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ENCYCLOPÆDIA BRITANNICA.

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.

The ſciences originated in Egypt.

A. C. 640.

A. C. 590.

Diſcoveries of Thales.

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 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.

Diſcoveries of Oenopidus and Zenodorus.

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.

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.

A. C. 450.

He diſcovered, that if 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.

Conic ſections diſcovered by Plato. A. C. 390.

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.

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. 580.

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. 415.

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

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.

Moſchopulos's diſcovery of the magic ſquares.

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.

Algebra introduced into Italy by Leonard of Piſa. 1202, 1223.

A. D. 1230.

A. D. 1250.

A. D. 1494.

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.

A. D. 1505.

A. D 1535.

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.

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 1404. Died 1572.

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 abſciſs 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. 16[illegible]8

whom we may mention 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 1652.

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 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 ordinates were complex quantities raiſed to entire and poſitive powers, theſe ordinates were reſolved into ſeries, of which each term is a monomial. Wallis attempted to extend his theory to curves whoſe ordinates were complex and radical, by attempting to interpolate the ſeries of the former kind with a new ſeries; but he was unſucceſsful.

Diſcoveries of Newton.

39. It was left to Newton to remove this difficulty. He ſolved the problem in a more direct and ſimple manner by the aid of his new formula for expanding into an infinite ſeries any power of a binomial, whether its exponent was poſitive or negative, an integer or a fraction. Algebra is alſo indebted to this illuſtrious mathematician for a ſimple and extenſive method of reſolving an equation into commenſurable factors; for a method of ſumming up the powers of the roots of an equation, of extracting the roots of quantities partly commenſurable, and partly incommenſurable, and of finding by approximation the roots of literal and numerical equations of all orders.

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

40. About this time, William Lord Brouncker, in attempting to demonſtrate an expreſſion of Wallis on the magnitude of the circle, diſcovered the theory of continued fractions. When an irreducible fraction is expreſſed by numbers too great and complicated to be eaſily employed by the analyſt, the method of Lord Brouncker enables us to ſubſtitute an expreſſion much more ſimple 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 repreſenting the motions of the ſolar ſyſtem, and was enlarged and improved by other celebrated geometers. Lord Brouncker had likewiſe the merit of diſcovering an infinite ſeries to repreſent the area of the hyperbola. The ſame diſcovery was made by Nicholas Mercator, who publiſhed it in his *Logarithmotechnia* in 1668.

* *Opera Poſthuma*, tom. ii. *ſub finem.*

Labours of James Gregory.

41. The ſubject of infinite ſeries received conſiderable addition from Mr James Gregory. He was the firſt who gave the tangent and ſecant in terms of the arc, and, inverſely, the arc in terms of the tangent and ſecant. He conſtructed ſeries for finding directly the logarithm of the tangent and ſecant from the value of the arc, and the logarithm of the arc from that of the tangent and ſecant; and he applied this theory of infinite ſeries to the rectification of the ellipſis 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 ſides the element of the curve and thoſe of the abſciſs and ordinate, and thoſe ſides are treated as quantities infinitely ſmall.

Theory of evolutes diſcovered by Huygens, 1673.

43. The doctrine of evolutes had been ſlightly touched upon by Apollonius. It remained, however, for the illuſtrious Huygens to bring it to perfection. His theory of evolutes is contained in his *Horologium Oſcillatorium*, publiſhed in 1673, and may be regarded as one of the fineſt diſcoveries in geometry. When any curve is given, Huygens has pointed out the method of conſtructing a ſecond curve, by drawing a ſeries of perpendiculars to the firſt, which are tangents to the ſecond; and of finding the firſt curve from the ſecond. From this principle he deduces ſeveral theorems on the rectification of curves; and that remarkable property of the cycloid, in which an equal and ſimilar cycloid is produced by evolution.

Hiſtory of the diſcovery of fluxions.

44. In contemplating the progreſs of analyſis from the beginning of the 17th century, to the invention of fluxions, we cannot fail to perceive the principles of that calculus gradually unfolding themſelves to view. The human mind ſeemed to advance with rapidity towards that great diſcovery; and it is by no means unlikely that it would ſoon have arrived at the doctrine of fluxions, even if the ſuperior genius of Newton had not accelerated its progreſs. In Cavalerius' *Geometria Indiviſibilium*, we perceive the germ of the infiniteſimal calculus; and the method of Roberval for finding the tangents of curves, bears a ſtriking analogy to the metaphyſics of the fluxionary calculus. It was the glory of Newton, however, to invent and illuſtrate the method of fluxions; and the obſcure hints which he received from preceding mathematicians, do not in the leaſt detract from the merit of our illuſtrious countryman.

General remarks on the diſpute between Newton and Leibnitz.

45. On the claims of Leibnitz as a ſecond inventor of fluxions, and the illiberal violence with which they have been urged by foreign mathematicians, we would wiſh to ſpeak with delicacy and moderation. Who that can appreciate the diſcoveries of that celebrated mathematician, or is acquainted with that penetrating genius which threw light on every department of human knowledge, would willingly ſtain his memory with an ungracious imputation? The accuſation of plagiariſm is one of thoſe charges which it is difficult either to ſubſtantiate or repel, and when directed againſt a great man, ought never, without the cleareſt evidence, to be wantonly preferred or willingly received. If charitable ſentiments are ever to be entertained towards others,—to what claſs of beings ſhould they be more cheerfully extended than to thoſe who have been the ornaments of human nature? If ſociety has agreed to regard as ſacred the failings and excentricities of genius,—when ought that reverence to be more ſtrongly excited than when we are paſſing judgement on its mightieſt 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 ſuch an inveſtigation, a regard to truth, and a contempt of national prejudice, ſhould guide the inquiry.—We ſhould proceed with delicacy and forbearance.—We ſhould tread lightly even on the aſhes of genius. It is not uncommon to witneſs the indulgence of malicious pleaſure, in detracting from the merits of a diſtinguiſhed character. The aſſailant raiſes himſelf 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 flouriſh long. The ſame public opinion which conferred them will tear them from his brow, and conſign the accuſer to that infamy from which the brighteſt abilities will be inſufficient to raiſe him. The conſequences of ſuch conduct have been ſeen in the fall of Torricelli. It was the charges of plagiariſm, preferred by Roberval, that hurried this young and accompliſhed philoſopher to an early grave.

46. We have been led into theſe obſervations by ſtudying the diſpute between the followers of Newton and Leibnitz. The claims of the Britiſh, as well as thoſe of

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, quae 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;

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.

which is ſolved by Huygens in 1687.

James Bernouilli alſo finds the iſochronous curve.

53. It was at this time that the two brothers, James and John Bernouilli, began to diſplay theſe 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, 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 *linteariæ*, 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.

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.

James Bernouilli attends to the ſame ſubject,

1693.

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.

1695.

Problems propoſed by James to John Bernouilli.

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. 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: 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.

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

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. 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. In 1711 Newton publiſhed his *Method of Fluxions*. 1711. 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. A poſthumous work of Newton's, entitled the *Method of Fluxions, and of Infinite Series*, 1736. 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 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.

Leibnitz defends himſelf.

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.

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,

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.

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.

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, 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 Tranſactions for 1718, publiſhed a very ſimple ſolution, embracing all the geometrical curves, and a great number of the mechanical ones.

1717.

1718.

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 inverts 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. 1716.

79. The problem of reciprocal trajectories was at this time propoſed by the Bernouillis. This problem required the curves which, being conſtructed in two oppoſite 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 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. 1723.

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. 1725.

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 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 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.

1726.

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,

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* *Peterſburgh Tranſactions.*

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.

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 Exercíſes 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.* 1764, 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 ſmall,

His method of variations.

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

* *Peterſburgh Tranſactions*, 1762.

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, degageès 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. Tranſ. vol. 4th. entitle him to a high rank among modern mathematicians.

Mathematical. Matlock.

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 Wickſworth, 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 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 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

Maupertuis.

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
||
Maurice.

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 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 Motheim, 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 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.

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 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 מורטאי, *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 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, 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 Cerne 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 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 boys from Madagaſcar, whom he carefully trained up in good principles, and in continual exerciſe; by which he rendered them ſo good ſoldiers, that he very quickly obliged the Marones, or wild negroes, either to ſubmit or to quit the iſland: he taught the planters to cultivate their lands to advantage; he, by an aqueduct, brought freſh water to the ſea ſide; and whereas they had not ſo much as a boat at his coming thither, he made a very fine dock, where he not only built ſloops and large veſſels, but even a ſhip of the burden of 500 tons. However incredible it may ſeem, yet it is certainly fact, that in the ſpace of five years he converted this country into a paradiſe, that had been a mere wilderneſs for 5000; and this in ſpite of the inhabitants, and of the company, who being originally prejudiced by them, behaved ill to him at his return. He ſoon made the cardinal de Fleury, however, ſenſible of the true ſtate of things; and compelled the company to acknowledge, though they did not reward, his ſervices. He afterwards returned into the Indies, and perfected the work he had begun, and to him it is owing that the iſle of France was rendered one of the fineſt and moſt important ſpots upon the globe. Here no coffee is raiſed; but by the indefatigable induſtry of M. de Bourdonnais, ſugar, indigo, pepper, and cotton (which are not at Bourbon), came to be cultivated with ſucceſs. Since the departure of that moſt excellent governor, the plantations have been neglected, and are fallen off; but if a proper ſpirit of activity was raiſed among the inhabitants, they might ſoon be made to reſume their flouriſhing appearance. Mines of iron have been diſcovered in the mountains near the great plain, in the north-eaſt part of the iſland; and theſe mountains affording in great abundance the neceſſary 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-ſhells. Black cattle, ſheep, and goats, are preſerved with difficulty; the firſt generally die before they have been a year in the iſland, and this occaſions frequent importations of them from Madagaſcar and other parts. Common domeſtic poultry breed in great plenty; and, with fiſh and turtle, furniſh a great part of the food of the European inhabitants.

The approach to the iſland is extremely dangerous, it being ſurrounded with ledges of rocks, and many of them covered by the ſea. The ſhore abounds with coral and ſhells. This iſland is ſaid to contain 60 rivers: ſome are conſiderable ſtreams, and moſt of them have their ſources from lakes, of which there are ſeveral in the middle part of the iſland. The rivers afford plenty of various kinds of fiſh, particularly eels. Theſe are of an enormous ſize, ſome having been found that were ſix feet long, and ſix inches in circumference, and ſo extremely voracious, that it is dangerous to bathe in thoſe parts of the river where they lie, as they will ſeize a man without fear, and have ſtrength ſufficient 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 eſteem them a delicate morſel. The air is both hot and moiſt, but not unwholeſome. The place abounds with inſects, which are very troubleſome; but there are no ſerpents. It has been diſcovered, that off Port Louis the ſouth-eaſt wind generally blows with leaſt ſtrength about ſunriſe; and it alſo happens, on four or five days, at intervals, in the courſe of a month, that early in the morning the wind ceaſes in the northern part of the iſland for an hour or two, when a breeze riſes, although but faintly, from the north-weſt; during which, a ſhip ſtationed at the entrance of the channel to avail herſelf of this breeze, may enter the harbour and attack the forts.

This iſland, during the period of the French revolution, did not entirely eſcape from the ſtorm which then agitated the parent country. In the year 1799, a conſpiracy was formed, and broke out, for the purpoſe of reſiſting the government which had been eſtabliſhed under the authority of the republic. It was, however, ſoon ſuppreſſed by the activity of the municipality and governor-general, ſupported by the majority of the inhabitants, and order and tranquillity were again reſtored.

The population of this iſland in 1799 amounted to 65,000, viz. 55,000 ſlaves, and 10,000 whites and mulattoes. The following is a ſtate of the produce of this iſland 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 ſugar, 20,000,000 lbs.
Cloves, 20,000 lbs.

MAURUA, one of the Society iſlands in the South ſea. It is a ſmall iſland, entirely ſurrounded with a ridge of rocks, and without any harbour for ſhipping. It is inhabited; and its productions are the ſame with thoſe of the neighbouring iſlands. A high round hill riſes in the middle of it, which may be ſeen at the diſtance of 10 or 12 leagues. W. Long. 152. 32. S. Lat. 16. 25.

MAUSOLEUM, a magnificent tomb or ſepulchral monument. The word is derived from Mauſolus king of Caria, to whom Artemiſia his widow erected a moſt ſtately monument, eſteemed one of the wonders of the world, and called it, from his own name, *Mauſoleum*.

ST MAWES, a town of Cornwall, in England, ſeated on the eaſt ſide of Falmouth haven, in W. Long. 4. 56 N. Lat. 50. 6. Though but a hamlet of the pariſh of St Juſt, two miles off, without a miniſter, or either church, chapel, or meeting-houſe, it has ſent members to parliament ever ſince 1562, who are returned by its mayor or portreve. It conſiſts but of one ſtreet, under a hill, and fronting the ſea, and its inhabitants ſubſiſt purely by fiſhing. K. Henry VIII. built a caſtle here, oppoſite to Pendennis, for the better ſecurity 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 ſon of the emperor Maximianus Hercules, was, by the voluntary abdication of Diocleſian, and of his father, raiſed to the empire A. D. 306. He afterwards incited his father to reaſſume his imperial authority; and in a perfidious manner deſtroyed Severus, who had delivered himſelf into his hands, and relied upon his honour for the ſafety of his life. His victories and ſucceſſes were impeded by Galerius Maximianus, who oppoſed him with a powerful force. The defeat 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 vulgis 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 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, 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, 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 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 maſterpiece 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. 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 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, 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; 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,

$$\sqrt{1\times9}={}^2\sqrt{9}=3$$

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,

$\overline{2\times2}\times16=64$, and ${}^3\sqrt{64}=4$. Again,

${}^3\sqrt{2\times16^2}={}^3\sqrt{512}=8$. 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

England and Scotland. See the article *WEIGHTS and Meaſures*.

If any one of the ſtandards above mentioned be juſtly preſerved, it will ſerve as a foundation for the others, by which they may be corrected if inaccurate, or reſtored if entirely loſt. For inſtance, if we have a ſtandard foot, we can eaſily obtain an inch, and can make a box which ſhall contain a cubical inch, and may ſerve as a ſtandard for meaſures of capacity. If it be known that a pint contains 100 cubical inches, we may make a veſſel five inches ſquare, and four inches deep, which will contain a pint. If the ſtandard be required in any other form, we may fill this veſſel with water, and regulate another to contain an equal quantity. Standards for weights may be obtained from the ſame foundation; for if we know how many inches of water it takes to weigh a pound, we have only to meaſure that quantity, and the weight which balances it may be aſſumed as the ſtandard of a pound.

Again, If the ſtandard of a pound be given, the meaſure of an inch may be obtained from it; for we may weigh a cubical inch of water, and pour it into a regular veſſel; and having noticed how far it is filled, we may make another veſſel of like capacity in the form of a cube. The ſide of this veſſel may be aſſumed as the ſtandard for an inch; and ſtandards for a foot, a pint, or a buſhel, may be obtained from it. Water is the moſt proper ſubſtance for regulating ſtandards; for all other bodies differ in weight from others of the ſame kind; whereas it is found by experience that ſpring and river water, rain, and melted ſnow, and all other kinds, have the ſame weight; and this uniformly holds in all countries when the water is pure, alike warm, and free from ſalt and minerals.

Thus, any one ſtandard is ſufficient for reſtoring all the reſt. It may further be deſired to hit on ſome expedient, if poſſible, for reſtoring the ſtandards, in caſe that all of them ſhould ever fall into diſorder, or ſhould be forgotten, through the length of time, and the viciſſitudes of human affairs. This ſeems difficult, as no words can convey a preciſe idea of a foot-rule, or a pound weight. Meaſures, aſſumed from the dimenſions of the human body, as a foot, a hand-breadth, or a pace, muſt nearly be the ſame in all ages, unleſs the ſize of the human race undergo ſome change; and therefore, if we know how many ſquare feet a Roman acre contained, we may form ſome judgement of the nature of the law which reſtricted the property of a Roman citizen to ſeven acres; and this is ſufficient to render hiſtory intelligible; but it is too inaccurate to regulate meaſures for commercial purpoſes. The ſame may be ſaid of ſtandards, deduced from the meaſure of a barley-corn, or the weight of a grain of wheat. If the diſtance of two mountains be accurately meaſured and recorded, the nature of the meaſure uſed will be preſerved in a more permanent manner than by any ſtandard; for if ever that meaſure fall into diſuſe, and another be ſubſtituted in its place, the diſtance may be meaſured again, and the proportion of the ſtandards may be aſcertained by comparing the new and ancient diſtances.

But the moſt accurate and unchangeable manner of eſtabliſhing ſtandards is, by comparing them with the length of pendulums. The longer a pendulum is, it vibrates the ſlower; and it muſt have one preciſe length in order to vibrate in a ſecond. The ſlighteſt difference in length will occaſion a difference in the time; which will become abundantly ſenſible after a number of vibrations, and will be eaſily obſerved if the pendulum be applied to regulate the motion of a clock. The length of a pendulum which vibrates ſeconds in London is about $39\frac{1}{8}$ inches, is conſtantly the ſame at the ſame place, but it varies a little with the latitude of the place, being ſhorter as the latitude is leſs. Therefore, though all ſtandards of weights and meaſures were loſt, the length of a ſecond pendulum might be found by repeated trials: and if the pendulum be properly divided, the juſt meaſure of an inch will be obtained; and from this all other ſtandards may be reſtored. See *Whitchurſt on Invariable* MEASURES.

Meaſures are various, according to the various kinds and dimenſions of the things meaſured.—Hence ariſe lineal or longitudinal meaſures, for lines or lengths; ſquare meaſures, for areas or ſuperfices; and ſolid or cubic meaſures, 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 ariſe other diviſions of ancient and modern meaſures, domeſtic and foreign ones, dry meaſures, liquid meaſures, &c.

I. *LONG Meaſures, or Meaſures of Application.*

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

The Engliſh lineal ſtandard is the yard, containing 3 Engliſh feet; equal to 3 Paris feet 1 inch and $\frac{3}{18}$ of an inch, or $\frac{7}{9}$ of a Paris ell. The uſe of this meaſure was eſtabliſhed by Henry I. of England, and the ſtandard taken from the length of his own arm. It is divided into 36 inches, and each inch is ſuppoſed equal to 3 barleycorns. When uſed for meaſuring cloth, it is divided into four quarters, and each quarter ſubdivided into 4 nails. The Engliſh ell is equal to a yard and a quarter, or 45 inches, and is uſed in meaſuring linens imported from Germany and the Low Countries.

The Scots *elwand* was eſtabliſhed by King David I. and divided into 37 inches. The ſtandard is kept in the council chamber of Edinburgh, and being compared with the Engliſh yard, is found to meaſure $37\frac{1}{5}$ inches; and therefore the Scots inch and foot are larger than the Engliſh, in the proportion of 180 to 185; but this difference being ſo inconſiderable, is ſeldom attended to in practice. The Scots ell, though forbidden by law, is ſtill uſed for meaſuring ſome coarſe commodities, and is the foundation of the land meaſure of Scotland.

Itinerary meaſure is the ſame 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 haſp or hank, and 4 hanks make a ſpindle.

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

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 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	$416\frac{1}{3}$	250	125		Stadium	120	4	4.5
80000	60000	20000	5000	4000	$3333\frac{1}{3}$	2000	1000	8	Milliare	967	0	0.

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 - -	675½
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 - -	658¼
The Bruſſels foot - - -	609⅗
The Dantzick foot, from Hevelius's Selenographia - - -	636
The Lyons foot, by M. Auzout -	757⅖
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 - - -	494¼
The Roman foot in the Capitol, examined by Meſſrs Picard and Auzout -	653 or 653½
The ſame from the Greek foot -	652
From the vineyard Mattei - -	657½
From the palm - - -	658¼
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 - -	653½
From the diameters of the columns in the arch of Septimius Severus. - -	653⅕
From a ſlip of porphyry in the pavement of the Pantheon - - -	653⅓

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 - -	977¾	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	695½	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	2¾	Engliſh miles
A German mile	4	ditto
A Dutch mile	3¼	ditto
An Italian mile	$\frac{11}{12}$	ditto
A Spaniſh league	3⅔	ditto
A Ruſſian verſt	¾	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 5½ yards, the ſquare of the ſame contains 30¼ 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 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 $281\frac{1}{4}$ 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 $\frac{1}{16}$ 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 $\frac{1}{6}$ 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 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 *ſeſters* 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									
28⅞	Pint								
231	8	Gallon							
4158	144	18	Rundlet						
7276½	252	31½	1¾	Barrel					
9702	336	42	2⅓	1⅓	Tierce				
14553	504	63	3½	2	1½	Hogſhead			
19279	672	84	4⅔	2⅔	2	1⅓	Punchcon		
29106	1008	126	7	4	3	2	1½	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 Engliſh Wine Meaſure.

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

3. **Attic** reduced to Engliſh Wine Meaſure.

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

4. **Roman** reduced to Engliſh Wine Meaſure.

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

IV. *Meaſures*

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 $19\frac{1}{6}$ inches, the depth $7\frac{1}{3}$ 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 $103\frac{1}{2}$ 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 ſchepeles. 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. 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 17/120	0.031
20	Cab						0	0	2 5/6	0.073
36	1 4/5	Gomor					0	0	5 1/10	1.211
120	6	3 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 Meaſures of Capacity for Things dry, reduced to Engliſh Corn Meaſure.

							Peck.	Gall.	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			Xeſtes	0	0	0	33.158
180	18	12	3	1$\frac{1}{2}$		Choenix	0	0	1	15.705 $\frac{1}{2}$
8640	864	576	144	72	48	Medimnos	4	0	6	3.501

4. Roman Meaſures of Capacity for Things dry, reduced to Engliſh Corn meaſure.

							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 uſually 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 ſtuck upright to bound them; or *voyes*, as being ſuppoſed half a waggon load.

Measure for Horſes, is the hand, which by ſtatute contains four inches.

Measure, among *Botaniſts*. In deſcribing the parts of plants, Tournefort introduced a geometrical ſcale, which many of his followers have retained. They meaſured every part of the plant; and the eſſence of the deſcription conſiſted in an accurate menſuration of the whole.

As the parts of plants, however, are liable to variation in no circumſtance ſo much as that of dimenſion, Linnæus very rarely admits any other menſuration than that ariſing from the reſpective length and breadth of the parts compared together. In caſes that require actual menſuration, the ſame author recommends, in lieu of Tournefort's artificial ſcale, the following natural ſcale of the human body, which he thinks is much more convenient, and equally accurate.

The ſcale in queſtion conſiſts 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 creſcent or white appearance at the root of the finger (not thumb), meaſured from the ſkin towards the body of the nail; a line is equal to 12 hair-breadths, and is the 12th part of a Pariſian inch. 3. A nail (*unguis*), the length of a finger nail; equal to ſix lines, or half a Pariſian inch. 4. A thumb (*pollex*), the length of the firſt or outermoſt joint of the thumb; equal to a Pariſian inch. 5. A palm (*palmus*), the breadth of the palm excluſive of the thumb; equal to three Pariſian inches. 6. A ſpan (*ſpithama*) the diſtance between the extremity of the thumb and that of the firſt finger when extended; equal to ſeven Pariſian inches. 7. A great ſpan (*dodrans*), the diſtance between the extremity of the thumb and that of the little finger, when extended; equal to nine inches. 8. A foot (*pes*), meaſuring from the elbow to the baſis of the thumb; equal to 12 Pariſian 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 Pariſian inches, or two feet. 11. A fathom (*orgya*), the meaſure of the human ſtature; the diſtance between the extremities of the two middle fingers, when the arms are extended; equal, where greateſt, to ſix feet.

Measure is alſo uſed to ſignify the cadence and time obſerved in poetry, dancing, and muſic, to render them regular and agreeable.

The different meaſures 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 *αγφιλον*. 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 *μεγα ζυμος*, 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, hav-

Meath
||
Mecænas.

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.

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 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 liſe, 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, 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 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.

HISTORY.

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 deſcription 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 ſome authors, they were firſt uſed in France in the ſixth century; while others maintain that they were brought to Europe in the time of the cruſades, and that they had long been employed in the eaſt, where the ſcarcity of water precluded the application of that agent to machinery.

Stevinus diſcovers the parallelogram of forces. Died in 1635.

6. The ſcience of mechanics ſeems to have been ſtationary till the end of the 16th century. In 1577 a treatiſe on mechanics was publiſhed by Guidus Ubaldus, but it contained merely the diſcoveries of Archimedes. Simon Stevinus, however, a Dutch mathematician, contributed greatly to the progreſs of the ſcience. He diſcovered the parallelogram of forces; and has demonſtrated in his Statics, publiſhed in 1586, that if a body is urged by two forces in the direction of the ſides of a parallelogram, and proportional to theſe ſides, the combined action of theſe two forces is equivalent to a third force acting in the direction of the diagonal of the parallelogram, and having its intenſity proportional to that diagonal. This important diſcovery, which has been of ſuch ſervice in the different departments of phyſics, ſhould have conferred upon its author a greater degree of celebrity than he has actually enjoyed. His name has ſcarcely been enrolled in the temple of fame, but juſtice may yet be done to the memory of ſuch an ingenious man. He had likewiſe the merit of illuſtrating other parts of ſtatics; and he appears to have been the firſt who, without the aid of the properties of the lever, diſcovered the laws of equilibrium in bodies placed on an inclined plane. His works were reprinted in the Dutch language in 1605. They were tranſlated into Latin in 1608, and into French in 1634; and in theſe 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 ſolids. 1661.

7. The doctrine of the centre of gravity, which had been applied by Archimedes only to plane ſurfaces, was now extended by Lucas Valerius to ſolid bodies. In his work entitled *De Centro Gravitatis Solidorum Liber*, publiſhed at Bologna in 1661, he has diſcuſſed this ſubject with ſuch ability, as to receive from Galileo the honourable appellation of the *Novus noſtræ ætatis Archimedes*.

Diſcoveries of Galileo. Born 1564. Died 1642.

8. In the hands of Galileo the ſcience of mechanics aſſumed a new form. In 1572 he wrote a ſmall treatiſe on ſtatics, which he reduced to this principle, that it requires an equal power to raiſe two different bodies to altitudes in the inverſe ratio of their weights, or that the ſame power is requiſite to raiſe 10 pounds to the height of 100 feet, and 20 pounds to the height of 50 feet. This fertile principle was not purſued by Galileo to its different conſequences. It was left to Deſcartes 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 Tuſcan philoſopher. In addition to this new principle, Galileo enriched mechanics with his theory of local motion. This great diſcovery has immortalized its author; and whether we conſider its intrinſic value, or the change which it produced on the phyſical ſciences, we are led to regard it as nearly of equally importance with the theory of univeral gravitation, to which it paved the way. The firſt hints of this new theory were given in his SYSTEMA COSMICUM, *Dialogus* II. The ſubject was afterwards fully diſcuſſed in another, entitled *Diſcurſus et Demonſtrationes Mathematicæ circa duas novas Scientias pertinentes ad Mechanicam et Motum Localem*, and publiſhed in 1638. This work is divided into four dialogues; the firſt of which treats of the reſiſtance of ſolid bodies before they are broken: The ſecond points out the cauſe of the coheſion of ſolids. In the third he diſcuſſes his theory of local motions, comprehending thoſe which are equable, and thoſe 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 demonſtrates ſeveral propoſitions relative to the centre of gravity of ſolid bodies. In the firſt of theſe dialogues he has founded his reaſoning on principles which are far from being correct, but he has been more ſucceſsful in the other three. In the third dialogue, which contains his celebrated theory, he diſcuſſes the doctrine of equable motions in ſix theorems, containing the different relations between the velocity of the moving body, the ſpace which it deſcribes, and the time employed in its deſcription. In the ſecond part of the dialogue, which treats of accelerated motion, he conſiders all bodies as heavy, and compoſed of a number of parts which are alſo heavy. Hence he concludes that the total weight of the body is proportional to the number of the material particles of which it is compoſed, and then reaſons in the following manner. As the weight of a body is a power always the ſame in quantity, and as it conſtantly acts without interruption, the body muſt be continually receiving from it equal impulſes in equal and ſucceſſive inſtants of time. When the body is prevented from falling by being placed on a table, its weight is inceſſantly impelling it downwards, but theſe impulſes are inceſſantly deſtroyed by the reſiſtance of the table which prevents it from yielding to them. But where the body falls freely, the impulſes which it perpetually receives are perpetually accumulating, and remain in the body unchanged in every reſpect excepting the diminution which they experience from the reſiſtance of air. It therefore follows, that a body falling freely is uniformly accelerated, or receives equal increments of velocity in equal times. Having eſtabliſhed this as a definition, he then demonſtrates, that the time in which any ſpace is deſcribed by a motion uniformly accelerated from reſt, is equal to the time in which the ſame ſpace would be deſcribed by an uniform equable motion with half the final velocity of the accelerated motion; and that in every motion uniformly accelerated from reſt, the ſpaces deſcribed are in the duplicate ratio of the times of deſcription. After having proved theſe theorems, he applies the doctrine with great ſucceſs to the aſcent and deſcent of bodies on inclined planes.

1638.

Labours of Toricelli. 1644.

9. The theory of Galileo was embraced by his pupil Toricelli, who illuſtrated and extended it in his excellent work entitled *De motu gravium naturaliter accelerato*, publiſhed in 1644. In his treatiſe *De motu projectorum*, publiſhed in the Florentine edition of his works, in 1664, he has added ſeveral new and important propoſitions to thoſe which were given by his maſter on the motion of projectiles.

Invention of the ſteam engine.

10. It was about this time that ſteam began to be

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. 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.

1700.

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. 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.

Huygens ſolves the problem of the centre of oſcillation.

Works of Borelli. 1666.

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

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 $54\frac{2}{3}$ degrees to the axis of rotation, or, when the angle of weather is $35\frac{1}{3}$ 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 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.

Rendered general by Daniel Bernouilli.

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.

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*.

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.

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 the

1746.

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

* *Sup. Encycl.* § *Dynamics*.

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.

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.

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 †.

And into the ſubject of friction.

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.

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

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

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

† *Memoires Preſentées* tom. ix.

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

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.

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

Theory 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. Theory.

Fig. 3. 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. 2. 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. 3. 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.

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.

Fig. 4. 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.

For if we ſuppoſe B to be the fulcrum, and if removing 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. 1.); 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,

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

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

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

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 weights ſuſpended from the ſhorter arm. (Fig. 7.) 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.

