuch as the ſoda vitriolata tartariſata or phoſphorata. Rhubarb, ſo frequently employed, is, Dr Cullen thinks, in ſeveral reſpects, amongſt the moſt unfit purgatives; and indeed from its aſtringent quality, it is exceptionable at the commencement of the affection, unleſs it be conjoined with ſomething to render its operation more briſk, ſuch as mild muriated mercury, or calomel as it is commonly called.

Vomiting has been held a principal remedy in this diſeaſe; and may be uſefully employed in the beginning, with a view both to the ſtate of the ſtomach and of the fever: but it is not neceſſary to repeat it often; and, unleſs the emetics employed operate alſo by ſtool, they are of little ſervice. Ipecacuanha is by no means a ſpecific; and it proves only uſeful when ſo managed as to operate chiefly by ſtool.

For relieving the conſtriction of the colon, and evacuating the retained fæces, clyſters may ſometimes be uſeful; but they are ſeldom ſo effectual as laxatives given by the mouth; and acrid clyſters, if they be not effectual in evacuating the colon, may prove hurtful by ſtimulating the rectum too much.

The frequent and ſevere griping attending this diſeaſe, leads almoſt neceſſarily to the uſe of opiates; and they are very effectual for the purpoſe of relieving from the gripes: but, by occaſioning an interruption of the action of the ſmall inteſtines, they favour the conſtriction of the colon, and thereby aggravate the diſeaſe; and if, at the ſame time, the uſe of them ſuperſede in any meaſure the employing purgatives, it is doing much miſchief; and the neglect of purging ſeems to be the only thing which renders the uſe of opiates very neceſſary.

When the gripes are both frequent and ſevere, they may ſometimes be relieved by the employment of the ſemicupium, or by fomentation of the abdomen continued for ſome time. In the ſame caſe, the pains may be relieved, and the conſtriction of the colon may be taken off, by bliſters applied to the lower belly.

At the beginning of this diſeaſe, when the fever is any way conſiderable, bloodletting, in patients of tolerable vigour, may be proper and neceſſary; and, when the pulſe is full and hard, with other ſymptoms of an inflammatory diſpoſition, bloodletting ought to be repeated. But, as the fever attending dyſentery is often of the typhoid kind, or does, in the courſe of the diſeaſe, become ſoon of that nature, bloodletting muſt be cautiouſly employed.

From our account of the nature of this diſeaſe, it will be ſufficiently obvious, that the uſe of aſtringents in the beginning of it muſt be very pernicious. But although aſtringents may be hurtful at early periods of this affection, yet it cannot be denied, that where frequent looſe ſtools remain after the febrile ſymptoms have ſubſided, they are often of great ſervice for diminiſhing morbid ſenſibility, and reſtoring due vigour to the inteſtinal canal. Accordingly, on this ground a variety of articles have been highly celebrated in this affection; among others we may mention the quaſſia, radix indica lopeziana, verbaſcum, extractum catechu, and gum kino, all of which have certainly in particular caſes been employed with great advantage. And perhaps alſo, on the ſame principles we are to account for the benefit which has been ſometimes derived from the nux vomica, a remedy highly extolled in caſes of dyſentery by ſome of the Swediſh phyſicians; but this article, it muſt be allowed, often proves very powerful as an evacuant. Its effects, however, whatever its mode of operation may be, are too precarious to allow its ever being introduced into common practice; and in this country, it has, we believe, been but very rarely employed. Whether an acrid matter be the original cauſe of the dyſentery, may be uncertain; but, from the indigeſtion, and the ſtagnation of fluids, which attend the diſeaſe, we may ſuppoſe that ſome acrid matters are conſtantly preſent in the ſtomach and inteſtines; and therefore that demulcents may be always uſefully employed. At the ſame time, from the conſideration that mild oily matters thrown into the inteſtines in conſiderable quantity always prove laxative, Dr Cullen is of opinion, that the oleaginous demulcents are the moſt uſeful. Where, however, theſe are not acceptable to the patient's taſte, thoſe of the mucilaginous and farinaceous kind, as the decoctum hordei, potio cretacea, &c. are often employed with advantage.

As this diſeaſe is ſo often of an inflammatory or of a putrid nature, it is evident that the diet employed in it ſhould be vegetable and aceſcent. Milk, in its entire ſtate, is of doubtful quality in many caſes; but even ſome portion of the cream is often allowable, and whey is always proper.—In the firſt ſtages of the diſeaſe, the ſweet and ſubacid fruits are allowable, and even proper. It is in the more advanced ſtages only that any morbid acidity ſeems to prevail in the ſtomach, and to require ſome reſerve in the uſe of aceſcents. At the beginning of the diſeaſe, abſorbents ſeem to be ſuperfluous; and, by their aſtringent and ſeptic powers, they may be hurtful; but in after periods they are often of advantage.

When this diſeaſe is complicated with an intermittent,

tent, and is protracted from that circumſtance chiefly, it is to be treated as an intermittent, by adminiſtering the cinchona, which in the earlier periods of the diſeaſe is hardly to be admitted.

Class II. NEUROSES.

Order I. COMATA.

Comata, *Sauv.* Claſs VI. Ord. II. *Sag.* Claſs IX. Order V.
Soporoſi, *Lin.* Claſs VI. Ord. II.
Adynamiæ, *Vog.* Claſs VI.
Nervorum reſolutiones, *Hoffm.* III. 194.
Affectus ſoporoſi, *Hoffm.* III. 209.
Motuum vitalium defectus, *Junck.* 114.

255 Genus XLII. APOPLEXIA.

The Apoplexy.

Apoplexia, *Sauv.* gen. 182. *Lin.* 101. *Vog.* 229. *Boerh.* 1007. *Junck.* 117. *Sag.* gen. 288. *Wepfer.* Hiſt. apoplecticorum.
Carus, *Sauv.* gen. 181. *Lin.* 100. *Vog.* 231. *Boerh.* 1045. *Sag.* gen. 287.
Cataphora, *Sauv.* gen. 180. *Lin.* 99. *Vog.* 232. *Boerh.* 1045. *Sag.* gen. 286.
Coma, *Vog.* 232. *Boerh.* 1048.
Hæmorrhagia cerebri, *Hoffm.* II. 240.

To this genus alſo Dr Cullen reckons the following diſeaſes to belong:

Catalepſis, *Sauv.* gen. 176. *Lin.* 129. *Vog.* 230. *Sag.* gen. 281. *Boerh.* 1036. *Junck.* 44.
Affectus cerebri ſpaſmodico-ecſtaticus, *Hoffm.* III. 44.
Ecſtaſis, *Sauv.* gen. 177. *Vog.* 333. *Sag.* gen. 283.

The following he reckons ſymptomatic:

Typhomania, *Sauv.* gen. 178. *Lin.* 97. *Vog.* 23. *Sag.* gen. 284.
Lethargus, *Sauv.* gen. 179. *Lin.* 98. *Vog.* 22. *Sag.* gen. 285.

This diſeaſe appears under modifications ſo various, as to require ſome obſervations with reſpect to each.

256 Sp. I. The *Sanguineous Apoplexy.*

Deſcription. In this diſeaſe the patients fall ſuddenly down, and are deprived of all ſenſe and voluntary motion, but without convulſions. A giddineſs of the head, noiſe in the ears, corruſcations before the eyes, and redneſs of the face, uſually precede. The diſtinguiſhing ſymptom of the diſeaſe is a deep ſleep, attended with violent ſnorting; if any thing be put into the mouth, it is returned through the noſe; nor can any thing be ſwallowed without ſhutting the noſtrils; and even when this is done, the perſon is in the utmoſt danger of ſuffocation. Sometimes apoplectic patients will open their eyes after having taken a large doſe of an emetic; but if they ſhow no ſign of ſenſe, there is not the leaſt hope of their recovery. Sometimes the apoplexy terminates in a hemiplegia; in which caſe it comes on with a diſtortion of the mouth towards the ſound ſide, a drawing of the tongue the ſame way, and ſtammering of the ſpeech. Diſſections ſometimes ſhow a rupture of ſome veſſels of the meninges, or even veſſels of the brain itſelf; though ſometimes, if we may believe Dr Willis, no defect is to be obſerved either in the cerebrum or cerebellum.

Cauſes, &c. The general cauſe of a ſanguineous apoplexy is a plethoric habit of body, with a determination to the head. The diſeaſe therefore may be brought on by whatever violently urges on the circulation of the blood; ſuch as ſurfeits, intoxication, violent paſſions of the mind, immoderate exerciſe, &c. It takes place, however, for the moſt part, when the venous plethora has ſubſiſted for a conſiderable time in the ſyſtem. For that reaſon it commonly does not attack people till paſt the age of 60; and that whether the patients are corpulent and have a ſhort neck, or whether they are of a lean habit of body. Till people be paſt the age of childhood, apoplexy never happens.

Prognoſis. This diſeaſe very often kills at its firſt attack, and few ſurvive a repetition of the fit; ſo that thoſe who make mention of people who have ſurvived ſeveral attacks of the apoplexy, have probably miſtaken the epilepſy for this diſeaſe. In no diſeaſe is the prognoſis more fatal; ſince thoſe who ſeem to be recovering from a fit, are frequently and ſuddenly carried off by its return, without either warning of its approach or poſſibility of preventing it. The good ſigns are when the diſeaſe apparently wears off, and the patient evidently begins to recover; the bad ones are when all the ſymptoms continue and increaſe.

Cure. The great object to be aimed at, is to reſtore the connexion between the ſentient and corporeal parts of the ſyſtem; and when interruption to this connexion proceeds from compreſſion in the brain by blood, this is to be attempted, in the firſt place, by large and repeated bleedings; after which, the ſame remedies are to be uſed as in the ſerous apoplexy, aftermentioned. The body is to be kept in a ſomewhat erect poſture, and the head ſupported in that ſituation.

Sp. II. The *Serous Apoplexy.* 257

Apoplexia pituitoſa, *Sauv.* ſp. 7. Apoplexia ſeroſa. *Preyſinger*, ſp. 4. *Morg.* de cauſis, &c. IV. LX,
Carus à hydrocephalo, *Sauv.* ſp. 16.
Cataphora hydrocephalica, *Sauv.* ſp. 6.
Cataphora ſomnolenta, *Sauv.* ſp. 1.
Lethargus literatorum, *Sauv.* 7. *Van Swieten* in Aphor. 1010. 2 γ and 3 α.

Deſcription. In this ſpecies the pulſe is weak, the face pale, and there is a diminution of the natural heat. On diſſection, the ventricles of the brain are found to contain a larger quantity of fluid than they ought; the other ſymptoms are the ſame as in the former.

Cauſes, &c. This may ariſe from any thing which induces a debilitated ſtate of the body, ſuch as depreſſing paſſions of the mind, much ſtudy, watching, &c. It may alſo be brought on by a too plentiful uſe of diluting, acidulated drinks. It doth not, however, Comata. ever, follow, that the extravafated ferum above mentioned in the ventricles of the brain is always the caufe of the difeafe, fince the animal fluids are very frequently obferved to ooze out in plenty through the coats of the containing veffels after death, though no extravafation took place during life.

Prognofis. This fpecies is equally fatal with the other; and what hath been faid of the prognofis of the fanguineous, may alfo be faid of that of the ferous apoplexy.

Cure. In this fpecies venefection can fcarcely be admitted: acrid purgatives, emetics, and ftimulating clyfters, are recommended to carry off the fuperabundant ferum; but in bodies already debilitated, they may perhaps be liable to the fame exceptions with venefection itfelf. Volatile falts, cephalic elixirs, and cordials, are alfo prefcribed; and in cafe of a hemiplegia fupervening, the cure is to be attempted by aperient ptifans, cathartics, and fudorifics; gentle exercife, as riding in a carriage; with blifters and fuch ftimulating medicines as are in general had recourfe to in affections originally of the paralytic kind.

258 Sp. III. *Hydrocephalic* APOPLEXY, or *Dropfy* of the *Brain.*

Hydrocephalus interior, *Sauv.* fp. 1.
Hydrocephalus internus, *Whytt's* works, page 725. London Med. Obf. vol. iv. art. 3, 6, and 25. *Gaudelius* de hydrocephalo, apud *Sandifort* Thefaur. vol. ii.
Hydrocephalus acutus, *Quin. Diff.* de hydrocephalo, 1779.
Afthenia à hydrocephalo, *Sauv.* fp. 3.

Hiftory and defcription. This difeafe has been accurately treated within thefe few years by feveral eminent phyficians, particularly the late Dr Whytt, Dr Fothergill, and Dr Watfon; who concur in opinion, with refpect to the feat of the complaint, the moft of its fymptoms, and its general fatality. Out of twenty patients that had fallen under Dr Whytt's obfervation, he candidly owns that he had been fo unfortunate as to cure only one who laboured under the characteriftic fymptoms of the hydrocephalus; and he fufpects that thofe who imagine they have been more fuccefsful, had miftaken another diftemper for this. It is by all fuppofed to confift in a dropfy of the ventricles of the brain; and this opinion is fully eftablifhed by diffections. It is obferved to happen more commonly to healthy, active, lively children, than to thofe of a different difpofition.

Dr Whytt fuppofes that the commencement of this difeafe is obfcure; that it is generally fome months in forming; and that, after fome obvious urgent fymptoms rendering affiftance neceffary, it continues fome weeks before its fatal termination. This, in general, differs from what has hitherto been obferved by Dr Fothergill; the latter informing us, that he has feen children, who, from all appearance, were healthy and active, feized with this diftemper, and carried off in about 14 days. He has feldom been able to trace the commencement of it above three weeks.

Though the hydrocephalus be moft incident to children, it has been fometimes obferved in adults; as appears from a cafe related by Dr Huck, and from fome others. Apoplexia.

When the difeafe appears under its moft common form, the fymptoms at different periods are fo various as to lead Dr Whytt to divide the difeafe into three ftages, which are chiefly marked by changes occurring in the condition of the pulfe. At the beginning it is quicker than natural; afterwards it becomes uncommonly flow; and towards the conclufion of the difeafe it becomes again quicker than natural, but at the fame time often very irregular.

Thofe who are feized with this diftemper ufually complain firft of a pain in fome part below the head; moft commonly about the nape of the neck and fhoulders; often in the legs; and fometimes, but more rarely, in the arms. The pain is not uniformly acute, nor always fixed to one place; and fometimes does not affect the limbs. In the latter cafe, the head and ftomach have been found to be moft difordered; fo that when the pain occupied the limbs, the ficknefs or headach was lefs confiderable; and when the head became the feat of the complaint, the pain in the limbs was feldom or never mentioned. Some had very violent fickneffes and violent headachs alternately. From being perfectly well and fportive, fome were in a few hours feized with thofe pains in the limbs, or with ficknefs, or headach, in a flight degree, commonly after dinner; but fome were obferved to droop a few days before they complained of any local indifpofition. In this manner they continued three, four, or five days, more or lefs, as the children were healthy and vigorous. They then commonly complain of an acute deep-feated pain in the head, extending acrofs the forehead from temple to temple; of which, and a ficknefs, they alternately complain in fhort and affecting exclamations; dofing a little in the intervals, breathing irregularly, and fighing much while awake. Sometimes their fighs, for the fpace of a few minutes, are inceffant.

As the difeafe advances, the pulfe becomes flower and irregular, the ftrokes being made both with unequal force and in unequal times, till within a day or two of the fatal termination of the diforder, when it becomes exceeding quick; the breathing being at the fame time deep, irregular, and laborious. After the firft attack, which is often attended with feverifh heats, efpecially towards evening, the heat of the body is for the moft part temperate, till at laft it keeps pace with the increafing quicknefs of the pulfe. The head and præcordia are always hot from the firft attack. The fleeps are fhort and difturbed, fometimes interrupted by watchfulnefs; befides which there are ftartings.

In the firft ftage of the difeafe there feems to be a peculiar fenfibility of the eyes, as appears from the intolerance of light. But in the progrefs of the difeafe a very oppofite ftate occurs: The pupil is remarkably dilated, and cannot be made to contract by the action even of ftrong light; fuch, for example, as by bringing a candle very near to it. In many cafes there is reafon to believe that total blindnefs occurs: Often alfo the pupil of one eye is more dilated than that of another, and the power of moving the eyes is alfo morbidly affected. Thofe children, who were never obferved to fquint before, often become affected with

Comata.

with a very great degree of ſtrabiſmus. The patients are unwilling to be diſturbed for any purpoſe, and can bear no poſture but that of lying horizontally. One or both hands are moſt commonly about their heads. The urine and ſtools come away inſenſibly. At length the eyelids become paralytic, great heat accompanied with ſweat overſpreads the whole body, reſpiration is rendered totally ſuſpirious, the pulſe increaſes in its trembling undulations beyond the poſſibility of counting, till the vital motions entirely ceaſe; and ſometimes convulſions conclude the ſcene.

Many of the ſymptoms above enumerated are ſo common to worm caſes, teething, and other irritating cauſes, that it is difficult to fix upon any which particularly characterize this diſeaſe at its commencement. The moſt peculiar ſeem to be the pains in the limbs, with ſickneſs and inceſſant headach; which, though frequent in other diſeaſes of children, are neither ſo uniformly nor ſo conſtantly attendant as in this. Another circumſtance obſerved to be familiar, if not peculiar to this diſtemper, is, that the patients are not only coſtive, but it is likewiſe with the greateſt difficulty that ſtools can be procured. Theſe are generally of a very dark greeniſh colour with an oilineſs or a glaſſy bile, rather than the ſlime which accompanies worms; and they are, for the moſt part, extremely offenſive. No poſitive concluſion can be drawn from the appearance of the urine; it being various, in different ſubjects, both in its colour and contents, according to the quantity of liquor they drank, and the time between the diſcharges of the urine. From their unwillingneſs to be moved, they often retain their water 12 or 15 hours, and ſometimes longer. In complaints ariſing from worms, and in dentition, convulſions are more frequent than in this diſorder. Children ſubject to fits are ſometimes ſeized with them a few days before they die. Sometimes theſe continue 24 hours inceſſantly, and till they expire.

Cauſes. The cauſes of internal hydrocephalus are very much unknown. Some ſuppoſe it to proceed from a rupture of ſome of the lymphatic veſſels of the brain. But this ſuppoſition is ſo far from being confirmed by any anatomical obſervation, that even the exiſtence of ſuch veſſels in the brain is not clearly demonſtrated. That lymphatics, however, do exiſt in the brain, cannot be doubted; and one of the moſt probable cauſes giving riſe to an accumulation of water in the brain is a diminiſhed action of theſe. Here, however, as well as in other places, accumulation may alſo be the conſequence of augmented effuſion; and in this way, an inflammatory diſpoſition, as ſome have ſuppoſed, may give riſe to the affection. But from whatever cauſe an accumulation of water in the ventricles of the brain be produced, there can be no doubt that from this the principal ſymptoms of the diſeaſe ariſe, and that a cure is to be accompliſhed only by the removal of it. It is, however, probable, that the ſymptoms are ſomewhat varied by the poſition of the water, and that the affection of viſion in particular is often the conſequence of ſome morbid ſtate about the *thalami nervorum opticorum;* at leaſt, in many caſes, large collections of water in the ventricles have occurred, without either ſtrabiſmus, intolerance of light, or dilatation of the pupil. And in caſes where theſe ſymptoms have taken place to a remarkable degree, while upon diſſection after death but a very ſmall collection of water was found in the ventricles, it has been obſerved, that a peculiar tumid appearance was diſcovered about the optic nerves, which upon examination was found to ariſe from water in the cellular texture. This may have given compreſſion producing a ſtate of inſenſibility; but it may have been preceded, or it may even have originated from ſome inflammatory affection of theſe parts, producing the intolerance of light.

Apoplexia.

Prognoſis and Cure. Till very lately this diſorder was reckoned totally incurable; but of late it has been alleged, that mercury, if applied in time, will remove every ſymptom. This remedy was firſt ſuggeſted by Dr Dobſon of Liverpool, and afterwards employed apparently with ſucceſs by Dr Percival, Dr Makie, and others. But the practice has by no means been found to be generally ſucceſsful. In a great majority of inſtances, after mercury has had the faireſt trial, the diſorder has proved fatal. And it is a very remarkable circumſtance, that in this diſeaſe, after great quantities of mercury have been uſed both externally and internally, it rarely affects the mouth. But even in caſes where ſalivation has been induced, a fatal concluſion has yet enſued.

Of late the digitalis purpurea has been thought, in ſome caſes of hydrocephalus, as well as in other obſtinate dropſies, to be employed with benefit. But this alſo, in the hands of moſt practitioners, has very generally failed. Perhaps there is no remedy from which benefit has more frequently been obſerved than from bliſters. But we may conclude with obſerving, that the cure of the apoplexia hydrocephalica ſtill remains to be diſcovered.

Sp. IV. Apoplexy *from Atrabilis.* 259

Apoplexia atrabiliaris, *Sauv.* ſp. 12. *Preyſinger.* ſp. 6.

This takes place in the laſt ſtage of the diffuſion of bile through the ſyſtem, i. e. of the black jaundice; and in ſome caſes the brain has been found quite tinged brown. It cannot be thought to admit of any cure.

Sp. V. Apoplexy *from External Violence.* 260

Apoplexia traumatica, *Sauv.* ſp. 2.
Carus traumaticus, *Sauv.* ſp. 5.