Fig. 8. 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. 5. 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

the

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

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

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

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

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

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

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

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 F *m*, F *n* perpendicular to AE, BK produced. Then P ſhall be to W as F*n* is to F*m*. 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 ACF, AE*m* 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=F*m* : FA, and AC×FA=AE×F*m*. For the ſame reaſon in the ſimilar triangles BGK, BF*n* we have BG : BK=F*n* : FB, and BK×F*n* = BG×FB. Hence AE×F*m*=BK×F*n*, and AE : BK or P : W =F*n* : F*m*. 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 F *m* is evidently the ſine of the angle FA *m*, and F *n* the ſine of the angle FB*n*, FA, FB being made the radii ,—therefore P : W = Sin. FB *n* : Sin. FA *m*, or P : W $= \frac{1}{\text{Sin. FA}m} : \frac{1}{\text{Sin. FB}n}$. Since FA : F *m* = Rad. : Sin. FA*m*, we have $\text{F}m = \frac{\text{FA} \times \text{Sin. FA}m}{\text{Rad.}}$; and ſince FB : F*n*=Rad. : Sin. FB*n*, we have $\text{F}m = \frac{\text{FB} \times \text{Sin.FB}n}{\text{Rad.}}$ but in the caſe of an equilibrium P : W=F*n* : F*m*, conſequently $\text{P} : \text{W} = \frac{\text{FB} \times \text{Sin. FB}n}{\text{Rad.}} : \frac{\text{FA} \times \text{Sin. FA}m}{\text{Rad.}}$; and ſince magnitudes have the ſame ratio as their equimultiples, P : W=EB× Sin. EB*n* : FA×Sin. FA*m*.

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 *m* E, *n* K 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 F*m* is the ſine of FLA or LFS, and F*n* the ſine of FLS, therefore by ſubſtitution LS : SF=F*m* : F*n*, 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, 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 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 $A\,m$, $A\,n$.

Fig. 5.

Fig. 6. 60. Cor. 8. Let DE be a heavy wheel, and FG an obſtacle over which it is to be moved, by a force P, 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 $F\,m \times P = 0$.

Fig. 7. 61. Cor. 9. If a man be placed in a pair of ſcales 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.

Fig. 8. 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.

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.

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* *Phil. Tranſ.* 1794. p. 33.

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

$Af = FB$; 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 $2P = P + W$. 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 $E = 2P = 2W$, and $AB = 2AF$, 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 $= 2P = P + W$; 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.

Plate CCCXVII. Fig. 9.

Prop. IV.

64. When ſeveral levers AB, ab, $\alpha\beta$, 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 ab, and N the force which is exerted by the ſecond lever ab upon the third $\alpha\beta$, then by Prop. I.

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

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

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

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* Account of Newton's Diſcoveries

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

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

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

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 $Ax\times P=Bz\times W$, that is, the momenta of the power and weight are equal.

SECT. II. *On the Inclined Plane.*

Plate CCXVIII. Fig. 4.

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*.

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

Theory.

as the ſine of the plane's inclination, is to the ſine 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 ſine of the plane's inclination, or, on account of the ſimilar triangles FA *n*, MNO, as the length of the plane is to its height. In this caſe the power acts to the greateſt advantage.

73. Cor. 2. When the power acts in a vertical line A *s*, 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 caſe ſuſtains the whole weight.

74. Cor. 3. When the power acts parallel to the baſe 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 reſiſt the gravity of the weight; for the perpendicular from the fulcrum F, to which its energy is proportional, vaniſhes.

76. Cor. 5. Since the body W acts upon the plane in a direction AF perpendicular to the plane's ſurface, (for its force downwards may be reſolved into two, one parallel to the plane, and the other perpendicular to it), and ſince the reaction of the plane muſt alſo be perpendicular to its ſurface (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 preſſure upon the plane, will be reſpectively as the height, the baſe, 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, ſince theſe forces are in equilibrio, and ſince A *f* is parallel to *n* F, and F *f* to A *n*, the three ſides AF, A *f*, F *f*, will repreſent the three forces (Dynamics, §. 144.). But the triangle AF *f* is ſimilar to A *n* F, that is, to MNO, for it was already ſhewn that the angle *n* AF is equal to MNO, therefore, ſince in the triangle AF *f*, AF repreſents the preſſure on the plane, A *f* the weight of the body, and F *f* the energy of the power, theſe magnitudes will alſo be repreſented in the ſimilar triangle MNO by the ſides MN, MO, NO.

77. Cor. 6. If a power P and weight W are in equilibrio upon two inclined planes AB, AC; $P : W = AB : AC$. 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 ſince the ſtring is equally ſtretched at every point, the ſame power *p* will alſo ſuſtain the power P, conſequently $P : p = AB : AD$, and by compoſition $P : W = AB : AC$. Fig 6.

Prop. II.

78 If a ſpherical body is ſupported upon two inclined planes, the preſſures upon theſe planes will be inverſely as the ſines of their inclination, while the abſolute weight of the body is repreſented by the ſine of the angle formed by the two planes.

Fig. 7.

Let AC, BC be the two inclined planes, and F the ſpherical body which they ſupport. The whole of its matter being ſuppoſed 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 ſurface of theſe planes, and therefore we may conſider the body F as influenced by three forces acting in the directions FC, FM, FN; but theſe forces are repreſented by the ſides of the triangle ABC perpendicular to their directions, (Dynamics, §. 144.), conſequently the abſolute weight of the body F, the preſſure upon the plane AC, and the preſſure upon the plane BC, are reſpectively as AB, AC, and BC, that is, as the ſines of the angles ACD, ABC, BAC, for in every triangle the ſides are as the ſines of the oppoſite angles, or, to expreſs it in ſymbols, W being the abſolute weight of the body, *w* the preſſure on AC, and *w′* the preſſure on BC,

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

But on account of the parallels AB, DF, the angle $ABC = BCF$, and $BAC = ACD$, therefore the preſſures upon the planes are inverſely as the ſines of their inclination, the abſolute weight of the body being repreſented by the ſine of the angle formed by the ſurfaces of the two planes.

Corollaries.

79. Cor. 1. Since the two ſides of a triangle are greater than the third, the ſum of the relative weights ſupported by the two planes is greater than the abſolute weight of the body.

80. Cor. 2. If the inclination of each plane is 60°, then ACB muſt alſo be 60°, and the triangle ABC equilateral, conſequently the preſſure upon each plane is equal to the abſolute weight of the body.

81. Cor. 3. When the inclination of each plane increaſes, the preſſure which each ſuſtains is alſo increaſed; and when their inclination diminiſhes till it almoſt vaniſhes, the preſſure upon each plane is one half of the abſolute weight of the body F.

Prop. III.

82. If a body is raiſed 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.

Fig. 8.

Let the weight W be drawn uniformly up the inclined plane AB, from B to D, by a power whoſe direction is parallel to DH. Upon DB deſcribe 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 ſpace equal to BD, yet its velocity in the direction DH is meaſured by the ſpace FD uniformly deſcribed; and for the ſame reaſon, though the weight W deſcribes the ſpace BD, yet its velocity in the direction in which it acts, that is, in a vertical direction, is evidently meaſured by the ſpace DE uniformly deſcribed. Then becauſe 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.)

21.) the triangles DFE, DHC are ſimilar, and (GEOMETRY, Sect. IV. Theor. 20.) $DF : DE = DH : HC$. But $DH : HC = \text{ſin. } DCH : \text{ſin. } HDC$, 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 $P : p = \text{ſin. } CBD : \text{ſin. } ABD$. 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, §. 44), for AB CB are the directions of the forces P and p. We have therefore $P : p = DE : BE$; but $DE : BE = \text{ſin. } DBE : \text{ſin. } BDE$, and on account of the parallels DE, AB, the angle $BDE = ABD$, conſequently $P : p = \text{ſin. } DBE : \text{ſin. } BDE$.

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 $BE : BD = \text{ſin. } BDE : \text{ſin. } BED$; 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, $p : W = \text{ſin. } ABF : \text{ſin. } ABC$. In the ſame way it may be ſhown that $P : W = \text{ſin. } CBF : \text{ſin. } ABC$. Hence we have $P + p : W = \overline{\text{ſin. } CBF + \text{ſin. } ABF} : \text{ſin. } ABC$, 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 $P : p = \text{ſin. } DBE : \text{ſin. } BDE$, and by the principles of trigonometry, $\text{ſin. } DBE : \text{ſin. } DBE = \text{coſec. } BDE : \text{coſec. } DBE$, we have $P : p = \text{coſec. } ABF : \text{coſec. } CBF$. 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 $P : p = \text{ſec. } BAF : \text{ſec. } BCF$.

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, Fig. 10. 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 ra-

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 $P:W = \overline{FB+\tfrac{1}{2}t} : \overline{FA+\tfrac{1}{2}T}$.

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.

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. On the fuſee of a watch. 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. Parent.* tom. ii. p. 678.; *Traité d'Horlogerie, par M. Berthoud*, tom. i. chap. 26.; and *Traité de Mecanique, par M. de la Hire*, prop. 72.

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. On the pulley. 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.

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 CF*p*, 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 CF*p* 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 $W=10P$, 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 2P, and the rope B the ſame weight; conſequently the rope AB ſuſtains 4P. 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, pound, 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.

Prop. VI.

Plate CCCXIX. Fig. 1. 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, PCB be the angles formed by the ropes. Then, by the laſt propoſition,

$$P : p = \text{rad.} : 2\ \text{coſ. MAP}$$

$$p : \pi = \text{rad.} : 2\ \text{coſ. NBA}$$

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

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

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, 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.*

Plate CCXIX. Fig. 3. 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.

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.

Fig. 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.

Join MN, which will cut DC perpendicularly at the 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 e 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, 5.

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 power does not in the leaſt depend upon the ſize of the cylinder FCK, but that it increaſes with the diſtance of that point from the centre A, to which the power is applied, and alſo with the ſhortneſs of the diſtance between the threads. Therefore, if P, *p* be the powers applied to two different ſcrews, D, *d* the diſtances of theſe powers from the axis, and T, *t* the diſtances between the threads; their energy in overcoming a given reſiſtance will be directly as their diſtances from the axis, and inverſely as the diſtances 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 endleſs ſcrew, there will be an equilibrium when the power is to the weight, as the diſtance of the threads multiplied by the radius of the axle, is to the diſtance of the power from the axis of the ſcrew multiplied by the radius of the wheel.

Fig. 12. The endleſs ſcrew, which is repreſented in fig. 12. conſiſts of a ſcrew EF, ſo combined with the wheel and axle ABC, that the threads of the ſcrew 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′ repreſent the power produced by the ſcrew at the circumference of the wheel; then, by the laſt propoſition, P : W′ as the diſtance between the threads is to the diſtance of P from the axis of the ſcrew; 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 compoſition, P : W as the diſtances of the threads multiplied by the radius of the axle C, is to the diſtance 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 ſcrew, 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 deſcribes the circumference of the circle HBG uniformly, the weight uniformly riſes through a ſpace equal to the diſtance between two adjacent threads; therefore, the velocity of the power is to the velocity of the weight as the diſtance between the threads is to the arch deſcribed by the power, that is, (by Art. 133.), as the weight is to the power.

Prop. IV.

137. To explain the conſtruction and advantages of Mr Hunter's double ſcrew *.

Fig. 13. Let the ſcrew CD work in the plate of metal BA, and have *n* threads in an inch: the cylinder CD, of which this ſcrew is formed, is a hollow tube, which is alſo formed into a ſcrew, having $\overline{n+1}$ threads in an inch, and into this female ſcrew is introduced a male ſcrew DE, having, of courſe, $\overline{n+1}$ threads in an inch. The ſcrew DE is prevented from moving round with CD by the frame ABGF and the croſs bar *a b*, but is permitted to aſcend and deſcend without a motion of rotation. Then, by a revolution of the ſcrew CD, the other ſcrew DE will riſe through a ſpace equal to $\frac{1}{\overline{n+1}\times n}$, and if the circumference deſcribed by the lever CK be *m* inches, we ſhall have $P:W=\frac{1}{\overline{n+1}\times n}:m$; or $P:W=1:mn\times\overline{n+1}$.

138. This reaſoning will be more perſpicuous by ſuppoſing *n*, or the number of threads in CD, to be 12, and, $\overline{n+1}$ or the number of threads in DE will conſequently be 13. Let us ſuppoſe that the handle CK is turned round 12 times, the ſcrew CD will evidently aſcend through the ſpace of an inch, and if the ſcrew DE is permitted to have a motion of rotation along with CD, it will alſo advance an inch. Let the ſcrew DE be now moved backwards by 12 revolutions, it will evidently deſcribe a ſpace of $\frac{12}{13}$ of an inch, and the conſequence of both theſe motions will be that the point E is advanced $\frac{1}{13}$ of an inch. But, ſince DE is prevented from moving round with CD, the ſame 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 caſes have advanced $\frac{1}{13}$ of an inch. Since, therefore, it has advanced $\frac{1}{13}$ of an inch in 12 turns, it will deſcribe 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 deſcribe, in the ſame time, a ſpace equal to $16\times3.1416=50.2656$ inches, the circumference of the circle deſcribed 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 ſcrew is much greater than that of the common ſcrew, for a common one with a lever 8 inches long muſt have 156 threads in an inch to give the ſame power, which would render it too weak to overcome any conſiderable reſiſtance.

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

Scholium.

140. The ſcrew is of extenſive uſe as a mechanical power, when a very great preſſure is required, and is very ſucceſsfully employed in the printing preſs. In the preſs which is uſed for coining money, the power of the ſcrew is advantageouſly combined with an impulſive force, which is conveyed to the ſcrew by the intervention of a lever. The ſcrew is alſo employed for raiſing water, in which form it is called the ſcrew of Archimedes (Hydrodynamics, §. 328); and it has been lately employed in the flour mills in America for puſhing the flour which comes from the millſtones, to the end of a long trough, from which it is conveyed to other parts

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

* *Phil. Tranſ.* vol. lxxi. p. 65.

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.

PROP. I.

Fig. 2.

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

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 $=5\times Cc$, 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 O z, 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,

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

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

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

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 geſellchhaft* 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.

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=φ D : φ *f*; 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.) $\overline{A\times A\varphi}+\overline{B\times B\varphi}=\overline{C\times C\varphi}+\overline{D+D\varphi}+\overline{E\times E\varphi}$; 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 $\overline{A\times X\varphi}+\overline{B\times X\varphi}+\overline{C\times X\varphi}+\overline{D\times X\varphi}+E\times X\varphi=\overline{A\times XA}+\overline{B\times XB}+\overline{C\times XC}+\overline{D\times XD}+E\times XE$, then dividing by A+B+C+D+E, we have

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

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 $A\times Ax=B\times By$, 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.

Fig. 7. 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.

Prop. VI.

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

Fig. 8. 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 $BD:DC=be:cc$; 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 $AF=\frac{2}{3}AD$.

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 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 mn, ſo that $Fn : Fm =$ triangle ABC : triangle ACE, then F will be the centre of gravity of theſe triangles. Join Fo, and find a point f, ſo that $fo : Ff =$ 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 $Ff=\frac{1}{3}$ 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 bcd, and joining cm, it may be eaſily ſhewn, that $bm=md$, and $mn=\frac{1}{3}mc$, ſo that n is the centre of gravity of the ſection bcd. It follows, therefore, that Af 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 φC. But, as the lines Af, φC 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 $Ff=\frac{1}{3}FC$, and $F\varphi=\frac{1}{3}FA$, we have $F\varphi : FA = Ff : FC$, therefore (Geometry, Theor. 8. Sect. IV.) φf is parallel to AC. The triangle φfH will conſequently be ſimilar to AHC, and $H\varphi : HC = Hf : HA = f\varphi : AC = 1 : 3$; therefore $H\varphi=\frac{1}{3}HC=\frac{1}{4}\varphi C$, and $fH=\frac{1}{3}AH=\frac{1}{4}Af$.

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.

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 $DdgG$, we ſhall find its centre of inertia by multiplying each weight by its diſtance from any line mn 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 $DdgG$, 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 $FB=\frac{\text{fluent of } x\times\dot{x}\times DG}{\text{fluent of } \dot{x}\times DG}$, or calling y the ordinate DE, we have $DG=2\,y$, and $FB=\frac{\text{fluent of } x\,2\,y\dot{x}}{\text{fluent of } 2\,y\dot{x}}$, or $FB=\frac{\text{fluent of } x\,y\,\dot{x}}{\text{fluent } y\,\dot{x}}$ 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, whoſe diameter is $2\,\mathrm{DE}=2y$, 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 $\mathrm{FB}=\frac{\text{fluent of } 2\pi x y^2\dot{x}}{\text{fluent of } 2\pi y^2\dot{x}}$, and dividing by $2\pi y$, we have $\mathrm{FB}=\frac{\text{fluent of } y x\dot{x}}{\text{fluent of } y\dot{x}}$.

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 $\mathrm{FB}=\frac{\text{fluent of } 2\pi x y\dot{z}}{\text{fluent of } 2\pi y\dot{z}}$, and dividing by 2π we obtain $\mathrm{FB}=\frac{\text{fluent of } x y\dot{z}}{\text{fluent of } y\dot{z}}$.

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 $\mathrm{GBD}=2\,\mathrm{BD}=2\dot{z}$; conſequently their momenta will be $2x\dot{z}$, and we ſhall have $\mathrm{FB}=\frac{\text{fluent } 2x\dot{z}}{\text{fluent } 2\dot{z}}=\frac{\text{fluent } x\dot{z}}{\text{fluent } \dot{z}}=\frac{\text{fluent } x\dot{z}}{z}$.

PROP. IX.

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

Fig. 12. Let $\mathrm{AE}=x$, $\mathrm{FC}=y$, and AD the radius of the circle $=\mathrm{R}$, conſequently $\mathrm{ME}=2\mathrm{R}-\mathrm{EA}$. Then, ſince by the property of the circle (GEOMETRY, Theor. 28. Sect. IV.) $\mathrm{ME}\times\mathrm{EA}=\mathrm{BE}^2$, we have, by ſubſtitution, $\mathrm{BE}^2=2\mathrm{R}\times\mathrm{EA}-\mathrm{EA}\times\mathrm{EA}$, or $y^2=2\mathrm{R}x-x^2$; hence $y=\sqrt{2\mathrm{R}x-x^2}$. Now, by Art. 174. we have the diſtance of the centre of gravity from A, that is, $\mathrm{AG}=\frac{\text{fluent } x y\dot{x}}{\text{fluent } y\dot{x}}$; 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 $\mathrm{AG}=\frac{\text{fluent } x y\dot{x}}{\frac{1}{2}\mathrm{ABEC}}$. Then, by ſubſtituting inſtead of y, in this equation, the value of it deduced from the property of the circle, we have $\mathrm{AG}=\frac{\text{fluent of } x\dot{x}\sqrt{2\mathrm{R}x-x^2}}{\mathrm{ABEC}}$; 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 $\mathrm{R}-x$, and we have $\mathrm{GD}=$ fluent $\frac{(\mathrm{R}-x)\dot{x}(\overline{2\mathrm{R}x-x^2})}{\frac{1}{2}\mathrm{ABEC}}$. Now, in order to find the fluxion of the numerator of the preceding fraction, aſſume $z=2\mathrm{R}x-x^2$, and $z^{\frac{1}{2}}=\sqrt{2\mathrm{R}x-x^2}$, and by taking the fluxion, we have $\dot{z}=2\mathrm{R}\dot{x}-2x\dot{x}=2\overline{\mathrm{R}-2x}\times\dot{x}$; but this quantity is double of the firſt term of the numerator, therefore $\frac{\dot{z}}{2}=\overline{\mathrm{R}-x}\times\dot{x}$. By ſubſtituting theſe values in the fractional formula, we obtain $\mathrm{GD}=$ fluent $\frac{z^{\frac{1}{2}}}{2}\times\frac{1}{2}\dot{z}=\frac{z^{\frac{3}{2}}}{3}=\frac{\overline{\sqrt{2\mathrm{R}x-xx}}|^{\frac{3}{2}}}{3}$; but ſince $y=\overline{2\mathrm{R}x-xx}|^{\frac{1}{2}}$ we have, by raiſing both ſides to the third power, $y^3=\overline{2\mathrm{R}x-xx}|^{\frac{3}{2}}$; therefore $\mathrm{GD}=\frac{\frac{1}{3}y^3}{\frac{1}{2}\mathrm{ABEC}}=\frac{\frac{1}{24}\times 8y^3}{\frac{1}{2}\mathrm{ABEC}}=\frac{\frac{1}{12}(2y)^3}{\mathrm{ABEC}}$, 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 $=\mathrm{GD}=\frac{\frac{1}{12}(2r)^3}{\mathrm{ABEC}}=\frac{(2r)^3}{12\,\mathrm{ABEC}}=\frac{8\times r^3}{12\mathrm{ABEC}}=\frac{r^3}{1\frac{1}{2}\mathrm{ABEC}}$, 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 $\mathrm{ABEC}:\mathrm{BCB}=mn:\mathrm{G}n$, then the point n will be the centre of gravity of the ſector.—By proceeding in this way, it will be found that $\mathrm{D}n$, 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 $\mathrm{FB}=\frac{\text{fluent of } x y\dot{x}}{\text{fluent } y\dot{x}}$, therefore, by ſubſtituting the preceding values of $xy\dot{x}$ and $y\dot{x}$ in the formula, we obtain $\mathrm{FB}=\frac{\text{fluent of } ax^{n+1}\dot{x}}{\text{fluent of } ax^n\dot{x}}$, and by taking the fluents it becomes

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

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, $\text{FB}=\frac{3}{5}x$, 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 $\text{FB}=\frac{2}{3}\,x$, 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 $\text{FB}=\frac{\text{fluent of } y^2x\dot{x}}{\text{fluent of } y^2\dot{x}}$; therefore, by ſubſtituting the preceding values of $y^2x\dot{x}$, and $y^2\dot{x}$ in that formula, we obtain $\text{FB}=\frac{\text{fluent of } a^2x^{2n+1}\dot{x}}{\text{fluent of } a^2x^{2n}\dot{x}}$, and by taking the fluents we ſhall have

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

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

When $n=1$, the ſolid becomes a cone, and $\text{FB}=\frac{3}{4}x$, 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 $\text{EP}=x$, $\text{EC}=y$, $\text{DC}=\text{R}$, 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, $y : \text{R} = \text{C}s : \text{C}r$; but C r is the fluxion of the arc NC, and C s the fluxion of the abſciſſa PE; therefore $y : \text{R} = \dot{x} : \dot{z}$, and $\dot{z}y=\text{R}\,\dot{x}$, and $\dot{z}=\frac{\text{R}\,\dot{x}}{y}$. Now, by Art. 175. $\text{FB}=\frac{\text{fluent of } x\,y\,\dot{z}}{\text{fluent of } x\,y\,\dot{z}}$, therefore, by ſubſtituting the preceding value of $\dot{z}$ in this formula, we obtain $\text{FB}=\frac{\text{fluent of R } x\dot{x}}{\text{fluent of R } \dot{x}}$, for

$$\frac{\dfrac{\text{R}x\dot{x}\dot{z}}{y}}{\dfrac{\text{R}\dot{x}z}{y}}=\frac{\text{R}\,y\,x\dot{x}\dot{z}}{\text{R}\,y\,\dot{x}\,\dot{z}}\text{ (and dividing by } y\dot{z})=\frac{\text{R}x\dot{x}}{\text{R}\dot{x}}.$$

By taking the fluents we obtain $\text{FB}=\frac{1}{2}\frac{\text{R}\,x^2}{\text{R}x}=\frac{1}{2}\,x$, 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.

Fig. 13.

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 $\text{PC}=\text{DE}=x$; $\text{EC}=y$; $\text{DC}=\text{DA}=\text{R}$, and $\text{AC}=z$, then it may be ſhewn, as in the laſt propoſition, that $y : \text{R}=\dot{x} : \dot{z}$; hence $\dot{z}\,y=\text{R}\,\dot{x}$. But, by Art. 176. we have $\text{FB}=\frac{\text{fluent of } y\,\dot{z}}{z}$, 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 $\text{FB}=\frac{\text{fluent of R }\dot{x}}{z}$, and, taking the fluent, we have $\text{FB}=\frac{\text{R}\,x}{z}$, 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 $d=\frac{\text{R}\,x}{z}$, and $d\,z=\text{R}\,x$; hence $z : x=\text{R} : d$, or $2\,\text{Z} : 2\,x=\text{R} : d$, 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.

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

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

187. When y is equal to 2 R, or when the arc ABC becomes equal to the whole circumference of the circle, x vaniſhes, and is $=0$, and therefore $\frac{R\,x}{z}=0$, 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 $d=\frac{\frac{1}{2}\,C^{1}}{A}$, 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.

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 $\frac{4\,a-3\,x}{6\,a-4\,x}\times x$, 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 $\frac{R\,x}{z}$, 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 $\frac{2\,c\,R}{3\,a}$, 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 $\frac{2\,R+3\,x}{8}$, 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 $\frac{4\,m-3\,x}{6\,m-4\,x}\times x$, 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 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 $\frac{3}{8}$ 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 Aa, and $f\varphi$ will be to Aa 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 Bb in a ſecond; and having drawn φG parallel to Bb, 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 Cc. 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 Aa; therefore Aa 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.

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 Fig. 14. 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 β, κ, be taken ſo that $B\beta : C\kappa = C : B$, the ſpaces Bβ, Cκ will repreſent the mutual action of the bodies B, C, that is Bβ will repreſent the action of C upon B, or the motion which is the reſult of that action, and Cκ 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 $B : C = C\kappa : B\beta$, therefore $FC : FB = C\kappa : B\beta$; but C$\kappa$ is a magnitude taken from FC, and Bβ is a magnitude taken from FB, conſequently (Playfair's Euclid, Book V. Prop. 19.) the remainder $\kappa F : \beta F = FC : FB$, that is, $\kappa F : \beta F = B : C$, 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.

Prop. XV.

193. If a body is placed upon a horizontal plane, or ſuſpended by two threads, it cannot be in

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 $G\varphi$, 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 G i 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 $G\varphi$ (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 G i 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 G m vaniſhes, and G has no power to turn round F. The body AB therefore cannot be in equilibrio till the perpendicular G i falls 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.

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 G i, 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.

Scholium.

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.

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 ſituation.—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.

Fig. 22.

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. $\overline{P\times D}+\overline{p\times d}+\overline{\pi\times\delta}=\overline{P+p+\pi}\times GP$, but $D:d:\delta:GP=A:a:\alpha:Gg$, therefore $\overline{P\times A}+\overline{p\times a}+\overline{\pi\times\alpha}=\overline{P+p+\pi}\times Gg$. But $\overline{P\times A}+\overline{p\times a}+\overline{\pi\times\alpha}$ &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.

Fig. 12.

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.

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.

493. The theorem of Leibnitz, however, as well as that of Guldinus, was demonſtrated by Varignon in the Memoirs of the Academy for 1714, p. 78. Leibnitz obſerves that the method will ſtill hold, even if the centre round which the revolution is performed be continually changed during the generating motion. For further information on this ſubject, the reader is referred to Dr Wallis's work, *De Calculo Centri Gravitatis*, Hutton's Menſuration, Prony's Architecture Hydraulique, vol. i. p. 88, and Gregory's Mechanics, vol. i. p. 64.

Prop. XVIII.

209. To ſhow the uſe of the doctrine of the centre of gravity in the explanation of ſome 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 riſe from a chair, we naturally draw our feet inwards, and reſt upon their extremities, in order to bring the centre of gravity directly below our feet, and we put the body into that poſition in which its equilibrium is tottering, a poſition which renders the ſmalleſt force capable of producing motion, or of overturning the body. In this ſituation, in order to prevent ourſelves from falling backwards, we thruſt forward the upper part of the body for the purpoſe of throwing the centre of gravity beyond our feet; and when the equilibrium is thus deſtroyed, we throw out one of our feet, and gradually raiſe the centre of gravity till the poſition of the body is erect.—When we walk, the body is thrown into the poſition of tottering equilibrium by reſting it on one foot; this equilibrium is deſtroyed by puſhing forward the centre of gravity, and the body again aſſumes the poſition of tottering equilibrium by reſting it on the other foot. During this alternate proceſs of creating and deſtroying a tottering equilibrium, the one foot is placed upon the ground, and the other is raiſed from it; but in running, which is performed in exactly the ſame way, both the feet are never on the ground at the ſame time: At every ſtep there is a ſhort interval, during which the runner does not touch the ground at all.

210. When we aſcend 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 deſcending an inclined plane, the body is thrown backward, in order to prevent the line of direction from falling too ſuddenly without the baſe. In carrying a burden, the centre of gravity is brought nearer to the burden, ſo that the line of direction would fall without our feet if we did not naturally lean towards the ſide oppoſite 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 horſe walks, he firſt ſets out one of his fore feet and one of his hind feet, ſuppoſe the right foot; then at the ſame inſtant he throws out his left fore foot and his left hind foot, ſo as to be ſupported only by the two right feet. His two right feet are then brought up at the ſame inſtant, and he is ſupported only by his two left feet.—When a horſe pulls at a load which he can ſcarcely overcome, he raiſes both his fore feet, his hind feet become the fulcrum of a lever, and the weight of the horſe collected in his centre of gravity acts as a weight upon this lever, and enables him to ſurmount the obſtacle. (See Appendix to Ferguſon's Lectures, vol. ii.)

Method in which a rope-dancer keeps his equilibrium.

212. When a rope-dancer balances himſelf upon the fore part of one foot, he preſerves his equilibrium in two ways, either by throwing one of his arms or his elevated foot, or his balancing pole, to the ſide oppoſite to that towards which he is beginning to fall, or by ſhifting the point of his foot, on which he reſts, to the ſame ſide towards which he is apt to fall; for it amounts to the ſame thing whether he brings the centre of gravity directly above the point of ſupport, or brings the point of ſupport directly below the centre of gravity. For this purpoſe the convex form of the foot is of great uſe, for if it had been perfectly flat, the point of ſupport could not have admitted of ſmall variations in its poſition *.

213. We have already ſeen (Art. 197.) that any body is more eaſily 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 ſhould be placed as low as poſſible. This may often be effected by a judicious diſpoſition of the load, of which the heavieſt materials ſhould always have the loweſt place. The preſent conſtruction of our mail and poſt coaches is therefore adverſe to every principle of ſcience, and the cauſe of many of thoſe accidents in which the lives of individuals have been loſt. The elevated poſition of the guard, the driver, and the outſide paſſengers, and the two boots which contain the baggage, raiſes the centre of gravity of the loaded vehicle to a very great height, and renders it much more eaſily overturned than it would otherwiſe have been. When any accident of this kind is likely to happen, the paſſengers ſhould bend as low as poſſible, and endeavour to throw themſelves to the elevated ſide of the carriage.—In two-wheeled carriages where the horſe 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 horſe's back when he is going down hill, and when he has the leaſt occaſion for it; and taking the load from the back of the horſe when he is going up hill, and requires to be preſſed to the ground.

The conſtruction of mail coaches erroneous.

Fig. 24.

214. A knowledge of the laws of the centre of gravity enables us to explain the experiment repreſented in fig. 24. where the veſſel of water CG is ſuſpended on a rod AB, paſſing below its handle, and reſting on the end E of the beam DE. The extremity B of the rod AB is ſupported by another rod BF, which bears againſt the bottom of the veſſel; ſo that the veſſel 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 ſame vertical line with the point of ſupport E.

A loaded cylinder may be made to aſcend an inclined plane by its own weight.

215. The cylinder G may be made to aſcend the inclined plane ABC by putting a piece of lead or any heavy ſubſtance on one ſide of its axis, ſo that the centre of gravity may be moved from G towards *g*. Hence

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* See Dr *T. Young's Natural Philoſophy*, vol. i. p. 64.

it is obvious, that the centre of gravity g will deſcend, and by its deſcent the body will riſe towards A. The inclination of the plane, however, muſt be ſuch, that before the motion commences, the angles formed by a vertical line drawn from g with a line drawn from G perpendicularly to AB, muſt be leſs than the angle of inclination ABC, or, which is the ſame 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 aſcend an inclined plane by its own weight.
Fig. 26.

216. Upon the ſame principle, a double ſcalene cone may be made to aſcend an inclined plane without being loaded with a weight. In fig. 26. let ABC be the ſection of a double inclined plane, AB, BC being ſections of its ſurfaces perpendicular to the line in which the double ſcalene cone ADEFC moves. Then, ſince the centre of gravity of a cone is in the line joining the vertex and the centre of its baſe, and ſince the axis of a ſcalene cone is not perpendicular to its baſe, the line which joins the centres of both the cones, when in the poſition repreſented in the figure, will be above the line which joins the centres of their baſes. If the circle, therefore, in fig. 27. repreſents the baſe of one of the cones, and C its centre, the line which joins the centres of gravity of the two cones will terminate in ſome point G at a diſtance from the centre, and therefore the double cone will aſcend the plane upon the ſame principles, and under the ſame conditions, as thoſe mentioned in the laſt paragraph.

Fig. 27.

CHAP. V. *On the Motion of Bodies along inclined Planes and Curves, on the Curve of ſwifteſt deſcent, and on the Oſcillations 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 ſine of its inclination is to radius.

Let ABC be the inclined plane, A the place of the body, and let AB repreſent 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 deſtroyed by the reſiſtance or reaction of the plane. The part of the force of gravity, therefore, which makes the body arrive at C is repreſented by AD, while the whole force of gravity is repreſented by AB; but the triangle ABD is equiangular to ABC, and AD : AB=AB : AC, that is, the accelerating force which makes the body deſcend the inclined plane, is to the whole force of gravity as the height of the plane is to its length, or as the ſine of the plane's inclination is to radius; for when AC is radius, AB becomes the ſine 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 alſo uniform; conſequently the laws of accelerated and retarded motions, as exhibited in the article DYNAMICS, are alſo true when the bodies move along inclined planes. If H, therefore, repreſent the height AB of the plane, L its length AC, g the force of gravity, and A the accelerating force, we ſhall have, by the propoſition, L : H$=g$: A, hence $\mathrm{A}=g\times\frac{\mathrm{H}}{\mathrm{L}}$, or, ſince g : A=radius : ſin. ACB, and A $=g\times$ ſin. 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 ſpace deſcribed, 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 ſubſtituting the value of A inſtead of g in the preceding equation, we ſhall have $s'=\text{ſin.}\,\varphi\times\frac{1}{2}t'^2$; $v'=g\,\text{ſin.}\,\varphi t=\sqrt{2gs'\,\text{ſin.}\,\varphi}$, and $t=\frac{v'}{g.\,\text{ſin.}\,\varphi}=\sqrt{\frac{2s'}{g.\,\text{ſin.}\,\varphi}}$.

219. COR. 2. If one body begins to deſcend through the vertical AB at the ſame time that another body deſcends along the plane AC, when the one is at any point m, the poſition 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 A m to A n; but forces are meaſured by the ſpaces deſcribed in the ſame time; therefore, the ſpaces deſcribed in the ſame time, are as A m, A n, that is, as the length of the plane is to its height; for A m : A n= AC : AB; conſequently, when the body that deſcends along the vertical line AB is at m, the other body will be at n.—Through the three points A, m, n deſcribe the ſemicircle A $m\,n$; then, ſince A $n\,m$ is a right angle, the centre of the ſemicircle will be in the line A m (Playfair's Euclid, Book iv. Prop. 5.); conſequently, *if two bodies deſcend from the point* A *at the ſame 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 ſame inſtant.* It alſo follows from this corollary, that if from the point A there be drawn any number of lines making different angles with the diameter A m, and if bodies be let fall from A, ſo as to move along theſe 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 ſame plane, the bodies will be in the circumferences of ſpheres which touch each other in the point A.

220. COR. 3. If any number of bodies deſcend from the ſame 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 deſcending the plane AC, is $v=\sqrt{2gs.\,\text{ſin.}\,\varphi}$, and the velocity of a body falling in the vertical line AB is $v'=\sqrt{2gs'}$. But, ſince $v=v'$, we have $\sqrt{2gs.\,\text{ſin.}\,\varphi}=\sqrt{2gs'}$ or $2gs\ \text{ſin.}\,\varphi=2gs'$, and dividing by $2g$; $s\ \text{ſin.}\,\varphi=s'$, conſequently $s:s'=\text{ſin.}\,\varphi:1$, or AB : AC=ſin. DAB : radius. Therefore, when $v=v'$, that is, when the velocities of the two bodies are equal, the ſpaces deſcribed are as ſin. DAB : radius, which can only happen when BC is perpendicular to AB. In the ſame way it may be ſhewn 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 deſcending along AC is

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 $cG = Bd$. The two bodies again ſet off from the points C, G with the ſame celerity, and ſince $GF = Cc$, 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 *ab*, *bc*, *cd* be the ſimilar ſyſtems of inclined planes, and let T be the time of deſcending ABCD, and *t* the time of deſcending *abcd*. Fig. 2.

By Cor. 4. Prop. 1. we have

$$\text{Time along } AB : \text{Time along } Ac = AB : Ac,$$
$$\text{Time along } ab : \text{Time along } \alpha\beta = ab : \alpha\beta,$$

But, on account of the ſimilar triangles AB*c*, *ab*β, we have,

$$AB : Ac = ab : \alpha\beta.$$

Hence (Euclid, Book v. Prop. 11. 16.)

$$\text{Time along } AB : \text{Time along } ab = \text{Time along } Ac : \text{Time along } \alpha\beta.$$

(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.

$$\text{Time along AB+BC+CD: Time along } \overline{ab+bc+cd} = \text{Time along } \overline{\text{A}c+c\text{G}+\text{GF}}\text{: Time along } \overline{a\beta+\beta\varkappa+\varkappa f},$$

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.

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.

Fig. 4.

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 FD 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 abſciſs 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. 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$=x'$, E$v=v$, 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.

Fig. 5.

Properties of the Cycloid.

Fig. 3. 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.

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 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 P*p* be an infinitely ſmall arc, the perpendicular to the curve drawn from the points P*p* will meet at M, and P*p* 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, $FE \doteq \overline{FN}^2$, or $\sqrt{FE} \doteq FN$, 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.

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 $\sqrt{\overline{CF\times EF}-\overline{CF\times TF}}$, 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; $FN^2=\overline{CF\times EF}$, 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 F*p* or F*m* was made equal to FP, and, *p r* being made equal to PR, the remainder F*r* muſt be equal to FR, therefore, the velocity at R varies as $\sqrt{\overline{Fm}^2-\overline{Fr}^2}$, but (Euclid 47. 1.) $rm=\sqrt{\overline{Fm}^2-\overline{Fr}^2}$, 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 F*m*.

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 F*m*, that

Theory. 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 $T \doteqdot \frac{\sqrt{L}}{\sqrt{g}}$, $\sqrt{g} \times T \doteqdot \sqrt{L}$; and if the time of oſcillation is 1 ſecond, we have $\sqrt{g} \doteqdot \sqrt{L}$, or $g \doteqdot L$, 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 $n \doteqdot \frac{1}{t}$; but by Corollary 3. $t \doteqdot \sqrt{l}$, therefore $n \doteqdot \frac{1}{\sqrt{l}}$, and $l \doteqdot \frac{1}{n^2}$, 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

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.

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 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.

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 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.

$$v'=\frac{BV-B'V\pm2B'V'}{B'+B'}$$
$$v''=\frac{\pm BV'\pm B'V'+2BV}{B+B'}.$$

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 $v''=V'$.

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 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

$1+nV-1+nv$, the whole velocity loſt by B,
$1+nv-1+nV'$, 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

$v'=V-\overline{1+nV-1+nv}$ the velocity of B after impact.
$v''=V'+1+nv-1+nV'$ the velocity of B′ after impact.

Now by ſubſtituting in the place of v its value as determined in Caſe 2. Prop. 2. we obtain

$$v'=V-\frac{\overline{1+n}\times\overline{B'V-B'V'}}{B+B'}.$$

$$v''=V'+\frac{\overline{1+n}\times\overline{BV-BV'}}{B+B'}.$$

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 $B+B' : \overline{1+n}\times B'$ as the relative velocity of the bodies before impact is to the velocity loſt by B.

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 $v''-v'=V'+\frac{\overline{1+n}\times\overline{BV-BV'}}{B+B'}-V-\frac{\overline{1+n}\times\overline{B'V-B'V'}}{B+B'}=V'-V+\frac{\overline{1+n}\times\overline{B+B'}\times\overline{V-V'}}{B+B'}$, 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.

When the body is perfectly hard. Fig. 6.

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 elaſtic.

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, 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 D *m* 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 D *e*; then, if the impinging body approach the plane in the direction CD, with a velocity repreſented by CD, D *e* 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 D *m*, 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 D *e*, the diagonal of the parallelogram D *m e* N. The velocity, therefore, before impact is to the velocity after impact as DC : D *e*, or as DE : D *e*, or as ſin. D *e* E, ſin. DE *e*, or as ſin. D *e m* : ſin. DE *e*, or as ſin. FD *e* : ſin. FDE. Now, by producing D *e* ſo as to meet the line CE produced in G, we have, on account of the parallels FE, *m e*, D *m* : 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 D *m* : DF=tang. ∠CDF : tang. ∠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.*

Scholium.

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 Fig. 8.
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.

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 Fig. 9.
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

rallelogram NF; and for the ſame reaſon the body B will deſcribe the diagonal BQ of the parallelogram PH.

Fig. 10.

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 Dc, touching the ball C at c, the place where the ball D impinges; produce BC to E, and through c draw AcF perpendicular to EB, and complete the rectangle FE. The force Dc may be reſolved into the forces Ec, cF, of which Ec is employed to move the ball C in the direction CB and with the velocity Ec; but the force cF 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.

Scholium.

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, applique 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.*

Theory.

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 $6\times 50=300$. 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 $4\times 50=200$, 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 $5\times 50+50=500$. 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 $2\times 60=120$, and $3\times 60=180$, 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 $2\frac{1}{2}\times 120=300$; 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 $=2.5\times 159\frac{1}{2}=398.75$, while the energy of the moving force, or the ſum of all the moving powers, is equal to 500.

Plate CCCXXII. fig. 1.

Theory.

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.

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.

502. 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

$x=$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.
$\varphi=$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.

Fig. 2.

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; $x:y=R:\frac{Ry}{x}$, the weight which will keep R in equilibrio, or the weight which is equal 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

$$\frac{Pxy-Ry^2-\varphi y^2}{ax^4+by^2+my^2}=\text{the velocity of the working point}$$

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, $v \doteq Ft$, 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

$$y=\frac{\overline{a^2\times\overline{R+\varphi}|^2+P^2a\times\overline{m+b}}|^{\frac{1}{2}}-aR-a\varphi}{Pm+Pb}\times x.$$

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 P m and $\varphi=0$, the laſt formula becomes

$$y=\frac{\overline{P^2R^2+P^3R}|^{\frac{1}{2}}-PR}{PR}\times x=\sqrt{\frac{P^2R^2+P^3R}{P^2R^2}}-\frac{PR}{PR}\times x$$

$$=x\sqrt{\frac{P}{R}+1}\Big|-1,$$

and when $x=1$, and $R=1$, we have

$$y=\sqrt{P+1}|-1,$$

and when $P=1$, and $x=1$, we obtain

$$y=\sqrt{\frac{1}{R}+1}\Big|-1.$$

When $x=1$,

$$y=\sqrt{\frac{}{R}+1}\Big|-1.$$

Theſe various formulæ, 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 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

$$\frac{\mathrm{P}xy\mathrm{R}-\mathrm{R}^2y^2-\varphi\mathrm{R}y^2}{ax^2+by^2+my^2},$$

which repreſents the work performed, is equal to the fluxion of the numerator, becauſe the denominator is conſtant, that is, $\mathrm{P}xy\dot{\mathrm{R}}-2\mathrm{R}\dot{\mathrm{R}}y^2-\varphi\dot{\mathrm{R}}y^2=0$, and, dividing by $\dot{\mathrm{R}}$; $\mathrm{P}xy-2\mathrm{R}y^2-\varphi y^2=0$, hence $2\mathrm{R}y^2=\mathrm{P}xy-\varphi y^2$, and $\mathrm{R}=\frac{\mathrm{P}xy-\varphi y^2}{2y^2}$, which, divided by y, gives $\mathrm{R}=\frac{\mathrm{P}x-\varphi y}{2y}$. 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 φy, we have for the reſiſtance $\mathrm{R}+\frac{1}{15}\mathrm{R}$, or $\frac{16}{15}\mathrm{R}=\frac{\mathrm{P}x-\varphi}{2y}$, or $\mathrm{R}=\left(\frac{\mathrm{P}x}{2y}\right)\div\frac{16}{15}$, 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 my^2 it may be made mx^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, $\frac{\mathrm{R}y-\mathrm{R}^2y^2}{a+m+d\mathrm{R}y^2}$, or, for the ſake of ſimplicity, making $a+m=q$, we have for the performance of the machine $\frac{\mathrm{R}y-\mathrm{R}^2y^2}{q+dry^2}$; 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 $\mathrm{R}=\frac{\overline{q^2+qdy}|^{\frac{1}{2}}-q}{dy^2}$.

When $b=\mathrm{R}$ then $d=1$, and we ſhall have

$$\mathrm{R}=\frac{\overline{q^2+qy}|^{\frac{1}{2}}-q}{y^2}.$$

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 $\mathrm{R}\times\overline{1+\sqrt{2}}$; $\mathrm{R}\times\overline{\frac{1}{2}+\sqrt{\frac{3}{8}}}$; $\mathrm{R}\times\overline{\frac{1}{3}+\sqrt{\frac{4}{27}}}$; $\mathrm{R}\times\frac{1}{4}+\sqrt{\frac{5}{64}}$, $\mathrm{R}\times\frac{1}{5}+\sqrt{\frac{6}{125}}$, &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 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 ab, cd, ef, &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 AbB 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$abc$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 $b\,c\,d\,c$ 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 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. Fig. 6.

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 $a\,m$, $b\,n$, $c\,o$, dp, $e\,q$, &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 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 TUVBkA 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.*

Fig. 7. 321. Hence we have the following practical method of aſcertaining the form of an equilibrated arch, whoſe ſpan is AB, and altitude Dk, and which is to ſupport a roadway of the form T′U′V′. Let a chain A$abck$B, of uniform denſity, be ſuſpended from the points A, B, ſo that it forms a catenary whoſe altitude is Dk, 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 AkB 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 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.

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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 = $q\,e$, 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 D d, E e, B b, &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 D c, D p, 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.

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

$$\text{D}c : \text{E}q = \frac{1}{\text{ſin. AD}d} : \frac{1}{\text{ſin. }d\text{D}p},$$

and for the ſame reaſon

$$\text{E}q : \text{B}s = \frac{1}{\text{ſin. E}eq} : \frac{1}{\text{ſin. }b\text{B}s}.$$

Hence

$$\text{E}q \div \frac{1}{\text{ſin. E}eq}.$$

Now, ſince E q : E e = ſin. E $e\,q$: ſin. E $q\,c$, we have E $e = \frac{\text{E}q \times \text{ſin. E}qe}{\text{ſin. E}eq}$, that is, ſince DE m = E $q\,c$, and e EB = E $e\,q$; E $e = \frac{\text{E}q \times \text{ſin. DE}m}{\text{ſin. }e\text{EB}}$. But E$q \div \frac{1}{\text{ſin. E}eq}$ therefore, by ſubſtitution, we obtain

$$\text{E}e \div \frac{\text{ſin. DE}m}{\text{ſin. E}eq \times \text{ſin. }e\text{EB}}.$$

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 c E q and e EB or E $c\,q$ 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

$$\text{E}e \div \frac{\text{ſin. DE}m}{\text{ſin. }e\text{E}m \times \text{ſin. }e\text{E}m} \div \frac{\text{ſin. DE}m}{\overline{\text{ſin. }e\text{E}m}|^2}.$$

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,

$$\text{E}c \div \frac{1}{\text{radius of curvature} \times \overline{\text{ſin. } e\text{E}m}^2}.$$

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, mn a tangent to any point E, and Ee 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 Ecbd varies as E$c \times gd$, but gd=E$d\times$ſin. dEg, Ed being radius, and dEg =EnB, on account of the parallels Ec, UB, therefore the weight of the column Ecbd varies as E$c\times$ E$d\times$ſin. EnB, that is, as E$c\times$ſin. EnB, becauſe Ed is a conſtant quantity; but the preſſure at E was proved to vary as $\frac{1}{\text{radius curvature} \times \overline{\text{ſin. } e\text{E}m}^2}$, therefore the weight of the column Ecbd or E$c\times$ ſin. EnB varies alſo as this quantity, that is,

$$\text{E}c \times \text{ſin. E}n\text{B} \div \frac{1}{\text{radius curvature} \times \overline{\text{ſin. } e\text{E}m}^2}.$$

But as the angle EnB is equal to the angle eEm, we ſhall have, by ſubſtitution and diviſion,

$$\text{E}c \div \frac{1}{\text{radius curvature} \times \overline{\text{ſin. } e\text{E}m}|^3}, \text{ that is,}$$

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 Ec, we ſhall proceed to ſhew the application of the formula to

Fig. 10. the caſe when the arch is a portion of a circle.

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 ce, which will be parallel to BE. Then ſince GEF is a right angle, and eEF=EFB, the angle GEe is the complement of EFB, therefore, ſin. GEc=coſ. EFB=FD. But, in the preſent caſe, the radius of curvature is the radius of the arch, or R, therefore, E$c \div \frac{1}{\text{R} \times \text{ſin. GE}e}$, or by ſubſtitution, E$c \div \frac{1}{\text{R}\,b^3}$, 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$c \div \frac{1}{\text{R}^3}$, and E$c$ becomes BU = m, hence $\frac{1}{\text{R}^4} : \frac{1}{b^3} = m :$ 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$^3 : b^3$ =$\overline{\text{BF}}^3$: DF^3, hence $\frac{\text{R}^3}{b^3}=\frac{\overline{\text{BF}^3}}{\text{DF}^3}$, and multiplying each ſide by m, we have $\frac{m\text{R}^3}{b^3}=\frac{m\overline{\text{BF}^3}}{\text{DF}^3}$; but $\frac{m\text{R}^3}{b^3}$=Ec, therefore the vertical diſtance of the ſurface of the roadway from the point F, or E$c=\frac{m\overline{\text{BF}^3}}{\text{DF}^3}=\frac{\text{BU}\times\overline{\text{BF}^3}}{\text{DF}^3}$. When the point E coincides with B, BF=DF, and Ee=BU. When E coincides with A, the coſine DF vaniſhes, and therefore Ec, or the diſtance of the point A from the extrados or roadway, is infinite. The curve VUcT, 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 tUv, and making the denſity of the ſuperincumbent columns Pn, Eo, which preſs upon the points P, E reſpectively, in the ratio of Pp, Ec, 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 Bd, 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 $vdbat$ 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 UcT cuts the horizontal line tUv, the point H coincides with U. By ſubſtituting BF—BD inſtead of DF in the value of Ec, formerly determined, and by putting BD=y, we have E$c=\frac{m\text{R}^3}{\overline{\text{R}-y}|^3}$. But when H coincides with U, c coincides with o, and therefore Eo=Ec=BD+BU =$y+m$, conſequently, $\frac{m\text{R}^3}{\overline{\text{R}-y}|^3}=y+m$, and multiplying by $\overline{\text{R}-y}|^3$, we have $m\text{R}^3=y\times\overline{\text{R}-y}|^3+m\times\overline{\text{R}-y}|^3$, or $m\text{R}^3+m\times\overline{\text{R}-y}|^3=y\times\overline{\text{R}-y}|^3$, and, dividing by the coefficients of m, we have

$$m=\frac{y\times\overline{\text{R}-y}|^3}{\text{R}^3-\overline{\text{R}-y}|^3}, \text{ that is,}$$

The thickneſs of the roadway above the keystone, when the extrados is a ſtraight line, is equal to the quotient ariſing

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

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60°, we have $m=\frac{1}{3}$ 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 U r, 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.*

$$\mathrm{ED}=\mathrm{AF}\times\frac{\text{Hyperbol. log. }\dfrac{\mathrm{BU}+\mathrm{BD}+\sqrt{2\,\mathrm{BU}\times\mathrm{BD}+\overline{\mathrm{BD}}^2}}{\mathrm{BU}}}{\text{Hyperbol. log. }\dfrac{\mathrm{BU}+\mathrm{BF}+\sqrt{2\,\mathrm{BU}\times\mathrm{BF}+\overline{\mathrm{BF}}^2}}{\mathrm{BU}}}$$

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 c U.	Value of c E.	Value of c U.	Value of c E.	Value of c U.	Value of c E.	Value of c U.	Value of c E.	Value of c U.	Value c E.
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
4	6.144	17	8.766	26	13.106	35	20.665	44	33.299
6	6.324	18	9.168	27	13.761	36	21.774	45	35.135
8	6.580	19	9.517	28	14.457	37	22.948	46	37.075
10	6.914	20	9.934	29	15.196	38	24.190	47	39.126
12	7.330	21	10.381	30	15.980	39	25.505	48	41.293
13	7.571	22	10.858	31	16.811	40	26.894	49	43.581
14	7.834	23	11.368	32	17.693	41	28.364	50	46.000

335. The conſtruction of arches has alſo been deduced from conſidering the arch-ſtones as fruſtums of poliſhed wedges without friction, which endeavour to force their way through the arch. This principle has been adopted by Belidor, Parent, Boſſut, Prony, and other French philoſophers, and likewiſe by our ingenious countryman, the late Mr Atwood. This theory, however, is more plauſible than uſeful. So far from the arch-ſtones having liberty to ſlide between thoſe which are contiguous to them, without friction, they are bound together by the ſtrongeſt cement, and ſometimes connected by iron pins or wedges. The theory likewiſe requires, that the weight of the arch muſt regularly increaſe 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 denſity or the magnitude of the arch-ſtones muſt be very great at the ſpring of the arch, where the portion of the vertical tangent is a maximum. Thoſe who wiſh to be acquainted with the mode of inveſtigation, by which the equilibrium of arches is eſtabliſhed in this theory, may conſult Prony's *Architecture Hydraulique*, tom. i. p. 152.

On the Conſtruction of Piers and Abutments.

336. In the conſtruction of piers and abutments, there are two circumſtances which claim our attention. 1. The ſtrength that muſt be given to them, in order to reſiſt the lateral thruſt which they ſuſtain from the adjacent ſemiarches, and which tend either to overſet them, or make them ſlide upon their baſe. 2. The form which muſt be given to their extremities, ſo that the force of the current may be a minimum.—The adheſion of the pier to the place on which it reſts is always much greater than one-third of the preſſure; and as the lateral thruſt of the arch which this adheſion reſiſts, is oblique to the horizon, and may be reſolved into two forces, one of which is horizontal, and the other vertical, we have the vertical portion of the lateral thruſt, the weight of the pier, and the friction on its baſe, combined in reſiſting the horizontal portion of the lateral thruſt, which tends to make the pier ſlide upon its baſe, ſo that there is no danger of the pier yielding to ſuch a preſſure.—We do not here conſider, that the lateral thruſt which tends to give a horizontal motion to the pier, is completely counteracted by the lateral thruſt of the oppoſite ſemiarch, becauſe it is neceſſary that the pier ſhould have ſufficient ſtability to reſiſt the lateral thruſt of one ſemiarch, in caſe of the failure of the oppoſite one. Let us therefore conſider the ſtrength of the pier which will prevent it from being overſet.

337. For this purpoſe, let ABC be an arch, MHTO the pier, and BUHA the loaded ſemiarch, whoſe preſſure tends to overturn the pier. Let G be the centre of gravity of the maſs BUHA: Join GA, and from G draw GK perpendicular to AC. Then, ſince the whole preſſure of the arch is exerted at its ſpring A; and ſince this preſſure is the ſame 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 ſuperincumbent maſs acts upon the point A. Now, by DYNAMICS, the force GA may be reſolved 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 ſuperincumbent maſs, we have $\mathrm{GK} : \mathrm{KA} = \mathrm{W} : \frac{\mathrm{W} \times \mathrm{KA}}{\mathrm{GK}}$, the preſſure upon A. Now, as this force tends to turn the pier round O by means of the lever OA, and as $\mathrm{ON} = \mathrm{AM}$ is the perpendicular from the centre of motion upon the line of direction, we have $\mathrm{AM} \times \frac{\mathrm{W} \times \mathrm{KA}}{\mathrm{GK}}$ for the force which tends to overturn the pier. Now, the force which is oppoſed to this is the weight of the pier MHTO collected in its centre of gravity *g*, which acts by the vertical lever $\mathrm{O}m = \frac{1}{2}\mathrm{OM}$, becauſe *g* is in the centre of the rectangle TM (Art. 164.). But the weight or area of the pier may be repreſented by $\mathrm{OM} \times \mathrm{MH}$; therefore, the force which reſiſts the lateral thruſt of the loaded arch is $\mathrm{OM} \times \mathrm{MH} \times \frac{1}{2}\mathrm{OM}$, or $\frac{1}{2}\mathrm{MH} \times \mathrm{OM}$. Now, in the caſe of an equilibrium between theſe oppoſing forces, we have $\mathrm{AM} \times \frac{\mathrm{W} \times \mathrm{KA}}{\mathrm{GK}} = \frac{1}{2}\mathrm{MH} \times \mathrm{OM}^2$, which, by reduction, becomes $\mathrm{OM} = \sqrt{\frac{2\,\mathrm{AM} \times \mathrm{W} \times \mathrm{KA}}{\mathrm{MH} \times \mathrm{GK}}}$. This formula gives us the breadth of the pier which is capable of balancing the lateral thruſt; and therefore OM muſt be taken a little greater than the preceding value. In practice, OM is generally between one-fifth and one-ſeventh of AC, the ſpan 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 ſeen in Dr Hutton's work, already quoted, p. 49. A very ſimple method of doing this is to form the part BVIHA of a piece of card, and to find its centre of gravity G by the rules given in Articles 201, 202, 203. This indeed ſuppoſes all the materials to be homogeneous; but if they are of various kinds, we can load the arch made of card in a ſimilar 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 ſhould be given to the ends of the pier, in order that the impulſe of the current may be the leaſt poſſible. The theory of the reſiſtance of fluids, indeed, differs ſo widely from experiment, that ſuch an inveſtigation would, in this place, be of little practical utility. It may be ſufficient merely to remark, that the pier ſhould have an angular form, and that the impulſe of the current will be diminiſhed as the angle is more acute. When the ends are ſemicircular, the impulſe of the ſtream is reduced to one half; and though a triangular termination of the piers reduces the impulſe ſtill more, yet ſemicircular ends are more pleaſing to the eye, and are particularly advantageous when ſmall veſſels have occaſion to paſs the arch. When thoſe veſſels happen to impinge againſt the piers, the ſemicircular ends are more able to bear the ſhock, and do leſs injury to the veſſel, while the additional quantity of maſonry will give greater ſtability 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 b C 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 $b c$ 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 b F. 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, $'b$C$'$ paſſes above, or without bB. The curvature may be ſo abrupt, that even b'G$'$ ſhall paſs without $'b$B$'$, 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 $b c$, 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

Theory.

is to MO as the weight of the arch HA*h* 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 ∂d, 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, $\int dy\sqrt{\dot{x}^2+\dot{y}^2} : dy\sqrt{\dot{x}^2+\dot{y}^2} = be : bF, = be : CG, = \partial d : CG, = \dot{x} : CG$. 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 $=o$.

" 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 *b*F to *b*C, diminiſhes the angle *cb*G, 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.

Theory.

" 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 $L\int\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{a} = L\frac{\dot{x}}{\dot{y}}t$, and therefore $\int\frac{dy\sqrt{\dot{x}^2+\dot{y}^2}}{a} = t\frac{\dot{x}}{\dot{y}}$.

" 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 $\frac{dy\dot{x}\sqrt{\dot{x}^2+\dot{y}^2}}{\int dy\sqrt{\dot{x}^2+\dot{y}}}$ 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 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 $\int dy\sqrt{\dot{x}^2+\dot{y}^2}$. 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 $=\sqrt{x^2+y^2}$.

"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 $\frac{dy\dot{x}\sqrt{\dot{x}^2-\dot{y}^2}}{\ddot{x}}=\int dy\sqrt{\dot{x}^2+\dot{y}^2}$. Let a be the radius of the hemiſphere. We have $\dot{x}=\frac{ay\dot{y}}{\sqrt{a^2-y^2}}$, and $\ddot{x}=\frac{a^2\dot{y}^2}{a^2-y^2|^{\frac{3}{2}}}$. Subſtituting theſe values in the formula, we obtain the equation $y^2\sqrt{a^2-y^2}=\int\frac{a^2y\dot{y}}{\sqrt{a^2-y^2}}$. 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.

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."

SCHOLIUM.

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.