The treatment of this diſeaſe, as it ariſes from ſome external injury, properly falls under the article Surgery.

Sp. VI. Apoplexy *form Poiſons.* 261

Apoplexia temulenta, *Sauv.* ſp. 3.
Carus à narcoticis, *Sauv.* ſp. 14.
Lethargus à narcoticis, *Sauv.* ſp. 3.
Carus à plumbagine, *Sauv.* ſp. 10.
Apoplexia mephitica, *Sauv.* ſp. 14.
Aſphyyia à mephitide *Sauv.* ſp. 9.
Aſphyxia à muſto, *Sauv.* ſp. 3.
Catalepſis à fumo, *Sauv.* ſp. 3.
Aſphyxia à fumis, *Sauv.* ſp. 2.
Aſphyxia à carbone, *Sauv.* ſp. 16.
Aſphyxia foricariorum, *Sauv.* ſp. 11.
Aſphyxia ſideratorum, *Sauv.* ſp. 10.
Carus ab inſolatione, *Sauv.* ſp. 12.

Carus

Comata.

Carus à frigore, *Sauv.* fp. 15.
Lethargus à frigore, *Sauv.* fp. 6.
Afphyxia congelatorum, *Sauv.* fp. 5.

The poifons which bring on an apoplexy when taken internally may be either of the ftimulant or fedative kind, as fpirituous liquors, opium, and the more virulent kinds of vegetable poifons. The vapours of mercury, or of lead, in great quantity, will fometimes produce a fimilar effect; though commonly they produce rather a paralyfis, and operate flowly. The vapours of charcoal, or fixed air, in any form, breathed in great quantity, alfo produce an apoplexy, or a ftate very fimilar to it; and even cold itfelf produces a fatal fleep, though without the apoplectic ftertor.—To enumerate all the different fymptoms which affect the unhappy perfons who have fwallowed opium, or any of the ftronger vegetable narcotics, is impoffible, as they are fcarcely to be found the fame in any two patients. The ftate induced by them feems to differ fomewhat from that of a true apoplexy; as it is commonly attended with convulfions, but has the particular diftinguifhing fign of apoplexy, namely, a very difficult breathing or fnorting, more or lefs violent according to the quantity of poifonous matter fwallowed.

Of the poifonous effects of fixed air, Dr Percival gives the following account. "All thefe noxious vapours, whether arifing from burning charcoal, the fermenting grape, the Grotti di Cani, or the cavern of Pyrmont, operate nearly in the fame manner. When accumulated and confined, their effects are often inftantaneous: they immediately deftroy the action of the brain and nerves, and in a moment arreft the vital motions. When more diffufed, their effects are flower, but ftill evidently mark out a direct affection of the nervous fyftem.

"Thofe who are expofed to the vapours of the fermenting grape, are as inftantly deftroyed as they would be by the ftrongeft electrical fhock. A ftate of infenfibility is the immediate effect upon thofe animals which are thruft into the Grotti di Cani, or the cavern of Pyrmont: the animal is deprived of motion, lies as if dead; and if not quickly returned into the frefh air, is irrecoverable. And if we attend to the hiftories of thofe who have fuffered from the vapours of burning charcoal, we fhall in like manner find, that the brain and moving powers are the parts primarily affected.

"A cook who had been accuftomed to make ufe of lighted charcoal more than his bufinefs required, and to ftand with his head over thefe fires, complained for a year of very acute pain in the head; and after this was feized with a paralytic affection of the lower limbs, and a flow fever.

"A perfon was left reading in bed with a pan of charcoal in a corner of the room. On being vifited early the next morning, he was found with his eyes fhut, his book open and laid on one fide, his candle extinguifhed, and to appearance like one in a deep fleep. Stimulants and cupping-glaffes gave no relief; but he was foon recovered by the free accefs of frefh air.

"Four prifoners, in order to make their efcape, attempted to deftroy the iron work of their windows, by the means of burning charcoal. As foon as they commenced their operations, the fumes of the charcoal being confined by the clofenefs of the prifon, one of them was ftruck dead; another was found pale, fpeechlefs, and without motion; afterwards he fpoke incoherently, was feized with a fever, and died. The other two were with great difficulty recovered.

Apoplexia.

"Two boys went to warm themfelves in a ftove heated with charcoal. In the morning they were found deftitute of fenfe and motion, with countenances as compofed as in a placid fleep. There were fome remains of pulfe, but they died in a fhort time.

"A fifherman depofited a large quantity of charcoal in a deep cellar. Same time afterwards his fon, a healthy ftrong man, went down into the cellar with a pan of burning charcoal and a light in his hand. He had fcarcely defcended to the bottom, when his candle went out. He returned, lighted his candle, and again defcended. Soon after, he called aloud for affiftance. His mother, brother, and a fervant, hafted to give him relief; but none of them returned. Two others of the village fhared the fame fate. It was then determined to throw large quantities of water into the cellar; and after two or three days, they had accefs to the dead bodies.

"Cœlius Aurelianus fays, that thofe who are injured by the fumes of charcoal become cataleptic. And Hoffman enumerates a train of fymptoms, which in no refpect correfpond with his idea of fuffocation. Thofe who fuffer from the fumes of burning charcoal, fays he, have fevere pains in the head, great debility, faintnefs, ftupor, and lethargy.

"It appears from the above hiftories and obfervations, that thefe vapours exert their noxious effects on the brain and nerves. Sometimes they occafion fudden death; at other times, the various fymptoms of a debilitated nervous fyftem, according as the poifon is more or lefs concentrated. The olfactory nerves are firft and principally affected, and the brain and nervous fyftem by fympathy or confent of parts. It is well known, that there is a ftrong and ready confent between the olfactory nerves and many other parts of the nervous fyftem. The effluvia of flowers and perfumes, in delicate or irritable habits, produce a train of fymptoms, which, though tranfient, are analogous to thofe which are produced by the vapours of charcoal; viz. vertigo, ficknefs, faintnefs, and fometimes a total infenfibility. The female malefactor, whom Dr Mead inoculated by putting into the noftrils doffils of cotton impregnated with variolous matter, was, immediately on the introduction, afflicted with an excruciating headach, and had a conftant fever till after the eruption.

"The vapours of burning charcoal, and other poifonous effluvia, frequently produce their prejudicial, and even fatal effects, without being either offenfive to the fmell or oppreffive to the lungs. It is a matter of importance, therefore, that the common opinion fhould be more agreeable to truth; for where fuffocation is fuppofed to be the effect, there will be little apprehenfion of danger, fo long as the breaft keeps free from pain or oppreffion.

"It may be well to remember, that the poifon itfelf is diftinct from that grofs matter which is offenfive to the fmell; and that this is frequently in its moft active ftate when undiftinguifhed by the fenfe. Were the

Comata. the following cautions generally attended to, they might in some instances be the happy means of preserving life. Never to be confined with burning charcoal in a small room, or where there is not a free draught of air by a chimney or some other way. Never to venture into any place in which air has been long pent up, or which from other circumstances ought to be suspected; unless such suspected place be either previously well ventilated, or put to the test of the lighted candle: for it is a singular and well-known fact, that the life of flame is in some circumstances sooner affected and more expeditiously extinguished by noxious vapours than animal-life; a proof of which I remember to have received from a very intelligent clergyman, who was present at a musical entertainment in the theatre at Oxford. The theatre was crowded; and during the entertainment, the candles were observed to burn dim, and some of them went out. The audience complained only of faintness and languor; but had the animal effluvia been still further accumulated or longer confined, they would have been extinguished as well as the candles.

"The most obvious, effectual, and expeditious means of relief to those who have unhappily suffered from this cause, are such as will dislodge and wash away the poison, restore the energy of the brain and nerves, and renew the vital motions. Let the patient therefore be immediately carried into the open air, and let the air be fanned backwards and forwards to assist its action; let cold water be thrown on the face; let the face, mouth, and nostrils, be repeatedly washed; and as soon as practicable, get the patient to drink some cold water. But if the case be too far gone to be thus relieved, let a healthy person breathe into the mouth of the patient; and gently force air into the mouth, throat, and nostrils. Frictions, cupping, bleeding, and blisters, are likewise indicated. And if, after the instant danger is removed, a fever be excited, the method of cure must be adapted to the nature and prevailing symptoms of the fever."

With regard to the poison of opium, Dr Mead recommends the following method of cure. Besides evacuations by vomiting, bleeding, and blistering, acid medicines and lixivial salts are proper. These contract the relaxed fibres, and by their diuretic force make a depletion of the vessels. Dr Mead says he has given repeated doses of a mixture of salt of wormwood and juice of lemons, with extraordinary success. But nothing perhaps is of greater consequence, than to use proper means for the prevention of sleep, by rousing and stirring the patient, and by forcing him to walk about; for if he be once permitted to fall into a sound sleep, it will be found altogether impossible to awake him.

Of a kind somewhat akin to the poison of opium seems to be that of laurel-water, a simple water distilled from the leaves of the lauro-cerasus or common laurel. The bad effects of this were particularly observed in Ireland, where it had been customary to mix it with brandy for the sake of the flavour; and thus two women were suddenly killed by it. This gave occasion to some experiments upon dogs, in order to ascertain the malignant qualities of the water in question; and the event was as follows: All the dogs fell immediately into totterings and convulsions of the limbs, which were soon followed by a total paralysis, so that no motion could be excited even by pricking or cutting them. No inflammation was found upon dissection, in any of the internal membranes. The most remarkable thing was a great fulness and distension of the veins, in which the blood was so fluid, that even the lymph in its vessels was generally found tinged with red. The same effects were produced by the water injected into the intestines by way of clyster. Apoplexia.

To make the experiment more fully, Dr Nicholls prepared some of this water so strong, that about a dram of heavy essential oil remained at the bottom of three pints of it, which by frequent shaking was again quite incorporated with it. So virulent was this water, that two ounces of it killed a middle-sized dog in less than half a minute, even while it was passing down his throat. The poison appeared to reside entirely in the above-mentioned essential oil, which comes over by distillation, not only from the leaves of laurel, but from some other vegetables; for ten drops of a red oil distilled from bitter almonds, when mixed with half an ounce of water, and given to a dog, killed him in less than half an hour.

Volatile alkalies are found to be an antidote to this poison; of which Dr Mead gives the following instance. About an ounce of strong laurel-water was given to a small dog. He fell immediately into the most violent convulsions, which were soon followed by a total loss of his limbs. When he seemed to be expiring, a phial of good spirit of sal ammoniac was held to his nose, and a small quantity of the same forced down his throat: he instantly felt its virtue; and by continuing the use of it for some time, he by degrees recovered the motion of his legs; and in two hours walked about with tolerable strength, and was afterwards quite well.

With regard to the pernicious effects of cold, there is no other way of counteracting them but by the application of external heat. We are apt to imagine, that the swallowing considerable quantities of ardent spirits may be a means of making us resist the cold, and preventing the bad effects of it from arising to such a height as to destroy life; but these do not appear to be in the least possessed of any such virtue in those countries liable to great excesses of cold. The cinchona, by strengthening the solids, as well as increasing the motion of the fluids, is found to answer better than any other thing as a preservative: but when the pernicious effects have already begun to discover themselves, nothing but increasing by some means or other the heat of the body can possibly be depended upon: and even this must be attempted with great care; for as, in such cases, there is generally a tendency to mortification in some of the extremities, the sudden application of heat will certainly increase this tendency to such a degree as to destroy the parts. But for the external treatment of such mortifications, see the article SURGERY.

Sp. VII. APOPLEXY from *Passions* of the *Mind*. 262

Carus à pathemate, *Sauv.* sp. 11.
Asphyxia à pathemate, *Sauv.* sp. 7.
Ecstasis catoche, *Sauv.* sp. 1.
Ecstasis resoluta, *Sauv.* sp. 2.

Apoplexies

Comata.

Apoplexies from violent paſſions may be either ſanguineous or ſerous, though more commonly of the former than the latter ſpecies. The treatment is the ſame in either caſe. Or they may partake of the nature of catalepſy; in which caſe the method of treatment is the ſame with that of the genuine catalepſy.

263 Sp. VIII. The *Cataleptic* Apoplexy.

Catalepſis, *Sauv.* gen. 176. *Lin.* 129. *Vog.* 230. *Sag.* gen. 281. *Boerh.* 1036. *Junck.* 44.

Dr Cullen ſays he has never ſeen the catalepſy except when counterfeited; and is of opinion that many of thoſe caſes related by other authors have alſo been counterfeited. It is ſaid to come on ſuddenly, being only preceded by ſome languor of body and mind; and to return by paroxyſms. The patients are ſaid to be for ſome minutes, ſometimes (though rarely) for ſome hours, deprived of their ſenſes, and all power of voluntary motions; but conſtantly retaining the poſition in which they were firſt ſeized, whether lying or ſitting; and if the limbs be put into any other poſture during the fit, they will keep the poſture in which they are placed. When they recover from the paroxyſm, they remember nothing of what paſſed during the time of it, but are like perſons awaked out of ſleep.—Concerning the cure of this diſorder we find nothing that can be depended upon among medical writers.

264 Sp. IX. Apoplexy from *Suffocation*.

Aſphyxia ſuſpenſorum, *Sauv.* ſp. 4.
Aſphyxia immerſorum, *Sauv.* ſp. 1.

This is the kind of apoplexy which takes place in thoſe who are hanged or drowned. For the treatment of thoſe perſons, ſee the articles Drowning and Hanging.

Beſides the ſpecies above mentioned, the apoplexy is a ſymptom in many other diſtempers, ſuch as fevers both continued and intermitting, exanthemata, hyſteria, epilepſy, gout, worms, iſchuria, and ſcurvy.

265 Genus XLIII. PARALYSIS.

The Palsy.

Paralyſis, *Boerh.* 1057.
Hemiplegia, *Sauv.* gen. 170. *Lin.* 103. *Vog.* 220.
Paraplexia, *Sauv.* gen. 171.
Paraplegia, *Lin.* 102. *Vog.* 227.
Paralyſis, *Sauv.* gen. 169. *Lin.* 104. *Vog.* 226. *Junck.* 115.
Atonia, *Lin.* 120.

266 Sp. I. The *Partial Palsy*.

Paralyſis, *Sauv.* gen. 169. *Lin.* 104. *Vog.* 226. *Junck.* 115.
Paralyſis plethorica, *Sauv.* ſp. 1.
Paralyſis ſeroſa, *Sauv.* ſp. 12.
Paralyſis nervea, *Sauv.* ſp. 11.
Mutitas à gloſſolyſi, *Sauv.* ſp. 1.
Aphonia paralytica, *Sauv.* ſp. 8.

Paralyſis.

Sp. II. Hemiplegia, or *Palsy of one ſide of the* Body. 267

Hemiplegia, *Sauv.* gen. 170. *Lin.* 108. *Vog.* 228. *Sag.* gen. 276.
Hemiplegia ex apoplexia, *Sauv.* ſp. 7.
Hemiplegia ſpaſmodica, *Sauv.* ſp. 2.
Hemiplegia ſeroſa, *Sauv.* ſp. 10.

Sp. III. Paraplegia, or *Palsy of one half of the* Body *taken tranſverſely*. 268

Paraplexia, *Sauv.* gen. 171. *Sag.* gen. 277.
Paraplegia, *Lin.* 102. *Vog.* 227.
Paraplexia ſanguinea, *Sauv.* ſp. 2.
Paraplexia à ſpina bifida, *Sauv.* ſp. 3.
Paraplexia rheumatica, *Sauv.* ſp. 1.

Deſcription. The palſy under all the different forms here mentioned as particular ſpecies, ſhows itſelf by a ſudden loſs of tone aud vital power in a certain part of the body. In the ſlighter degrees of the diſeaſe, it only affects a particular muſcle, as the ſphincter of the anus or bladder, thus occaſioning an involuntary diſcharge of excrements or of urine; of the muſcles of the tongue, which occaſions ſtammering, or loſs of ſpeech; of the muſcles of the larynx, by which the patient becomes unable to ſwallow ſolids, and ſometimes even liquids alſo.—In the higher degrees of the diſeaſe, the paralytic affection is diffuſed over a whole limb, as the foot, leg, hand, or arm; and ſometimes it affects a whole ſide of the body, in which caſe it is called *hemiplegia;* and ſometimes, which is the moſt violent caſe, it affects all the parts below the waiſt, or even below the head, though this laſt be exceedingly rare. In theſe violent caſes, the ſpeech is either very much impeded, or totally loſt. Convulſions often take place in the ſound ſide, with the cynic ſpaſm or involuntary laughter, and other diſtortions of the face. Sometimes the whole paralytic part of the body becomes livid, or even mortifies before the patient's death; and ſometimes the paralytic parts gradually decay and ſhrivel up, ſo as to become much leſs than before. Whether the diſeaſe be more or leſs extended, many different varieties may be obſerved in its form. Sometimes there occurs a total loſs of ſenſe while motion is entire; in others a total loſs of motion with very ſlight or even no affection of ſenſe; and in ſome caſes, while a total loſs of motion takes place in one ſide, a total loſs of ſenſe has been obſerved on the other. This depends entirely on the particular nerves or branches of nerves in which the affection is ſituated; loſs of ſenſe depending on an affection of the ſubcutaneous nerves; and loſs of motion on an affection of thoſe leading to the muſcles.

Cauſes, &c. Palſies moſt commonly ſupervene upon the different ſpecies of coma, eſpecially the apoplexy. They are alſo occaſioned by any debilitating power applied to the body, eſpecially by exceſſes in venery. Sometimes they are a kind of criſis to other diſtempers, as the colic of Poictou, and the apoplexy. The hemiplegia eſpecially often follows the laſt-mentioned diſeaſe. Aged people, and thoſe who are by any other means debilitated, are ſubject to palſy; which will ſometimes alſo affect even infants, from the repulſion of exanthemata of various kinds. Palſies are alſo the infallible conſequences of injuries to the large nerves.

3 B Prognoſis.

Comata.

Prognosis. Except in the slighter cases of palsy, we have little room to hope for a cure; however, death does not immediately follow even the most severe paralytic affections. In hemiplegia it is not uncommon to see the patients live several years; and even in the paraplegia, if death do not ensue within two or three weeks, it may not take place for a considerable time. It is a promising sign when the patient feels a slight degree of painful itchiness in the affected parts; and if a fever should arise, it bids fair to cure the palsy. When the sense of feeling remains, there is much more room to hope for a cure than where it is gone, as well as the power of motion. But when we observe the flesh to waste, and the skin to appear withered and dry, we may look upon the disease to be incurable. Convulsions supervening on a palsy are a fatal sign.

Cure. Many remedies have been recommended in palsies: but it must be confessed, that, except in the slighter cases, medicines seldom prove effectual; and before any plan of cure can be laid down, every circumstance relative to the patient's habit of body and previous state of health should be carefully weighed. If hemiplegia or paraplegia should come on after an apoplexy, attended with those circumstances which physicians have supposed to denote a viscid state of the blood, a course of the attenuant gums, with fixed alkaline salts, and chalybeate waters, may do service; to which it will be proper to add frictions with the volatile liniment down the spine: but in habits where the blood is rather inclined to the watery state, it will be necessary to give emetics from time to time; to apply blisters, and insert issues.

The natural hot baths are often found useful in paralytic cases; and where the patients cannot avail themselves of these, an artificial bath may be tried by dissolving salt of steel in water, and impregnating the water with fixed air. Frictions of the parts, and scourging them with nettles, have also been recommended, and may do service, as well as volatile and stimulating medicines taken inwardly. And it is probably by operating in this manner, that the use of camphor, or a mercurial course continued for some length of time to such a degree as gently to affect the mouth, have been found productive of a cure in obstinate cases of this affection. Of late years, an infusion of the arnica montana or German leopard's bane, has been highly extolled in the cure of this disease, by some foreign writers: but the trials made with it in Britain, particularly at Edinburgh, have been by no means equally successful with those related by Dr Collins, who has strongly recommended this medicine to the attention of the public. Another remedy has of late been highly extolled in palsy, the rhus toxicodendron or poison oak. It has been employed with some success in France by Mr Fresnoi; and Dr Alderson of Hull, in a late dissertation on this plant, has published several cases, even of very obstinate palsy, in which its use was attended with wonderful success. In some cases also at Edinburgh, it has been used with apparent advantage, but in a much greater number without any benefit.

In certain cases of palsy, unexpected cures have been accomplished both by electricity and by galvanism. But in a considerable majority of instances, palsy from which the patient has not what may be called a natural recovery, will be found incurable by any remedies which have hitherto been recommended.

Syncope.

Sp. IV. The Palsy from *Poisons*. 269

Paralysis metallariorum, *Sauv.* sp. 22.
Hemiplegia saturnina, *Sauv.* sp. 14.

This kind of palsy arises most frequently from lead taken into the body, and is a consequence of the colica pictonum, under which it is more particularly treated.

TREMOR, or Trembling. 270

Tremor, *Sauv.* gen. 129. *Lin.* 139. *Vog.* 184. *Sag.* 236.

This by Dr Cullen is reckoned to be always symptomatic either of palsy, asthenia, or convulsions; and therefore need not be treated of by itself.

Order II. ADYNAMIÆ. 271

Adynamiæ, *Vog.* Class VI.
Defectivi, *Lin.* Class VI. Order I.
Leipopsychiæ, *Sauv.* Class VI. Order IV. *Sag.* Class IX. Order IV.

Genus XLIV. SYNCOPE. 272

Fainting.

Syncope, *Sauv.* gen. 174. *Sag.* 94. *Vog.* 274. *Sag.* 280. *Junck.* 119.
Leipothymia, *Sauv.* gen. 173. *Lin.* 93. *Vog.* 273. *Sag.* 279.
Asphyxia, *Sauv.* gen. 175. *Lin.* 95. *Vog.* 275. *Sag.* 281.
Virium lapsus et animi deliquia, *Hoffm.* III. 267.

Sp. I. The *Cardiac* Syncope. 273

Syncope plethorica, *Sauv.* sp. 5. *Senac.* Tr. de Cœur, p. 540.
Syncope à cardiogmo, *Sauv.* sp. 7. *Senac.* de Cœur, 414. *Morgagn.* de Sed. XXV. 2. 3. 10.
Syncope à polypo, *Sauv.* sp. 8. *Senac.* p. 471.
Syncope ab hydrochardia, *Sauv.* sp. 12. *Senac.* 533. *Schreiber* Almag. L. III. § 196.
Syncope *Lanzoni*, *Sauv.* sp. 18. *Lanzon.* Op. II. p. 462.
Asphyxia Valsalviana, *Sauv.* sp. 13.

Sp. II. *Occasional* Syncope. 274

Leipothymia à pathemate, *Sauv.* sp. 1. *Senac.* p. 544.
Syncope pathetica, *Sauv.* sp. 21.
Asphyxia à pathemate, *Sauv.* sp. 7.
Syncope ab antipathia, *Sauv.* sp. 9. *Senac.* p. 544.
Syncope à veneno, *Sauv.* sp. 10. *Senac.* p. 546.
Syncope ab apostematis, *Sauv.* sp. 11. *Senac.* p. 554.
Syncope à sphacelo, *Sauv.* sp. 14. *Senac.* p. 553.
Syncope ab inanitione, *Sauv.* sp. 1. *Senac.* p. 536.
Syncope à phlebotomia, *Sauv.* sp. 4.
Syncope à dolore, *Sauv.* sp. 2. *Senac.* p. 583.

Asphyxia

Adynamiæ.

Aſphyxia traumatica, *Sauv.* ſp. 14.
Aſphyxia neophytorum, *Sauv.* ſp. 17.

Deſcription. A ſyncope begins with a remarkable anxiety about the heart; after which follows a ſudden extinction, as it were, not only of the animal powers and actions, but alſo of the vital powers, ſo that the patients are deprived of pulſe, ſenſe, and motion, all at once. In thoſe caſes which phyſicians have diſtinguiſhed by the name of *leipothymia*, the patient does not entirely loſe his ſenſes, but turns cold and pale; and the pulſe continues to beat, though weakly; the heart alſo ſeems to tremble rather than beat; and the reſpiration is juſt perceptible. But in the true ſyncope or full aſphyxia, not the ſmalleſt ſign of life can be perceived; the face has a death-like paleneſs, the extremities are cold, the eyes ſhut, or at leaſt troubled; the mouth ſometimes ſhut, and ſometimes gaping wide open; the limbs flaccid, and the ſtrength quite gone; as ſoon as they begin to recover, they fetch deep and heavy ſighs.

Cauſes, &c. Fainting is occaſioned moſt commonly by profuſe evacuations, eſpecially of blood; but it may happen alſo from violent paſſions of the mind, from ſurfeits, exceſſive pain, &c. People of delicate conſtitutions are very ſubject to it from ſlight cauſes; and ſometimes it will ariſe from affections of the heart and large veſſels not eaſy to be underſtood. Fainting is alſo a ſymptom of many diſorders, eſpecially of that fatal one called a *polypus of the heart*, of the plague, and many putrid diſeaſes.

Prognoſis. When fainting happens in the beginning of any acute diſtemper, it is by no means a good omen; but when it takes place in the increaſe or at the height of the diſeaſe, the danger is ſomewhat leſs; but in general, when fainting comes on without any evident cauſe, it is to be dreaded. In violent hæmorrhagies it is favourable; as the bleeding veſſels thus have time to contract and recover themſelves, and by this means the patient may eſcape.

Cure. When perſons of a full habit faint through exceſs of paſſion, they ought to be blooded without delay, and ſhould drink vinegar or lemon juice diluted with water; and, after the bowels are emptied by a clyſter, take a paregoric draught, and go to bed.

The paſſion of anger, in a peculiar manner, affects the biliary ſecretion, cauſes an oppreſſion at the ſtomach, with nauſea and retching to vomit, and a bitter taſte in the mouth, with giddineſs: theſe ſymptoms ſeem to indicate an emetic; which, however, in theſe caſes muſt be carefully avoided, as it might endanger the patient, by bringing on an inflammation of the ſtomach.

The general effects of a ſudden fright have been mentioned on a former occaſion. When theſe are ſo violent as to require medical aid, our firſt endeavours muſt be to take off the ſpaſmodic conſtriction, and reſtore freedom to the circulation; by bleeding, if the habit be at all inclined to fulneſs; and by giving a mixture, with equal parts of the vinum antimoniale and tinctura opii camphorata, in ſome agreeable vehicle, which will bring on ſleep and encourage perſpiration. It was formerly mentioned, that convulſions, or even an epilepſy, may be brought on by frights; which ſhould make people cautious of playing fooliſh tricks in this way.

Dyſpepſia.

When a ſurfeit, or any ſpecies of ſaburra, occaſions a leipothymia, an emetic is the immediate remedy, as ſoon as the patient, by the help of acrid ſtimulants, ſhall be ſo far rouſed as to be able to ſwallow one: in theſe caſes, tickling the fauces with a feather dipt in ſpirit of hartſhorn, will be proper, not only to rouſe the patient, but alſo to bring on vomiting.

A ſyncope is moſt commonly brought on by profuſe diſcharges or evacuations, either of the blood or of the ſecreted humours.

In order to revive the patients, they ought to be laid along in a horizontal poſture, in an airy place; the legs, thighs, and arms, are to be rubbed with hot flannels; very ſtrong vinegar, aromatic vinegar, or ſalt of hartſhorn, or volatile alkaline ſpirit, are to be held to the noſtrils, and rubbed into them; or, being properly diluted, poured down the throat; cold water is to be ſprinkled on the face and neck; and when by theſe means the patient ſhall be ſufficiently revived, wine boiled up with ſome grateful aromatic, is to be given in the proper quantity.

In the fainting conſequent upon profuſe uterine hæmorrhagies, it will be a ſafer practice to abſtain from all heating and ſtimulant things; as life, in theſe caſes, is preſerved by the coagulation of the blood in the extremities of the open veſſels; which might be prevented by the pouring in hot wine or volatile alkaline ſpirits.

When a ſyncope is the conſequence of the too violent operation of either an emetic or cathartic, the tinctura thebaica, mixed with ſpiced wine, is the moſt efficacious remedy; but the opiate muſt be given gradually, and in very ſmall doſes.

A ſyncope, or even aſphyxia, wherein the patient ſhall lie for ſeveral hours, is frequent in hyſteric conſtitutions; and during the fit requires fetid antiſpaſmodics, together with acrid ſtimulants: to prevent returns, nothing anſwers better than the cinchona joined with chalybeates.

Genus XLV. DYSPEPSIA. 275

Depraved Digestion.

Dyſpepſia, *Vog.* 277.
Apepſia, *Vog.* 276.
Diaphora, *Vog.* 278.
Anorexia, *Sauv.* gen. 162. *Lin.* 116. *Sag.* gen. 286.
Cardialgia, *Sauv.* gen. 202. *Lin.* 48. *Vog.* 157. *Sag.* gen. 160.
Gaſtrodynia, *Sauv.* gen. 203. *Sag.* gen. 161.
Soda, *Lin.* 47. *Vog.* 161.
Nauſea, *Sauv.* gen. 250. *Lin.* 182. *Vog.* 159. *Sag.* gen. 185.
Vomitus, *Sauv.* gen. 251. *Lin.* 183. *Vog.* 214. *Sag.* gen. 186.
Flatulentia, *Sauv.* gen. 272. *Lin.* 165. *Vog.* 127. *Sag.* gen. 207.

The idiopathic ſpecies are,

Anorexia pituitoſa, *Sauv.* ſp. 2.
Anorexia à ſaburra, *Sauv.* ſp. 9.
Anorexia exhauſtorum, *Sauv.* ſp. 8.

Adynamiæ.

Anorexia paralytica, *Sauv.* sp. 1.
Nausea ex cacochylia, *Sauv.* sp. 11.
Vomitus pituitosus, *Sauv.* sp. 26.
Vomitus ruminatio, *Sauv.* sp. 6.
Vomitus à saburra, *Sauv.* sp. 2.
Vomitus à crapula, *Sauv.* sp. 1.
Vomitus lacteus, *Sauv.* sp. 3.
Flatulentia infantilis, *Sauv.* sp. 5.
Flatulentia acida, *Sauv.* sp. 1.
Flatulentia nidrosa, *Sauv.* sp. 2.
Cardialgia bradypepta, *Sauv.* sp. 9.
Cardialgia à saburra, *Sauv.* sp. 2.
Cardialgia lactantium, *Sauv.* sp. 11.
Cardialgia flatulenta, *Sauv.* sp. 3.
Cardialgia paralytica, *Sauv.* sp. 7.
Gastrodynia saburralis, *Sauv.* sp. 1.
Gastrodynia flatulenta, *Sauv.* sp. 2.
Gastrodynia periodynia, *Sauv.* sp. 7.
Gastrodynia astringens, *Sauv.* sp. 9.
Gastrodynia atterens, *Sauv.* sp. 10.
Gastrodynia à frigore, *Sauv.* sp. 18.

Besides these there are a great number of symptomatic species.

Description. It is by no means easy to define exactly the distemper called *dyspepsia*, when considered as an original disease, as there are very few maladies which some way or other do not show themselves by an affection of the stomach; and much more difficult still must it be to enumerate all its symptoms. The most remarkable, however, and the most common, are the following: Want of appetite; distension of the stomach when no food has been taken for some time before; slight dejection of spirits; a gradual decay of the muscular strength; languor, and aversion from motion; the food which is taken without appetite is not well digested; the stomach and intestines are much distended with flatus, whence the patients are tormented with spasms, gripes, and sickness: frequently a limpid water, having an acid or putrid taste, is brought up; sometimes the food itself is thrown up by mouthfuls; and sometimes, though rarely, the same is swallowed again, after the manner of ruminating animals. While matters are in this situation, the heart sometimes palpitates, and the breath is quick, and drawn with difficulty; the head aches and is giddy; and sometimes both these symptoms are continual, and very violent, insomuch that the patient is not only tormented with pain, but staggers as if he was drunk. From the too great acescency or putrefaction of the aliment, a cardialgia or heartburn comes on; and in this situation a spontaneous diarrhœa sometimes carries off the disease; but in other cases there is an obstinate costiveness, attended with colic-pains. Frequently the pulse is quick, sometimes slow, but always weak: the circulation is so languid, that the blood can scarce reach the extreme vessels, or at least stagnates in them, so that the face becomes livid, swelled, and has an unusual appearance: and at the same time that the circulation and nervous power are in this languid state, the perspiration becomes less copious; the skin becomes dry and corrugated; the natural heat, especially of the extremities, is much diminished; the tongue is white; and an universal laxity takes place, insomuch that the uvula and velum pendulum palati are sometimes enlarged to such a degree as to become extremely troublesome. The patient is either deprived of rest, or wakes suddenly out of his sleep, and is disturbed by frightful dreams; at the same time that the mind seems to be affected as well as the body, and he becomes peevish, fretful, and incapable of paying attention to any thing as usual. At last hectic symptoms come on, and the whole frame becomes so irritable, that the slightest cause excites an universal tremor, and sometimes violent vomiting and diarrhœa. Sometimes the salivary glands are so relaxed, that a salivation comes on as if excited by mercury; the serum is poured out into the cavity of the abdomen and cellular substance of the whole body, and the patient becomes affected with anasarca or ascites.

Dyspepsia.

Causes, &c. The causes of dyspepsia may be any thing which debilitates the system in general, but in a particular manner affects the stomach. Such are, opium taken in immoderate quantities, which hurts by its sedative and relaxing powers; spirituous liquors drunk to excess; tobacco, tea, coffee, or any warm relaxing liquor, taken in too great quantity; acid, unripe fruits; vomits or purges too frequently taken; an indolent sedentary life, &c. &c. All these act chiefly upon people of a weak and delicate habit; for the robust and hardy seldom labour under a dyspepsia, or at most a very slight one.

Prognosis. When a dyspepsia first occurs, it is frequently removed without great difficulty; when it is symptomatic, we must endeavour to cure the primary disease; and without this we cannot expect a complete removal of the affection; but when it frequently returns, with symptoms of great debility, hectic fever, or dropsy, we have great reason to dread the event.

Cure. A radical cure of dyspepsia is only to be expected by removing from the stomach and system that debility on which the disease depends. On this ground, the objects chiefly to be aimed at in the cure are, 1st, The avoiding whatever will tend to diminish the vigour of the stomach; 2d, The employing such remedies as have influence in increasing that vigour; and, in the third place, The obviating urgent symptoms, particularly those which tend to increase and support the affection. Of the avoiding causes, which tend to diminish the vigour of the stomach, after what has already been said of the causes inducing the disease, it is unnecessary to make any farther observations; and indeed every dyspeptic patient will be taught by experience what is to be done with this intention. The medicines chiefly employed with the view of increasing vigour are those of the tonic kind: but, previous to their use, it will be necessary to evacuate the contents of the alimentary canal by vomits or purgatives. If there be a tendency to putrescency, antiseptics must then be exhibited; but more frequently there is a prevailing acidity, which creates an intolerable heart-burn. To palliate this symptom, magnesia alba may be given; which is much preferable to the common testaceous powders, as being purgative while dissolved in an acid, when the others are rather astringent. In the third volume of the Medical Observations, we have an account of two cases of dyspepsia attended with a very uncommon degree of cardialgia, in which magnesia was so succesful, that we can hardly doubt of its efficacy in slighter degrees of the disorder.

But

Adynamiæ. But although acidity may often be ſucceſsfully obviated in this manner, yet the beſt way of counteracting this ſymptom, as well as of obviating coſtiveneſs, flatulence, and a variety of others, is by reſtoring the tone of the ſtomach in particular, and indeed of the ſyſtem in general. With this intention, recourſe is had to a variety of tonics both from the mineral and vegetable kingdom; particularly chalybeates in different forms, gentian, colombo, and the like; but of all the tonics which can be employed in this affection, none are attended with greater benefit than exerciſe and cold bathing; and the proper and prudent employment of theſe is no leſs effectual in removing the diſeaſe, than in preventing the return of it after it is once removed.

276 Genus XLVI. HYPOCHONDRIASIS.

Hypochondriac Affection.

Hypochondriaſis, *Sauv.* gen. 220. *Lin.* 76. *Vog.* 218. *Sag.* 332.
Morbus hypochondriacus, *Boerh.* 1098.
Malum hypochondriacum, *Hoffm.* III. 65. *Junck.* 36.

Although ſome of the noſological writers, particularly Sauvages, have conſidered this genus as conſiſting of different ſpecies, Dr Cullen is of opinion, that there is only one idiopathic ſpecies, the *hypochondriaſis melancholica.* He conſiders not only the hypochondriaſis hyſterica, phthiſica, and aſthmatica, but alſo the bilioſa, ſanguinea, and pituitoſa, as being only ſymptomatic; but he views the true melancholic hypochondriaſis as being a proper idiopathic diſeaſe, perfectly diſtinct from hyſteria, with which it has often been confounded.

Deſcription. The ſymptoms of hypochondriaſis are, ſtretching, preſſing, griping, and tormenting pains, under the ribs, and chiefly in the left ſide; which ſometimes are exaſperated, and become pungent, burning, or lancinating. Frequently there is an inflation of the left hypochondrium, which ſometimes becomes ſtationary, and by Hippocrates was taken for a ſymptom of an enlarged ſpleen. When theſe ſymptoms take place in the right hypochondrium, they are commonly attended with colic pains, uncertain flying heats, eſpecially in the head, with a tranſient redneſs of the face, and very frequently an œdematous ſwelling of the feet ſucceeds. To theſe are ſuperadded almoſt all the affections of the ſtomach occurring in dyſpepſia, beſides a variety of other ſymptoms, ſuch as palpitations, ſleepleſs nights, and the like. But beſides theſe, there occurs alſo a particular depreſſion of ſpirit and apprehenſion of danger, which may be conſidered as one of the great characterizing ſymptoms of the diſeaſe.

Cauſes, &c. The general cauſes of the hypochondriac affection are ſaid to be a plethora, and preternatural thickneſs of the blood; ſuppreſſions of cuſtomary evacuations; high and full diet, together with a ſparing quantity of drink; an hereditary diſpoſition; indolence; atony of the inteſtines; violent paſſions of the mind, &c.

Prognoſis. The hypochondriac affection, when left to itſelf, is more troubleſome than dangerous; but, if improperly treated, it may bring on various diſeaſes of a more fatal tendency, ſuch as the melancholy, bloody urine and nephritis, jaundice, vertigo, palſy, apoplexy. &c. Chloroſis.

Cure. This is to be attempted by ſuch medicines as counteract occaſional cauſes, and obviate urgent ſymptoms, which may be all comprehended under bleeding, gentle evacuants, chalybeates, the cinchona, and exerciſe, eſpecially riding on horſeback, which in this diſeaſe is greatly preferable to any other. When the circumſtances of the patient can afford it, a voyage to Spain, Portugal, or ſome of the warmer countries in Europe, will be of great ſervice.

Genus XLVII. CHLOROSIS. 277

Green sickness.

Chloroſis, *Sauv.* gen. 309. *Lin.* 222. *Vog.* 305. *Sag.* gen. 135. *Boerh.* 1285. *Hoffm.* iii. 311. *Junck.* 86.

Of this genus alſo Dr Cullen thinks there is but one idiopathic ſpecies: viz. what ſome diſtinguiſh by the title of *chloroſis virginea,* others of *chloroſis amatoria.*

Deſcription. This diſeaſe uſually attacks girls a little after the time of puberty, and firſt ſhows itſelf by ſymptoms of dyſpepſia. But a diſtinguiſhing ſymptom is, that the appetite is entirely vitiated, and the patient will eat lime, chalk, aſhes, ſalt, &c. very greedily; while at the ſame time there is not only a total inappetence to proper food, but it will even excite nauſea and vomiting. In the beginning of the diſeaſe, the urine is pale, and afterwards turbid; the face becomes pale, and then aſſumes a greeniſh colour; ſometimes it becomes livid or yellow: the eyes are ſunk, and have a livid circle round them; the lips loſe their fine red colour; the pulſe is quick, weak, and low, though the heat is little ſhort of a fever, but the veins are ſcarcely filled; the feet are frequently cold, ſwell at night, and the whole body ſeems covered with a ſoft ſwelling; the breathing is difficult: nor is the mind free from affection more than the body; it becomes irritated by the ſlighteſt cauſes; and ſometimes the patients love ſolitude, become ſad and thoughtful. There is a retention of the menſes throughout the whole courſe of the diſorder; and at laſt all the bad ſymptoms increaſing, a leucophlegmaſia, anaſarca, atrophy, and death, ſucceed.

Cauſes. The cauſe of chloroſis is thought to be an atony of the muſcular fibres of the alimentary canal, eſpecially of the ſtomach, joined with a ſimilar atony of the perſpiratory veſſels over the whole ſurface of the body, and the whole depending on an atony of thoſe ſmall arteries which pour out the menſtrual blood. This atony may be occaſioned by the ſame cauſes which bring on dyſpepſia and hypochondriaſis, but very frequently ariſes from love and other paſſions of the mind.

Prognoſis. The chloroſis in all caſes is tedious, though it does not generally prove fatal; but we can never promiſe a certain cure unleſs the menſes make their appearance.

Cure. The remedies here in general are the ſame as in the dyſpepſia and hypochondriaſis; only in the chloroſis ſtronger purgatives may be made uſe of: thoſe which ſtimulate the rectum are uſeful by ſtimu-

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lating alſo the veſſels of the uterus; and for this reaſon indulgence in venery has ſometimes been ſaid to produce a cure, particularly with love-ſick maids. The cold bath is alſo extremely proper.

278 ORDER III. SPASMI.

Spasmi, *Sauv.* Claſs IV. *Vog.* Claſs V. *Sag.* Claſs VIII.
Motorii, *Lin.* Claſs VII.
Morbi ſpaſmodici et convulſivi, *Hoffm.* III. 9.
Spaſmi et convulſiones, *Junck.* 45, 54.
Epilepſia, *Boerh.* 1071, 1088.

279 GENUS XLVIII. TETANUS.

Tetanus, *Sauv.* gen. 122. *Lin.* 127. *Vog.* 180. *Sag.* gen. 228.
Catochus, *Sauv.* gen. 123. *Lin.* 128. *Vog.* 183. *Sag.* gen. 229.
Opiſthotonos, *Vog.* 181.
Epiſthotonos, *Vog.* 182.