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 $n\times\overline{\mathrm{A}-\mathrm{M}}$, 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,

$$n\times\overline{\mathrm{A}-\mathrm{M}}\times\dot{t}=\int d\,r\,\dot{v}.$$

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

$$n\times\overline{\mathrm{A}-\mathrm{M}}\times\dot{t}=\dot{u}\int\frac{d\,r^2}{a};$$

and ſince $\dot{t}=\frac{a\,\dot{\mathrm{M}}}{u}$, we have by ſubſtitution

$$n\times\overline{\mathrm{A}-\mathrm{M}}\times\frac{a\,\dot{\mathrm{M}}}{u}=\dot{u}\int\frac{d\,r^2}{a},$$

whoſe fluent is

$$n\times\overline{2\mathrm{AM}-\mathrm{M}^2}=u^2\int\frac{d\,r^2}{a^2}.$$

Taking the ſquare root of both ſides of the equation, we have

$$\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}=u\times\left.\overline{\int\frac{d\,r^2}{a^2}}\right|^{\frac{1}{2}}.$$

Multiplying both ſides by $\frac{a\,\dot{\mathrm{M}}}{u}$, and dividing by $\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}$, the equation becomes

$$\frac{a\,\dot{\mathrm{M}}}{u}=\frac{\frac{a\,\dot{\mathrm{M}}}{u}\times u\times\left.\overline{\int\frac{d\,r^2}{a^2}}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}}=\frac{a\,\dot{\mathrm{M}}\times\frac{1}{a}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}}$$

$$=\frac{\dot{\mathrm{M}}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}}.$$

Therefore, ſince $\dot{t}=\frac{a\,\dot{\mathrm{M}}}{u}$, we ſhall have

$$\dot{t}=\frac{\dot{\mathrm{M}}\times\left.\overline{\int d\,r^2}\right|^{\frac{1}{2}}}{\sqrt{n}\times\sqrt{2\mathrm{AM}-\mathrm{M}^2}},\text{ or}$$

$$\dot{t}=\frac{\dot{\mathrm{M}}}{\sqrt{2\mathrm{AM}-\mathrm{M}^2}}\times\left.\overline{\int\frac{d\,r^2}{n}}\right|^{\frac{1}{2}}.$$

But $\frac{\dot{\mathrm{M}}}{\sqrt{2\mathrm{AM}-\mathrm{M}^2}}$ 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

$$\mathrm{T}=\left.\overline{\int\frac{p\,r^2}{n}}\right|^{\frac{1}{2}}\times 180°.$$

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,

$$\mathrm{T}=\left.\overline{\frac{l}{g}}\right|^{\frac{1}{2}}180°.$$

Therefore, ſince the time in which the cylinder oſcillates muſt be equal to the time in which the pendulum oſcillates, we have

$$\left.\overline{\int\frac{p\,r^2}{n}}\right|^{\frac{1}{2}}180°=\left.\overline{\frac{l}{g}}\right|^{\frac{1}{2}}\times 180°.$$

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 $\pi=6.28318$ 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

Theory.

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

$$\overline{\frac{\int p r^2}{n}}\Big|^{\frac{1}{2}}\times 180^\circ=\overline{\frac{a^2}{2n}}\Big|^{\frac{1}{2}}\times 180^\circ.\quad \text{Therefore}$$

$$T=\overline{\frac{\mu a^2}{2n}}\Big|^{\frac{1}{2}}\times 180,\ \text{and ſince}\int\frac{p r^2}{r}=\frac{l}{g},$$

$\frac{\mu a^2}{2n}=\frac{l}{g}$, 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.

Theory.

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

$$nA^2-\frac{2mA^{\nu+1}}{\nu+1}=UU\int\frac{p r^2}{a^2},$$

which dividing by $\int\frac{p r^2}{a^2}$, becomes

$$U^2=\frac{nA^2-\frac{2mA^{\nu+1}}{\nu+1}}{\int\frac{p r^2}{a^2}}.$$

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,

$$\frac{nM'^2}{2}+\frac{mM'^{\nu+1}}{\nu+1}=\frac{U^2-u^2}{2}\times\int\frac{p r^2}{a^2}.$$

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′

$$A-M'=\frac{2mA^{\nu}}{n\times\overline{\nu+1}},$$

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

$$M=\frac{1}{\left(N\times\frac{2m\times\overline{\nu-1}}{n\times\overline{\nu+1}}+\frac{1}{A^{\nu-1}}\right)\times\frac{1}{\nu-1}},$$

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 $n\times\overline{A-M}$

$$n \times \overline{A-M} = \frac{2mA^{\nu}}{\nu+1} + \frac{2m'A^{\nu'}}{\nu'+1}.$$

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

$$F = \frac{ma\delta^4}{l},$$

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 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 $y = m\sqrt{\frac{P}{R}+1}-1$ 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=3 R; but in the preceding table

$R=10$, 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.
$\frac{1}{4}$	1.3885	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 R=3, the preceding formula becomes $\frac{\overline{10\times3}-\overline{3\times3}}{10+3}=\frac{21}{13}=1.6154$.

When R=4, the formula becomes $\frac{\overline{10\times4}-\overline{4\times4}}{10+4}=\frac{24}{14}=1.7143$.

When R=4.142, the formula becomes $\frac{\overline{10\times4.142}-\overline{4.142}|^2}{10+4.142}=\frac{24.26384}{14.142}=1.7157$.

When R=5, the formula becomes $\frac{10\times5-5\times5}{10+5}=\frac{25}{15}=1.6666$.

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.

Deſcription of a powerful capſtane.

Plate CCCXXIII. Fig 4.

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; 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 1½ 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.

Fig. 5.

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.

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, Bulfinger, 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 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 $\frac{1}{58}$ of the force of preſſion. In cylinders of elm, the friction was greater by $\frac{2}{3}$, 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 $\frac{1}{8}$ 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 $\frac{1}{11}$, 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

Friction wheels.

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 $\text{Tang. } x = \frac{H}{V}$, 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 ſub-

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* *Mem. Acad.* 1699. p. 217.

ject with more care and ſucceſs than any of his predeceſſors. His experiments were made both with the apparatus of Amontons, and with one of his own invention; and as there was no great diſcrepancy in the reſults, he was authoriſed 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 concluſions which were obtained. We can only preſent the reader with ſome of thoſe leading reſults which may be uſeful in the conſtruction of machinery.

1. The rigidity of ropes increaſes, the more that the fibres of which they are compoſed are twiſted.

2. The rigidity of ropes increaſes in the duplicate ratio of their diameters. According to Amontons and Deſaguliers, the rigidity increaſes in the ſimple ratio of the diameters of the ropes; but this probably aroſe from the flexibility of the ropes which they employed: for Deſaguliers remarks, that when he uſed a rope whoſe diameter was half an inch, its rigidity was increaſed in a greater proportion; ſo that it is probable that if they had employed ropes from two to four inches in diameter, like thoſe uſed by Coulomb, they would have obtained ſimilar reſults. (See N° 9.)

3. The rigidity of ropes is in the ſimple and direct ratio of their tenſion.

4. The rigidity of ropes is in the inverſe ratio of the diameters of the cylinders round which they are coiled.

5. In general, the rigidity of ropes is directly as their tenſions and the ſquares of their diameters, and inverſely as the diameters of the cylinders round which they are wound.

6. The rigidity of ropes increaſes ſo 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 ſmall ropes is diminiſhed when penetrated with moiſture; but when the ropes are thick, their rigidity is increaſed.

8. The rigidity of ropes is increaſed and their ſtrength diminiſhed when they are covered with pitch; but when ropes of this kind are alternately immerſed in the ſea and expoſed to the air, they laſt longer than when they are not pitched.—This increaſe of rigidity, however, is not ſo perceptible in ſmall ropes as in thoſe which are pretty thick.

9. The rigidity of ropes covered with pitch is a ſixth part greater during froſt than in the middle of ſummer, but this increaſe of rigidity does not follow the ratio of their tenſions.

10. The reſiſtance to be overcome in bending a rope over a pulley or cylinder may be repreſented by a formula compoſed of two terms. The firſt term $\frac{a\,D^n}{r}$ is a conſtant quantity independent of the tenſion, a being a conſtant 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 ſecond term of the formula is $T \times \frac{b\,D^n}{r}$, where T is the tenſion of the rope, b a conſtant quantity, and D^n and r the ſame 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 diminiſhes 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 uſed, its flexibility is increaſed, 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 purpoſe of rendering uniform a deſultory or reciprocating motion, ariſing either from the nature of the machinery, from an inequality in the reſiſtance to be overcome, or from an irregular application of the impelling power. When the firſt mover is inanimate, as wind, water, and ſteam, an inequality of force obviouſly ariſes from a variation in the velocity of the wind, from an increaſe or decreaſe of water occaſioned by ſudden rains, or from an augmentation or diminution of the ſteam 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 theſe variable powers. The ſame inequality of force obtains when machines are moved by horſes or men. Every animal exerts its greateſt ſtrength when firſt ſet to work. After pulling for ſome time, its ſtrength will be impaired; and when the reſiſtance is great, it will take frequent though ſhort relaxations, and then commence its labour with renovated vigour. Theſe intervals of reſt and vigorous exertion muſt 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, conſiſting either of croſs bars, or a maſſy circular rim, be connected with the machinery, all theſe inconveniences will be removed. As every fly wheel muſt revolve with great rapidity, the momentum of its circumference muſt be very conſiderable, and will conſequently reſiſt 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 ſhort reſt the animal renews his efforts; but the machine is now moving with its former velocity, and theſe freſh efforts will have a tendency to increaſe that velocity. The fly, however, now acts as a reſiſting power, receives the greateſt part of the ſuperfluous motion, and cauſes the machinery to preſerve its original celerity. In this way the fly ſecures to the engine an uniform motion, whether the animal takes occaſional relaxations or exerts his force with redoubled ardour.

384. We have already obſerved that a deſultory or variable motion frequently ariſes from the inequality of the reſiſtance, or work to be performed. This is particularly manifeſt in thraſhing mills, on a ſmall ſcale, which are driven by water. When the corn is laid unequally

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 pounds, 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.

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.

* See Part III. Plate CCCXXIX. Fig. 1.

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

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(D) This has been demonſtrated by Mr Atwood. See his Treatiſe on Rectilineal and Rotatory Motion.

extremity of a piece of wood two feet long, and diſcharge it in the uſual way, there will be more force accumulated than with the hand alone, for the ſtone deſcribes a larger arch in the ſame time, and muſt therefore be projected with greater force.

392. When coins or medals are ſtruck, a very conſiderable accumulation of power is neceſſary, and this is effected by means of a fly. The force is firſt accumulated in weights fixed in the end of the fly. This force is communicated to two levers, by which it is farther condenſed; and from theſe levers it is tranſmitted to a ſcrew, by which it ſuffers a ſecond condenſation. The ſtamp is then impreſſed on the coin or medal by means of this force, which was firſt accumulated by the fly, and afterwards augmented by the intervention of two mechanical powers.

393. Notwithſtanding the great advantage of fly wheels, both as regulators of machines and collectors of power, their utility wholly depends upon the poſition which is aſſigned them relative to the impelled and working points of the engine. For this purpoſe no particular rules can be laid down, as their poſitions depend altogether on the nature of the machinery. We may obſerve however, in general, that when fly wheels are employed to regulate machinery, they ſhould be near the impelling power; and when uſed to accumulate force in the working point they ſhould not be far diſtant from it. In hand mills for grinding corn, the fly is for the moſt part very injudiciouſly fixed on the axis to which the winch is attached; whereas it ſhould always be faſtened to the upper millſtone ſo as to revolve with the ſame rapidity. In the firſt poſition indeed it muſt equalize the varying efforts of the power which moves the winch; but when it is attached to the turning millſtone, it not only does this, but contributes very effectually to the grinding of the corn.

Deſcription of the conical pendulum. Fig. 8.

394. A new kind of fly, called a conical pendulum, has been ingeniouſly employed by Mr Watt for procuring a determinate velocity at the working point of his ſteam-engine. It is repreſented in fig. 8. where AB is a vertical axis moving upon pivots, and driven by means of a rope paſſing from the axis of the large fly over the ſheave 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 whoſe centre of motion is L, and whoſe other extremity is connected with the cock which admits the ſteam 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 conſequence of this receſs, the points, C, H, K are depreſſed and the other extremity of the lever is raiſed; and the cock admits a certain quantity of ſteam into the cylinder. When the velocity of the fly is by any means increaſed, the balls recede ſtill farther from the axis, the extremity of the lever is raiſed higher, and the cock cloſes a little and diminiſhes the ſupply of ſteam. From this diminution in the impelling power, the velocity of the fly and the conical pendulum decreaſes, and the balls reſume their former poſition. In this way, when there is any increaſe or diminution in the velocity of the fly, the correſponding increaſe or diminution in the centrifugal force of the balls raiſes or depreſſes the arm of the lever, admits a greater or a leſs quantity of ſteam into the cylinder, and reſtores to the engine its former velocity.

Chap. V. *On the Teeth of Wheels, and the Wipers of Stampers.*

395. In the conſtruction of machines, we muſt not only attend to the form and number of their parts, but alſo to the mode by which they are to be connected. It would be eaſy to ſhew, did the limits of this article permit it, that, when one wheel impels another, the impelling power will ſometimes act with greater and ſometimes with leſs force, unleſs 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 ſide of another. It may be ſufficient to ſhew, 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 ſmall pins or ſpindles 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 ſame happens during the formation of the part co of the epicycloid or. Let us now ſuppoſe that the tooth mp begins to act on the pin a, and that b, c are ſucceſſive poſitions of the pin a after a certain time; then, nq, or will be the poſitions of the tooth mp after the ſame time; but $ab=mn$ and $ac=mo$, therefore the wheels AB, CD, when the arch is driven by epicycloidal teeth, move through equal ſpaces 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 illuſtrating the application of this property of the epicycloid, which was diſcovered by Olaus Roemer the celebrated Daniſh aſtronomer, we ſhall call the ſmall 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 theſe modes of action requires a different form for the teeth.

1. When the action is begun and completed after the teeth have paſſed 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 ſides of the line of centres.

Firſt mode of action. Plate CCCXXIV. Fig. 1.

397. 1. The firſt of theſe modes of action is repreſented 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 paſſed this line, and is completed when the leaf m comes into the ſituation n. When this mode of action is adopted, the acting faces of

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(D) In figs. 1, 2, 3, 4, the letter B is ſuppoſed to be placed at the centre of the wheels.

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. $y=\frac{cb}{a+b}$; then by inverting the firſt analogy, we have $b:a=y:x$, and conſequently the radius of the wheel, viz. $x=\frac{ay}{b}$; 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 ſubſtracted, 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.

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

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(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.

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 deſcribe 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 ſhape for the teeth of a wheel whoſe diameter is AB. Dr Robiſon obſerves, that as this form admits of ſeveral teeth to be acting at the ſame time (twice the number that can be admitted in M. de la Hire's method), the preſſure is divided among ſeveral teeth, and the quantity upon any one of them is ſo diminiſhed, that thoſe dents and impreſſions which they unavoidably make upon each other are partly prevented. He candidly allows, however that the teeth thus formed are not completely free from ſliding and friction, though this ſlide is only $\frac{1}{80}$th of an inch, when a tooth three inches long fixed on a wheel ten feet in diameter drivesanother wheel whoſe diameter is two feet. *Append. to Ferguſon's Lectures.*

406. *On the Formation of Exterior and Interior Epicycloids, and on the Diſpoſition 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 truſt, is the moſt ſimple 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 ſame curvature as the circular baſe upon which the generating circle AB is to roll. When the generating circle is large, the ſegment B will be ſufficient: in any part of the circumference of this ſegment, fix a ſharp pointed nail *a*, ſloping in ſuch a manner that the diſtance of its point from the centre of the circle may be exactly equal to its radius; and faſten to the board GH a piece of thin braſs, or copper, or tinplate, *a b*, diſtinguiſhed by the dotted lines. Place the ſegment B in ſuch a poſition that the point of the nail *a* may be upon the point *b*, and roll the ſegment towards G, ſo that the nail *a* may riſe gradually, and the point of contact between the two circular ſegments may advance towards *m*; the curve *a b* deſcribed upon the braſs plate will be an accurate exterior epicycloid. In order to prevent the ſegments from ſliding, their peripheries ſhould be rubbed with roſin or chalk, or a number of ſmall iron points may be fixed on the circumference of the generating ſegment. Remove, with a file, the part of the braſs 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 reſt may be eaſily formed. When an *interior epicycloid* is wanted, the concave ſide of its circular baſe muſt be uſed. The method of deſcribing it is repreſented in fig. 7. where CD is the generating circle, F the concave circular baſe, MN the piece of wood on which this baſe is fixed, and *c d* the interior epicycloid formed upon the plate of braſs, by rolling the generating circle C, or the generating ſegment D, towards the right hand. The *cycloid*, which is uſeful in forming the teeth of *rack work*, is generated preciſely in the ſame manner, with this difference only, that the baſe on which the generating circle rolls muſt be a ſtraight line.

Fig. 6.

Fig. 7.

Diſpoſition of the teeth.

In order that the teeth may not embarraſs one another before their action commences, and that one tooth may begin to act upon its correſponding leaf of the pinion, before the preceding tooth has ceaſed to act upon the preceding leaf, the height, breadth, and diſtance of the teeth muſt be properly proportioned. For this purpoſe the pitch-line or circumference of the wheel, which is repreſented in fig. 2. and 3. by the dotted arches, muſt be divided into as many equal ſpaces as the number of teeth which the wheel is to carry. Divide each of theſe ſpaces into 16 equal parts; allow 7 of theſe for the greateſt breadth of the teeth, and 9 for the diſtance between each; or the diſtance of the teeth may be made equal to their breadth. If the wheel drive a trundle, each ſpace ſhould be divided into 7 equal parts, and 3 of theſe allotted for the thickneſs of the tooth, and $3\frac{2}{3}$ for the diameter of the cylindrical ſtave of the trundle. If each of the ſpaces already mentioned, or if the diſtance between the centres of each tooth, be divided into three equal parts, the height of the teeth muſt be equal to two of theſe. Theſe diſtances and heights, however, vary according to the mode of action which is employed. The teeth ſhould 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 ſmall addition ſhould 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, ſo long ago as the end of the 17th century. It conſiſts in one fluted or toothed cone acting upon another, as is repreſented in fig. 8. where the cone OD drives the cone OC, conveying its motion in the direction OC. If theſe cones be cut parallel to their baſes as at A and B, and if the two ſmall cones between AB and O be removed, the remaining parts AC and BD may be conſidered as two bevelled wheels, and BD will act upon AC in the very ſame manner, and with the ſame effect, that the whole cone OD acted upon the whole cone OC. If the ſection be made nearer the baſes of the cones, the ſame effect will be produced: this is the caſe in fig. 9. where CD and DE are but very ſmall 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 ſize and ſituation of the wheels for this purpoſe, 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 ſuppoſe that the axis CD muſt have four times the velocity of AB, or muſt perform four revolutions while AB performs one. Then the number of teeth in the wheel fixed upon AB muſt be four times greater than the number of teeth in the wheel fixed upon CD, and their radii muſt have the ſame proportion. Draw *c d* parallel to CD at any convenient diſtance, and draw *a b* parallel to AB at four times that diſtance, then the lines *i m* and *i n* drawn perpendicular to AB and CD reſpectively, will mark the ſituation and ſize of the wheels required. In

Fig. 10.

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 *de*; *a b* and *e h*, therefore, will be ſtraight lines and *b c* will be a cycloid, and *de* 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

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 Om, mn, &c. the more the better, and oe into the ſame number ab, bc, cd, &c. and through the points m, n, p, H draw the indefinite lines AB, AC, AD, AE, and make AB equal to Ab, AC to Ac, AD to Ad, and AE to Ae; 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 Ab, 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, Ob being to Oc as Om to On. If it be required to raiſe the weight MN with an accelerated or retarded motion, we have only to divide the line Oe 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, aD, bD, cD, and BD cutting the circle BFH in the points m, n, o, p.

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 Bm, and ſet it from q to r: Take Bn and ſet it from s to t: Take Bo and ſet it from u to v. and laſtly ſet Bp from M to E. Through the points r, t, v, E, draw the indefinite lines DN, DO, DP, DQ, and make DN equal to Dc; DO equal to Db; DP equal to Da; 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 Bm is equal to qr, and the point N will be at c, becauſe DN is equal to Dc; the extremity of the lever, therefore, will be found in the point c, having moved through Bc. 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 Bc, cb, ba, ac, (F) in the ſame time that the power has moved through the equal ſpaces qB, sq, us, Mu. 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 cB, viz. in the points e, g, h. Then, having ſet the arch Bm from e to d, the arch Bn 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 Dc; DS equal to Db; DT equal to Da, 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 Bc in the ſame time that the power, or wheel, has moved through the diviſion eB. In the ſame manner it may be ſhewn, that the lever will riſe through the equal heights cb, ba, aC, in the ſame time that the power moves through the correſponding ſpaces eg, gi, iM. 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 Bc is vertical, and paſſes, when prolonged, through D, the centre

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(F) The arches Bc, cb, &c. are not equal; but the perpendiculars let fall from the points c, a, b, &c. upon the horizontal lines, paſſing through ab, &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 e H, in the points k, i, r, 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 c 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	220	145 ſeconds		Amontons
170	1	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.

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 $\frac{19}{20}$ 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 $\frac{6}{8}$ 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 walku 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, $11\frac{1}{3}$ 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 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.*

Plate CCCXXV. Fig. 1.

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 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 milſtone.

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 $54\frac{3}{4}$ degrees to the axis of rotation, or when the angle of weather is $35\frac{1}{4}$ (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 $35\frac{1}{4}$ 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.

The inclination aſſigned by Parent, erroneous.

Euler's theorem.

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.

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. It 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 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 power of horizontal wind-mills is only $\frac{1.13}{4.40}$, 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 $\frac{1}{3}$ 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 *n*D, whether the rims are conical or cylindrical. This oblique action muſt 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 mA, nB 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 oA of the triangle oAn 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 poſitition, 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 Ar, Bs, 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 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 up 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) Fig. 6. 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, 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 *m n* 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 F φ, 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*, E φ, one of which E *n* is ſolely employed in dragging the cart up the inclined plane DA, while the other E φ 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 R′F′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 E φ, or as F′ *m* to F *n*. Now $E\,\varphi = F\,r = FE\times\text{ſin.}\;n\,EF$; hence $E\,\varphi = FE\times\text{ſin.}\;\overline{(n\,E\,g'-FE\,g')}$ (g' E being parallel to AB′), and $E\,n = EF\times\text{coſ.}\;(n\,E\,g'-FE\,g')$. In like manner we have $E\,f = FE\times\text{ſin.}\;(n\,E\,g'-F'E\,g')$, and $E\,m = EF\times\text{coſ.}\;(n\,E\,g'-F'E\,g')$. Now $\text{ſin.}\;FE\,g' = \text{ſin.}\;FE\,g = \frac{R\,g}{ER}$, and $\text{ſin.}\;FE\,g' = \frac{R'\,g'}{ER'} = \frac{R\,g}{ER'}$; but $R\,g = R'\,g' = BR - EQ = BR - BR\times\text{coſ.}\;n\,E\,g' = BR\times(1-\text{coſ.}\;n\,E\,g)$. By ſubſtituting this value in the equations which contain the values of E φ, 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

$$FE\,g = \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g},}{ER}, \text{ and}$$

$$F'E\,g' = \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g}}{ER'}.$$

By ſubſtituting theſe values in the preceding equations, we have

$$E\,\varphi = EF\times\text{ſin.}\;(n\,E\,g - \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g}}{ER},$$

$$E\,f\,n = EF\times\text{ſin.}\;(n\,E\,g - \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g}}{ER'},$$

$$E\,n = EF\times\text{coſ.}\;(n\,E\,g - \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g}}{ER},$$

$$E\,m = EF\times\text{coſ.}\;(n\,E\,g - \frac{BR\times\overline{1-\text{coſ.}\;n\,E\,g}}{ER'}.$$

If AB is horizontal, and the declivity $AD=\frac{1}{6}$, we ſhall have $n\,E\,g = 9^\circ\ 28'$, or in parts of the radius=0.16522, and coſ. $n\,E\,g = 0.98638$. Then, if EF=200 pounds, BR=$3\frac{1}{2}$ feet, ER=8 feet, ER′=12 feet, then we ſhall have from the preceding formulæ, E φ=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 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.

Carriages that move without horſes. Fig. 8.

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.

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 cyclindrical boxes about ſix inches in diameter, and one and a half broad.

Fig. 10.

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. 11.

458. The carriage repreſented in fig. 11. is made ſo as to ſail againſt the wind by means of the ſpiral ſails

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. Fig. 12.

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. 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 38½ 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 = Fig. 2.

$$\frac{W\times SR\times SO}{SD^2}=\frac{P\times t^2 l}{s}-P.$$

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 2¼ 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 abſo- Fig. 3.

ſolutely

lutely removed, and a maſs of $2\frac{3}{4}$ ounces uniformly accumulated in the circumference of the wheel *a b c d*. This being premiſed, let the boxes A and B be replaced, being ſuſpended by the ſilk thread over the wheel or pulley *a b c d*, and balancing each other: ſuppoſe that any weight m be added to A ſo that it ſhall deſcend, the exact quantity of matter moved, during the deſcent of the weight A, will be aſcertained, for the whole maſs will be $A+B+m+2\frac{3}{4}$ oz.

In order to avoid troubleſome computations in adjuſting the quantities of matter moved and the moving forces, ſome determinate weight of convenient magnitude may be aſſumed as a ſtandard, to which all the others are referred. This ſtandard weight in the ſubſequent experiments is $\frac{1}{4}$ of an ounce, and is repreſented 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 conſtructed ſo 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 ſuſpended, $=1\frac{1}{2}$ oz. or according to the preceding eſtimation, the weight of each box will be denoted by $6\,m$; theſe
Fig. 3. boxes contain ſuch weights as are repreſented by fig. 3. each of which weighs an ounce, ſo 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, ſuch as $\frac{1}{2}m$, $\frac{1}{4}m$, may be alſo included in the boxes, according to the conditions of the different experiments hereafter deſcribed.

If $4\frac{3}{4}$ oz. or $19\,m$, be included in either box, this with the weight of the box itſelf will be $25\,m$; ſo that when the weights A and B, each being $25\,m$, are balanced in the manner above repreſented, their whole maſs will be $50\,m$, which being added to the inertia of the wheels $11\,m$, the ſum will be $61\,m$. Moreover, three circular weights, ſuch as that which is repreſented at fig. 4. are conſtructed; each of which $=\frac{1}{4}$ oz. or m: if one of theſe be added to A and one to B, the whole maſs will now become $63\,m$, perfectly in equilibrio, and moveable by the leaſt weight added to either (ſetting aſide the effects of friction), in the ſame manner preciſely as if the ſame weight or force were applied to communicate motion to the maſs $63\,m$, exiſting in free ſpace and without gravity.

462. 2. *The moving force.* Since the weight of any ſubſtance is conſtant, and the exact quantity of it eaſily eſtimated, it will be convenient here to apply a weight to the maſs A as a moving force: thus, when the ſyſtem conſiſts of a maſs $=63\,m$, according to the preceding deſcription, the whole being perfectly balanced, let
Fig. 5. a weight $\frac{1}{4}$ oz. or m, ſuch as is repreſented in fig. 5. be applied on the maſs A; this will communicate motion to the whole ſyſtem; by adding a quantity of matter m to the former maſs $63\,m$, 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 deſcent of $A=\frac{m}{64\,m}$, or $\frac{1}{64}$ part of the accelerating force of gravity.

By the preceding conſtruction, the moving force may be altered without altering the maſs moved; for ſuppoſe 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 maſs moved $64\,m$ as before, and the force which accelerates the deſcent of $A=\frac{3\,m}{64\,m}=\frac{3}{64}$ parts of the force by which gravity accelerates falling bodies.

Suppoſe it were required to make the moving force $2\,m$, the maſs moved continuing the ſame. Let the three weights, each of which $=m$, be removed; A and B will balance each other; and the whole maſs will be $61\,m$: let $\frac{1}{2}m$, fig. 5. be added to A, and $\frac{1}{2}m$ Fig. 5. to B, the equilibrium will be preſerved, and the maſs moved will be $62\,m$; now let $2\,m$ be added to A, the moving force will be $2\,m$, and the maſs moved $64\,m$ as before; wherefore the force of acceleration $=\frac{1}{32}$ part of the acceleration of gravity. Theſe alterations in the moving force may be eaſily made in the more elementary experiments, there being no neceſſity for altering the contents of the boxes A and B: but the proportion and abſolute quantities of the moving force and maſs moved, may be of any aſſigned magnitude, according to the conditions of the propoſition to be illuſtrated.

463. 3. *Of the ſpace deſcribed.* The body A, fig. 1. Fig. 1. deſcends in a vertical line; and a ſcale about 64 inches in length divided into inches and tenths of an inch is adjuſted vertical, and ſo placed that the deſcending weight A may fall in the middle of a ſquare ſtage, fixed to receive it at the end of the deſcent: the beginning of the deſcent is eſtimated from 0 on the ſcale, when the bottom of the box A is on a level with 0. The deſcent of A is terminated when the bottom of the box ſtrikes the ſtage, which may be fixed at different diſtances from the point 0; ſo that by altering the poſition of the ſtage, the ſpace deſcribed from reſt may be of any given magnitude leſs than 64 inches.

464. 4. *The time of deſcription* is obſerved by a pendulum, vibrating ſeconds; and the experiments intended to illuſtrate the elementary propoſitions, may eaſily be ſo conſtructed that the time of motion ſhall be a whole number of ſeconds. The eſtimation of the time, therefore, admits of conſiderable exactneſs, provided the obſerver takes care to let the bottom of the box A begin its deſcent preciſely at any beat of the pendulum; then the coincidence of the ſtroke of the box againſt the ſtage, and the beat of the pendulum at the end of the time of motion, will ſhow how nearly the experiment and the theory agree. There might be various devices for letting the weight A begin its deſcent at the inſtant of a beat of the pendulum W; for inſtance, let the bottom of the box A, when at 0 on the ſcale, reſt on a flat rod, held in the hand horizontally; its extremity being coincident with 0, by attending to the beats of the pendulum; and with a little practice, the rod which ſupports the box A may be removed at the moment the pendulum beats, ſo that the deſcent of A ſhall commence at the ſame inſtant.

465. 5. *Of the velocity acquired.* It remains only to deſcribe in what manner the velocity acquired by the deſcending weight A, at any given point of its path is made evident to the ſenſes. The velocity of A's deſcent being continually accelerated will be the ſame in two points of the ſpace deſcribed. This is occaſioned by the conſtant action of the moving force; and ſince the velocity of A at any inſtant is meaſured by the ſpace

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.

Fig 6.

In order to ſhow in what manner this is effected particularly, let us again ſuppoſe the boxes A and B$=25m$ 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 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 claſtic 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.*

Plate cccxxvi. Fig. 7.

467. This machine is repreſented in fig. 7. where KILM and LMNO are two flat pieces of wood joined 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 e W, f U, CV, AX, which paſſing over the pulleys U, V, X, W are faſtened to the two bars $u\,v$, $x\,w$, 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 $x = \frac{S n \times n}{FA}$.—*Append. to Ferguſon's Lectures.*

Deſcription of Machines.

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. 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.*

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. Fig. 2. 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.

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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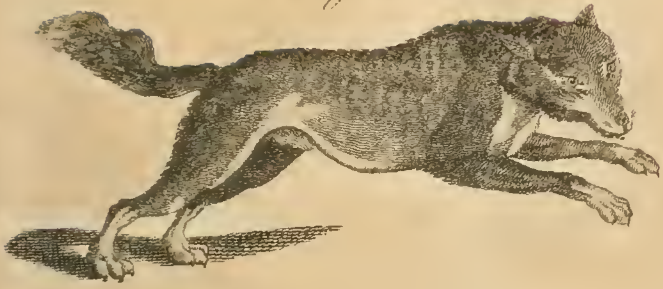
Fig. 28.



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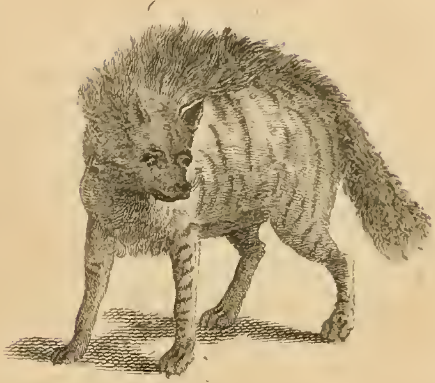

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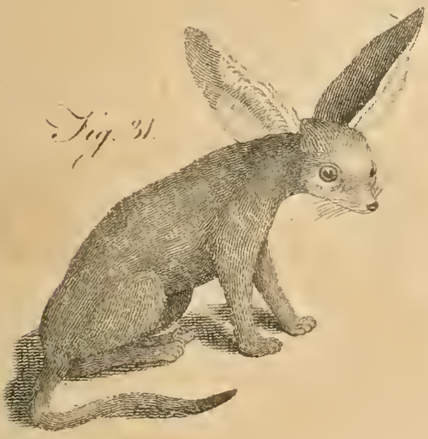

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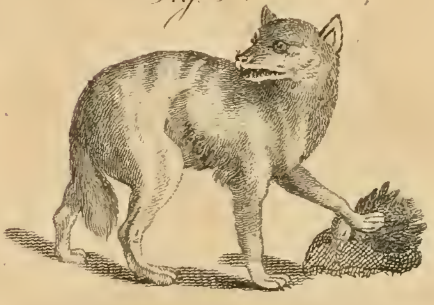

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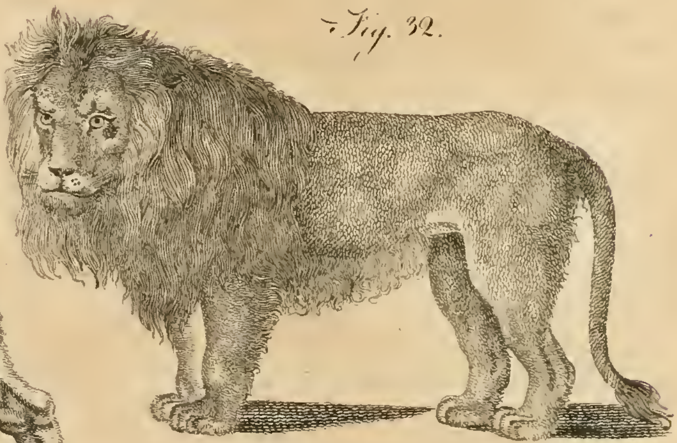

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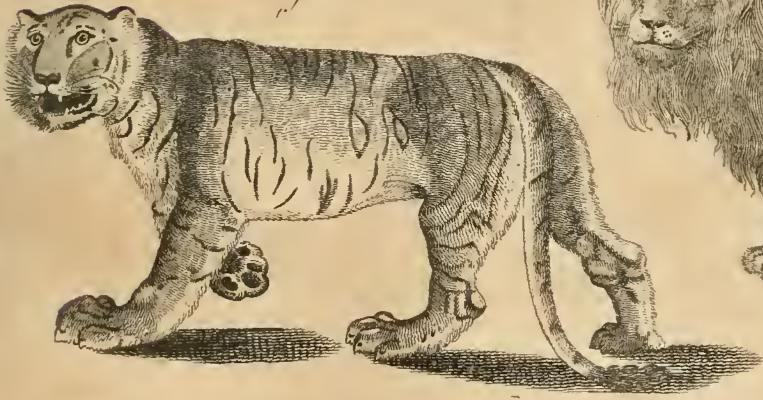
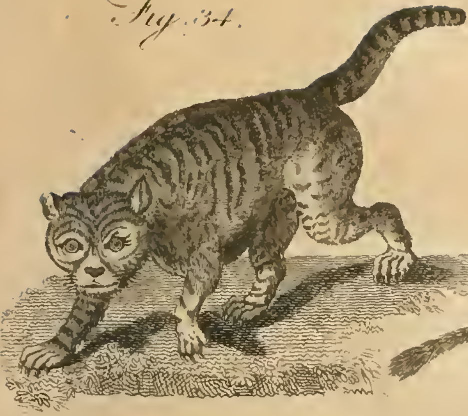


A. Bell Prin. Wal. Sculptor fecit.

Fig. 34.



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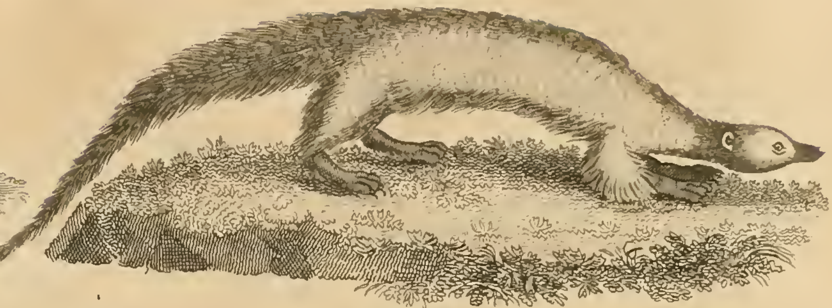

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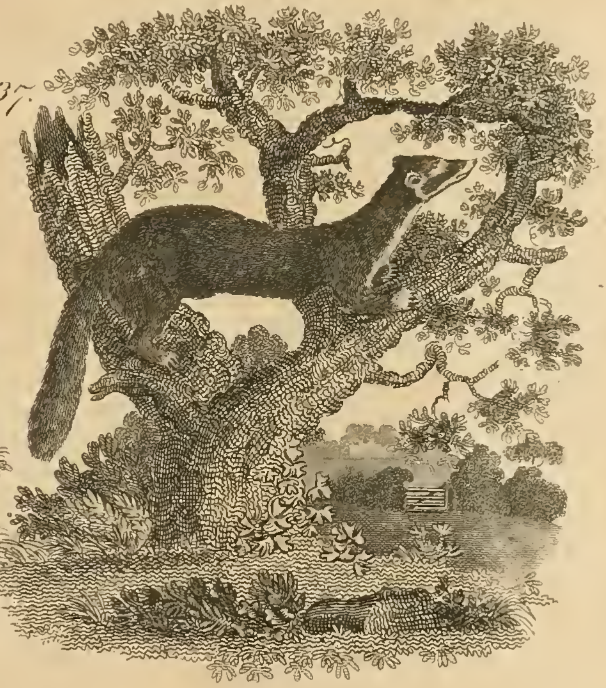

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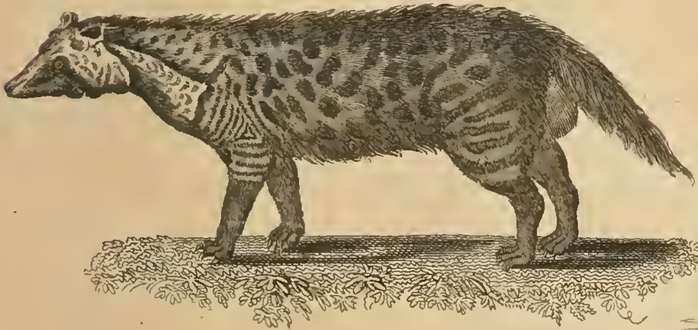

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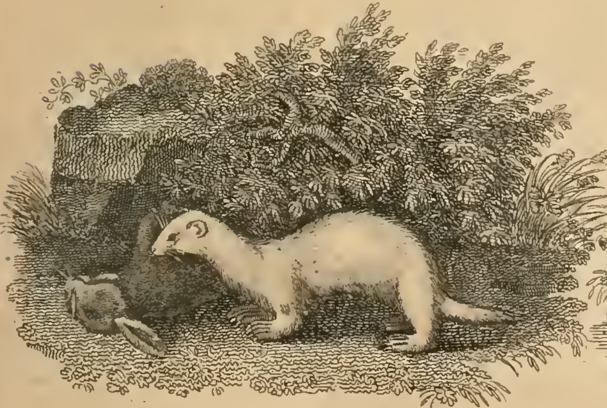

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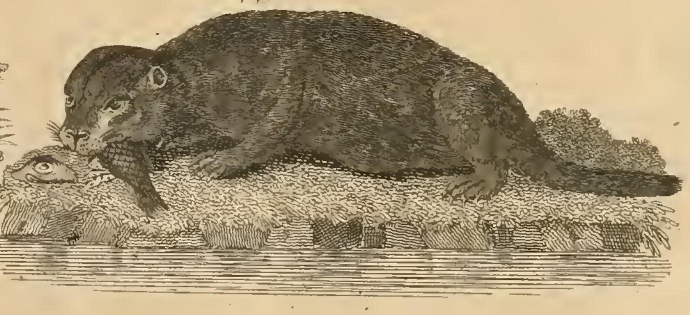
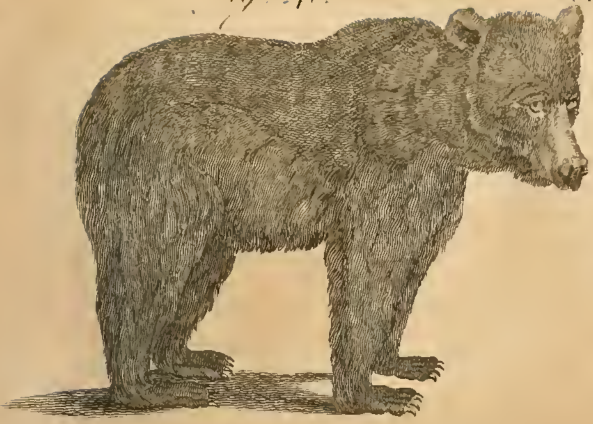


A. Bell Prin. Wall. Sculptor fecit.

MAMMALIA. Plate CCCVIII.

Fig. 40.



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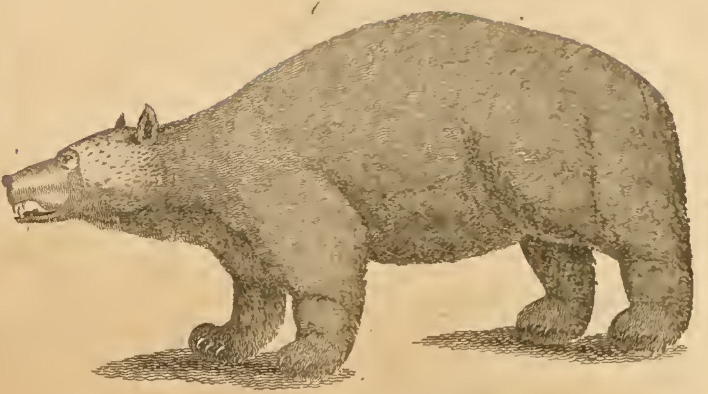

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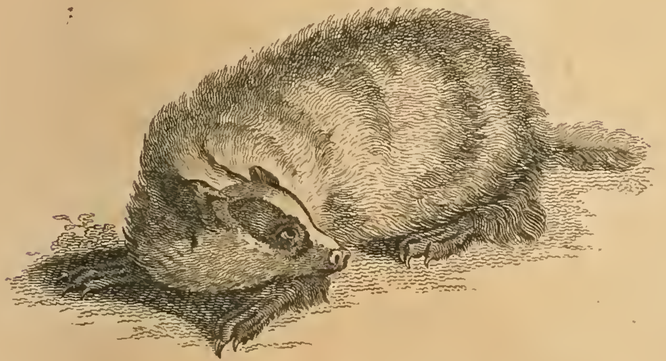

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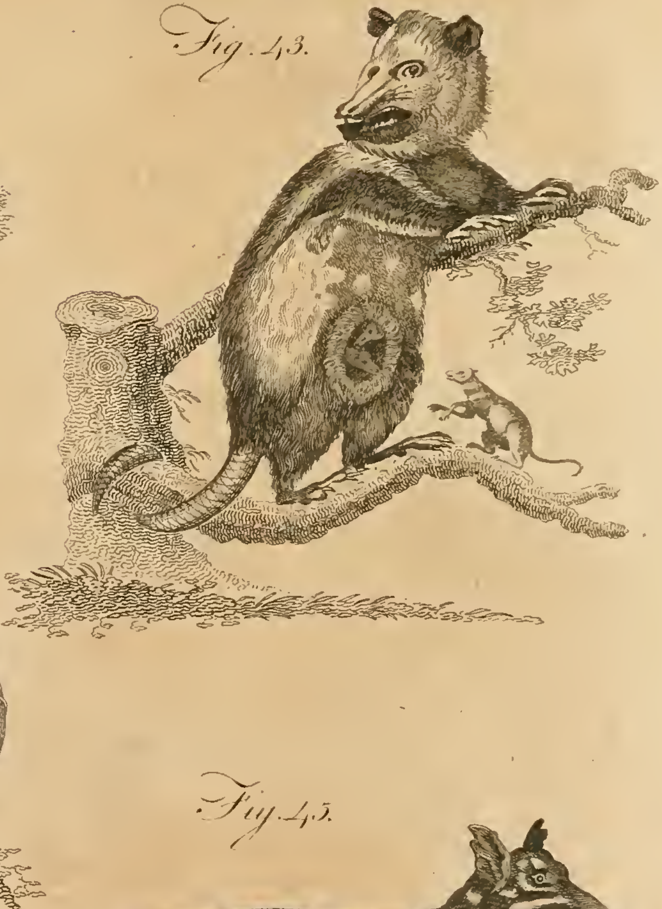

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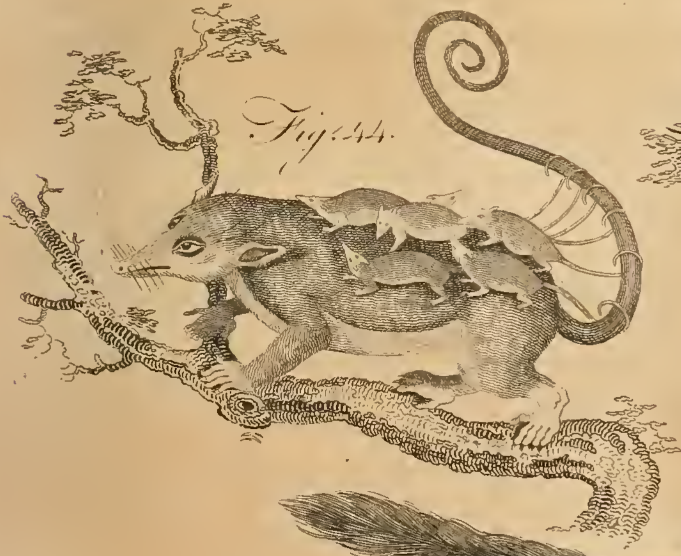

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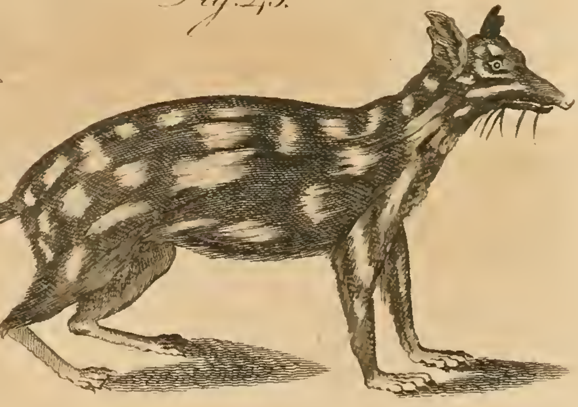


A. Bell Prin. Wal. sculptor f.

Fig. 46.

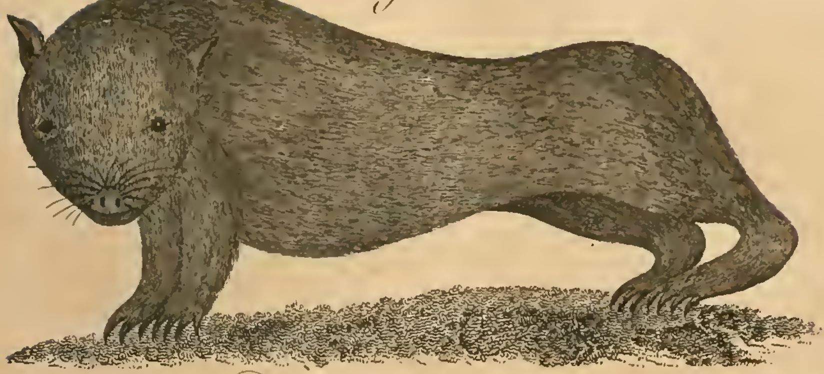
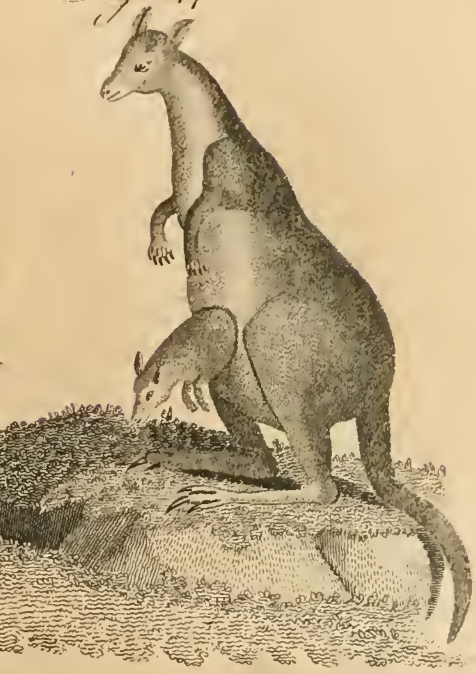


Fig. 47.



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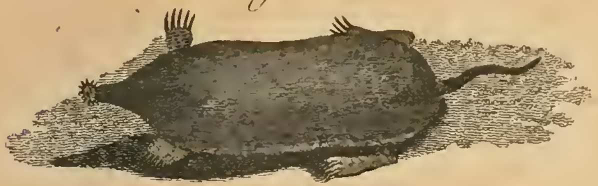
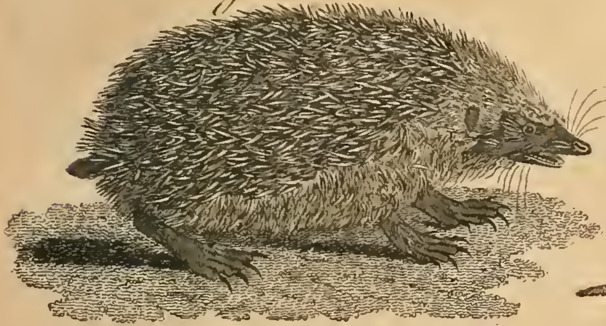


Fig. 50.



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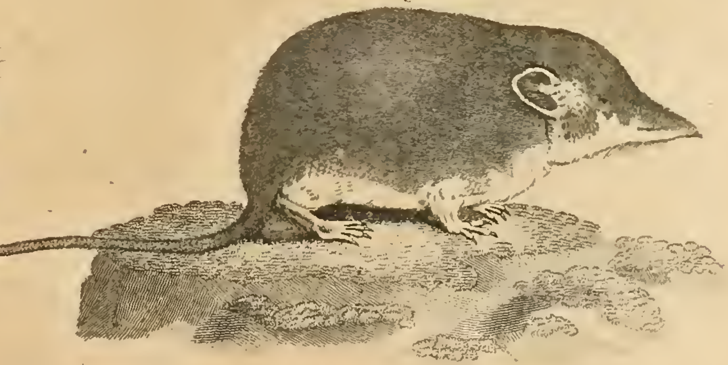

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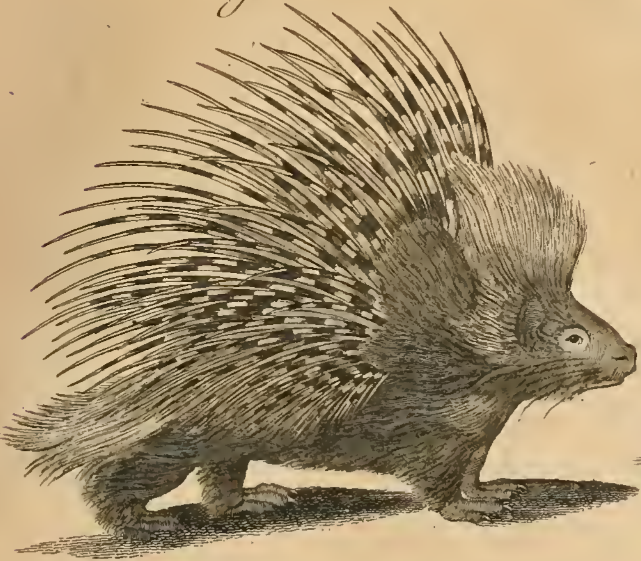

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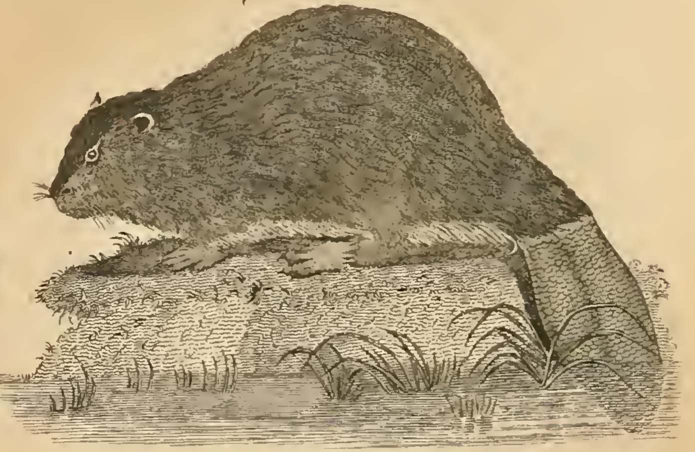
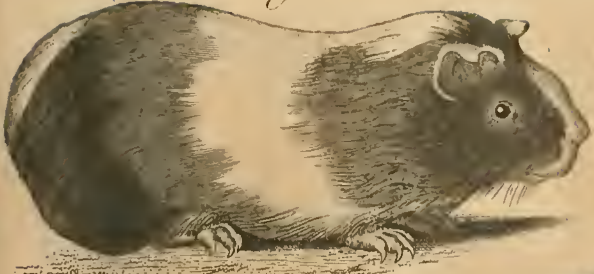


A.Bell Prin.Wal.s Sculptor fecit.

Fig. 53.



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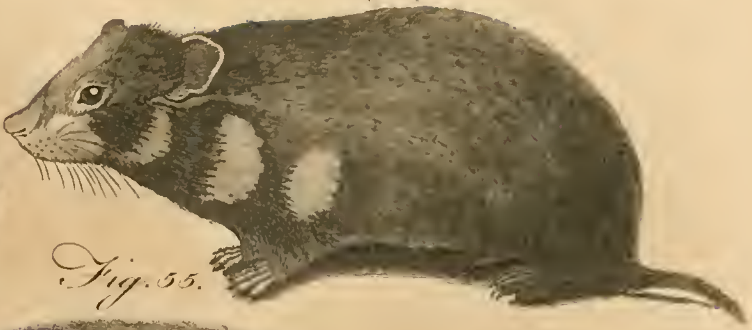

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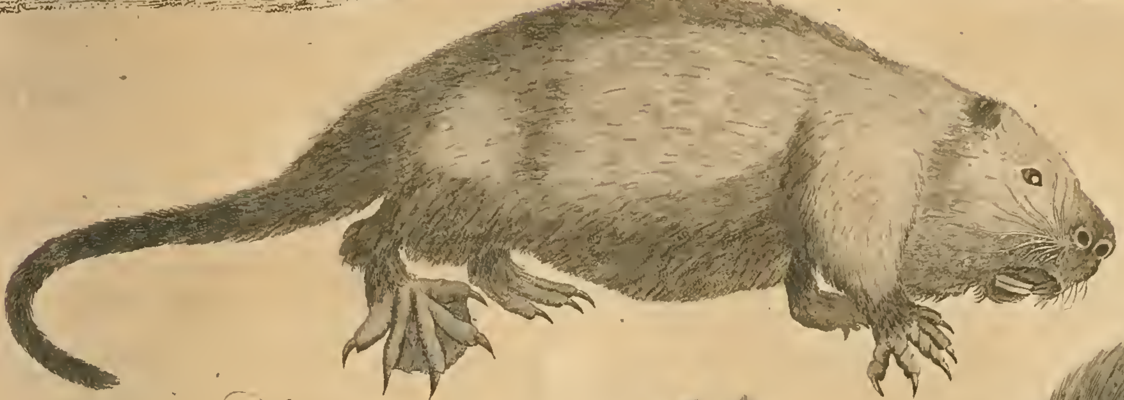

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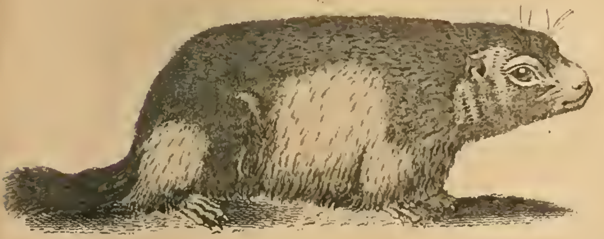

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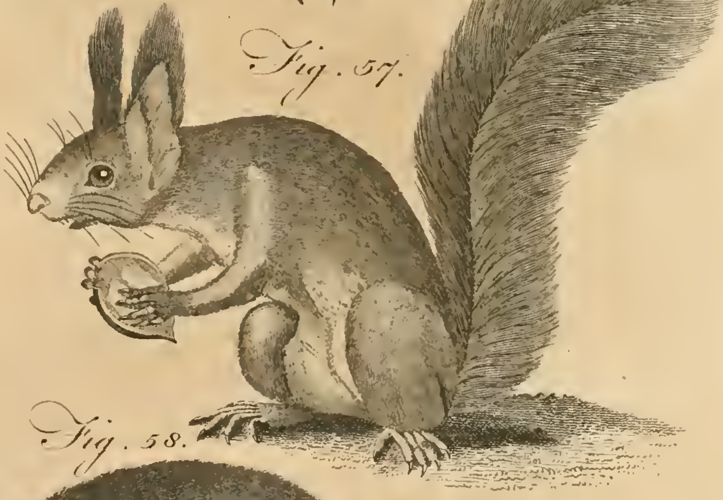
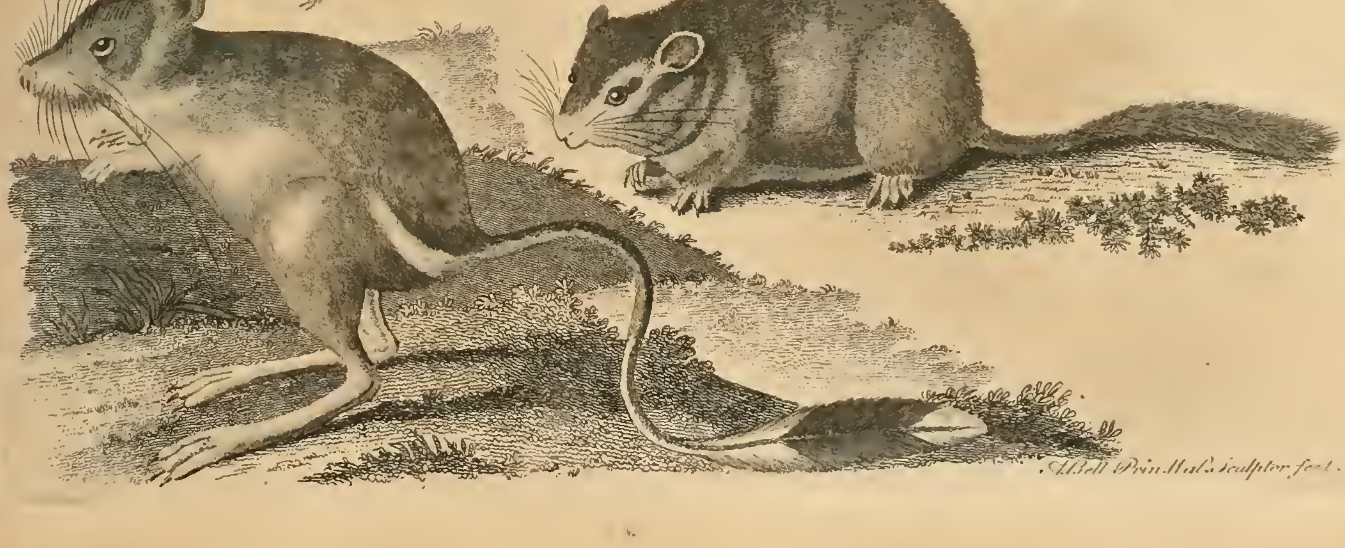


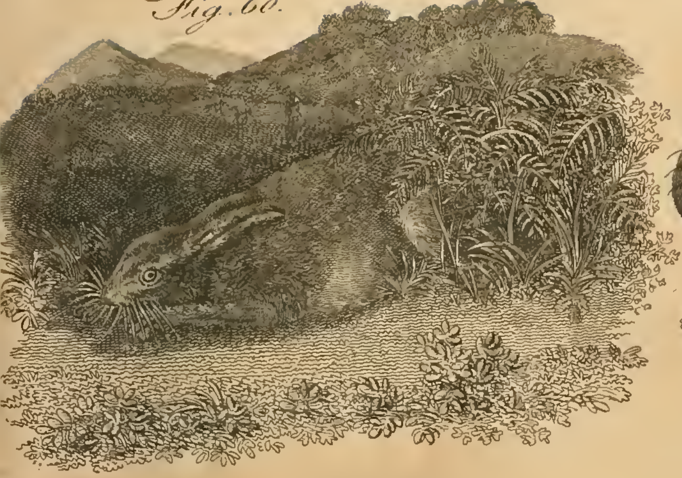
Fig. 59.

Fig. 58.



A. Bell Prin. Wal. sculptor fecit.

Fig. 60.