On this diſtemper Dr Lionel Chalmers has publiſhed a diſſertation in the firſt volume of the Medical Obſervations, which being ſuperior to any thing that has appeared in other medical writers on the ſubject, we ſhall here lay before the reader.

"Of all the diſeaſes to which man is ſubject, none deſerves more to be conſidered than the opiſthotonos and tetanus, either with regard to the variety of painful ſymptoms which almoſt without intermiſſion diſtract the ſick, or the danger of the diſeaſes themſelves, from which few recover, in compariſon of the number they attack. In both, the vital actions are very imperfectly performed, moſt of thoſe which are called *natural* being as it were ſuſpended at once; and ſo far is the patient from being able to execute any voluntary motion, that the whole machine undergoes the moſt excruciating diſtortions, from the violent and unnatural contractions of the muſcles. Happy it is for the inhabitants of the more temperate climates, that ſuch diſeaſes appear rarely among them; but in thoſe countries which lie in the more ſouthern and warmer latitudes, they are endemic, eſpecially to negro ſlaves. In South Carolina, they ſhow themſelves at all ſeaſons, but not ſo often in winter, more frequently in ſpring and autumn; and are moſt common in the ſummer, when people work abroad and are alternately expoſed to the ſcorching heat of the ſun and heavy ſhowers, which often happen ſuddenly, and greatly alter the temperature of the air. Others are ſeized with the opiſthotonos after ſleeping without doors, that they may enjoy the deceitful refreſhment of the cool night-air, when the weather is warm: one youth choſe to cut off his hair and ſhave his head on a warm day in March, and went to bed without a cap; but the weather changed, and became cold in the night, and he was found rigid with tetanus next morning.

"Theſe diſeaſes ſo rarely appear as originals in Europe, that a good hiſtory of them cannot be expected from the phyſicians who practiſe in that part of the world; nor has any thing like a full deſcription been given of them by any ancient or modern author which I have ſeen. Hippocrates indeed takes notice of them in many places, and ſeems to regard them only as conſequences of other diſeaſes, or of wounds or ulcers of the nervous or tendinous parts; of which ſymptomatic kind of opiſthotonos he gives three remarkable caſes in *lib.* v. § vii. *de Morb. vulg.* and repeats them in another place: but the few ſymptoms he recounts do not ſhow themſelves with us. Galen, Cœlius Aurelianus, Aretæus, &c. ſeem only to have copied Hippocrates, with the addition of ſome ſuppoſititious ſymptoms, which really do not appear; and the little that Bontius ſays of it is very faulty.

"Among the numerous claſs of ſpaſmodic diſeaſes, there are three which diſtinguiſh themſelves in a very particular manner, on which the names of *emproſthotonos*, *opiſthotonos*, and *tetanus*, have been juſtly enough beſtowed, as being expreſſive of the poſture into which they throw and confine the patient. When therefore thoſe muſcles which bend the head, neck, and body forwards, ſuffer ſuch involuntary, violent, and continued contractions, as to fix the chin to the breaſt, incurvate the ſpine and body, and retain the ſick in this painful and prone poſture, the diſeaſe is called *emproſthotonos*. When the poſterior muſcles are ſimilarly affected, ſo that the head is drawn towards the ſpine, and the ſpine itſelf is recurvated, it has then the name of *opiſthotonos;* although in fact, in this, all thoſe muſcles which act in deglutition, bend the head forwards, or turn it to either ſide, are equally contracted with thoſe which raiſe the head and ſpine. The *tetanus* differs from, or rather is compounded of, both the others; for in this the patient is found rigid and inflexible, being as it were braced between the oppoſite contractions of the anterior and poſterior muſcles; yet even here the head is much retracted.

"I never ſaw the *emproſthotonos;* and ſhall only ſpeak of the *opiſthotonos* and *tetanus*, the firſt being by far the moſt common, and in the laſt ſtage of which the tetanus frequently ſupervenes. Let it be obſerved, that the following deſcription by no means reſpects ſuch ſymptomatic contractions as often happen immediately before death, both in acute and chronic diſeaſes; neither will it agree with that ſpurious *opiſthotonos* or *tetanus* which appear ſometimes in the firſt and ſecond ſtages of quotidian intermittents in this country, however they may emulate the true diſeaſes in ſome of their ſymptoms.

"Stad. I. The *opiſthotonos*, contrary to what Bontius aſſerts, often comes on gradually and by ſlight approaches, the patient complaining rather of an uneaſy ſtiffneſs in the back-part of the neck and about the ſhoulders, than of any acute pain, with ſome degree of a general laſſitude. Theſe increaſe, and become ſo troubleſome when he attempts to turn his head, or to bend it forward, as to oblige him to walk very erect; for he can by no means look downward, nor to either ſide, without turning his whole body. He cannot open his jaws without pain; and has ſome difficulty in ſwallowing, which diſcourages him from attempting to eat. At times he feels a ſudden and painful traction under the *cartilago enſiformis*, which ſtrikes through to the back, and inſtantly increaſes the rigidity about the neck and ſhoulders, draws the head backward a little, and ſhuts the jaws cloſer. The pain under the *ſternum* returns more frequently and with greater violence;

Spasmi.

lence; and the other contractions become so strong, that the head from this time continues much retracted, and he now refuses nourishment, as swallowing is attended with great pain, and occasions a return of the spasm; which extends along the spine quite to the lower extremities, so that they will no longer support him, and he is under the necessity of going to bed.

"In this manner passes over the first stage of the *opisthotonos*, which sometimes takes up three or four days; the patient, as well as those about him, mistaking the first appearances of it for that rheumatic complaint, which is commonly called a *crick in the neck*; but it sometimes forms itself much quicker, and invades the unfortunate person with the whole train of its mischievous symptoms in a few hours: in which case, the danger may truly be estimated from the violence of the first attack; for such generally die in 24 36, or 48 hours, and very rarely survive the third day. But when it is less acute, few are lost after the ninth or eleventh; which number of days it would not be possible for them to complete, unless the violence of the disease was in a good measure subdued; although I had one who recovered, after having been subject to its tyrannical attacks daily for six weeks. In this stage the pulse is slow, and very hard, and the belly is bound; blood taken away seems not to be altered from the natural state, so that no indication can be deduced therefrom, and it only varies with regard to laxity or compaction, according to the age of the person and season of the year.

"Stad. II. The spasm under the sternum (which is the pathognomonic symptom of this disease) becomes more violent, returning every 10 or 15 minutes; and never fails to be instantly succeeded by a stronger retraction of the head, with great rigidity and pain all round the neck, and along the spine to the lower extremities, which are suddenly put to the stretch. The countenance is very pale and contracted; the jaws are that moment snapped together, and cannot afterwards be opened so wide as to receive the end of one's little finger; an attempt to do which, by way of experiment, almost constantly hurries on the spasm. The mastoid, coraco-hyoid and sterno-hyoid muscles, as well as all the others concerned in deglutition, and the deltoid and pectorals, are most violently contracted, so that the shoulders are strongly raised forward, and the arms are stretched out or drawn across the body; but the wrists and fingers seem not to be affected.

"Such is the condition of the patient in the time of the spasm, which ceases in a few seconds: after which the shoulders and arms recline, and the inferior extremities relax; yet not so entirely, but that such a degree of rigidity for the most part remains as will not permit them to bend when this is attempted by another person; for as to the sick himself, he cannot at all move them. The muscles on the sides and forepart of the neck continue still contracted, although not so strongly; but their action is overcome by the number and strength of the posterior ones; so that the retraction of the head constantly remains. The patient breathes quick for some minutes, as if he had been excessively exercised; and the pulse is small, fluttering, and irregular, but both become more calm and slow. The face is sometimes pale in the intervals, but oftener flushed; and the whole countenance expresses strong appearances of the most melancholy distress, as well because of the dread he has of a return of the spasm, which he is sure will soon happen, as from the pain he suffers by the present contractions, and the more general and severe ones which he has so lately sustained. The tongue is stiff and torpid; but so far as it can be seen, is not foul, The belly is always bound, and cannot easily be loosened. In drinking, the liquid passes with great difficulty to the stomach, even in the smallest quantity; and if the spasm should seize him at that time, which an attempt to swallow for the most part occasions, the liquor returns through the nose with some force. The patients desire to lie still as much as possible; and avoid drinking, speaking, or being moved, either of which are apt to occasion a return of the spasm.

Tetanus.

"Stad. III. In this last stage, the patient is reduced to the most calamitous and distressful circumstances: for he is on a continual rack, according to the most literal meaning of that word; the spasm returning oftener than once in a minute, is much more violent, and holds him longer, so that he has scarcely any remission. The anterior muscles of the whole body now suffer equal contractions with the posterior; but the last overcome the force of the others, so that the spine is strongly recurvated, and forms a hollow arch with the bed, and he rests on the back part of the head and the heels. The belly is flat, and is drawn inward; and the muscles are so rigidly contracted, that they will not give way to pressure, and do not seem in the least to yield to the descent of the diaphragm in inspiration; the several muscles about the neck, sides, and abdomen, being plainly distinguishable from each other. Although the lower extremities are always rigid in this state, yet are they so suddenly and violently distended in the time of the spasms, that were it not for the standers by, the patient would be projected feet foremost off the bed; while others again are as it were pushed upward with such a spring, that the head is struck with great force against whatever happens to be in the way, the thighs and legs being in this case no less rigid than the other parts. The tongue is spasmodically darted out, and is often miserably torn, as the teeth are that moment snapped together; so that it is necessary to prevent this by keeping the handle of a spoon, wrapped round with soft rags, between the teeth, when this can be done. At the time that the tongue is thus thrust out, the muscular flesh, which lies between the arch of the lower jaw and head of the trachea, seems to be drawn upwards within the throat. The countenance is very much contracted, and he is in a foam of sweat, the heat being very great; and the pulse between the spasms is exceedingly quick, small, and irregular, although the heart throbs so strongly, that its motions may be plainly seen, and a palpitating subsultory kind of undulation may not only be felt, but perceived all over the epigastric region. The eyes are watery and languid, and a pale or bloody froth bubbles out from between the lips. The jaws are for the most part locked fast, so that it is impossible to give drink or nourishment, nor could he swallow any thing that was put into his mouth. In this state patients are commonly delirious: and as they cannot subsist many hours under so great a suspension of the vital and natural functions, a mortal anxiety ensues and releases

Spafmi. releafes them; oftener a continued and fevere fpafm finifhes the tragedy, when it was before almoft at an end: but moft frequently a general convulfion puts a period to their fufferings; and whichever way this happens, they for the moft part relax juft before death.

"In the *tetanus*, the general fymptoms are nearly the fame as in the opifthotonos, except that from the firft attack, the lateral, abdominal, and other anterior mufcles, are equally contracted with the pofterior ones; and the arms become rigid as well as the lower extremities. The abdomen is always flat and rigid as in the laft ftage of the opifthotonos, and its contents feem to be thruft up into the thorax, which at the fame time appears to be much dilated. There are here alfo fome intervals between the fpafms, in the time of which the cheeks are drawn towards the ears, fo that all the teeth may be feen as in the fpafmus cynicus. Deglutition is more free in this than in the other difeafe; yet fo far is the fick from being equally balanced between the contractions of the oppofite mufcles, that the head is retracted and the fpine is recurvated, although not quite fo much as in the opifthotonos. And the fpafm, which commences under the fternum, is likewife common to the tetanus, which terminates as the other, and on the fame fatal days. But whoever recovers from either, labours long under a general atonia; and they cannot for fome months raife themfelves from a fupine or recumbent pofture without pain, nor without help for fome time."

Prognofis and Cure. There has never been any thing like a crifis obferved in thefe frightful cafes, or favourable termination from the mere efforts of nature; and therefore all the phyfician's dependence muft be upon art. As in cafes of tetanic affections, the difeafe often arifes from fome particular irritation, the removal of this muft neceffarily be an important object in the cure: But where it cannot be removed, benefit may often be obtained by the prevention of its influence being communicated to the brain. When, however, that influence is communicated to the brain, a cure is to be expected only by diminifhing and obviating it. This is principally brought about by the ufe either of thofe means which have a general tendency to diminifh action, or of thofe which induce a different ftate of action. On thefe grounds the operation of thofe remedies which are employed with greateft fuccefs in this affection, may, we apprehend, be explained. Fortunately it has been found, that opium is capable of giving fome relief, if adminiftered in proper time, and if the difeafe happens not to be in the moft violent degree: the warm bath muft alfo be brought in aid; and the patients fhould lie horizontally in the bath, and while in it have the whole body extremely well rubbed: when taken out, they are not to be dried, but immediately put to bed wrapt in the fofteft blankets; and while they remain there, the belly ought either to be ftuped, or two or three bladders filled with warm water kept conftantly lying on it. The bowels at the fame time muft, if poffible, be kept open, by folutions of manna and *fal polychreft*, or fome other purging falt, mixed with *oleum ricini*; or if that fhould not be at hand, with oil of fweet almonds and a little tincture of fena. The opiates are to be given in large and frequently repeated dofes; fuch as a grain of the *extractum thebaicum*, or 20 drops of the tincture, every fecond or third hour; and it will be fafeft not to truft to the thebaic tincture which is kept ready prepared in the fhops, but to order the neceffary dofe of folid opium, and either give it in pills or diffolve it in fome convenient liquid. If fwallowing fhould be difficult, or the jaws clofed up, the opium muft be given in clyfters; for during the whole courfe of the difeafe it will be of fervice to order emollient clyfters to be injected from time to time, fince thefe will anfwer not only as a relaxing fomentation, but alfo contribute to keep the inteftinal canal perfectly free.

Tetanus. When the patients recover, they continue for a long time very relaxed and weak: and no wonder, fince it is the nature of all fpafmodic affections to leave behind them extreme weaknefs and relaxation of the mufcular fibres. In order to perfect the recovery, a courfe of the cinchona and the Peruvian balfam is to be tried; and the fpine may be rubbed with fpirituous liniments, or with a mixture of rum and Barbadoes tar: but thefe and all other ftimulating things, either internally or externally, during the violence of the fpafms, muft, in the opinion of fome practitioners, be omitted, fince all of them as well as blifters have been alleged to exafperate the difeafe.

This, in general, is the plan of treatment recommended by Dr Chalmers.

The fame dreadful diforders frequently attack young children in the warm climates. Dr Hillary tells us, that they will there arife from the fame caufes which ufually produce convulfions with children in Britain, viz. from a retention of the meconium, or firft excrement after birth; or from a glutinous matter which is too often found in the inteftines of young children foon after the other is difcharged; or from a cheefy matter from the coagulation of the milk by an acid in the ftomach; or from hard excrements; or from fomething taken in by the mouth which is over acrid, or too hard to digeft, which irritates their tender bowels, and fo produces ftartings and convulfive fpafms, with all the other fymptoms which precede and accompany convulfions in young children in Britain. And this fhows how much more readily and eafily the nerves are affected and irritated in that warm climate, and the *tetanus* produced from a much lefs caufe there, than it is in Britain, where it is but feldom feen. But thefe caufes not being timely removed, their acrimony is increafed, partly by the heat of the climate, and partly by the fever which they produce, which ftill renders them more acrid, and fo increafes the irritation of their bowels, that it firft brings on ftartings, then convulfive fpafms, and regular convulfion fits; which, if not foon removed, ufually end in a perfect *tetanus*, and the difeafe is but feldom cured in fuch young children when it arrives at that ftate: for when the child lies in this miferable, rigid, immoveable condition, upon moving its hands or feet in the moft gentle manner, or foftly touching any part of its body, or giving it the leaft motion, even feeling its pulfe in the moft tender manner, or the leaft noife, or even touching its clothes, will bring on the convulfive fpafms, and caufe it to be ftrongly convulfed backwards, or drawn into a rigid ftraight line, ftrongly extended and immoveable like a ftatue, and will fo remain immoveable out of either of thofe poftures for a confiderable time, a minute or two; and when the difeafe is arrived at this degree, Dr Hillary thinks

Spaſmi. Tetanus.

thinks it is never cured. But if the phyſician be called in time, before the *tetanus* has come on (which is too ſeldom the caſe there), though he finds ſtrong convulſive ſpaſms have ſeized the child, or that it has had a convulſive fit or two, it may moſt commonly be relieved, the coming of the *tetanus* be prevented, and the life of the babe ſaved, as Dr Hillary has more than once ſeen, by removing and carrying off the irritating cauſe which ſtimulates their tender bowels, by ſuch gentle evacuations as are ſuitable to their age; and then quieting and compoſing the irritation of their nerves by proper anodynes, and correcting the remaining acrimony of the nutritious juices in the *primæ viæ*.

To anſwer theſe intentions, the following method, with variations *pro re nata et pro ratione ætatis*, as the cauſe is different, has been found to anſwer the deſired effect the beſt: ℞ *Seri lactis* ℥ij. *Sapon. Venet.* ℈j. *Mannæ Calab.* ʒij. *vel* iij. *Ol. amygd. dul.* ℥ſs. *Ol. fœniculi dul. gut.* ij. *Balſ. Peruv. gut.* v. *Miſce. Fi enema quam primum injiciendum.*

And if the ſymptoms of the approaching *tetanus* will permit, he gives ſomething of the following nature to aſſiſt the operation of the clyſter, and to carry off the acrimony the ſooner: ℞ *Aq. ſem. fœniculi* ℥iij. *Magneſ. albæ* ʒſs. *Ocul. cancr. præp.* ʒj. *Syr. è cichor. cum rheo, Roſar. ſolut. ana* ʒiij. *Miſce.* Or, ℞ *Aq. ſem. fœniculi* ʒiij. *Sapon. amygdal.* ʒſs. *Magneſ. albæ* ʒſs. *Syr. è cichor. cum rheo, Mannæ opt. ana* ʒij. *Ol. amygd. dul.* ʒiij. *Miſce: Exhibe cochl. parv. vel duo pro ratione ætatis, omni ſemihora, vel omni hora, donec reſpond. alvus.*

Two or three ſtools being obtained by theſe, the following is exhibited in order to abate the convulſive twitchings, and prevent the *tetanus* from coming on: ℞ *Aq. ſem. fœniculi* ℥iij. *Magneſ. albæ* ʒſs. *Ocul. cancr. præp.* ʒj. *Moſchi orient. gr.* iij. *Spir. C. C. gut.* xv. *Syr. è mecon.* ʒſs. *Miſce: Exhibe cochl. parv.* (a child's ſpoonful) *ter quaterve de die, vel ſæpius, urgent. convulſ. vel ſpaſm.*

But if the ſymptoms ſhow that the *tetanus* is more immediately coming on, ſo that we have no time to wait till the operation of the clyſter and opening laxative be over, ſomething of the following nature muſt be immediately given; or the *tetanus* will come on, and moſt probably prove fatal to ſuch tender babes. ℞ *Aq. fœniculi* ʒiiij. *Moſchi orient. gr.* j. *Tinct. thebaic. gut.* iiij. *Syr. è mecon.* ʒij. *Miſce pro duobus doſ. de quibus exhibe unam quamprimum, et alteram ſi convul. ſpaſm. redeunt.*

This, Dr Hillary obſerves, may be thought a bold attempt, to give *tinct. thebaica* to ſuch a tender young infant: but it is to be conſidered that the little patient will certainly die if the *tetanus* ſeize it, and that it will come on if this do not prevent it: and he has known a bold ignorant old midwife give four or five drops of that tincture to a very young infant without any prejudice more than its doſing three or four hours, though not in this caſe, but in one much leſs violent.

The clyſter may be given at the ſame time, and the opening laxative not long after it: though it may retard the operation of that for ſome time, yet it operates ſoon after, and gives relief; after which the other medicines, and fomenting the body and anointing it as before, may be uſed, if the phyſician finds it neceſſary; alſo a little of the laxative mixture may be given once or twice a day, if the above julep does not anſwer the intention of keeping the child's body open for a few days afterwards, which in this caſe is generally found neceſſary to be obſerved.

Theſe methods and medicines may be varied according to circumſtances. For neither the ſame method nor the ſame medicines will anſwer in all caſes, though the diſeaſe be the ſame; but they muſt be changed as the cauſes differ, or the conſtitution of the ſick, or the time of the diſeaſe, or as ſome other circumſtances may require: which is a thing of great importance, not only in this, but in the cure of moſt other diſeaſes.

When proper medicines are thus timely and judiciouſly given in this caſe, they ſeldom fail to carry off the irritating cauſe, quiet and eaſe the nerves, remove the convulſions and ſpaſms: and conſequently prevent the tetanus from coming on, and the death of the patient. But if calling in the phyſician be deferred till the tetanus has already ſtrongly ſeized the child, as is too often the caſe here, neither warm bathing, fomenting, nor any other methods or medicines whatever, will remove it or its cauſes, nor ſave the life of the little tender patient.

Dr Chalmers gives an account of his having cured one child ſeized with a *tetanus*, by purging with an infuſion of rhubarb: to which a few grains of muſk, and a little *ol. tartar. per deliq.* were added, together with the warm bath, and the frequent injection of clyſters made with an infuſion of chamomile flowers, to each of which was added a ſmall portion of Caſtile ſoap. It is much to be regretted, however, that in thoſe caſes where the aſſiſtance of the medical art is moſt wanted, it moſt generally fails. We have been aſſured by a gentleman who practiſed for ſome time in the warm parts of America, that out of 30 caſes of the tetanus he had ſeen, not one of the patients recovered, though he had given opium to the quantity of 20 grains thrice a-day; and others, he was aſſured, had taken 30 grains thrice a-day. In the beginning of the diſeaſe, the medicine produced a violent headach; but towards the end, it had no manner of effect whatever. In two patients, the diſeaſe came on from the ſlighteſt cauſes imaginable. The one accidentally fell in attempting to avoid a loaded cart, and put the heel of his ſhoe upon one of his thumbs in riſing; the other, in avoiding the ſame cart, ſlightly ruffled the ſkin of his noſe. Both were ſeized with the tetanus; and both died, notwithſtanding all poſſible aſſiſtance was given. The former had his thumb amputated without effect.

In the Edinburgh Phyſical and Literary Eſſays, vol. iii. Dr Donald Monro deſcribes a new method of cure, communicated to him by a gentleman who was formerly a practitioner in Jamaica. While this gentleman practiſed in that iſland, he had under his care a great number of caſes of tetanus attended with the locked jaw. At firſt, he uſed to give very freely of opium, muſk, and other medicines of this claſs; to bleed, and make other evacuations; while he uſed baths, fomentations, embrocations, and other external applications, but all without the leaſt ſucceſs; and, as he had loſt a great many patients without being ſo lucky as to make one cure, he began to believe that this diſorder always proved fatal, and was not to be cured by medicine, notwithſtanding what ſome practitioners

Spasmi. Tetanus.

titioners had alleged. However, having received an unexpected hint concerning the good effects of the mercurial ointment in such cases, he resolved to try it; and ordered the first patient that offered to be put into a warm room, and to be rubbed two or three times a-day with the ointment, till such time as a salivation was raised; when he with pleasure observed, that, as soon as the mercury began to affect the mouth, the convulsions of the muscles of the jaws, as well as all the other spasms and convulsions, ceased, and the patient was freed of all his complaints. After this, he treated every case of this kind which came under his care in the same manner, and cured twelve, which were all who applied to him for advice so early in the disorder that there was time to bring the mercury to the mouth before the fatal period was expected. A few died, in whom the disease was so far advanced before he saw them that there was no time to raise a salivation. None of the cases which were under this gentleman's care in the West Indies were the consequences of wounds or capital operations; nor has he had any opportunity of trying it since in cases of the locked jaw, which sometimes follows capital operations, owing to his having given over practice: but he thinks, that from the similarity of the complaint, there is no doubt that the mercurial frictions would be equally efficacious in such cases, as when the disorder comes from catching cold or other such causes.

In the second volume of the Medical Transactions, we have an account of a cure performed by Dr William Carter of Canterbury, by means very different from any of those above related.—On the 17th of May 1767, the doctor was called to a strong healthy man, in the 21st year of his age, and who had been confined to his bed for three weeks. What gave rise to his present disorder was an wound on the inner ankle of his right leg, which he had received six weeks before from a joiner's chisel. At that time his mouth was so far closed, as to admit only the most liquid nourishment, which he constantly sucked through his teeth: but his legs and jaw, and the whole length of the spina dorsi, were quite immoveable, being as stiff and rigid as those of a person long dead; his head was drawn backward, and he was frequently strongly convulsed. The motion indeed of both his arms was but a little impaired. From the beginning to the end, his sight, hearing, and memory, continued perfect; his appetite was good; and his senses, in the daytime, entire, though sometimes wandering in the night. At to his pulse, it was regular; if it deviated at all from the pulse of a person in health, it was rather slow than quick, and somewhat fuller than natural. Such was the situation of his patient; a detail of which had been given before the doctor set out on his journey, which he undertook with a determined resolution to make use of the method recommended by Dr Silvester, in the first volume of Medical Observations and Inquiries, published in the year 1757, (and which has been related from Dr Chalmers and Dr Hillary.) But, on his arrival at the house, he found great quantities of the *extractum thebaicum* dissolved had been already given him; and that, for the five last days, he had taken no less than 28 grains of that medicine, with 50 grains of musk, in the space of 24 hours, without any sensible effect, except the bringing on a confused sleep, out of which he frequently awoke in great hurries, attended with a violent pain in the head, which almost deprived him of his senses. The doctor was afraid to extend the dose; and soon determined to take some other method, though at a loss what method to pursue, as, during a course of almost 30 years practice, nothing of the same kind had ever fallen under his cognizance before. Reflecting, however, that this disorder had always been deemed of the spasmodic kind, and that the good effects produced by the *extractum thebaicum* must probably be owing to the relaxing and resolving faculty of that medicine, he directed a blister to be applied between the shoulders, the whole length of the spine; the jaw to be anointed with the *oleum latertiium;* and a purge, consisting of the *tinctura sacra*, *tinctura jalappæ*, and the *syrupus de rhamno carthartico*, to be given him. This was repeated three several times afterwards, at the distance of three or four days between each dose. On the intermediate days, he was ordered the *oleum succini*, the fetid gum, and the *oleum amygdalinum.* Of the first he took 30 drops, of the gum 20 grains, and of the last four ounces, in 24 hours. By these means, and these only, the convulsions soon ceased; and he grew daily better and better, till at the end of a fortnight he was able to walk about his room, and in less than three weeks became in all respects well, some small weakness in the parts only excepted. The jaw was relieved first, after that the spine, and last of all the legs. A pain and uneasiness in the places affected, neither of which he had felt before, were the forerunners of his approaching amendment.

For all this it seems reasonable to conclude, either that there is no certain remedy for tetanus in all cases, or that the medicines which prove effectual in one constitution will fail in another. Thus, it is possible, that in cases where opium proves ineffectual, mercury may be a remedy; and, on the contrary, where mercury fails, opium may be effectual; and even where both are ineffectual, the antispasmodics recommended by Dr Carter may be of use. It is therefore necessary for physicians to be extremely careful to observe the effects of the first doses of their remedies: for if the symptoms show not the least appearance of remission after a large dose of opium, it is improbable that it can be cured by a repetition of the medicine; and as no time can be lost with safety, it will then be proper to apply mercurial ointment, or whatever else may be judged proper.—In the Edinburgh Medical Commentaries we have an account of the cold bath being used as a remedy, by Dr Thomas Cochrane, at that time physician at Nevis. The patient was an East Indian boy, who had been gored by a cow, and afterwards exposed to a rainy damp air for some hours. Dr Cochrane ascribes his cure to the cold bath, which was applied by dashing the water upon his body. But as the patient at the same time got laudanum, at first in the quantity of 200 drops a-day, and afterwards in still larger doses; and had besides his throat and shoulders anointed with warm oil of turpentine, was bled, and had lenient clysters and laxatives; it is by no means easy to say what share the cold bath had in his cure. Dr Cochrane, however, says he has heard of some cases being treated successfully by cold water and

cinchona

cinchona in St Euftatia and St Kitt's, and in another letter mentions his having ufed the cold bath in other cafes of tetanus with fuccefs. But fince Dr Cochrane's publication, a more full and fatisfactory account of the benefit of this practice has been communicated in a paper publifhed by Dr Wright, in the fixth volume of the London Medical Obfervations. Dr Wright gives a particular account of fix cafes, in which the beft effects were obtained from dafhing cold water upon the patient; and he obferves, that fince he firft ufed this method of cure he never failed in one inftance to effect a recovery, and that in a fhorter time than by any other method hitherto propofed. This practice has on fome occafions been adopted by practitioners in Britain, although here the difeafe is a much lefs frequent occurrence. It has particularly been employed with fuccefs by Dr Currie of Liverpool; and we hope that ftill more extenfive practice will confirm the benefit to be derived from it, although not in every inftance, yet in many cafes of this affection. We are, however, forry to fay that we have of late heard of feveral cafes in which it has been tried in Britain, and which, notwithftanding the ufe of it, had a fatal termination.

Very lately a different mode of cure in this affection has been recommended by Dr Rufh, profeffor of medicine in Philadelphia, in a paper entitled Obfervations on the Caufe and Cure of Tetanus, publifhed in the fecond volume of the Tranfactions of the American Philofophical Society. Dr Rufh, viewing tetanus as being a difeafe occafioned by relaxation, thinks the medicines indicated to cure it are fuch only as are calculated to remove this relaxation, and to reftore tone to the fyftem. On this ground he recommends the liberal ufe of wine and cinchona; and tells us, that he has employed them with fuccefs in actual practice. When the difeafe arifes from an wound of any particular place, he recommends ftimulants to the part affected; fuch as dilatation of the wound, and filling it with oil of turpentine. How far this practice will be confirmed by more extenfive experience, we cannot take upon us to determine. We may only obferve, that a very contrary practice has been recommended as highly fuccefsful by fome practitioners in Spain, where tetanic affections are a very frequent occurrence in confequence of flight accidents. There gentle emollients are ftrongly recommended, particularly immerfing the wounded part in tepid oil for the fpace of an hour or fo at a time, and repeating this application at fhort intervals. By this mode many cafes, after very alarming appearances had taken place, are faid to have been completely and fpeedily removed. While the practice is very fimple, it appears at the fame time in many refpects very rational, and may perhaps be confidered as well deferving a trial in the firft inftance.

Among other remedies employed in tetanus it has been faid that the fpafms have fometimes been allayed by a ftrong electric fhock. And in obftinate cafes electricity or galvanifm certainly well deferve a trial.

280 Genus XLIX. TRISMUS.

The *Locked Jaw*.

Trifmus, *Sauv.* gen. 117. *Lin.* 124. *Sag.* gen. 223.
Capiftrum, *Vog.* 208.

Sp. I. *Trismus nascentium*.

Locked Jaw in children under two months old. 281

Trifmus nafcentium, *Sauv.* fp. 1. *Heifter Comp.* Med. Pract. cap. xv. § 10. *Cleghorn* on the Difeafes of Minorca, Introd. p. 33. *Hofer.* in Act. Helvet. tom. i. p. 65.

This diftemper is fo clofely connected with the tetanus, that it ought rather to be accounted a fymptom of the tetanus than a primary difeafe. And nothing need now be added to what has been faid refpecting tetanus.

Sp. II. The *Trismus* from *Wounds* or *Cold*. 282

Trifmus traumaticus, *Sauv.* fp. 2. *Lond. Med. Obf.* vol. i. art. 1, 7. Vol. ii. 34. Vol. iii. 31. Vol. iv. 7.
Angina fpafmodica, *Sauv.* fp. 18. *Zwingeri*, Act. Helvet. tom. iii. p. 319.
Convulfio à nervi punctura, *Sauv.* fp. 2.
Trifmus catarrhalis, *Sauv.* fp. 15. *Hillary's* Barbadoes, 221. *Lond. Med. Obf.* vol. iv. 7.

The internal remedies proper in all cafes of the locked jaw, from whatever caufe it may proceed, have been already mentioned under Tetanus: the external treatment of wounded parts which may give occafion to it belongs to the article Surgery. But of this alfo we have offered fome obfervations under the head of Tetanus; and, indeed, trifmus may be confidered as being merely an incipient tetanus, or rather a flight degree of that difeafe.

Genus L. CONVULSIO. 283

Convulsions.

Convulfio, *Sauv.* gen. 128. *Lin.* 142. *Vog.* 191. *Sag.* gen. 235.
Convulfio univerfalis, *Sauv.* fp. 11.
Hieranofos, *Lin.* 144. *Vog.* 190.
Convulfio habitualis, fp. 12.
Convulfio intermittens, *Sauv.* fp. 16.
Convulfio hemitotonos, *Sauv.* fp. 15.
Convulfio abdominis, *Sauv.* fp. 10.
Convulfio ab inanitione, *Sauv.* fp. 1.
Convulfio ab onanifmo, *Sauv.* fp. 13.
Scelotyrbe feftinans, *Sauv.* fp. 2.

Defcription. When convulfions attack only particular parts of the body, they are generally attended with fome kind of paralyfis at the fame time, by which means the affected parts are alternately convulfed and relaxed; a permanent convulfion, or unnatural contraction of particular mufcles, is called a *fpafm* or *cramp*. Thefe partial convulfions may attack almoft any part of the body; and are not unfrequently fymptomatic, in fevers, the cholera morbus, &c. The involuntary ftartings of the tendons, the picking of the bedclothes, &c. in acute difeafes, are all of them convulfive diforders. Convulfions, even when moft generally extended, differ from epilepfy in not being attended with any mental affection or abolition of fenfe, and not followed by the fame torpid ftate.

Caufes. Convulfions, not only of particular parts, but alfo over the whole body, often take place from caufes not very evident. Sometimes they feem to depend

Spasmi.

pend on a certain delicacy or irritability of the nervous system, which is framed with such exquisite sensibility as to be strongly affected by the slightest causes. Delicate women are often subject to hysterical convulsions, and also hypochondriac people. Convulsions, however, often take their rise from wounds, irritations of the stomach and intestines by worms, poisons, violent cathartics and emetics, &c.; and very often they are symptomatic, as in dentition, the smallpox, and many kinds of fevers.

Prognosis. Except in some few cases, convulsive disorders are always to be dreaded; but less in young people than in such as are advanced in life. Those which attack girls under the age of puberty, will generally cease on the appearance of the menses; and boys have likewise a chance of being relieved as they advance in life: but in grown-up people, unless the cause be very evident, a cure is hardly to be expected, especially after the disease has been of long continuance.

Cure. The treatment is very much the same with that of epilepsy, afterwards to be considered: but a recovery is most frequently obtained by the removal of the existing cause.

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Genus LI. CHOREA.

St Vitus's Dance.

Scelotyrbe, *Sauv.* gen. 136. *Sag.* 243.
Chorea, *Lin.* 139.
Scelotyrbe chorea Viti, *Sauv.* sp. 1.
Chorea St Viti, *Sydenh.* Sched. Monit.

Description. This disease shows itself first by a kind or lameness or instability of one of the legs, which the patients draw after them in a ridiculous manner: nor can they hold the arm of the same side still for a moment; for if they lay it on their breast, or any other part of their body, it is immediately forced away by a convulsive motion. If they be desirous of drinking, they use a number of odd gesticulations before they can bring the cup to their mouths, because their arms are drawn this way and that by the convulsions which affect them.

Causes, &c. The general cause of St Vitus's dance is a debility of the system; and hence, we find it attacks only weakly boys, and more especially girls, when under the age of puberty. But the particular causes determining the muscles to be affected in such and such a manner are entirely unknown.

Prognosis. As this disorder scarce ever attacks any persons but such as are under the age of puberty, there is almost a certain prospect of its being then cured, though generally the disorder is easily removed before that time.

Chorea, however, in some instances, proves an obstinate affection; but is hardly in any instance attended with danger.

Cure. It has hitherto been almost universally the common practice to treat this disease with antispasmodics and tonics, particularly opium, hyoscyamus, valerian, cinchona, preparations of iron, zinc, and copper, and cold bathing; and under the use of these the disease has, in general, been removed. But Dr James Hamilton, senior physician to the Royal Infirmary of Edinburgh, in a treatise which he has lately published on the use of purgative medicines, has recommended a very different practice in this disease, the use, viz. of brisk cathartics: these he advises to be repeated daily for some time. The great object, however, which he has in view, is not to evacuate from the system, but to produce a thorough and complete evacuation of the intestinal canal. He finds, that by the first doses, large quantities of black-coloured matter are discharged; and he recommends that the use of the purgatives should be persisted in till the stools assume a natural appearance. In confirmation of the utility of this practice, he has related several cases in which it produced a speedy and complete cure; and equal success has attended this practice when directed by several others. There can therefore be no hesitation in recommending it at least in every obstinate instance of chorea.

Raphania.

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Genus LII. RAPHANIA.

Raphania, *Lin.* 155. *Vog.* 143. *Lin.* Amœn. Acad. vol. vi.
Convulsio raphania, *Sauv.* sp. 7.
Eclampsia typhodes, *Sauv.* sp. 1. *Sennert.* de febr. l. iv. cap. 16. *Gregor. Horst.* Oper. tom. ii. l. viii. obs. 22. *Brunner* in Ephem. Germ. D. iii. A. ii. obs. 224. *Willisch.* ibid. cent. vii. obs. 13. *Wepfer.* de Affect. Capitis, obs. 120. *Breslauer* Sammlung 1717, Julio, Septembri, et Decembr. Ibid. 1723, Januar. A. N. C. vol. vii. obs. 41. *Bruckmann.* Comb. Norimb. 1743, p. 50.

Description. According to Sauvages, this distemper begins with a lassitude of the limbs, transient colds and shiverings, pain of the head, and anxieties of the præcordia. Then come on spasmodic startings of the fingers and feet; also of the tendons and muscles, conspicuous below the skin. The disease is attended with heat, fever, delirium, stupor, constriction of the breast, suffocating dyspnœa, loss of voice, horrid convulsions of the limbs, preceded by a formication, or sensation as of ants or other small insects creeping on the parts. In this state of the disease, the convulsive paroxysms are attended with most violent pains in the limbs, vomiting, or diarrhœa, with the passing of worms, thirst, and in young people an unnatural hunger. It continues from ten days to three months. About the eleventh or twentieth day, some are relieved by copious sweats, or purple exanthemata: while others fall into a tabes, with stupor, or stiffness of the joints.

Causes, &c. This disease is frequently epidemic in Suabia and other parts of Germany; where it is said to be produced by seeds of radishes, which are often mixed with rye in that country; and from this supposed cause the disease takes its name. It is also, however, a very common opinion, that this disease depends on the rye used in diet being of a bad quality, and particularly containing a large proportion of what is called *spurred rye.*

Cure. In this affection, the cure, as far as it has yet been discovered, is very much the same with that of epilepsy, the disease next to be considered. But from what has been said of the advantages derived from the use of purgatives in chorea, analogy would lead us to make a trial of them also in cases of raphania.

GENUS

286 GENUS LIII. EPILEPSIA.

FALLING SICKNESS.

Epilepſia, *Sauv.* gen. 134. *Lin.* 143. *Vog.* 188. *Sag.* gen. 24. *Boerh.* 1071. *Hoffm.* III. 9. *Junck.* 54.
Eclampſia, *Sauv.* gen. 133. 180. *Sag.* gen. 240.

287 Sp. I. The *CEREBRALIS*, or *Epilepſy* depending on an affection of the *Brain*.

Epilepſia plethorica, *Sauv.* ſp. 1.
Eclampſia plethorica. *Sauv.* ſp. 7.
Epilepſia cachectica, *Sauv.* ſp. 2.

288 Sp. II. The *SYMPATHICA*, or *Sympathetic Epilepſy*, with a ſenſation of ſomething riſing from a certain part of the body towards the head.

Epilepſia ſympathica, *Sauv.* ſp. 8.
Epilepſia pediſymptomatica, *Sauv.* ſp. 6.

289 Sp. III. The *OCCASIONALIS*, or *Epilepſy* ariſing from various irritating cauſes.

Epilepſia traumatica, *Sauv.* ſp. 13.
Eclampſia traumatica, *Sauv.* ſp. 9.
Epilepſia à dolore, *Sauv.* ſp. 10.
Epilepſia rachialgica, *Sauv.* ſp. 14.
Eclampſia à doloribus, *Sauv.* ſp. 4.
a, Rachialgica.
b, Ab otalgia.
c, A dentitione.
Eclampſia parturientium, *Sauv.* ſp. 3.
Eclampſia verminoſa, *Sauv.* ſp. 2.
Eclampſia ab atropa, *Sauv.* ſp. 11.
Eclampſia ab œnanthe, *Sauv.* ſp. 12.
Eclampſia à cicuta, *Sauv.* ſp. 13.
Eclampſia à coriaria, *Sauv.* ſp. 14.
Epilepſia exanthematica, *Sauv.* ſp. 11.
Epilepſia cachectica, *Sauv.* ſp. 2.
Epilepſia ſtomachica, *Sauv.* ſp. 3.
Eclampſia à ſaburra, *Sauv.* ſp. 5.
Epilepſia à pathemate, *Sauv.* ſp. 7.
Eclampſia ab inanitione, *Sauv.* ſp. 8.
Epilepſia neophytorum, *Sauv.* ſp. 15.

Deſcription. The epilepſy often attacks ſuddenly, and without giving any warning: but more frequently is preceded by a pain in the head, laſſitude, ſome diſturbance of the ſenſes, unquiet ſleep, unuſual dread, dimneſs of ſight, a noiſe in the ears, palpitation of the heart, coldneſs of the joints; and in ſome there is a ſenſation of formication, or a cold air, &c. aſcending from the lower extremities towards the head. In the fit, the perſons fall ſuddenly to the ground (whence the name of the *falling-ſickneſs*), frequently with a violent cry. The thumbs are ſhut up cloſe in the palms of the hands, and are with difficulty taken out; the eyes are diſtorted, ſo that nothing but the whites are to be ſeen; all ſenſation is ſuſpended, inſomuch, that by no ſmell, noiſe, or otherwiſe, nor even by pinching the body, can they be brought to themſelves; they foam at the mouth, with a hiſſing kind of noiſe; the tongue is frequently lacerated by the teeth, and there is a violent convulſive motion of the arms and legs. Sometimes, however, the limbs, inſtead of being agitated by convulſive motions, are all ſtiff, and the patients are as immoveable as a ſtatue. In children, the penis is erected; and in young men there is an emiſſion of the ſemen, and the urine is often thrown out to a conſiderable diſtance. At length there is a remiſſion of the ſymptoms, and the patients recover after a longer or ſhorter interval; when they complain of a pain, torpor, or heavineſs of the head, with a laſſitude of all the joints.