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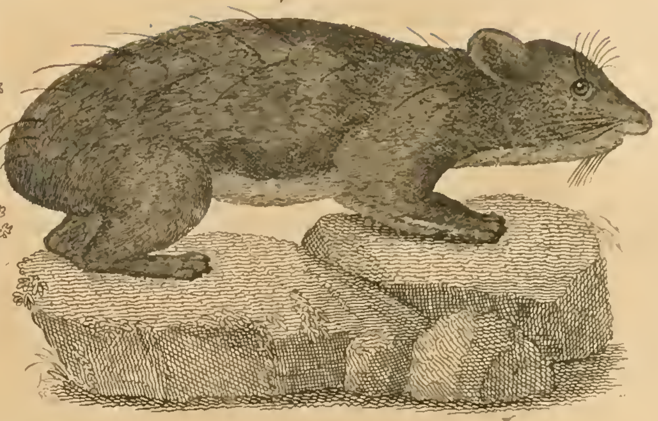

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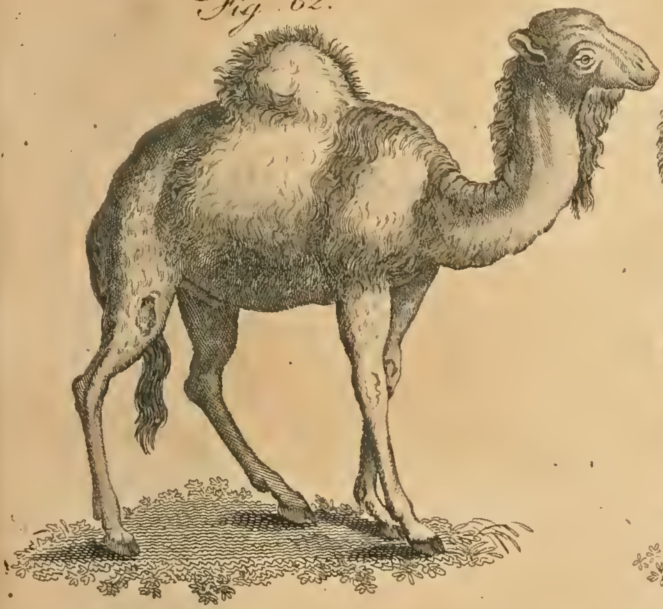

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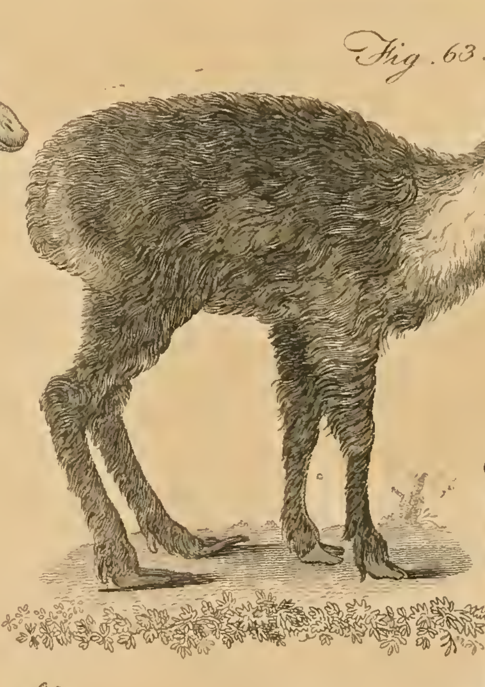

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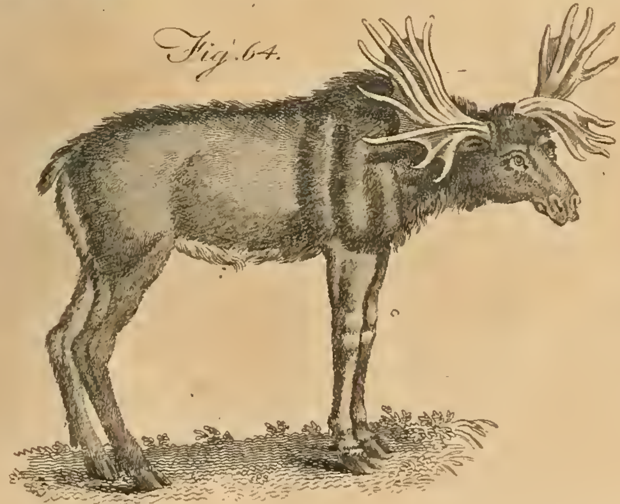

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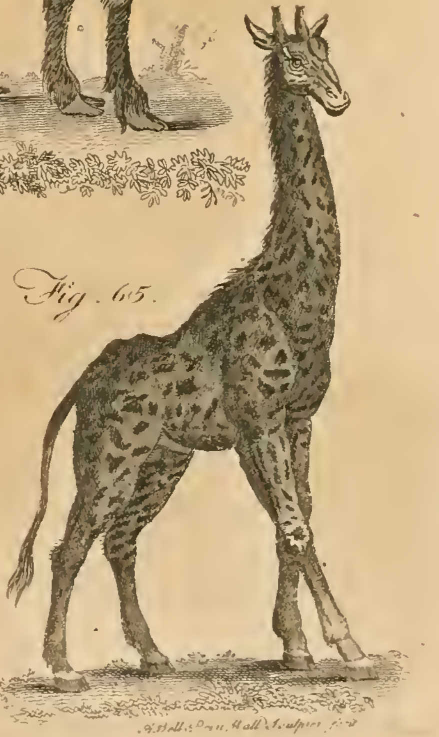


A. Hall & Son, Hall Sculpsit [illegible]

Fig. 66.

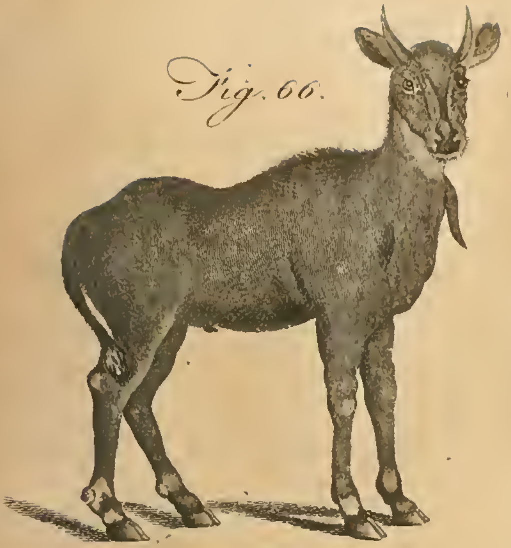
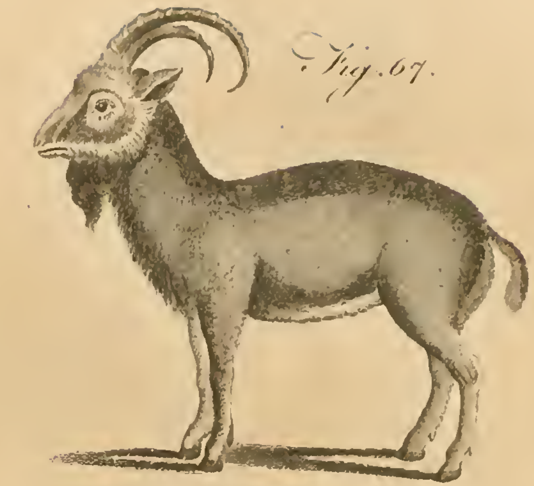


Fig. 67.



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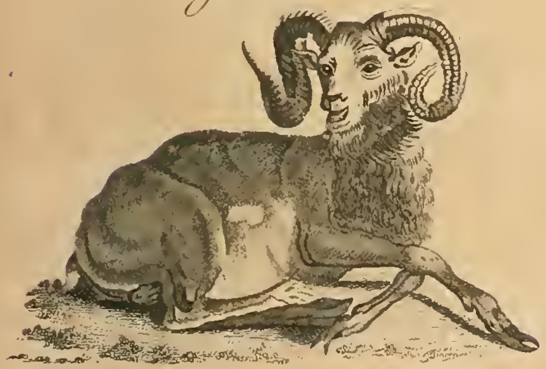

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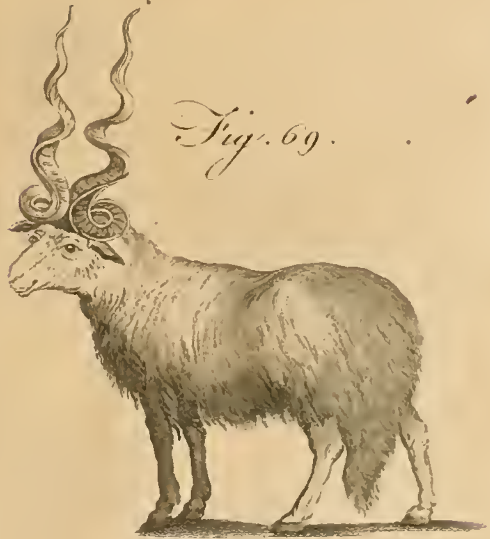

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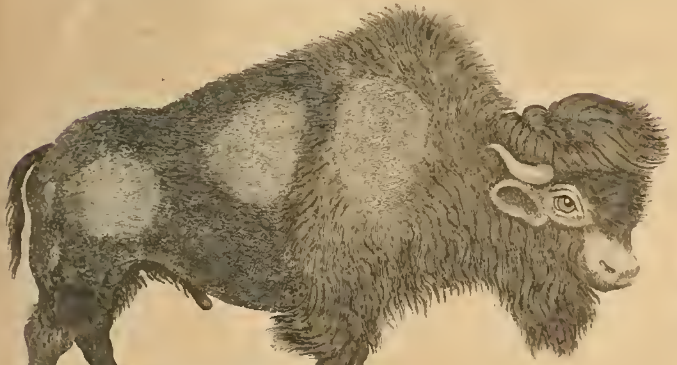

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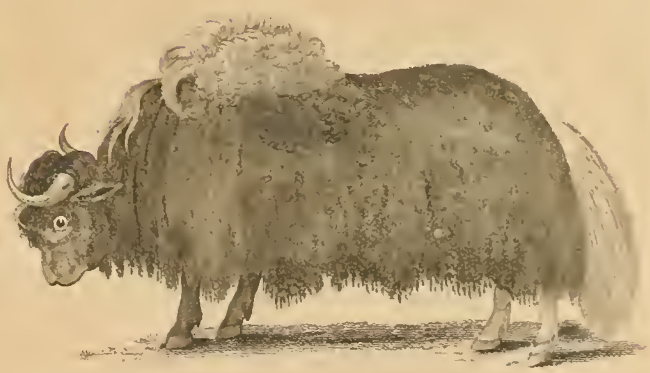

A. Bell Prin. Wal. Sculptor fecit.

Fig. 72.

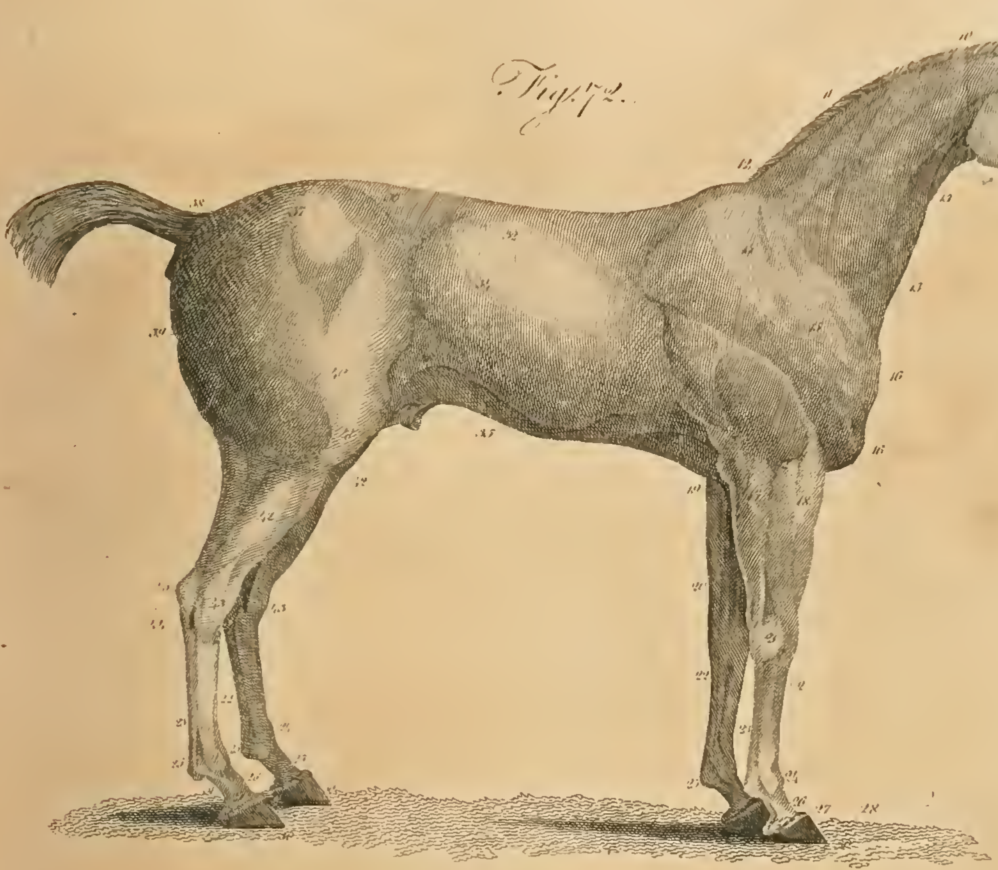
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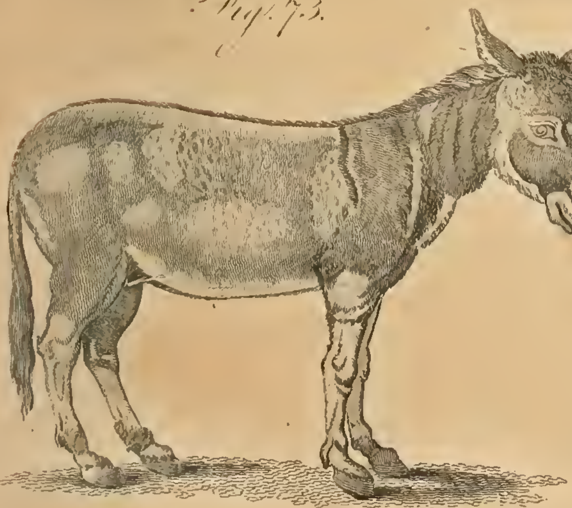
Fig. 73.



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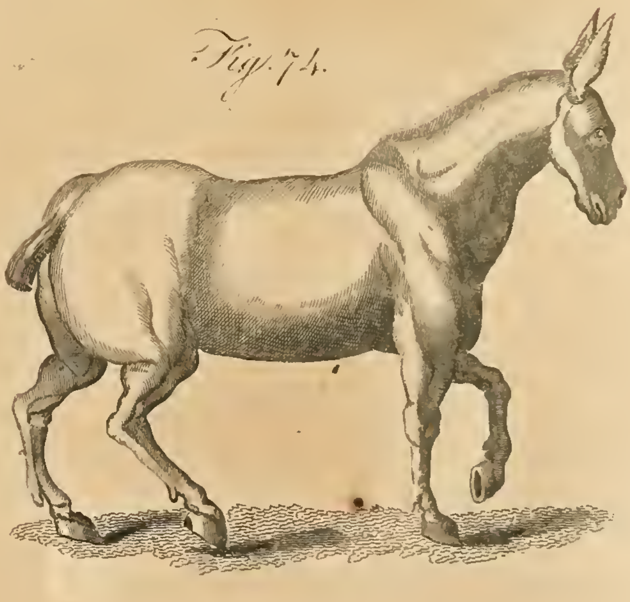
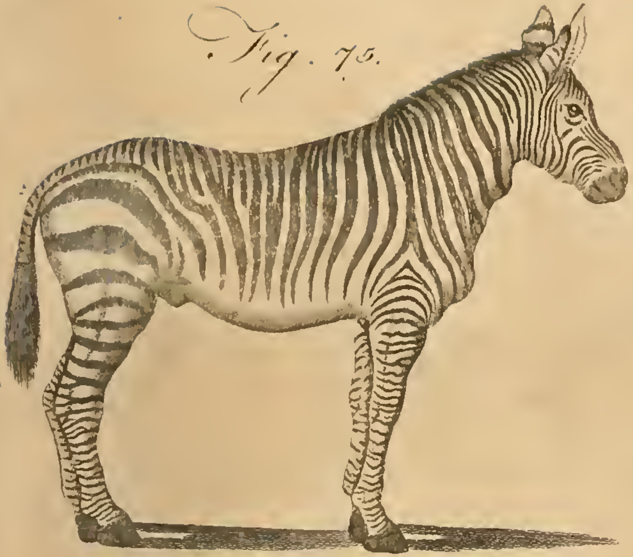


A. Bell Prin. Wal. Sculptor fecit.

MAMMALIA. Plate CCCXIV.

Fig. 75.



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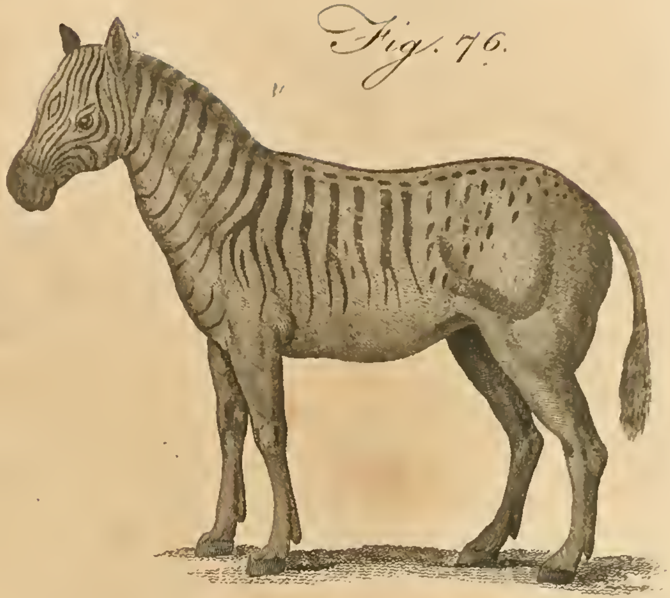

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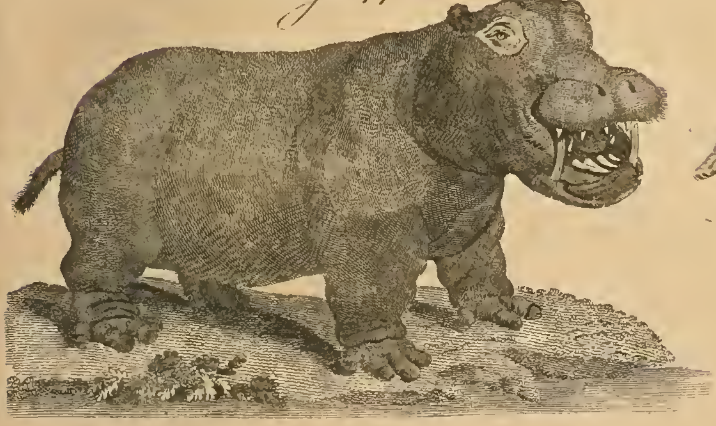

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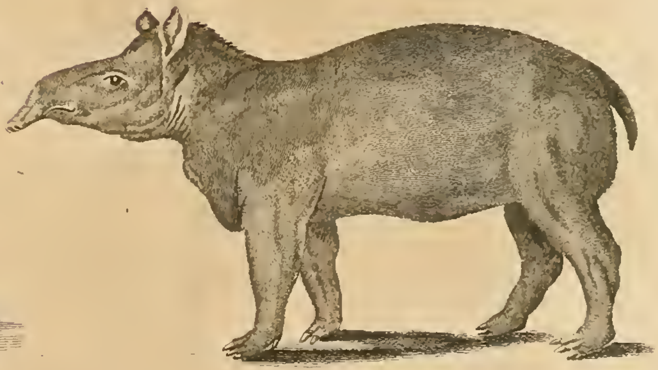

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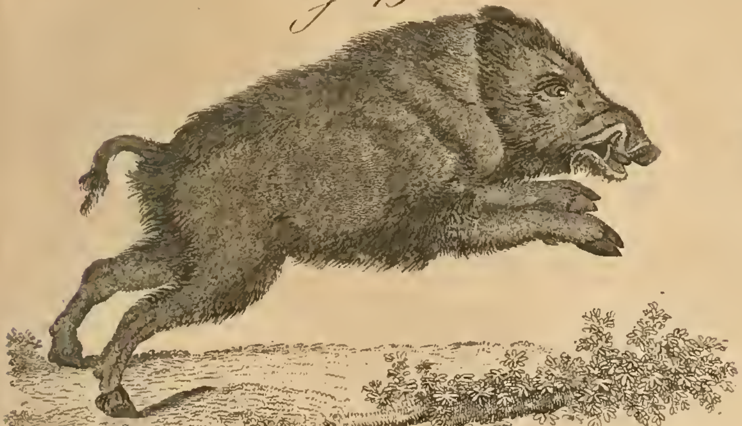

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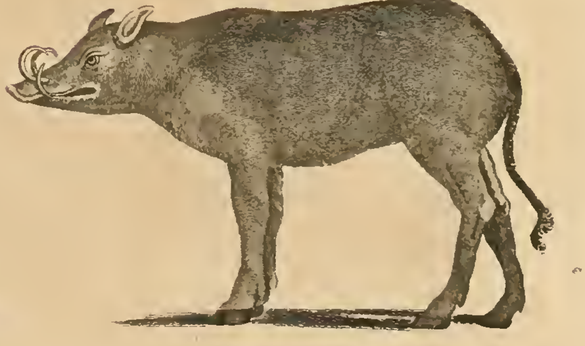

A.Bell Prin. Wal. Sculptor fecit.

Fig. 5.

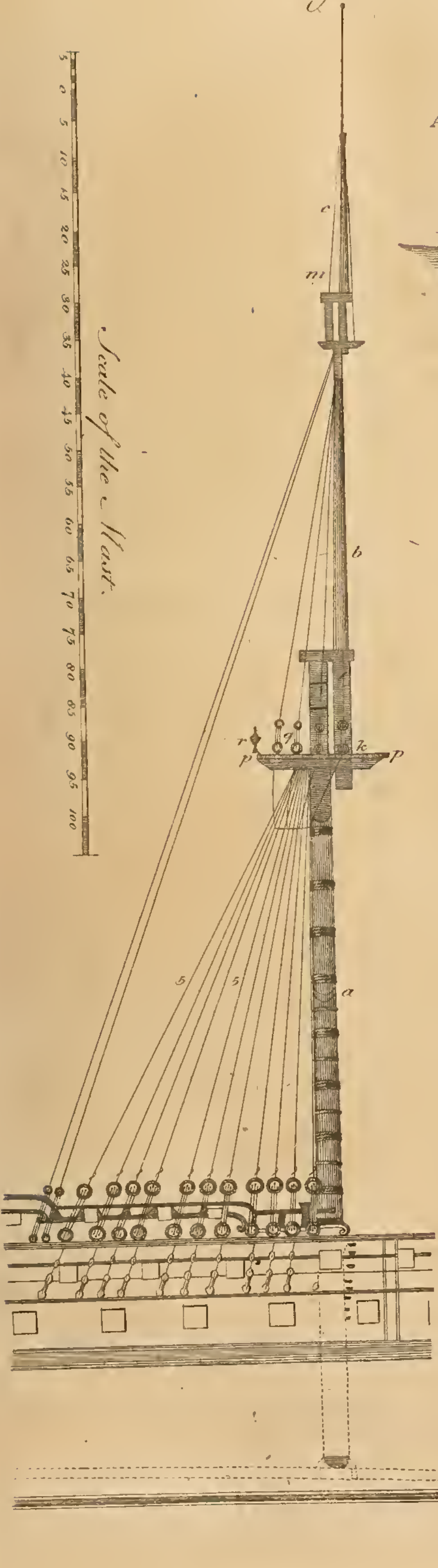
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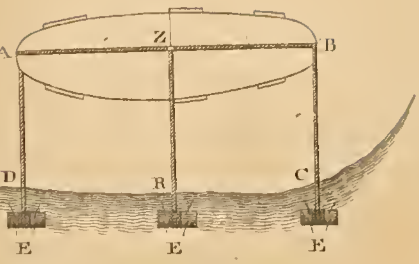
Fig. 6.



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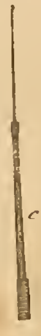
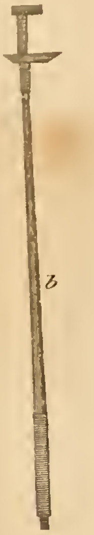


Fig. 2.



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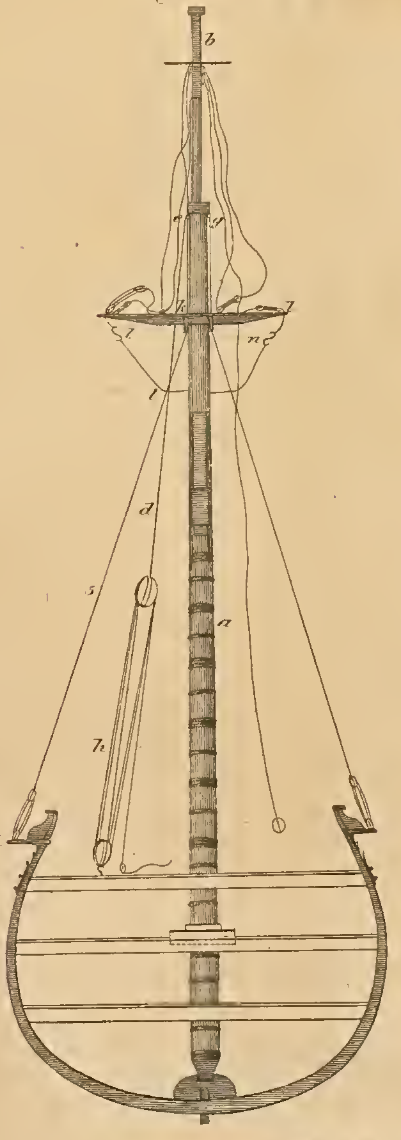
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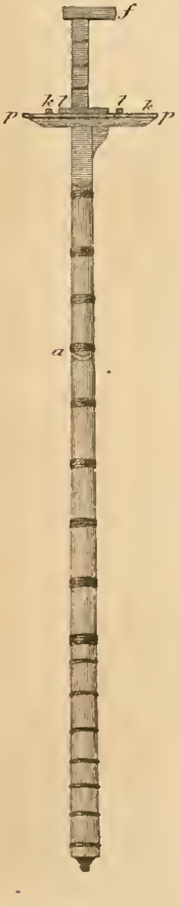
Fig. 1.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 1.

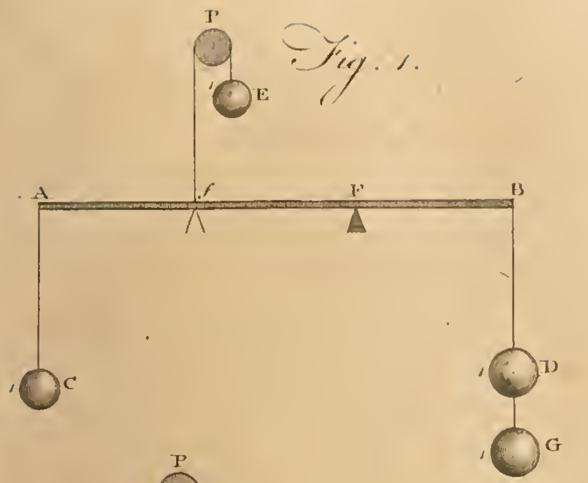

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Fig. 2.

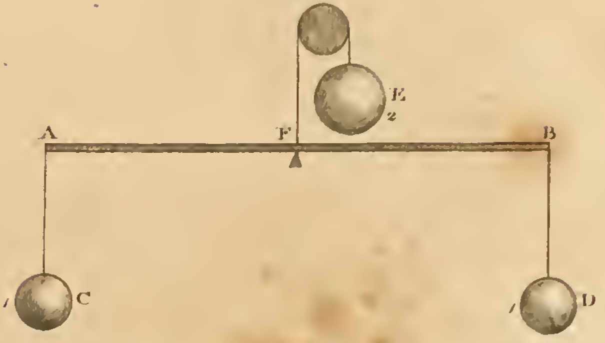
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Fig. 3.

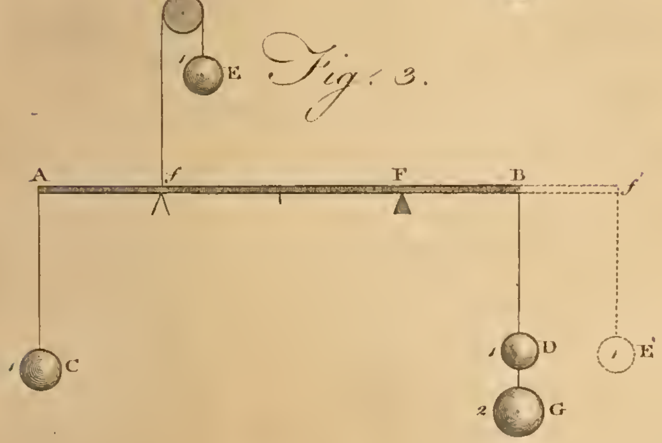
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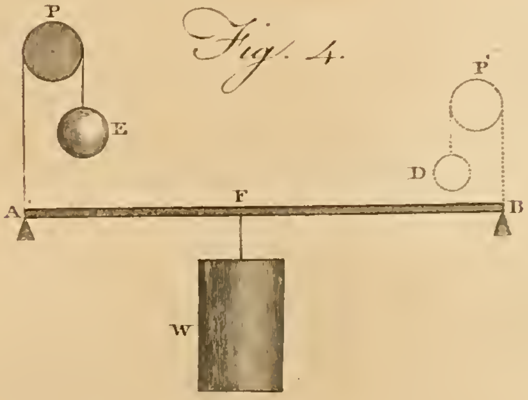
Fig. 4.