Cauſes, &c. The diſſection of epileptic ſubjects has ſhown a variety of morbid appearances, which may be ſuppoſed to have contributed to the diſeaſe; ſuch as, indurations in the brain or meninges; caries of the internal ſurface of the cranium; projections of the bony ſubſtance of the ſame, preſſing upon the brain; collections of ſerum or purulent matter, and earthy concretions within the ſkull; beſides many others which are recorded by Bonetus, Morgagni, and Lieutaud. But often the cauſes are impoſſible to be diſcovered; for even in thoſe who have died of the diſeaſe, the brain and all other parts of the nervous ſyſtem have been apparently ſound. The diſeaſe will attack ſtrong as well as weak people; and in thoſe who are ſubject to it, any conſiderable exceſs in drinking, a ſurfeit, violent paſſion, or venery, &c. will certainly bring on a fit. Some have epileptic paroxyſms returning periodically after conſiderable intervals; and the diſeaſe has been thought to have ſome dependence on the phaſes of the moon.

Prognoſis. If the epilepſy comes on before the time of puberty, there are ſome hopes of its going off at that time. But it is a bad ſign when it attacks about the 21ſt year, and ſtill worſe if the fits grow more frequent; for then the animal functions are often deſtroyed, as well as thoſe of the mind, and the patient becomes ſtupid and fooliſh. Sometimes it will terminate in melancholy or madneſs, and ſometimes in a mortal apoplexy or palſy. It has ſometimes, however, been obſerved, that epilepſies have been removed by the appearance of cutaneous diſeaſes, as the itch, ſmallpox, meaſles, &c. While the diſeaſe is recent, therefore, we are not to deſpair of a cure; but if it be of long ſtanding, or hereditary, there is very little reaſon to expect that it can be removed.

Cure. From the ſymptoms occurring in epilepſy, which conſiſts of involuntary convulſive motions, and an affection of the mental powers, there is reaſon to conclude that the fit immediately depends on the induction of ſome peculiar action of the brain; but that convulſions may enſue from this cauſe, it would ſeem neceſſary that there ſhould alſo occur a peculiar diſpoſition to action in the moving fibres. On this ground, then, we may ſuppoſe the cure to be chiefly expected on one of two principles; either by our being able to prevent the peculiar action of the brain, or to remove the diſpoſition to action in the moving fibres. The firſt is chiefly to be accompliſhed by the removal of irritating cauſes, by preventing their influence from being propagated to the brain, when they are applied to remote parts; or by counteracting their influence, from inducing in the brain a ſtate of action different from that to which they give riſe. The ſecond end is chiefly to be obtained by diminiſhing the mobility of the nervous energy, and by ſtrengthening

Spafmi. Epilepfia.

ening the tone of the moving fibres. It muft, however be allowed, that in all convulfive diforders, excepting thofe which are cured by nature about the time of puberty, the cure by artificial means is very difficult. Numberlefs fpecifics have been recommended, but all of them have failed of anfwering the expectation. When the caufe can be difcovered, that muft be removed. In other cafes, the cold bath, valerian root, caftor, mufk, opium, the fetid gums, cinchona, with the whole tribe of nervous and antifpafmodic medicines, have been recommended: but none of thefe, or indeed any combination of them, have been found generally ufeful; though the flighter, or fymptomatic cafes, may often be removed by them.

Of late the *calx* or *oxide*, improperly called the *flowers*, of zinc, have obtained fuch reputation in convulfive diforders as to be received into the Edinburgh Pharmacopœia under the title of *oxidum zinci.* They were propofed by Dr Gaubius as an antifpafmodic, in his *Adverfaria;* and their efficacy has fince been confirmed by various obfervations. In an inaugural differtation publifhed by Dr Hart at Leyden, the medical virtues of the flowers of zinc are confidered. He obferves, that they have long been ufed externally, chiefly for inflammations of the eyes from acrid lymph. Glauber firft propofed the internal ufe of them; and Gaubius difcovered them to be the remedy of a celebrated empiric Luddemannus, which he ftyled his *luna fixata.* After this he exhibited them with fuccefs in convulfive and fpafmodic difeafes. Dr Hart fuppofes, that they act either as abforbents, or as poffeffing a fpecific virtue: but is a ftrong advocate for their efficacy, on whatever principles they may operate; and, in favour of his opinion, relates feven cafes in which they proved fuccefsful. A girl of 17 years of age was feized with a flight *chorea* from a fright; and when the difeafe had continued fix days, fhe began to take the flowers of zinc, by which her diforder was removed in lefs than three weeks. Her cure required only 16 grains of the zinc. In a few months the complaints returned, from the fame caufe; and were removed by four grains of the medicine divided into ten dofes. A boy of about four years old, labouring under a real epilepfy, fufpected to be hereditary, was cured by a grain of the flowers of zinc taken every day for fome time.—A man 50 years old, thrown into convulfions from a violent paffion, was cured by a grain of the calx taken every two hours. The difeafe had gone off upon venefection and the ufe of fome other remedies; but returned again in two weeks, when it was finally removed by the zinc. The two laft cafes are related from Dr Gaubius, who affirms that he has ufed the flowers of zinc in cafes of the chincough, hyfteric hiccough, and fpafmus cynicus; that they frequently did more than other medicines, but were by no means fuccefsful in every cafe. The other cures mentioned by Dr Hart are fimilar to thofe above mentioned. But it does not appear that he ever faw a confirmed epilepfy cured by this medicine.

In the firft volume of the Edinburgh Medical Commentaries, we have an account by Mr Benjamin Bell, of a man afflicted with a confirmed epilepfy, who was confiderably relieved by the flowers of zinc.

In a young man labouring under the epilepfy, in whom the fits were preceded by an *aura epileptica*, or fenfation like air arifing from the infide of the knee-joint, the difeafe was alfo relieved, but not cured.

Dr Percival relates fome cafes of epilepfy which feem to have been cured by the flowers of zinc; and in other cafes, where the difeafe was not entirely removed by it, the fpafms were neverthelefs much mitigated. He did not obferve that it promoted any evacuation; excepting that in fome, upon being firft taken, it occafioned a little ficknefs, which went off with a ftool. He adds, that thofe apothecaries who do not prepare this medicine themfelves, are in great danger of being impofed upon, as it is fometimes a mere corrofion of the zinc by an acid, and even imperfectly wafhed.

The good effects of the oxide of zinc as an antifpafmodic are alfo attefted by Dr Haygarth of Chefter and Dr White of York. The former gives a teft of their goodnefs which may be of ufe to thofe who do not prepare them, namely, that the true flowers of zinc, when ftrongly heated, become yellow, but reaffume their white colour on being allowed to cool. The latter gives a cafe of hieranofos, or ftrange convulfions of almoft all the mufcles of the body, cured by zinc, after a number of other remedies had failed. But, although from thefe and other refpectable authorities, there can be no doubt that zinc has often been fuccefsful in epilepfy; yet it is equally certain, that in many others it has had a fair trial, without producing any benefit.

In Dr Home's clinical experiments and hiftories, alfo, oxide of zinc is mentioned as having been found ferviceable upon trial in the Royal Infirmary of Edinburgh. Of the other principal remedies which have been recommended for the epilepfy and other convulfive diforders allied to it, we have the following account by the fame author.

1. *The cold-bath* was tried in one who had a convulfive diforder of one fide, but the fymptoms were rendered much worfe by it.

2. *Venefection.* Not to be depended on in convulfions.

3. *Electricity.* In two convulfive cafes was of no fervice.

4. *Epifpaftics.* Do not feem to be powerful antifpafmodics.

5. *Valerian.* In nine convulfive cafes, for which this remedy has been reckoned almoft a fpecific, it not only made no cure, but could fcarcely be reckoned to do any good. Dr Home fuppofes that it acts as a bitter tonic, fomething like the *ferpentaria Virginiana.* Though much ufed at prefent, he tells us it has always appeared to him a weak, often a hurtful, medicine.

6. *Mufk.* Six convulfive patients treated with large dofes of this remedy, were neither cured nor in the leaft relieved.

7. *Caftor* feems to be unworthy of the confidence formerly put in it. It is indeed poffeffed of a fedative power, and therefore may be ufeful in fpafmodic feverifh cafes.

8. *Afafœtida* has confiderable antifpafmodic powers, but is not always fuccefsful. It heats and quickens the pulfe; and is therefore improper in cafes attended with inflammation. It difagrees with fome from a peculiarity of conftitution; exciting pain in the ftomach, and

and vomiting: but this can be known only after the exhibition of the medicine.

9. *Cinchona.* Of ſeven ſpaſmodic caſes, ſix were either cured or mitigated. An epilepſy of eight years ſtanding was very much relieved by taking the bark for a month, and one of two years ſtanding by taking it for ten days. But the medicine is of a heating nature, and therefore is not to be employed in caſes attended with inflammatory ſymptoms.

10. *Peony root* was given to two epileptic patients without the leaſt ſucceſs.

11. *Viſcus quercinus*, or miſletoe, was given in the quantity of two ſcruples five times a-day to an epileptic patient, without ſucceſs.

12. *Extractum hyoſciami* was given to an epileptic patient, to one afflicted with the hemitotonos, and to one who laboured under the hyſteric affection, without the leaſt good effect.

13. *Folia aurantiorum* were exhibited with the like bad ſucceſs. Five drams of the powdered leaves were taken at once without any ſenſible effect.

14. *Cardamine pratenſis*, in three epileptic caſes, was not attended with any ſucceſs.

15. *Opium* did no good.

16. *Ammoniaretum cupri* made no cure in four caſes of epilepſy in which it was tried.

That in many caſes all theſe remedies have been employed without ſucceſs, is not to be denied: and indeed it may with confidence be aſſerted, that a great majority of caſes of epilepſy are incurable by any remedy that has yet been diſcovered. At the ſame time, as there is incontrovertible evidence that ſome of them have ſucceeded at leaſt in certain caſes, the more powerful may always be conſidered as deſerving a fair trial. The ammoniaretum cupri, in particular, ſeems well entitled to the attention of practitioners; for though it be a medicine of great activity, yet under prudent adminiſtration it may be employed even with very young ſubjects without any hazard; and in ſeveral inveterate caſes, which had obſtinately reſiſted other medicines, it has brought about a complete recovery.

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Genus LIV. PALPITATIO.

Palpitation of the Heart.

Palpitatio, *Sauv.* gen. 130. *Lin.* 132. *Vog.* 213. *Sag.* 237. *Hoffm.* III. 83. *Junck.* 33.

The palpitation of the heart is ſometimes ſo violent, that it may be heard at a conſiderable diſtance. It may proceed from a bad conformation of the heart itſelf, or ſome of the large veſſels. It may alſo be occaſioned by wounds or abſceſſes in the heart; or it may proceed from polypous concretions or oſſifications of that viſcus, or from plethora, fear, or ſpaſmodic affections of the nervous ſyſtem. When it proceeds from diſeaſes of the heart or large veſſels, it is abſolutely incurable. In ſpaſmodic caſes, the remedies above related may be uſed. If the patient be plethoric, bleeding will probably remove the diſorder, at leaſt for the preſent.

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Genus LV. ASTHMA.

Aſthma, *Sauv.* gen. 145. *Lin.* 161. *Vog.* 268. *Sag.* gen. 282.
Aſthma convulſivum, et ſpaſmodico-flatulentum, *Hoffm.* III. 94.
Aſthma ſpaſticum, *Junck.* tab. 51.

Sp. I. *Spontaneous Asthma.*

Aſthma humidum, *Sauv.* ſp. 1. Flatulentum, *Floyer* on the Aſthma, chap. i.
Aſthma convulſivum, *Sauv.* ſp. 2. *Willis* Pharm. rat. P. II. ſect. i. cap. 12.
Aſthma hyſtericum, *Sauv.* ſp. 3. *Floyer* on the Aſthma, chap. i.
Aſthma ſtomachicum, *Sauv.* ſp. 8. *Floyer*, Scheme of the ſpecies of Aſthma. Periodic Aſthma, 6.
Orthopnœa ſpaſmodica, *Sauv.* ſp. 3.
Orthopnœa hyſterica, *Sauv.* ſp. 4.

Sp. II. The *Exanthematic Asthma.*

Aſthma exanthematicum, *Sauv.* ſp. 11.
Aſthma cachecticum, *Sauv.* ſp. 13.

Sp. III. The *Plethoric Asthma.*

Aſthma plethoricum, *Sauv.* ſp. 15.

The aſthma is a chronic diſeaſe, which may continue to give very great diſtreſs, at intervals, for a conſiderable number of years. Sir John Floyer, when he wrote his celebrated treatiſe, had laboured under repeated paroxyſms for thirty years.

The common diſtinction is into *humid* and *dry*; the former is accompanied with an expectoration of mucus or purulent matter, but the latter is not. In the genuine humoral aſthma, the patients are obliged to lean forward; the inſpiration is ſhort and ſpaſmodic; and the expiration very ſlow.

Aſthmatic perſons have generally ſome warning of the attack, from a languor, loſs of appetite, oppreſſion, and ſwelling of the ſtomach from flatulence, which precede the fit; but it is uſually in the middle of the night that the violent difficulty of breathing comes on.

The duration of the paroxyſm is uncertain, as it will ſometimes terminate in three or four hours, while at other times it will continue for as many days; nay, it has been known to laſt three weeks without intermiſſion. While it ſubſiſts, the patient is in very great diſtreſs, not being able to lie in bed, nor ſcarcely to ſpeak or expectorate, ſo great is the difficulty of breathing; and yet, notwithſtanding all this apparent interruption to the free paſſage of the blood through the lungs, an inflammation here ſeldom or never ſupervenes a fit of the aſthma. As the paroxyſm wears off, and the breathing becomes free, there is more or leſs of an expectoration of mucus; and the urine, from being pale and limpid, becomes high coloured, and lets fall a copious ſediment.

In order to obtain relief in the fit, we muſt ſometimes bleed, unleſs extreme weakneſs or old age ſhould forbid, and repeat it according to the degrees of ſtrength and fulneſs: a purging clyſter, with a ſolution of aſafœtida, muſt be immediately injected; and if the violence of the ſymptoms ſhould not ſpeedily abate, it will be proper to apply a bliſtering plaſter to the neck or breaſt.

In the height of the paroxyſm, an emetic might be followed

followed by dangerous ſymptoms, as it would increaſe the accumulation of blood in the veſſels of the head; but vomiting will often prevent a fit of the aſthma, eſpecially if the ſtomach ſhould chance to be loaded with any ſort of ſaburra. A very ſtrong infuſion of roaſted coffee has been found to give eaſe in an aſthmatic paroxyſm.

Sir John Pringle ſays it is the beſt abater of the paroxyſms of the periodic aſthma that he has ſeen. The coffee ought to be of the beſt Mocco, newly burnt, and made very ſtrong immediately after grinding it. He commonly ordered an ounce for one diſh; which is to be repeated freſh after the interval of a quarter or half an hour; and which is to be taken without milk or ſugar. The medicine in general is mentioned by Muſgrave in his treatiſe *de Arthritide anomala;* but he firſt heard of it from a phyſician in Litchfield, who had been informed by the old people of that place, that Sir John Floyer, during the latter part of his life, kept free from, or at leaſt lived eaſy under, his aſthma, from the uſe of very ſtrong coffee. This diſcovery, it ſeems, he made after the publication of his book upon that diſeaſe. Dr Percival ſays he has frequently directed coffee in the aſthma with great ſucceſs.

In the intervals of the fit, perſons ſubject to the aſthma, eſpecially the humid ſpecies, ſhould take emetics from time to time. An infuſion of tobacco is an emetic that has been ſaid to be very ſerviceable in ſome aſthmatic caſes; but its operation is both ſo diſtreſſing and ſo dangerous, that it will never probably be introduced into common uſe as an emetic. Smoking or chewing the ſame has been known to prevent the frequency and ſeverity of the paroxyſms. Aſthmatic patients may alſo uſe the *lac ammoniaci*, with a due proportion of *oxymel ſcilliticum* and *vinum antimoniale*, with a view to promote expectoration; or the gum ammoniac, and others of ſimilar virtues, may be formed into pills, and combined with ſoap, as mentioned for the dyſpnœa pituitoſa; or a maſs may be compoſed of aſafœtida and balſam of Tolu, with ſyrup of garlic; and theſe pills may be waſhed down by a medicated wine, impregnated with ſquills, horſe-radiſh root, and muſtard ſeed; or a ſtrong bitter infuſion, with a little antimonial wine.

In ſome caſes crude mercury will be found ſerviceable; in others flowers of ſulphur, made into an electuary with honey or ſyrup of garlic; and if, notwithſtanding the uſe of theſe things, a coſtive habit ſhould prevail, it will be neceſſary, from time to time, to give a few grains of pills of aloes and myrrh, ſoap and aloes, or a maſs of equal parts of rhubarb, ſcammony, and ſoap.

The *dry* or *ſpaſmodic aſthma*, during the extreme violence of the fit, is beſt relieved by opiates; and ſometimes very large doſes are required. But in order to obtain permanent relief, nothing is found to anſwer better than ipecacuanha in ſmall doſes. Three, five, eight, or ten grains, according to the ſtrength and conſtitution of the patient, given every other day, have been productive of the happieſt effects; acting ſometimes as an evacuant, pumping up the viſcid phlegm; at others, as an antiſpaſmodic or ſedative. Iſſues are generally recommended in both ſpecies, and will often be found uſeful.

Changes of weather are uſually felt very ſenſibly by aſthmatic people, who in general cannot live with tolerable eaſe in the atmoſphere of large cities; though we ſhall ſometimes meet with patients who agree better with this air, which is ſo replete with groſs effluvia of various kinds, than with the pureſt that can be found in country ſituations. And ſome are found who breathe with the moſt eaſe in a crowded room, with a fire and candles.

A light diet of meats that are eaſy of digeſtion, and not flatulent, is requiſite for aſthmatic people; and the exerciſe of riding is often highly ſerviceable.

When the aſthma is found to depend on ſome other diſeaſe, whether it be the gout or an intermittent fever, or when it proceeds from the ſtriking in of ſome cutaneous eruption, regard muſt always be had to the primary diſeaſe: thus, in the *aſthma arthriticum*, ſinapiſms to the feet, or bliſtering, will be abſolutely neceſſary, in order, if poſſible, to bring on a fit of the gout. And when the dregs of an ague give riſe to an aſthma, which is termed *febriculoſum*, and invades at regular intervals, we muſt have recourſe to the Peruvian bark. The *aſthma exanthematicum* will require bliſters or iſſues, to give vent to the acrid matters which were repelled from the ſurface of the body; and courſes of ſulphureous waters, goats whey, and ſweetening diet drinks, or perhaps mercurial alteratives, in order to correct the ſharpneſs of the juices.

Genus LVI. DYSPNŒA. 292

Habitual Difficulty of Breathing.

Dyſpnœa, *Sauv.* gen. 144. *Lin.* 160. *Vog.* 267. *Sag.* 251. *Junck.* 32.

Sp. I. The *Catarrhal Dyspnoea.* 293

Aſthma catarrhale, *Sauv.* ſp. 16.
Aſthma pneumonicum, *Willis* Pharm. rat. P. II. ſect. i. cap. 12.
Aſthma pituitoſum, *Hoffm.* III. ſect. ii. cap. 2. § 3.
Aſthma pneumodes, *Sauv.* ſp. 17.

This is readily known by the ſymptoms of pneumonia and catarrh attending it, and to the removal of theſe ſymptoms the care of the phyſician muſt be principally directed.

Sp. II. The *Dry Dyspnoea.* 294

Dyſpnœa à tuberculis, à hydatibus, &c. *Sauv.* ſp. 2, 4, 5, 20.
Orthopnœa à lipomate, *Sauv.* ſp. 18.

This is generally accompanied with a phthiſis pulmonalis; but Sauvages mentions one ſpecies of phthiſis to which the dry dyſpnœa ſeems more particularly to belong. The patients fall away by degrees, and have a great difficulty of breathing, continual thirſt, and little or no ſpitting. When opened after death, their lungs are found not to be ulcerated, but ſhrivelled and contracted as if they had been ſmoke-dried. Goldſmiths and chemiſts are ſaid to be ſubject to this diſeaſe by reaſon of the vapours they draw in with their breath. Sauvages doth not mention any particular remedy. Shortneſs of breath ariſing from *tubercles*, as they are termed, or a ſcirrhous enlargement of the lymphatic glands which are diſperſed through the lungs, is commonly

monly found in ſcrophulous habits, and may be diſtinguiſhed by the concomitancy of thoſe external ſwellings and appearances which particularly mark the ſcrophula. This ſpecies of dyſpnœa generally ends in a phthiſis. Courſes of goats whey, and of ſea water, have been known to do ſervice; but it muſt be confeſſed, that a perfect cure is ſeldom obtained. Iſſues are of uſe in theſe caſes, as they appear to prevent the ill effects of over fulneſs, if it ſhould happen at any time to ſupervene.

295 Sp. III. *Dyspnoea* from *Changes* in the *Weather*. (*Sauv.* ſp. 12.)

This ſeems to be a diſeaſe entirely ſpaſmodic, and the antiſpaſmodics already related are accordingly indicated.

296 Sp. IV. The *Dyspnoea* from *Earthy Subſtances* formed in the *Lungs*.

Sauvages mentions this diſeaſe as much more common in brutes than in the human race: but Dr Cullen mentions his having ſeen ſome inſtances of it; and we have ſeveral accounts by different authors of calculous matters being coughed up by people labouring under a dyſpnœa, and threatened with conſumption. In three caſes of this kind which fell under Dr Cullen's inſpection, there was no appearance of earthy or ſtony concretions in any other part of the body. The calcareous matter was coughed up frequently with a little blood, ſometimes with mucus only, and ſometimes with pus. In one of theſe caſes, an exquiſite phthiſis came on, and proved mortal: in the other two the ſymptoms of phthiſis were never fully formed; and after ſome time, merely by a milk diet and avoiding irritation, the patients entirely recovered.

Sauvages alſo greatly recommends milk in theſe caſes, and ſoap for diſſolving the concretions. The reaſon why brutes are more ſubject to theſe pulmonary calculi than mankind, is, that they very ſeldom cough, and thus the ſtagnating mucus or lymph concretes into a kind of gypſeous matter.

297 Sp. V. The *Watery Dyspnoea*.

Dyſpnœa pituitoſa, *Sauv.* ſp. 1.
Orthopnœa ab hydropneumonia, *Sauv.* ſp. 12.

This may ariſe from too great a defluxion of mucus on the lungs, or from an effuſion of ſerum, as is mentioned under the pneumonia. The treatment of the diſeaſe may be gathered from what has been already ſaid under the heads of Pneumonia, Catarrh, Empyema, &c.

298 Sp. VI. The *Dyspnoea* from *Corpulency*.

Orthopnœa à pinguedine, *Sauv.* ſp. 6.

There have been many inſtances of ſuffocation and death occaſioned by too great corpulency. Theſe fatal effects, however, may be almoſt always avoided, if the perſons have reſolution to perſiſt in an active and very temperate courſe of life; avoiding animal food, much ſleep, and uſing a great deal of exerciſe. In the third volume of the Medical Obſervations, however, there is an extraordinary inſtance of internal obeſity which neither ſhowed itſelf externally, nor could be removed by any medicines.

Other ſpecies of dyſpnœa have been conſidered under Phthisis. It is frequently ſymptomatic of diſeaſes of the heart and large veſſels, or ſwellings of the abdomen, &c.

Genus LVII. PERTUSSIS. 299

Chincough.

Pertuſſis, *Sydenham*, Ed. Leid. p. 200, 311, 312.
Huxham de aëre, ad ann. 1732.
Tuſſis convulſiva, ſive ferina, *Hoffm.* III. 111.
Tuſſis ferina, *Sauv.* ſp. 10. *Sag.* ſp. 10.
Tuſſis convulſiva, *Sauv.* ſp. 11. *Sag.* ſp. 11.
Amphimerina tuſſiculoſa, *Sauv.* ſp. 13.

Deſcription. This diſeaſe comes on at firſt like a common cold; but is from the beginning attended with a greater degree of dyſpnœa than is common in catarrh, and there is a remarkable affection of the eyes, as if they were ſwelled, and a little puſhed out of their ſockets. By degrees the fits of coughing become longer and more violent, till at laſt they are plainly convulſive, ſo that for a conſiderable time the patient cannot reſpire, and when at laſt he recovers his breath, inſpiration is performed with a ſhrill kind of noiſe like the crowing of a cock. This kind of inſpiration ſerves only as an introduction to another convulſive fit of coughing, which is in like manner followed by another inſpiration of the ſame kind; and thus it continues for ſome time, very often till the patient vomit, which puts an end to the paroxyſm at that time. Theſe paroxyſms are attended with a violent determination of the blood towards the head, ſo that the veſſels become extremely turgid, and blood not unfrequently flows from the mouth and noſe. The diſeaſe is tedious, and often continues for many months. It is not commonly attended with fever, unleſs at the commencement.

Cauſes, &c. The chincough is an infectious diſorder, and very often epidemic: but the nature of the contagion is not underſtood; at leaſt it is no farther underſtood than that of ſmallpox, meaſles, or ſimilar epidemics. We well know that it is from a peculiar and ſpecific contagion alone that this diſeaſe, as well as the others above-mentioned, can ariſe. But with regard to the nature of any of them, we are totally in the dark. It generally attacks children, or adults of a lax habit, making its attack frequently in the ſpring or autumn; at the ſame time, when this contagion is introduced into any town, village, or neighbourhood, it will rage epidemically at any ſeaſon. Thoſe alone are affected with this diſeaſe who had never before been ſubjected to it. For in this affection, as well as in ſmallpox, having had the diſeaſe once, gives defence againſt future contagion. Every individual, however, does not ſeem to be equally readily affected with this contagion; like other contagious diſeaſes occurring only once in a lifetime, it may naturally be expected to be more frequent among children than at any other period of life. But many, though frequently expoſed to contagion, are yet not affected with the diſeaſe: and thoſe children who live upon unwholeſome watery food, or breathe unwholeſome air, are moſt liable to its attacks, or at leaſt ſuffer

Spasmi. most from them. In general it has been concluded, that whatever weakens the solids, or tends to bring on a dissolution of the fluids, predisposes to this disease, and increases its severity.

Prognosis. The chincough is not very often fatal. During one epidemic, however, it is often observed to be much more dangerous and more severe than during another. This is also remarked with regard even to particular periods of the same epidemic; and it is also observed, that on certain families this disease is much more severe than on others. Its danger, however, is still more connected with the period of life at which it occurs. In children under two years of age it is most dangerous; and kills them by producing convulsions, suffocation, inflammation, and suppuration of the brain or in the lungs, ruptures, and incurvation of the spine. In pregnant women it will produce abortion; and in adults inflammations of the lungs, and all the consequences of pneumonia, more frequently than in children. From a long continuance of the disease patients will become asthmatic, ricketty, and scrofulous. It is generally reckoned a good sign when a fit terminates by vomiting; for in this disease there seems to be a great increase of the secretion of mucus, and the vomiting affords great relief.

Cure. Pertussis is one of those diseases which, after the contagion has exerted its influence, can be terminated only by running a certain course: but it is much less limited in its course than smallpox and measles, and often it runs on to a very great length, or at least it is very difficult to distinguish certain sequelæ of this disease from the disease itself. And when it exists in the former of these states, it admits of an artificial termination. In the treatment of this affection, therefore, the objects at which a practitioner chiefly aims, are, in the first place, the obviating urgent symptoms, and forwarding the natural termination of the disease; and secondly, the inducing an artificial termination. With these intentions various practices are employed on different occasions. The most approved remedies are vomits, purges, bleeding, and the attenuating pectorals; for the other kinds generally do hurt: but large evacuations of any kind are pernicious. In the Medical Observations, vol. iii. Dr Morris recommends castor and cinchona; but in cases attended with any degree of inflammation, the latter must certainly do hurt, and the former will generally be insignificant. Dr Butter, in a dissertation expresly on the subject, relates 20 cases of it cured by the extract of hemlock. He directs half a grain daily for a child under six months old; one grain for a child from six months to two years; afterwards allowing half a grain for every year of the patient's age till he be 20: beyond that period, he directs ten grains to be given for the first day's consumption, gradually increasing the dose according to the effect. If the patient have not two stools daily, he advises magnesia or the *sulphas potassæ cum sulphure*, to be added to the hemlock mixture. By this method he says the peculiar symptoms of the disease are removed in the space of a week; nothing but a slight cough remaining. The use of hemlock, however, has by no means become universal in consequence of this publication, nor indeed has this remedy been found equally successful with others who have given it a fair trial. Colica.

The remedy most to be depended upon in this disease is change of air. The patient, as soon as the disease is fully formed, ought to be removed to some other part of the country: but there is no occasion for going to a distant place; a mile or two, or frequently a smaller distance, will be sufficient; and in this new habitation, the frequency of the cough is almost instantly diminished to a most surprising degree. After remaining there for some time, however, the cough will often be observed to become again more frequent, and the other symptoms increased. In this case, another change of air, or even a return to the former habitation, becomes necessary. Manifest benefit has even been derived by changing a patient from one room of a house to another. But although change of air has thus been advantageous, it must also be remarked, that when it has been had recourse to at very early periods it has often done mischief, particularly by aggravating the febrile and inflammatory symptoms. If the disease be attended with fever, bleeding and other antiphlogistic remedies are proper. Dr Buchan recommends an ointment made of equal parts of garlic and hog's lard applied to the soles of the feet; but if it have any effect, it is probably merely as an *emplastrum calidum.* It ought to be put on a rag and applied like a plaster. Opiates may sometimes be useful, but in general are to be avoided. They are chiefly serviceable where the cough is very frequent, with little expectoration. In these cases benefit has sometimes also been derived from sulphuric ether, and sometimes from the tincture of cantharides. An almost instantaneous termination has on some occasions been put to this disease by exciting a high degree of fear, or by inducing another febrile contagion: But the effects of both are too uncertain and too dangerous to be employed in practice.

Genus LVIII. PYROSIS. 300
The Heart-Burn.

Pyrosis, *Sauv.* gen. 200. *Sag.* 158.
Soda, *Lin.* 47. *Vog* 154.
Scotis, the Water-Brash.
Pyrosis Suecica, *Sauv.* sp. 4.
Cardialgia sputatoria, *Sauv.* sp. 5.

This disease, whether considered as primary or symptomatic, has already been fully treated under Dyspepsia.

Genus LIX. COLICA. 301
The Colic.

Colica, *Sauv.* gen. 204. *Lin.* 50. *Vog.* 160. *Sag.* 162. *Junck.* 106.
Colica spasmodica et flatulenta, *Hoffm.* II. 284.
Rachialgia, *Sauv.* gen. 211. *Sag.* 168.
Ileus, *Sauv.* gen. 252. *Vog.* 162. *Sag.* gen. 187.
Iliaca, *Lin.* 185.
Dolor et spasmus iliacus, *Hoffm.* II. 263.
Passio iliaca, *Junck.* 107.

Sp. I. *The Spasmodic* Colic. 302

Colica flatulenta, pituitosa, &c. *Sauv.* sp. 1. 2. 5. 6. 7.
Ileus

Spasmi.

Ileus physodes, volvulus, inflammatorius, &c. *Ejusd.* sp. 1. 3. 5. 7. 8. 9.

Description. The colic is chiefly known by a violent pain in the abdomen, commonly about the umbilical region. The pain resembles various kinds of sensations, as of burning, twisting, boring, a ligature drawn very tight, &c. The belly is generally costive, though sometimes there is a violent evacuation of bilious matters upwards and downwards. In these cases the disease is sometimes accompanied from the beginning with a weak and intermitting pulse, cold sweats, and fainting. In some the disease comes on gradually, beginning with an habitual costiveness; and if purgatives be taken, they do not operate. The pain comes on generally after a meal, and soon occasions nausea and vomiting. Sometimes the disease is attended with pyrexia, violent thirst, and a full pulse; the vomiting becomes more violent, and excrementitious matters are thrown up with the most exquisite pain and tension of the abdomen; and hiccough comes on, which continues obstinately; till at last a cessation of pain and fetid breath indicate a mortification of the intestines and approaching death. Sometimes the peristaltic motion of the intestines is so totally inverted, that all their contents are evacuated by the mouth, and even clysters will be vomited; which constitutes that disease commonly called the *iliac passion.*

Causes, &c. Colics may arise from any sudden check given to perspiration, as by violent cold applied to any part of the body, especially to the lower extremities and abdomen. Very frequently they are occasioned by austere, acid, or indigestible aliments taken into the stomach. By any of these, a violent colic, or indeed an iliac passion, may be occasioned; for Dr Cullen justly observes, that this last, though commonly accounted a different species of disease, differs from colic in no other way than in being in every respect in a much higher degree. In those who have died of this disease and been dissected, the intestines have sometimes been found twisted; but more commonly there hath been an *introsusception* of the intestine, that is, one part of the gut seems to have entered within the other. In the Edinburgh Medical Essays, vol. iii. we have a dissertation on the use of the warm bath in the bilious colic, in which the author derives the disorder from a spasmodic constriction of the intestine occasioned by the acrimony of the bile. By this, he says, the intestine is not only contracted into an unusual narrowness, but the sides of it have been found, upon dissection, so closely joined, that no passage could be made downwards more than if they had been strongly tied by a ligature. The formation of the *introsusceptio* he explains by quoting a passage from Peyerus, who made the following experiment on a frog. Having irritated the intestine of the animal in several different places, he observed it to contract at those places most violently, and to protrude its contents upwards and downwards wherever the relaxed state of the part would permit; by which means the contents were heaped together in different parts. Hence some parts of the intestine being dilated much more than enough, by reason of the great quantity of matter thrown into them, formed a kind of sack which readily received the constricted part into it. If this happen in the human body, there is the greatest danger of a mortification; because the part which is constricted, and at any rate disposed to inflammation, has that disposition very much increased by its confinement within the other, and by the pressure of the contents of the alimentary canal from the stomach downwards upon it. An iliac passion may also arise from the strangulation of part of the intestine in a hernia; and even a very small portion of it thus strangulated may occasion a fatal disease. In the Medical Observations, vol. iv. however, we have an account of an iliac passion arising from a very different cause, which could neither have been suspected nor cured by any other way than the operation of *gastrotomy*, or opening the abdomen of the patient, in order to remove the cause of the disorder. The patient, a woman of about 28 years of age, died after suffering extreme torture for six days. The body being opened, some quantity of a dirty coloured fluid was found in the cavity of the abdomen. The jejunum and ileum were greatly distended with air. A portion of the omentum adhered to the mesentery, near that part where the ileum terminates in the cæcum. From this adhesion, which was close to the spine, there ran a ligamentous cord or process about two inches and a half long, unequally thick, in some places not thicker than a packthread; which by its other extremity adhered to the coats of the ileum, about two inches above the cæcum. This cord formed a circle with the mesentery, large enough to admit a hen's egg to pass through it. The cord had formed a noose (in a manner difficult to be explained), which included a doubling of about two inches of the lower end of the ileum; and was drawn so tight, that it not only put a stop to the passage of every thing through the bowels, and brought on a gangrene of the strangulated part, but it had even cut through all the coats of the intestine on the opposite side to the mesentery, and made an aperture about an inch long. In the Memoirs of the Academy of Surgery are mentioned several similar cases.

Colica.

Prognosis. The colic is never to be reckoned void of danger, as it may unexpectedly terminate in an inflammation and gangrene of the intestines. Those species of it which are attended with purging must be considered as much less dangerous than those in which the vomiting is very violent. The iliac passion, or that attended with the vomiting of feces, is always to be accounted highly dangerous; but if the passage through the intestines be free, even though their peristaltic motion should be inverted, and clysters evacuated by the mouth, there is much more hope of a cure, than when the belly is obstinately costive, and there is some fixed obstruction which seems to bid defiance to all remedies.

Cure. In the cure of the spasmodic colic, the recovery must ultimately depend on producing a resolution of the spasmodic affection. In order to accomplish this, it is in general necessary to evacuate the contents of the intestines, and to remove morbid irritability existing in that part of the system. But in order to preserve the life of the patient from the most imminent hazard, it is still more necessary to prevent and remove those inflammatory affections which often occur in this disease. As the chief danger in colics arises from an inflammation and consequent mortification of the

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the inteſtines, it is eſſentially neceſſary, in the firſt place, to diminiſh the tendency to a pyrexia, if there ſhould happen to be any. This is accompliſhed by bleeding, emollient injections, warm bathing, and cooling medicines taken inwardly. Dr Porter ſtrongly recommends the warm bath in thoſe colics attended with violent evacuations of bile. He ſuppoſes it to do ſervice by relaxing the conſtriction of the inteſtines, and thus preventing or removing the introſuſceptio. In the mean time opiates may be given to eaſe the pain, while every method is tried, by cathartics and glyſters of various kinds, to procure a ſtool. In obſtinate caſes, where ſtimulating cathartics have proved ineffectual, the milder kinds, ſuch as manna, ſenna, oleum ricini, &c. will ſometimes ſucceed; but when every thing of this kind fails, recourſe muſt be had to ſome of the more extraordinary methods. Some have recommended the ſwallowing of leaden bullets, on a ſuppoſition that by their weight they would force through the obſtruction; but theſe ſeem much more likely to create than to remove an obſtruction. It is impoſſible they can act by their gravity, becauſe the inteſtines do not lie in a ſtraight line from the pylorus to the anus; and though this were actually the caſe, we cannot ſuppoſe that the weight of a leaden bullet could prove very efficacious in removing either a ſpaſmodic conſtriction or an obſtruction from any other cauſe. But when we conſider, not only that the inteſtines conſiſt of a great multitude of folds, but that their periſtaltic motion (by which only the contents are forced through them) is inverted, the futility of this remedy muſt be evident. It might rather be ſuppoſed to aggravate the diſeaſe; as the lead, by its preſſure, would tend to fix the introſuſception more firmly, or perhaps puſh it ſtill farther on. The ſame thing may be ſaid of quickſilver: not to mention the pernicious conſequences to be apprehended from ſwallowing large quantities of this mineral, even if it ſhould prove efficacious in relieving the patient for the preſent. There are, however, ſome late caſes on record, particularly one by Mr William Perry, publiſhed in the ſixteenth volume of the Edinburgh Medical Commentaries, in which the hydrargyrus, ſwallowed in great quantities, was attended with the happieſt effects, after every other remedy had been tried in vain.

Another method has been propoſed, in the Medical Eſſays, for relieving the miſerable patients in this diſorder, which in many caſes has been known to do ſervice. The patient is to be taken out of bed, and made to walk about on the cold floor of a damp apartment. At the ſame time, baſons of cold water are to be daſhed on his feet, legs, and thighs; and this muſt be continued for an hour or longer, if a ſtool be not procured before that time, though this will generally be the caſe much ſooner. The exerciſe does not at all impair the patient's ſtrength, but rather adds to it; and ſome very remarkable inſtances are adduced in the 6th volume of the Medical Eſſays, where this proved effectual after all other medicines had failed. In one perſon the diſeaſe had come on with a habitual coſtiveneſs, and he had been for a week tormented with the moſt violent pain and vomiting, which could be ſtopped neither by anodynes nor any other medicines, the ſharpeſt clyſters being returned unaltered, and all kinds of purgatives thrown up ſoon after they were ſwallowed; but by the

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above mentioned method, a ſtool was procured in 35 minutes, and the patient recovered. In ſome others the coſtiveneſs had continued for a much longer time.—Other remedies are, the blowing air into the inteſtines by means of a bellows, and the injecting clyſters of the ſmoke of tobacco. But neither of theſe ſeem very capable of removing the diſeaſe. They can affect only the parts below the obſtruction; while, to cure the diſeaſe, it is neceſſary that the obſtructed parts themſelves ſhould be reached by the medicine, and therefore we have not many well atteſted inſtances of their ſucceſs. In ſome obſtinate caſes, however, benefit has certainly been derived from tobacco-ſmoke injections, and likewiſe from injections of tepid water to the extent of ſeveral pounds. For putting in practice theſe modes of cure, a particular apparatus has been contrived; and in caſes even apparently deſperate, neither ſhould be neglected. The cold water gives a general and very conſiderable ſhock to the ſyſtem, checks the perſpiration, and thus drives the humours inward upon the inteſtines, by which they receive a much more effectual ſtimulus than can be ſuppoſed to ariſe from any kind of clyſter. But when all methods have failed, the only chance the patient can have for life is by a manual operation.

In thoſe colics which are attended with faintings, &c. from the beginning, and which generally attack hyſteric women and other debilitated perſons, all kinds of evacuations are pernicious; and the cure is to be attempted by anodynes and cordials, which will ſeldom fail of ſucceſs. Even there alſo, however, it is neceſſary that the belly ſhould be moved; and for this purpoſe injections, containing a ſolution of aſafœtida, which operate powerfully as antiſpaſmodics, are preferable to moſt other modes of cure.

Sp. II. Colica Pictonum. *The Colic of Poictou.* 303

Rachialgia Pictonum, *Sauv.* ſp. 1.
Rachialgia metallica, *Sauv.* ſp. 3.
Colica Pictonum *Citeſii.*

Another cauſe to which violent colics are frequently to be aſcribed, and which often gives occaſion to them where it is very little ſuſpected, is lead, or ſome ſolution or fume of it, received into the body. To this cauſe is evidently owing the colics to which plumbers, lead-miners, and ſmelters of lead, are ſubject. To the ſame cauſe, though not ſo apparent at firſt ſight, are we to aſcribe the Devonſhire colic, where lead is received into the body diſſolved in cyder, the common drink of the inhabitants of that country. This has been proved by experiment; for lead has been extracted from cyder in quantity ſufficient to produce pernicious effects on the human body. The colic of Poictou, and what is called the *dry belly-ach* in the Weſt Indies, are of the ſame nature; for which reaſon we give the following general deſcription of the ſymptoms of all theſe diſeaſes.