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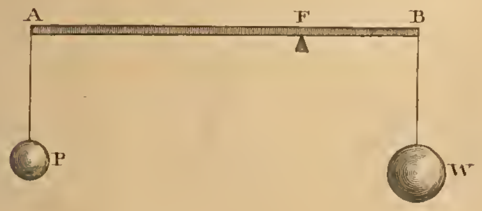

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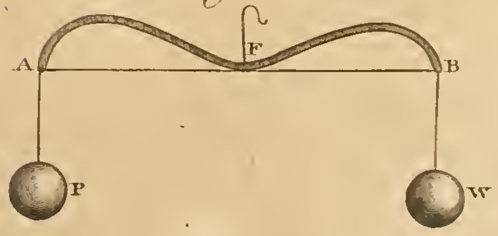

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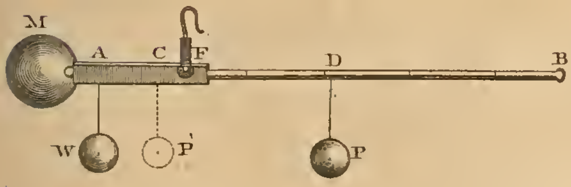
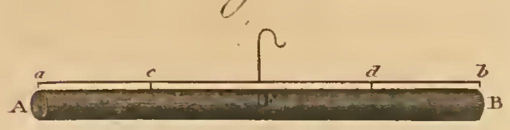


Fig. 8.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 1.

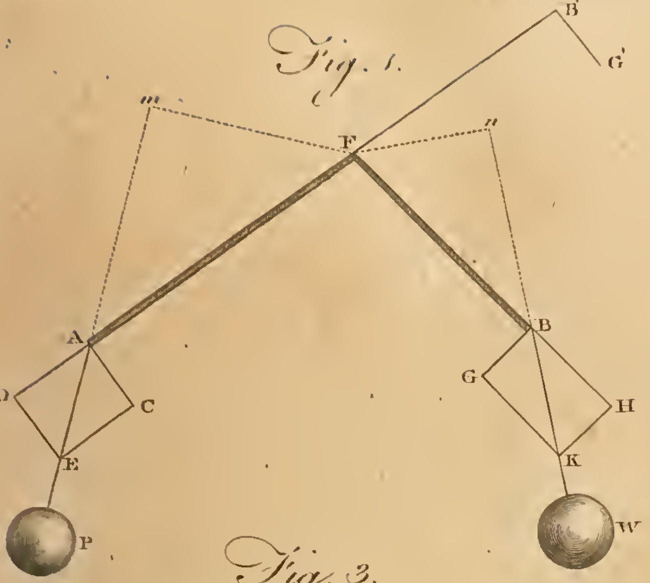

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Fig. 2.

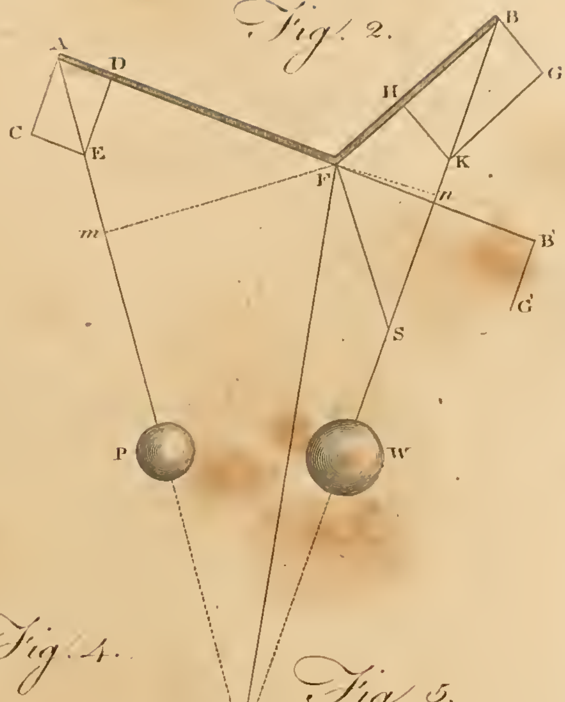
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Fig. 3.

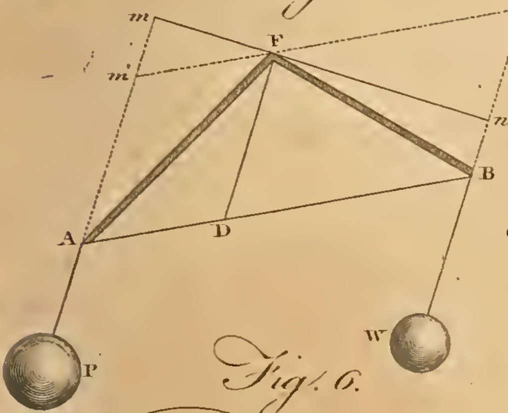
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Fig. 4.

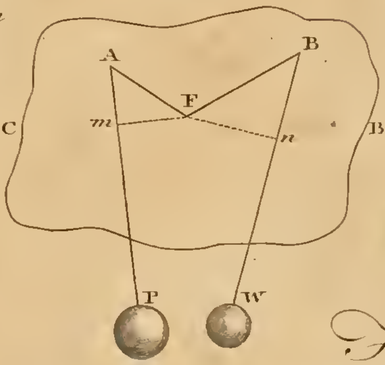
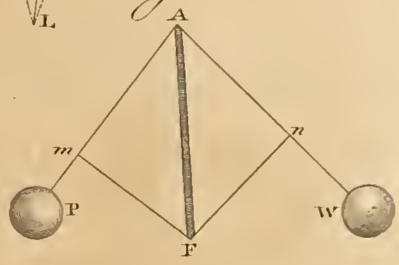


Fig. 5.



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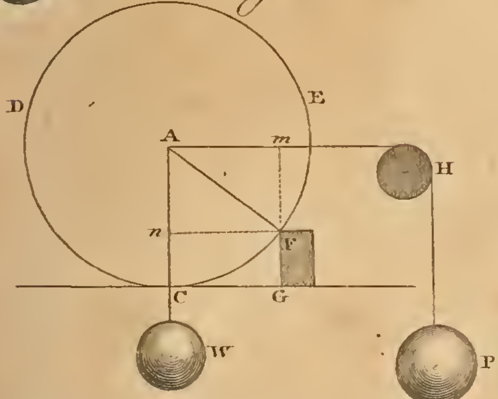
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Fig. 7.

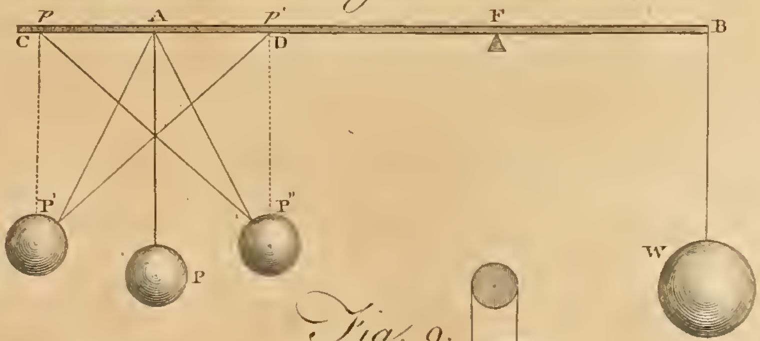
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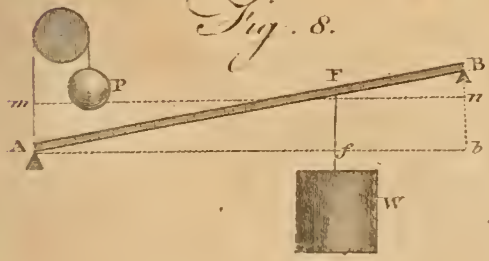
Fig. 8.



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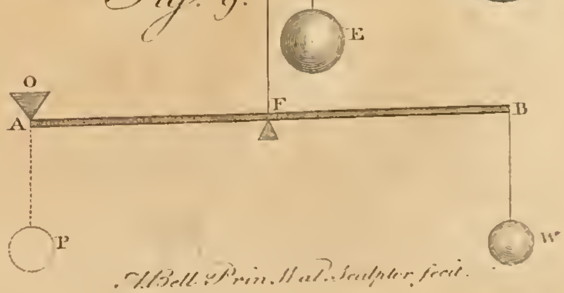

A. Bell Prin. Wal. Sculptor fecit.

MECHANICS.

Plate CCCXVIII.

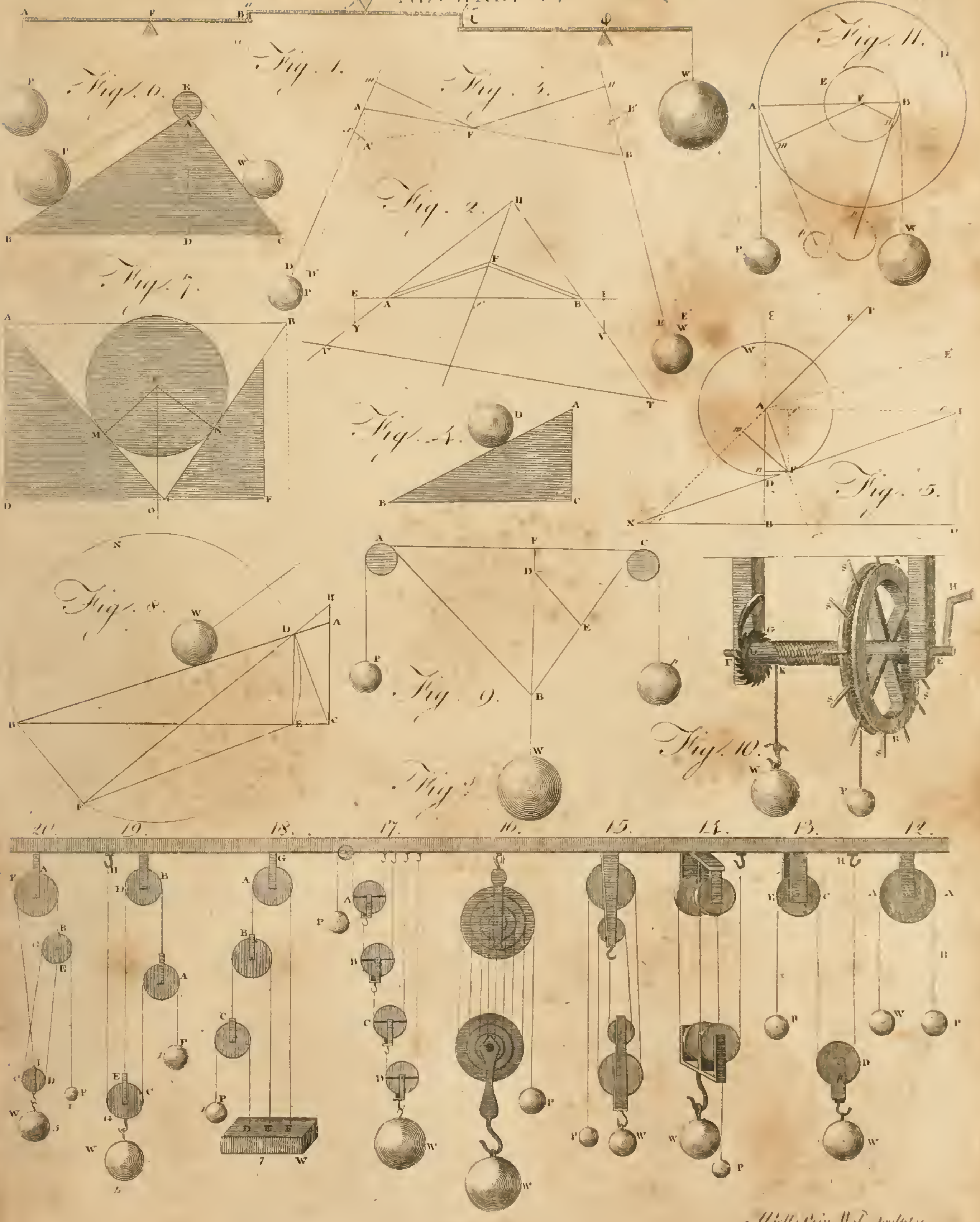
Fig. 1.
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A. Bell Prin. Wal. Sculpsit

Fig. 1.

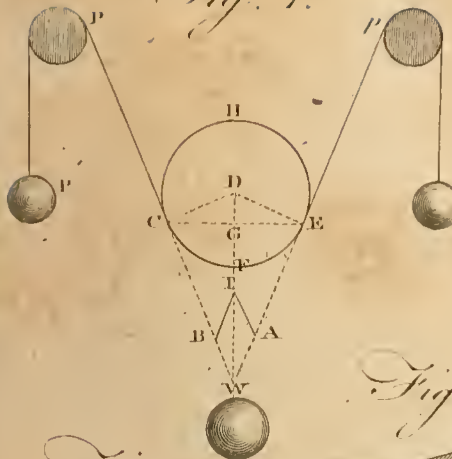
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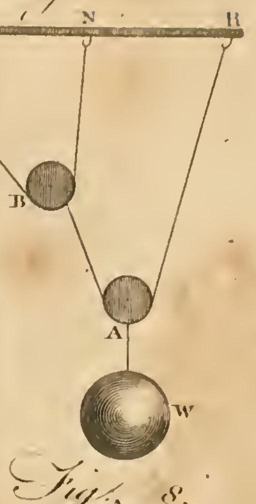
Fig. 2.



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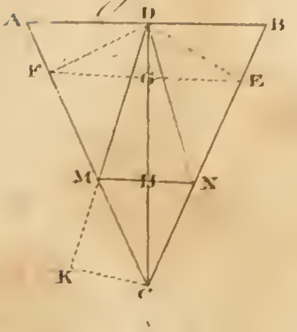
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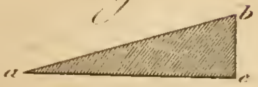
Fig. 4.



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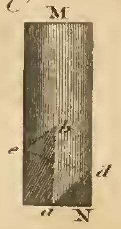


Fig. 6.

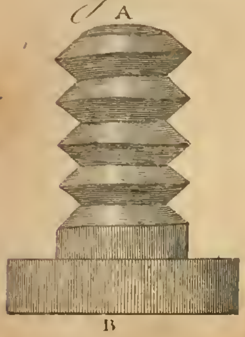
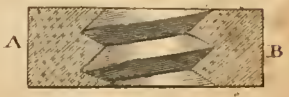


Fig. 7.



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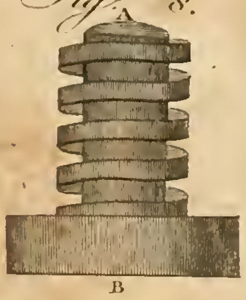


Fig. 9.

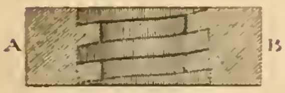


Fig. 10.

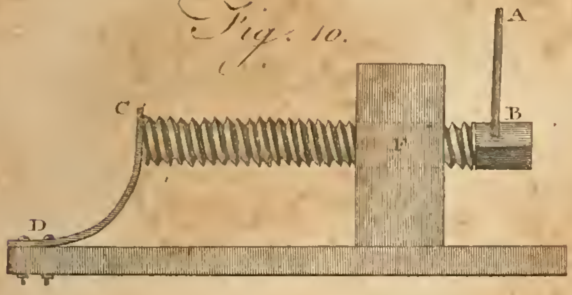


Fig. 11.

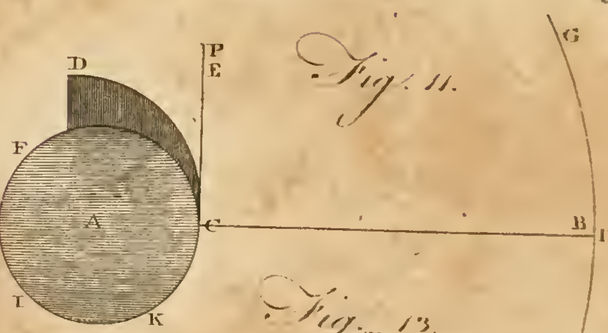

P
E
D
G
F
A
C
B
F
I
K

Fig. 12.

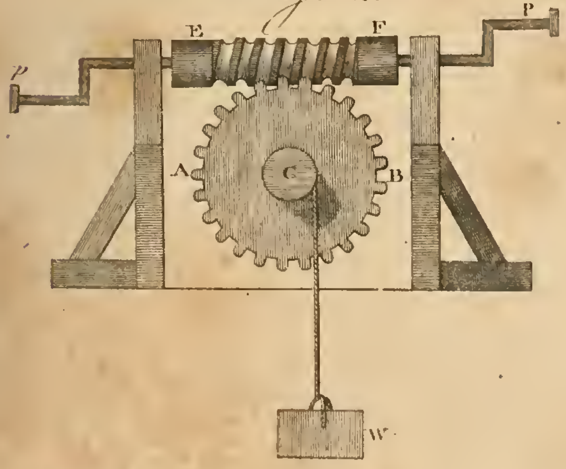
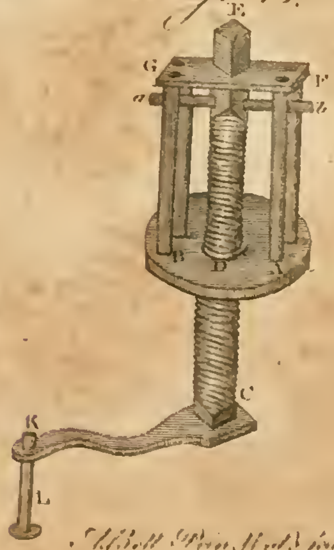


Fig. 13.


E
G
F
a
b
B
D
A
C
K
L

A. Bell Prin. Wall Sculptor fecit.

Fig. 1.

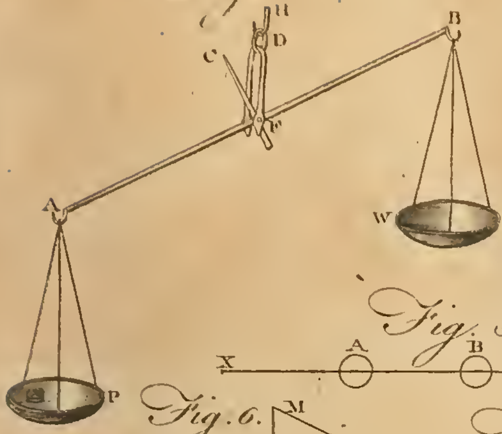
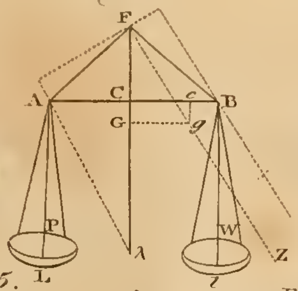


Fig. 2.


F
A
C
c
B
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l
Z

Fig. 3.

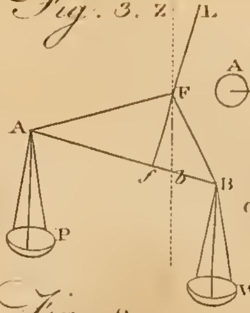


Fig. 4.

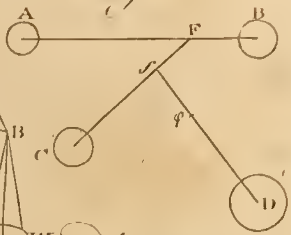


Fig. 5.

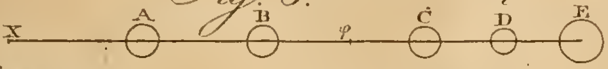


Fig. 6.

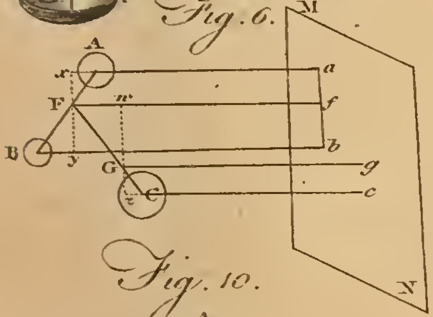

A
M
x
a
F
n
f
B
y
b
G
g
z
C
c
N

Fig 7

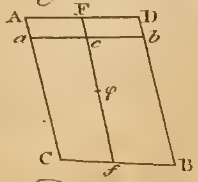

A
F
D
a
e
b
φ
C
f
B

Fig. 8.

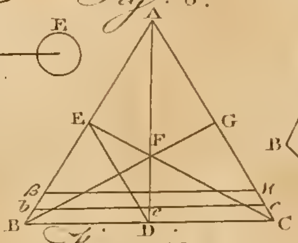
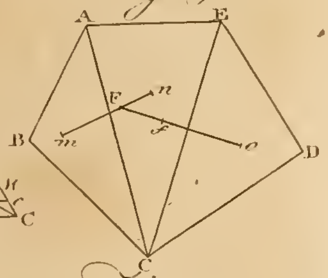

A
E
G
F
β
H
b
e
c
B
D
C

Fig. 9.


A
E
F
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B
m
f
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D
C

Fig. 12.

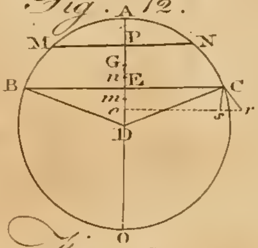

A
M
P
N
G
n
E
B
C
m
e
s
r
D
O

Fig. 13.

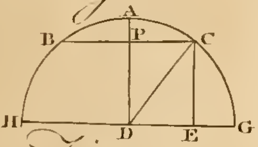


Fig. 10.

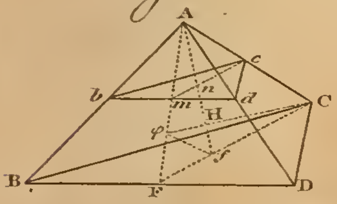

A
c
b
n
m
d
H
C
φ
f
B
F
D

Fig. 11.

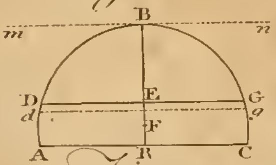

B
m
n
D
E
G
d
g
F
A
R
C

Fig. 16.

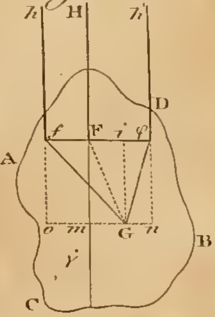

h
H
h
D
A
f
F
i
φ
o
m
G
n
γ
B
C

Fig. 17.

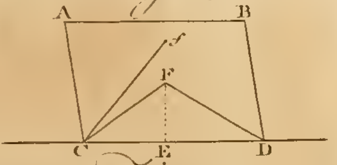


Fig. 14.

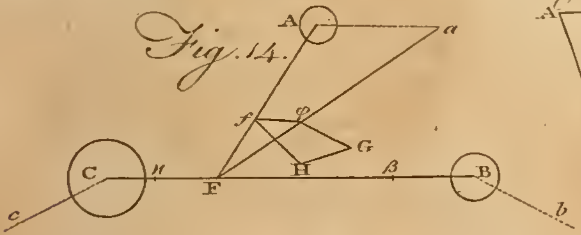

A
a
f
φ
G
C
n
H
β
B
F
c
b

Fig. 15.

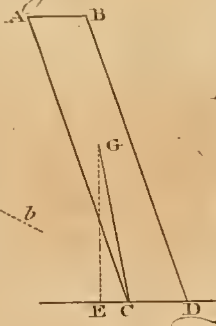


Fig. 18.

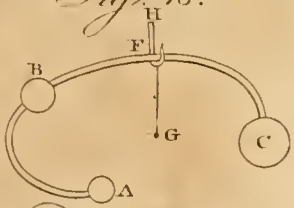


Fig. 20.

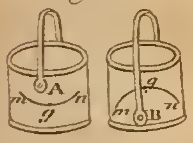


Fig. 21.

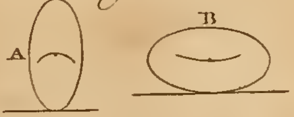


Fig. 25.

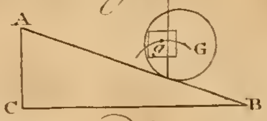


Fig. 19.

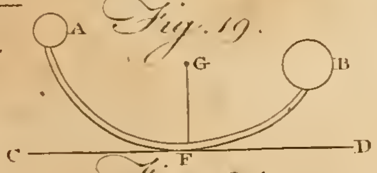


Fig. 24.

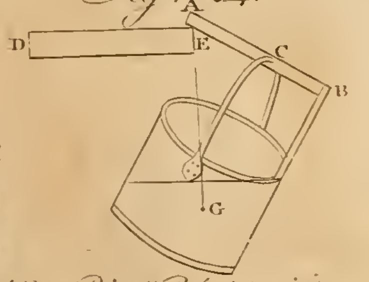


Fig. 23.

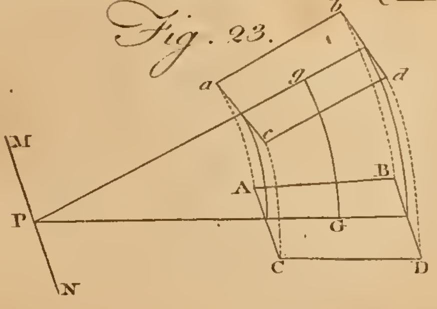

b
a
g
d
c
M
A
B
P
G
C
D
N

Fig. 27.

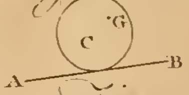


Fig. 26.

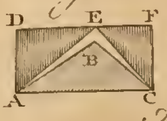
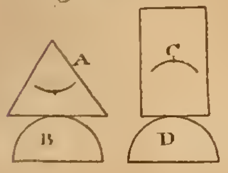


Fig. 22.



A. Bell Prin. Wal. Sculptor. fecit.

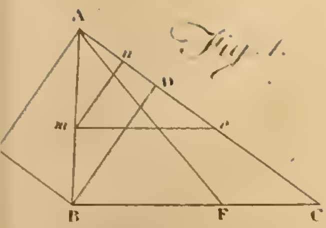


Fig. 1.

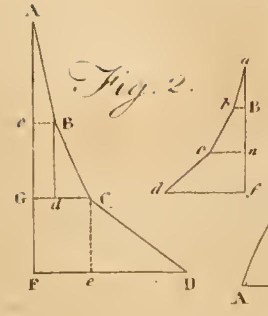


Fig. 2.
A
c
B
G
d
C
F
e
D
a
b
B
e
n
d
f

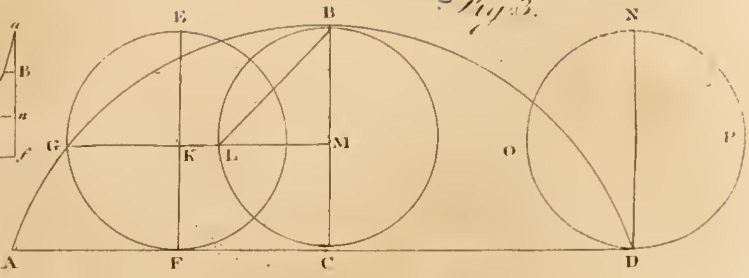


Fig. 3.
E
B
N
G
K
L
M
O
P
A
F
C
D

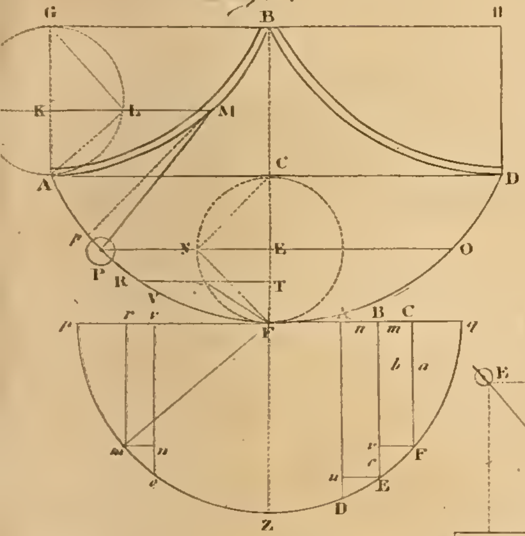


Fig. 4.
G
B
H
K
L
M
C
A
D
p
P
R
N
E
O
T
V
F
r
r
B
C
n
m
q
b
a
m
n
e
v
c
F
u
E
D
Z

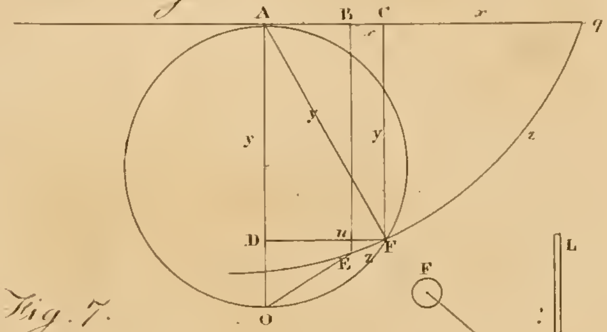


Fig. 5.
A
B
C
x
q
y
y
y
z
D
u
F
E
z
O

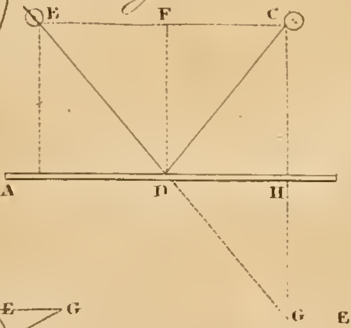


Fig. 7.

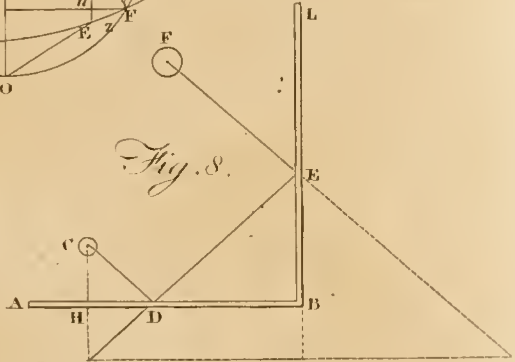


Fig. 8.
F
L
E
C
A
H
D
B
G
M
N

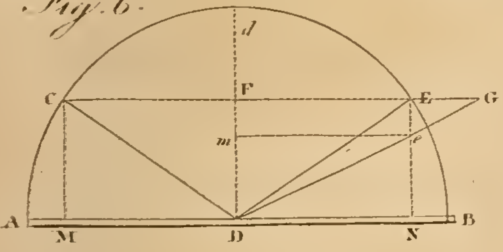


Fig. 6.
d
F
C
E
G
m
e
A
M
D
N
B

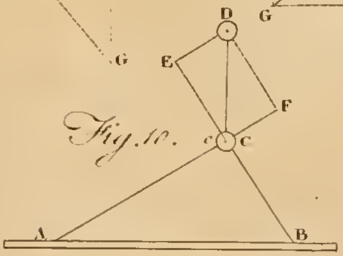


Fig. 10.

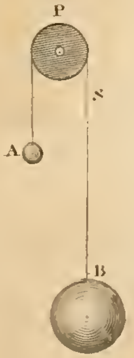


Fig. 11.