The patient is generally firſt ſeized with an acute pain at the pit of the ſtomach, which extends itſelf down with griping pains to the bowels. Soon after there is a diſtenſion, as with wind; and frequent retchings to vomit, without bringing up any thing but ſmall quantities of bile and phlegm. An obſtinate coſtiveneſs follows, yet ſometimes attended with a teneſmus, and

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and the bowels seem to the patient as if they were drawn up towards the back; at other times they are drawn into hard lumps, or hard rolls, which are plainly perceptible to the hand on the belly. Sometimes the coats of the intestines seem to be drawn up from the anus and down from the pylorus towards the navel. When a stool is procured by artificial means, as clysters, &c. the feces appear in little hard knots like sheep's dung, called *scybala*, and are in small quantity. There is, however, usually an obstinate costiveness; the urine is discharged in small quantity, frequently with pain and much difficulty. The pulse is generally low, though sometimes a little quickened by the violence of the pain; but inflammatory symptoms very seldom occur. The extremities are often cold, and sometimes the violence of the pain causes cold clammy sweats and fainting. The mind is generally much affected, and the spirits are sunk. The disease is often tedious, especially if improperly treated, insomuch that the patients will continue in this miserable state for twenty or thirty days successively; nay, instances have been known of its continuing for six months. In this case the pains at last become almost intolerable: the patient's breath acquires a strong fetid smell like excrements, from a retention of the feces, and an absorption of the putrid effluvia from them by the lacteals. At last, when the pain in the bowels begins to abate, a pain comes on in the shoulder-joints and adjoining muscles, with an unusual sensation and tingling along the spinal marrow. This soon extends itself from thence to the nerves of the arms and legs, which become weak; and that weakness increases till the extreme parts become paralytic, with a total loss of motion, though a benumbed sensation often remains. Sometimes, by a sudden metastasis, the brain becomes affected, a stupor and delirium come on, and the nervous system is irritated to such a degree as to produce general convulsions, which are frequently followed by death. At other times, the peristaltic motion of the intestines is inverted, and a true iliac passion is produced, which also proves fatal in a short time. Sometimes the paralytic affection of the extremities goes off, and the pain of the bowels returns with its former violence; and on the cessation of the pain in the intestines, the extremities again become paralytic; and thus the pain and palsy will alternate for a very long time.

Cure. Various methods have been attempted for removing this terrible disease. The obstinate costiveness which attends it, made physicians at first exhibit very strong purgatives and stimulating clysters. But these medicines, by increasing the convulsive spasms of the intestines, were found to be pernicious. Balsam of Peru, by its warm aromatic power, was found to succeed much better; and Dr Sydenham accordingly prescribed it in the quantity of 40 drops twice or thrice a-day taken on sugar. This, with gentle purgatives, opiates, and some drops of the hotter essential oils, continued to be the medicine commonly employed in this disease, till a specific was published by Dr Lionel Chalmers of South Carolina. This receipt was purchased by Dr Chalmers from a family where it had long been kept a secret. The only unusual medicine in this receipt, and on which the efficacy of it chiefly if not wholly depends, is sulphate of copper. This must be dissolved in water, in the quantity of one grain to an ounce, and the dose of the solution is a wine-glassful given fasting for nine successive mornings. For the first four or five days this medicine discharges much æruginous bile both ways; but the excretions of this humour lessen by degrees; and before the course be ended, it has little other effect than to cause some degree of squeamishness, or promote a few bilious stools, or perhaps may not move the patient at all. At the time of using this medicine the patients should live upon broth made of lean meat, gruel, or panada: but about the seventh or eighth day, they may be allowed bread and boiled chicken. Here the copper seems to do service by its tonic power; and for the same reason, alum, recommended by Dr Percival, most probably cures the disease. He says he has found this very efficacious in obstinate affections of the bowels, and that it generally proves a cure in the slighter cases of the colica pictonum. It was given to the quantity of fifteen grains every fourth, fifth, or sixth hour; and the third dose seldom failed to mitigate the pain, and sometimes entirely removed it. Among purgative medicines the *oleum ricini* is found to be the most efficacious. Mercury also, particularly under the form of calomel, has often been employed with success. And much benefit has been derived from combining the calomel with opium. From this combination there is often obtained, in the first instance, an alleviation of the pain, and afterwards a free discharge by the belly.

Sp. III. The Colic from *Costiveness*. 304

Colica stercorea, *Sauv.* sp. 3.
Ileus à fæcibus induratis, *Sauv.* sp. 2.

For the treatment of this species, see above.

Sp. IV. The *Accidental Colic*.

Colica Japonica,—accidentalis,—lactentium,—à veneno, *Sauv.* sp. 10. 14. 18. 20.
Cholera sicca auriginosa, à fungis venenatis, *ejusd.* sp. 2.

When colics arise from acrid poisonous matter taken into the stomach, the only cure is either to evacuate the poison itself by vomiting, or to swallow some other substance which may decompound it, and thus render it inactive. The most common and dangerous substances of this kind are corrosive mercury and arsenic. The former is easily decompounded by alkaline salts; and therefore a solution of lixivial salt, if swallowed before the poison has time to induce a mortification of the bowels, will prove a certain cure. Much more uncertain, however, is the case when arsenic is swallowed, because there is no certain and speedy solvent of that substance yet known. Milk has been recommended as efficacious; and lately a solution of *hepar sulphuris*. The latter may possibly do service; as arsenic unites readily with sulphur, and has its pernicious qualities more obtunded by that than by any other known substance: but indeed, even the solvent powers of this medicine are so weak, that its effects as well as those of others must be very uncertain.

Some kinds of fungi, when swallowed, are apt to produce colics attended with stupor, delirium, and convulsions; and the same sometimes happens from eating a large

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large quantity of the shell-fish known by the name of muscles (the MYTULUS). Some of the fungi, doubtless, may have an inherent poisonous quality; but generally they as well as the muscles act on a different principle. Their pernicious effects happen most commonly when they are taken on an empty stomach; and are then supposed to be occasioned by their adhering so close to its coats, that it cannot exert its powers, and the whole system is thrown into the utmost disorder. The malady may therefore be very easily prevented; but when once it has taken place, it cannot be removed till either vomiting be excited, or the stomach has recovered itself in such a manner as to throw off the adhering matter.

305 Sp. V. COLIC of *New-born Infants* from a *Retention* of the *Meconium*. (*Sauv.* sp. 19.)

This disorder would be prevented were children allowed immediately to suck their mothers, whose milk at first is purgative. But as this is not commonly done, the child is frequently troubled with colics. These, however, may be removed by a few grains of ipecacuanha, or a drop or two of antimonial wine. By these means the stomach is cleansed by vomiting, and the belly is generally loosened; but if this last effect does not happen, some gentle purge will be necessary.

306 Sp. VI. COLIC from a *Callosity* of the *Colon*.

It is often impossible to discover this distemper before the patient's death; and though it should, it does not admit of a cure.

307 Sp. VII. The COLIC from *Intestinal Calculi*. (*Sauv.* sp. 10. 15.)

When certain indigestible bodies, such as cherry-stones, plum-stones, small pieces of bones, &c. are swallowed, they frequently prove the basis of calculi, formed by an accretion of some kind of earthy matter; and being detained in some of the flexures of the intestines, often occasion very violent colics. These calculi do not discover themselves by any peculiar symptoms, nor do they admit of any particular method of cure. In the Medical Essays we have an instance of colics for six years, occasioned by calculi of this kind. The concretions were at last passed by stool; and their passage was procured by causing the patient drink a large quantity of warm water, with a view to promote the evacuation of bile, a redundancy of which was supposed to be the cause of her disorder.

308 GENUS LX. CHOLERA, the CHOLERA MORBUS.

Cholera, *Sauv.* 253. *Lin.* 186. *Vog.* 110. *Sag.* 188. *Hoffm.* II. 165.
Diarrhœa cholerica, *Junck.* 112.

309 Sp. I. The *Spontaneous CHOLERA*, coming on without any manifest cause.

Cholera spontanea, *Sauv.* sp. 1. *Sydenh.* sect. iv. cap. 2.
Cholera Indica, *Sauv.* sp. 7.

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Sp. II. The *Accidental CHOLERA*, from acrid matter taken inwardly. 310

Cholera crapulosa, *Sauv.* sp. 11.
Cholera à venenis, *Sauv.* sp. 4. 5.

The cholera shows itself by excessive vomiting and purging of bilious matters, with violent pain, inflation and distension of the belly. Sometimes the patients fall into universal convulsions; and sometimes they are affected with violent spasms in particular parts of the body. There is a great thirst, a small and unequal pulse, cold sweats, fainting, coldness of the extremities, and hiccough; and death frequently ensues in 24 hours.

In this disease, as a great quantity of bile is deposited in the alimentary canal, particularly in the stomach, the first object is to counteract its influence, and to promote an easy discharge of it. It is next necessary to restrain that increased secretion of bile, by which a fresh deposition in the alimentary canal would otherwise be soon produced. And, in the last place, measures must often be employed to restore a sound condition to the alimentary canal, which is frequently much weakened by the violence of the disease.

On these grounds, the cure of this distemper is effected by giving the patient a large quantity of warm water, or very weak broth, in order to cleanse the stomach of the irritating matter which occasions the disease, and injecting the same by way of clyster, till the pains begin to abate a little. After this, a large dose of laudanum is to be given in some convenient vehicle, and repeated as there is occasion. But if the vomiting and purging have continued for a long time before the physician be called, immediate recourse must be had to the laudanum, because the patient will be too much exhausted to bear any further evacuations. Sometimes the propensity to vomit is so strong, that nothing will be retained, and the laudanum itself thrown up as soon as swallowed. To settle the stomach in these cases, Dr Douglas, in the Medical Essays, recommends a decoction of oat-bread toasted as brown as coffee; and the decoction itself ought to be of the colour of weak coffee. He says he does not remember that this decoction was ever vomited by any of his patients. An infusion of mint-leaves or good simple mint-water is also said to be very efficacious in the same case.

The tincture of opium is sometimes retained when given in conjunction with a portion of the sulphuric acid properly diluted. But when it cannot be retained in a fluid form by the aid of any addition, it will sometimes sit upon the stomach when taken in a solid state.

After the violence of the disease is overcome, the alimentary canal, and the stomach in particular, requires to be braced and strengthened. With this view recourse is often had with advantage to different vegetable bitters, particularly to the use of the colombo root; which, while it strengthens the stomach, is also observed to have a remarkable tendency in allaying a disposition to vomiting, which often remains for a considerable time after the cholera may be said to be overcome.

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Genus LXI. DIARRHOEA.

Looseness.

Diarrhœa, *Sauv.* gen. 253. *Lin.* 187. *Vog.* 105. *Sag.* gen. 189. *Junck.* 112.
Hepatirrhœa, *Sauv.* gen. 246.
Cholerica, *Lin.* 190.
Cœliaca, *Sauv.* gen. 255. *Lin.* 189. *Vog.* 109. *Sag.* gen. 199.
Lienteria, *Sauv.* gen. 256. *Lin.* 188. *Sag.* gen. 191. *Vog.* 108.
Pituitaria, et leucorrhois, *Vog.* 111. 112.

312 Sp. I. The *Feculent Diarrhoea.*

Diarrhœa ftercorofa et vulgaris, *Sauv.* fp. 1. 2.

This is occafioned by too great a quantity of matter thrown into the alimentary canal; and what is difcharged has not the appearance of excrements, but is much whiter, and of a thinner confiftence. Voracious people who do not fufficiently chew their food, gormandizers, and even thofe who ftammer in their fpeech, are faid to be liable to this difeafe. In flighter cafes it is removed without any medicine, or by a dofe of rhubarb; but where the matters have acquired a putrid taint, the diforder may be much protracted and become dangerous. In this cafe lenient and antifeptic purgatives are to be made ufe of, after which the cure is to be completed by aftringents.

313 Sp. II. The *Bilious Diarrhoea.* (*Sauv.* fp. 8.)

This diftemper fhows itfelf by copious ftools of a very yellow colour, attended with gripes and heat of the bowels, thirft, bitternefs, and drynefs of the mouth, yellownefs of the tongue, and frequently follows an intermitting or bilious fever. When the fever is gone, the diarrhœa is to be removed by acidulated and cooling drinks, with fmall dofes of nitre.

314 Sp. III. The *Mucous Diarrhoea.*

Diarrhœa lactentium, *Sauv.* fp. 19.
Dyfenteria Parifiaca, *Sauv.* fp. 3.
Diarrhœa ab hypercatharfi, *Sauv.* fp. 16.
Dyfenteria à catharticis, *Sauv.* fp. 12.
Pituitaria, *Vog.* 111.
Leucorrhois, *Vog.* 112.
Diarrhœa pituitofa, *Sauv.* fp. 4.
Cœliaca mucofa, *Sauv.* fp. 3.
Diarrhœa ferofa, *Sauv.* fp. 10.
a. Diarrhœa urinofa.

This kind of diarrhœa, befides the matters ufually excreted, is attended with a copious dejection of the mucus of the inteftines with great pain; while the patient daily pines away, but without any fever.—Perfons of all ages are liable to it, and it comes on ufually in the winter-time; but is fo obftinate, that it will fometimes continue for years. In obftinate loofeneffes of this kind, vomits frequently repeated are of the greateft fervice. It is alfo very beneficial to keep the body warm, and rub the belly with ftimulating ointments; at the fame time that aftringent clyfters, rhubarb, and ftomachic medicines, are to be exhibited. Starch clyfters are very often efficacious.—Some kinds of loofenefs are contagious; and Sir John Pringle mentions a foldier who laboured under an obftinate diarrhœa, who infected all thofe that ufed the fame privy with himfelf. In the loofenefs which frequently followed a dyfentery, the fame author tells us that he began the cure with giving a vomit of ipecacuanha, after which he put the patients on a courfe of aftringents. He ufed a mixture of three drachms of extract of logwood, diffolved in an ounce and a half of fpirit of cinnamon, to which was added feven ounces of common water, and two drachms of tincture of catechu. Of this the patient took two fpoonfuls once in four or five hours, and fometimes alfo an opiate at bedtime. He recommends the fame medicine in obftinate diarrhœas of all kinds. A decoction of fimarauba bark was alfo found effectual, when the dyfenteric fymptoms had gone off. Dr Huck, who ufed this article in North-America, alfo recommends it in diarrhœas. Two or three ounces of the fimarauba are to be boiled in a pound and a half of water to a pound, and the whole quantity taken thoughout the day. He began with the weakeft decoction; and, when the ftomach of the patient could eafily bear it, he then ordered the ftrongeft: but at the fame time he acknowledges, that, unlefs the fick found themfelves fenfibly better within three days from the time they began the medicine, they feldom afterwards received any benefit from it. But when all aftringents have failed, Sir John Pringle informs us, he hath known a cure effected by a milk and farinaceous diet; and he thinks in all cafes the diforder would be much more eafily removed, if the patients could be prevailed on to abftain entirely from fpirituous liquors and animal-food. If the milk by itfelf fhould turn four on the ftomach, a third part of lime-water may be added. In one cafe he found a patient receive more benefit from good butter-milk than from fweet-milk. The chief drinks are decoctions of barley, rice, calcined hartfhorn, toaft and water, or milk and water.

Sp. IV. The Coeliac Passion. 315

Cœlica chylofa, *Sauv.* fp. 1.
Cœlica lactea, *Sauv.* fp. 4.

There are very great differences among phyficians concerning the nature of this difeafe, Sauvages fays, from Aretæus, it is a chronic flux, in which the aliment is difcharged half digefted. It is attended with great pains of the ftomach, refembling the pricking of pins; rumbling and flatus in the inteftines; white ftools, becaufe deprived of bile, while the patient becomes weak and lean. The difeafe is tedious, periodical, and difficult to be cured. Sauvages adds, that none of the moderns feem to have obferved the difeafe properly; that the excrements indeed are white, on account of a deficiency of the bile, but the belly is bound as in the jaundice. Dr Cullen fays there is a dejection of a milky liquid of the nature of chyle; but this is treated by Vogel as a vulgar error. He accufes the moderns of copying from Aretæus, who mentions white fæces as a fymptom of the diftemper; from whence authors have readily fallen into the notion that they never appeared of any other colour in

Spasmi.

persons labouring under the cœliac passion. This error quickly produced another, which has been very generally received; namely, that the chyle was thrown out of the lacteals by reason of some obstruction there, and thus passed along with the excrements; of which he says there is not the least proof, and agrees with Aretæus that the whiteness is only occasioned by the want of bile. He endeavours to prove at length, that the cœliac passion can neither be occasioned by an obstruction of the lacteals, nor of the mesenteric glands; though he owns that such as have died of this disease and were dissected, had obstructions in the mysenteric glands; but he denies that all those in whom such obstructions occur, are subject to the cœliac passion. He considers the distemper as arising from a cachexy of the stomachic and intestinal juices; and directs the cure to be attempted by emetics, purgatives, antiseptics, and tonics, as in other species of diarrhœa.

316 Sp. V. The Lientery.

Lienteria spontanea, *Sauv.* sp. 2.

The lientery, according to Sauvages, differs from the cœliac passion only in being a slighter species of the disease. The aliment passes very quickly through the intestines, with scarce any alteration. The patients do not complain of pain, but are sometimes affected with an intolerable hunger. The cure is to be attempted by stomachics and tonics, especially the Peruvian bark. This disease is most common at the earlier periods of life; and then rhubarb in small quantities, particularly when combined with magnesia, is often productive of the best effects.

317 Sp. VI. The *Hepatic Flux*.

Hepatirrhœa intestinalis, *Sauv.* sp. 2.

The hepatic diarrhœa is by Sauvages described as a flux of bloody serous matter like the washings of flesh, which percolates through the coats of the intestines by means of the anastomosing vessels. It is the cœliac passion of Trallianus; and which, according to Sauvages, rarely, if ever, occurs as a primary disease. It has, however, been observed to follow an inflammation of the liver, and then almost always proves fatal.

318 Genus LXII. DIABETES.

A profuse Discharge of Urine.

Diabetes, *Sauv.* gen. 263. *Lin.* 197. *Vog.* 115. *Sag.* gen. 199. *Junck.* 99. *Dobson*, Med. Observat. vol. v. p. 298. *Home's* Clinical Experiments, sect. xvi.

Diuresis, *Vog.* 114.

319 Sp. I. The Diabetes with *sweet Urine*.

Diabetes Anglicus, *Sauv.* sp. 2. *Mead* on Poisons, Essay I. Ejusdem Monita Med. cap. ix. sect. 2. *Dobson* in Lond. Med. Observ. vol. v. art. 27. *Myers* Diss. inaug. de Diabete, Edinb. 1779.

Diabetes febricosus, *Sauv.* sp. 7. *Sydenh.* Ep. resp. ad R. Brady.

Diabetes.

Sp. II. Diabetes with *insipid Urine*. 320

M. Lister Exerc. Medicin. II. de Diabete.

Diabetes legitimus, *Sauv.* sp. 1. *Aretæus* de Morb. diuturn. lib. ii. cap. 2.

Diabetes ex vino, *Sauv.* sp. 5. *Ephem. Germ.* D. I. A. II. Observ. 122.

Description. The diabetes first shows itself by a dryness of the mouth and thirst, white frothy spittle, and the urine in somewhat larger quantity than usual. A heat begins to be perceived in the bowels, which at first is a little pungent, and gradually increases. The thirst continues to augment by degrees, and the patient gradually loses the power of retaining his urine for any length of time. It is remarkable, that though the patients drink much, the quantity of urine always exceeds what is drank. In Dr Home's Clinical Experiments we have an account of two patients labouring under this disease: one of them drank between 10 and 12 English pints a-day without being satisfied. The quantity was greater in the forenoon than in the afternoon. In the other the case was reversed. He drank about four pints a-day, and more in the afternoon than the forenoon. The former discharged from 12 to 15 pints of urine in the day: the latter, 11 or 12; so that his urine always exceeded his drink by eight or at least seven pints. When the urine is retained a little while, there is a swelling of the loins, feet, and scrotum; in this disease the strength gradually decays; the skin is dry and shrivelled; œdematous swellings arise in various parts of the body, but afterwards subside without relieving the disease in the least; and the patient is frequently carried off by convulsions.

The most singular phenomenon in this disease is, that the urine seems to be entirely or very much divested of an animal nature, and to be largely impregnated with a saccharine matter scarce distinguishable from that obtained from the sugar-cane. This discovery was first made by Dr Dobson of Liverpool, who made some experiments on the urine of a person labouring under a diabetes, who discharged 28 pints of urine every day, taking during the same time from 12 to 14 pounds of solid and liquid food. Some of this urine being set aside, fell into a spontaneous effervescence, changed first into a vinous liquor, and afterwards into an acetous one, before it became putrid and offensive. Eight ounces of blood taken from the same patient, separated into crassamentum and serum; the latter being sweet to the taste, but less so than the urine. Two quarts of the urine, evaporated to dryness, left a white cake weighing four ounces two drams and two scruples. This cake was granulated, and broke easily between the fingers: it smelled sweet like brown sugar; neither could it by the taste be distinguished from sugar, except that it left a slight sense of coolness on the tongue. The experiment was repeated after the patient was recovered to such a degree as to pass only 14 pints of urine a-day. There was now a strong urinous smell during the evaporation; and the residuum could not be procured in a solid form, but was blackish, and much resembled very thick treacle. In Dr Home's patients, the serum of the blood had no preternatural sweetness; in one of them the crassamentum was

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