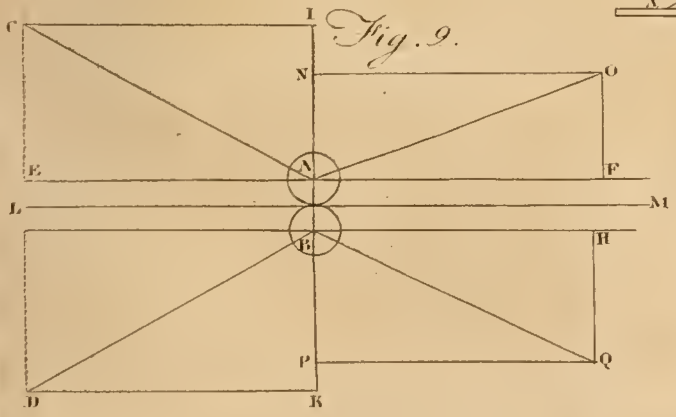


Fig. 9.
C
I
N
O
E
A
F
L
M
B
H
P
Q
D
K

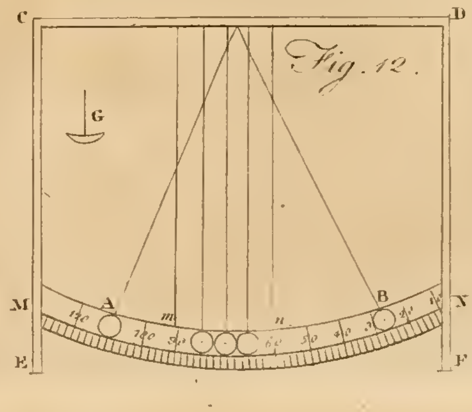


Fig. 12.
C
D
G
M
A
m
n
B
N
E
F

A. Bell Prin. Wal. Sculptor fecit

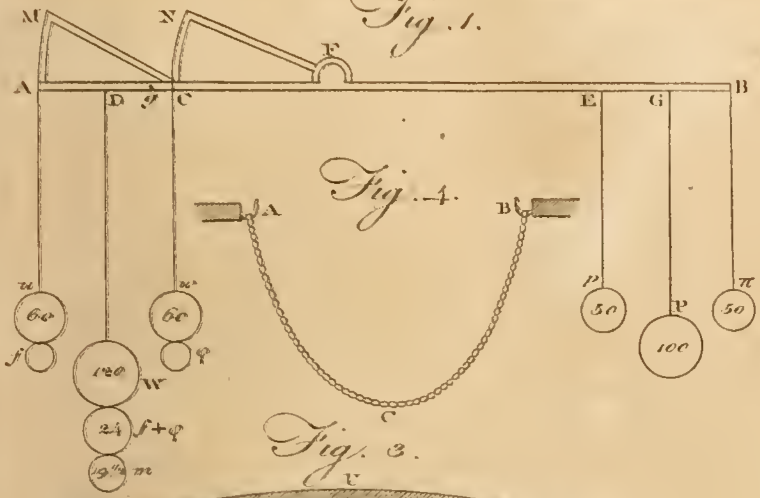


Fig. 1.

Fig. 4.

M
N
F
A
D
g
C
E
G
B
u
60
f
120
W
24
f+φ
9½ m
x
60
φ
p
50
P
100
π
50
A
B
C

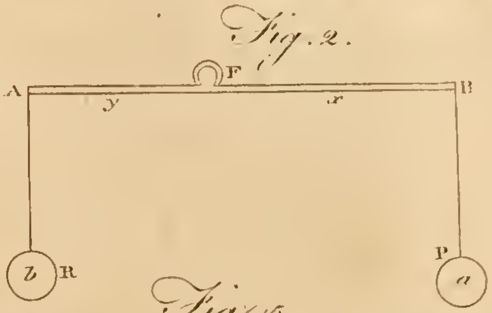


Fig. 2.

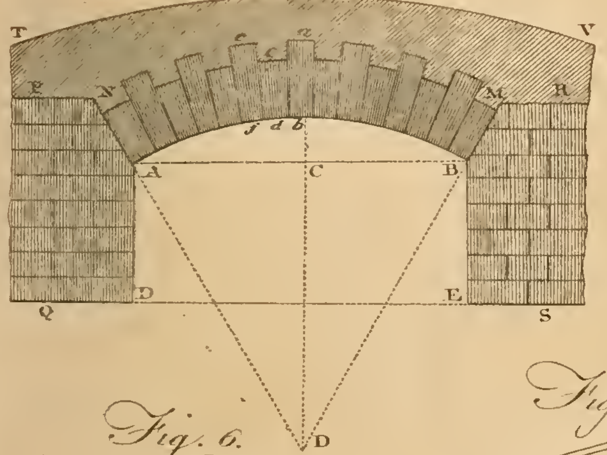


Fig. 3.

T
V
e
a
c
P
N
M
R
f
d
b
A
C
B
D
E
Q
S
D

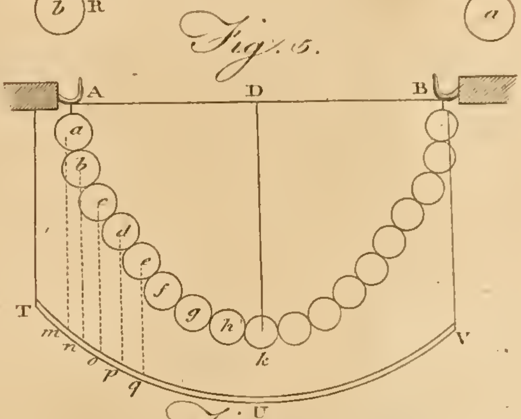


Fig. 5.

A
D
B
a
b
c
d
e
f
g
h
k
T
V
m
n
o
p
q
U

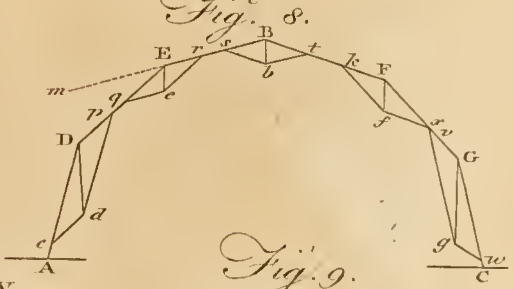


Fig. 8.

E
r
s
B
t
k
F
m
q
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b
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D
f
x
v
G
d
c
A
g
w
C

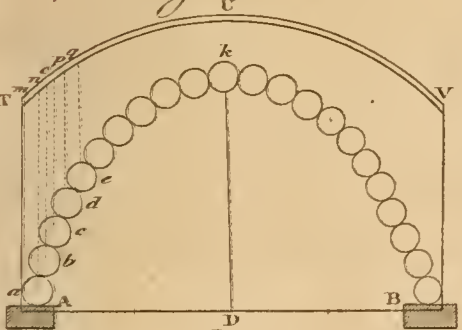

Fig. 6.

U
T
m
n
c
p
q
k
V
e
d
c
b
a
A
D
B

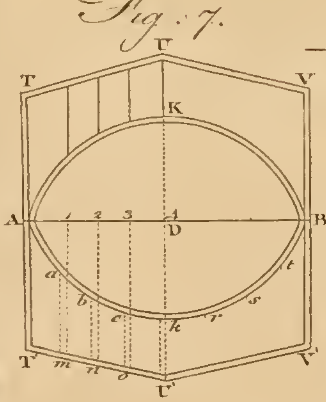

Fig. 7.

U
T
V
K
A
1
2
3
4
D
B
a
b
c
k
r
s
t
T'
m
n
o
U'
V'

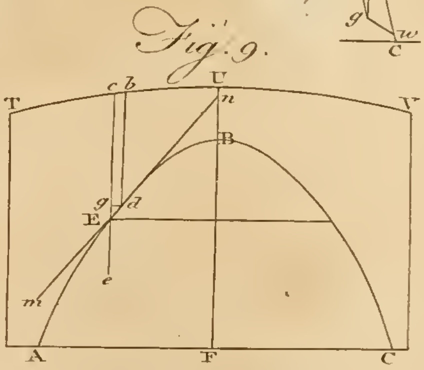

Fig. 9.

T
c
b
U
V
n
B
g
d
E
e
m
A
F
C

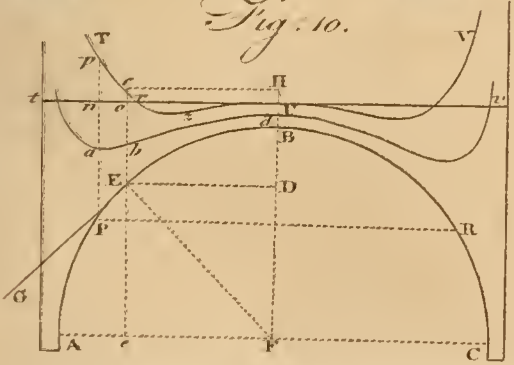

Fig. 10.

T
V
p
e
H
t
n
o
r
z
r
v
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a
b
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C

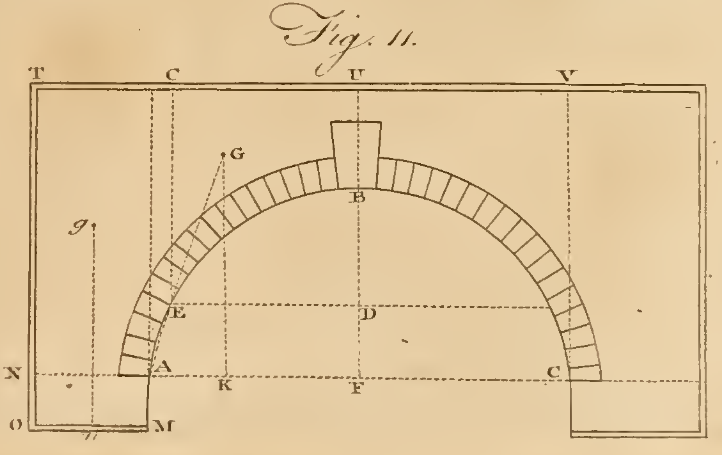

Fig. 11.

T
C
U
V
G
B
g
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n
M

A. Bell Prin. Wal. Sculptor fecit.

Fig. 1.

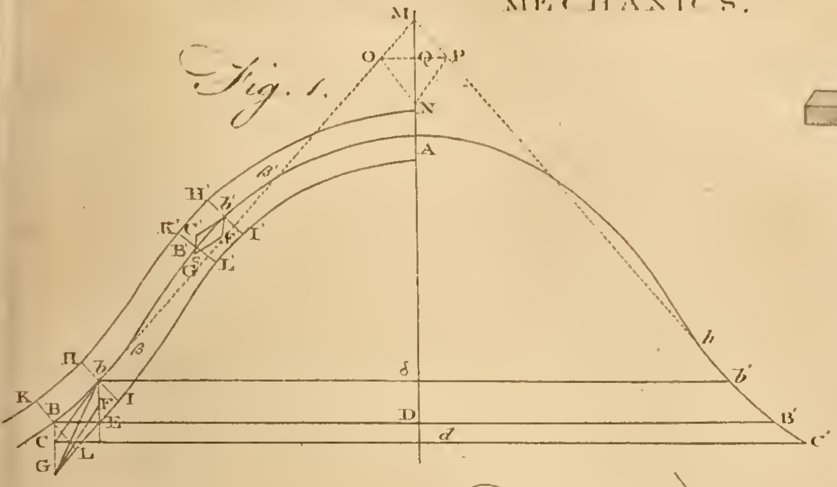

M
O
Q
P
N
A
B'
b'
β'
C'
K'
F'
I'
B
G'
L'
H
b
β
δ
h
b'
K
B
F
I
E
D
B'
C
L
d
C'
G

Fig. 2.

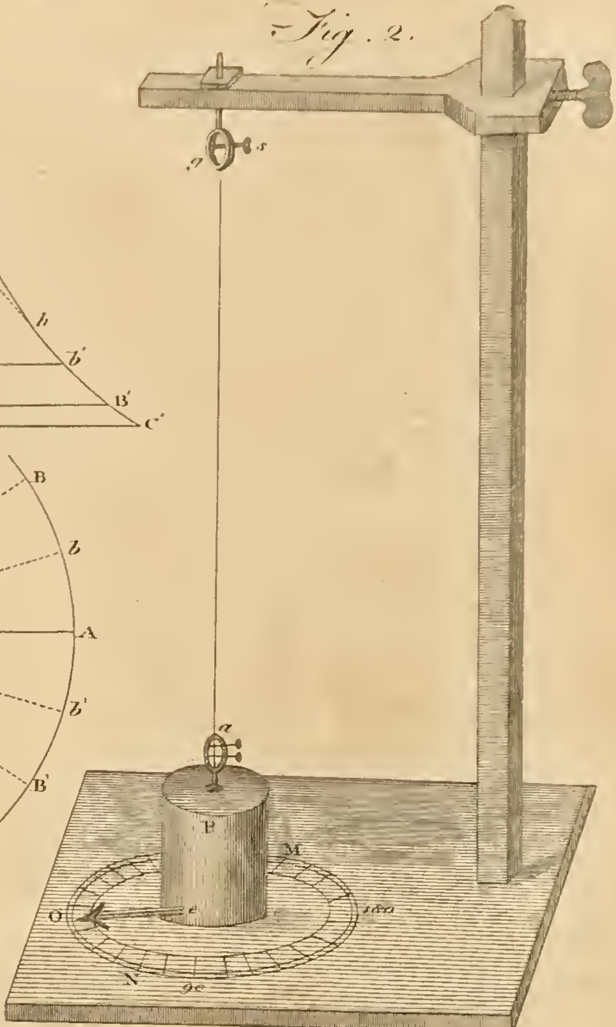

g
s
a
P
M
O
e
180
N
90

Fig. 6.

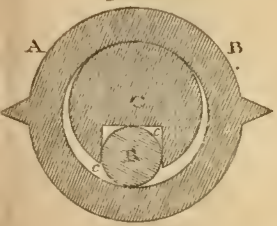


Fig. 3.

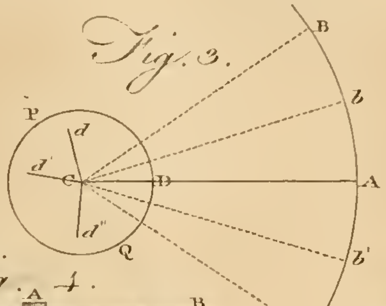

B
b
P
d
d'
C
D
A
d''
Q
b'
B'

Fig. 4.

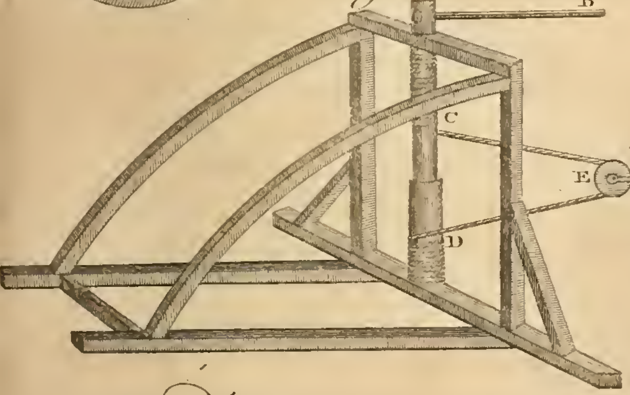


Fig. 5.

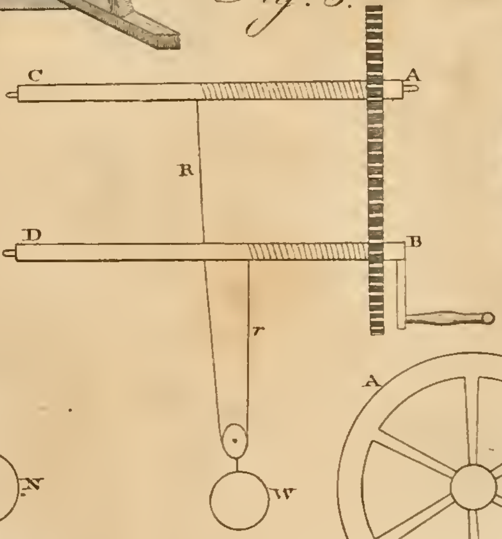


Fig. 7.

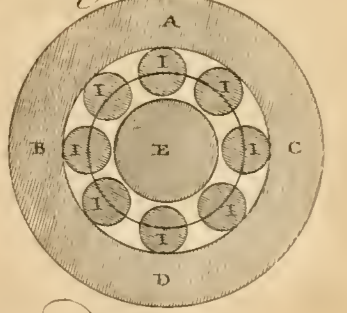

A
I
I
I
B
I
E
I
C
I
I
I
D

Fig. 8.

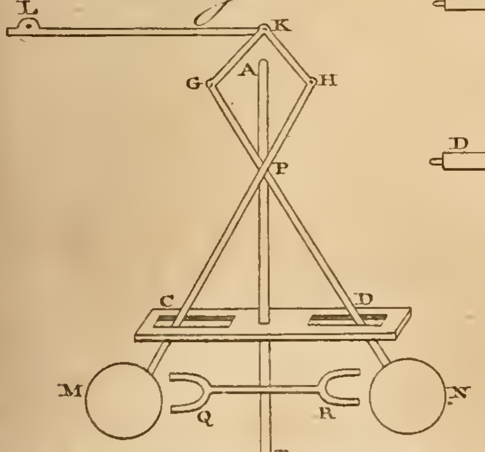
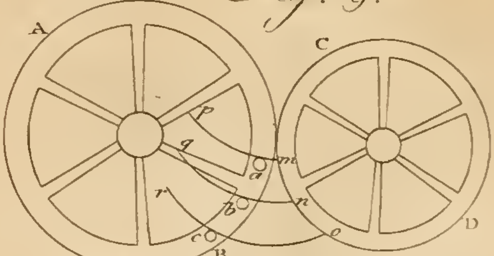

L
K
G
A
H
P
C
D
M
Q
R
N
B
E
F

Fig. 9.


A
C
p
q
m
a
r
b
n
c
B
e
D

A. Bell Prin. Wal. Sculptor fecit.

MECHANICS. Plate CCCXXIV.

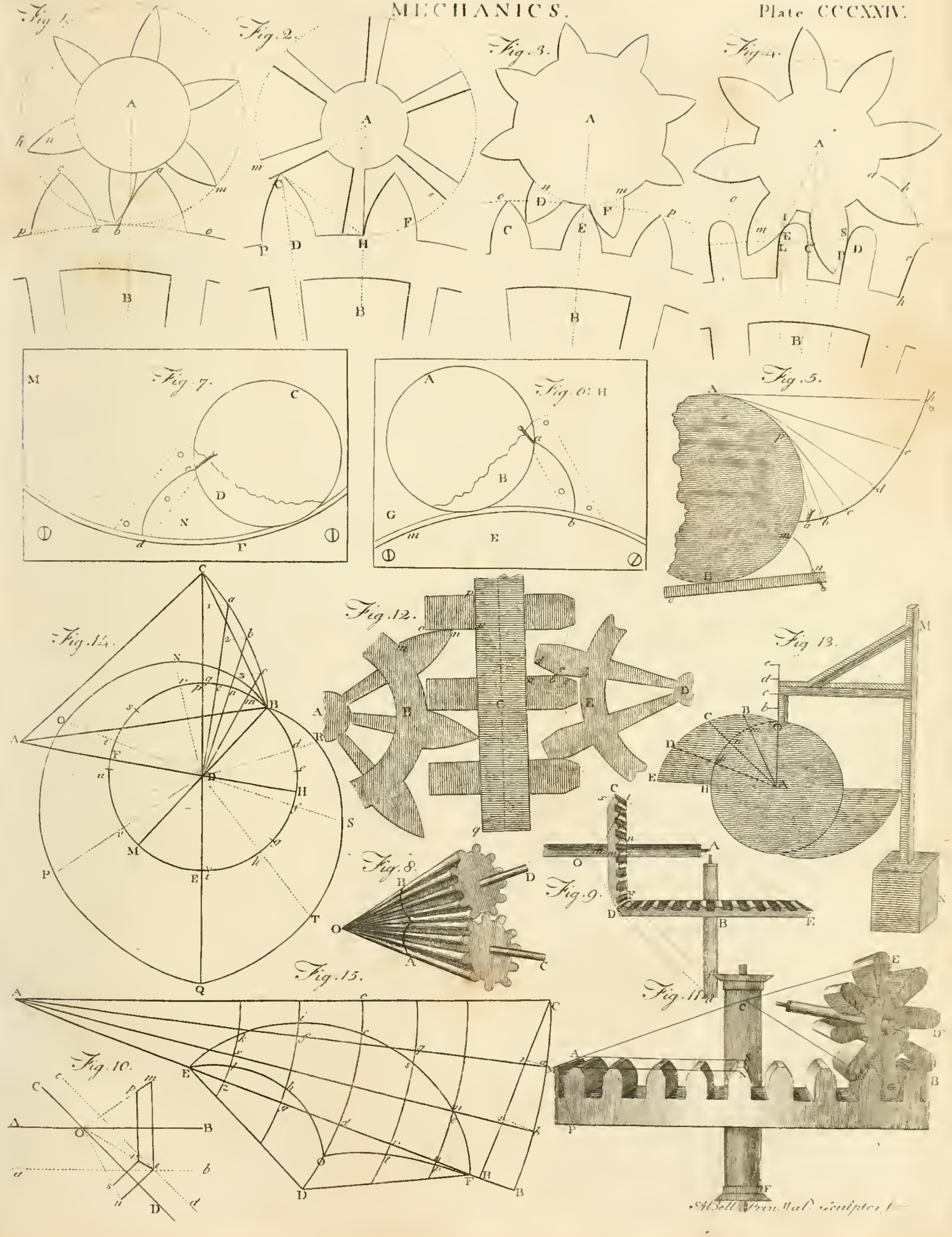


Fig. 1.
A
B
h
n
c
a
m
p
d
b
o
Fig. 2.
A
B
m
C
D
H
F
P
Fig. 3.
A
B
c
n
D
m
F
p
C
E
Fig. 4.
A
B
o
d
b
m
E
L
C
S
P
D
h
Fig. 5.
A
B
a
b
c
d
m
n
o
Fig. 6.
A
B
H
G
E
m
b
a
Fig. 7.
M
C
D
N
F
d
Fig. 8.
B
D
O
A
C
Fig. 9.
C
A
O
D
E
B
F
Fig. 10.
C
c
p
m
A
O
B
a
b
n
D
d
Fig. 11.
A
C
S
D
B
P
F
E
Fig. 12.
A
B
C
D
E
p
q
Fig. 13.
M
N
A
B
C
D
E
H
Fig. 14.
C
A
B
O
N
R
F
H
S
M
P
E
T
Q
Fig. 15.
A
C
E
D
F
H
B

A. Bell Prin. Wal. Sculptor f.

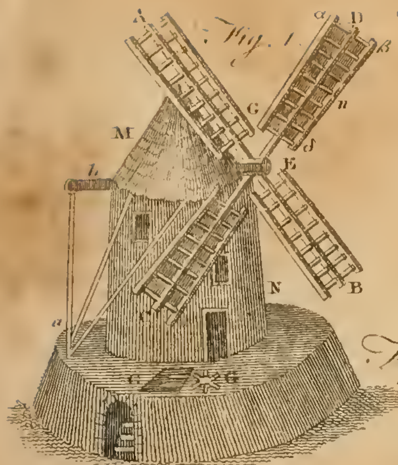


Fig. 1.
A
a
D
β
G
n
δ
M
h
E
N
B
a
C
G
G

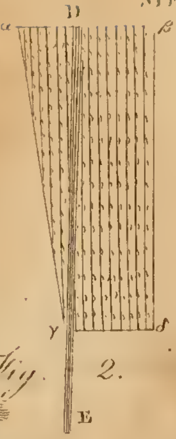


Fig. 2.

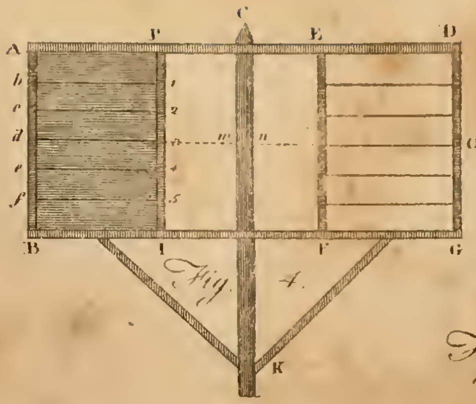


Fig. 4.
A
P
C
E
D
b
c
d
e
f
1
2
3
4
5
m
n
O
B
I
F
G
K

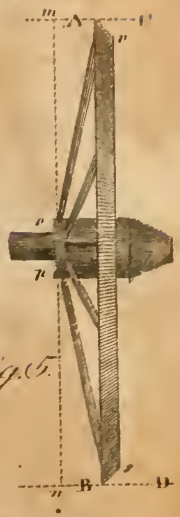


Fig. 5.

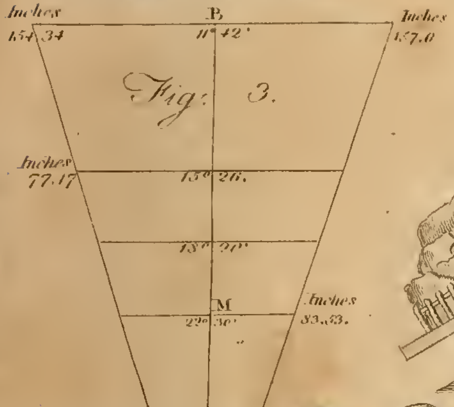


Fig: 3.
Inches
154.34
B
11° 42'
Inches
157.0
Inches
77.17
15° 26'
18° 20'
M
22° 30'
Inches
83.33.
38..58.Inches Apparent Breadth of the Sail
33° 38'
50 Inches Absolute Breadth of the Sail

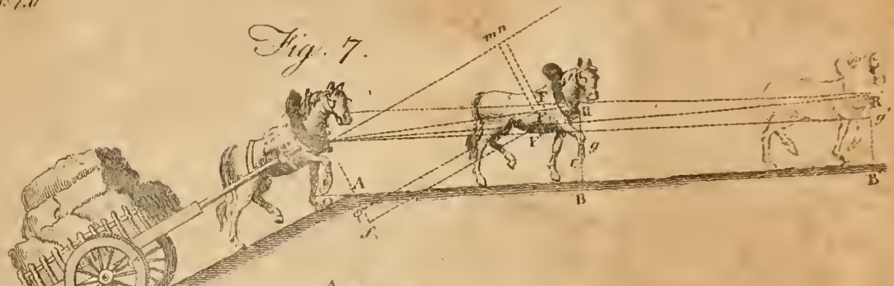


Fig. 7.
m n
T
R
F
R
g
C
g
A
O
B
B
S
D

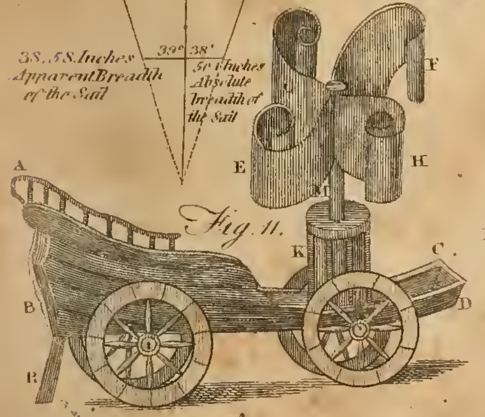


Fig. 11.
F
E
H
M
K
A
C
B
D
R

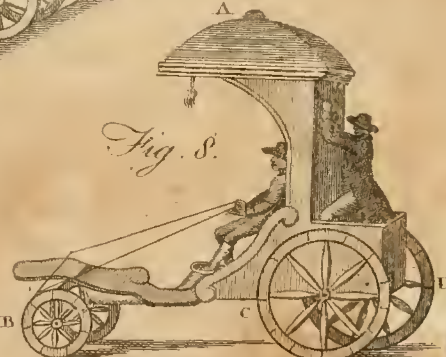


Fig. 8.

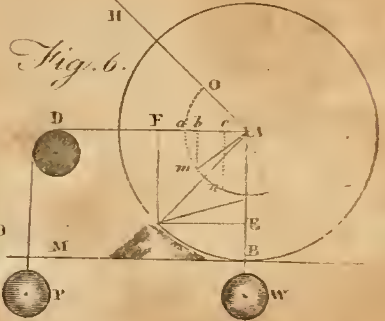


Fig. 6.
H
O
D
F
d
b
c
A
m
n
E
M
B
P
W

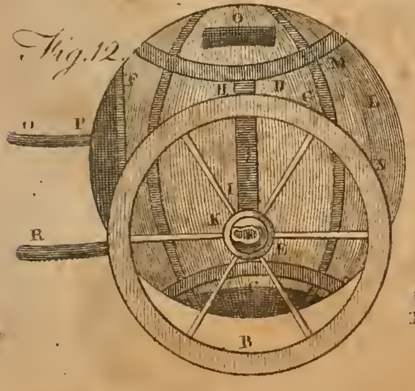


Fig. 12.
A
O
F
H
D
C
M
E
O
P
I
K
E
R
B

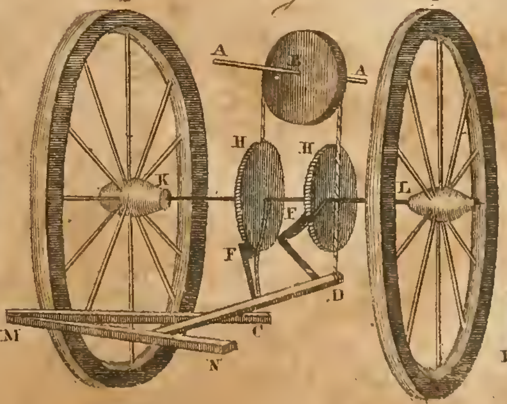


Fig. 9.
I
I
A
B
A
H
H
K
L
E
F
D
M
C
N

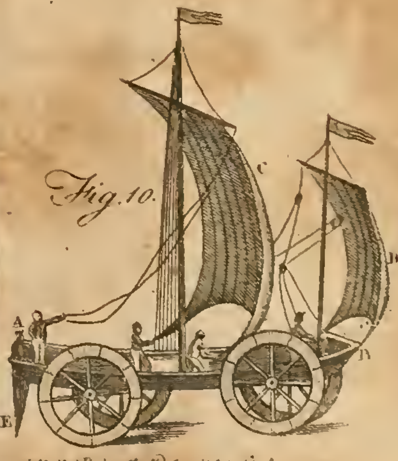


Fig. 10.

A. Bell Prin. Wall. sculptor fecit

Fig. 2.

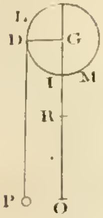


Fig. 6.

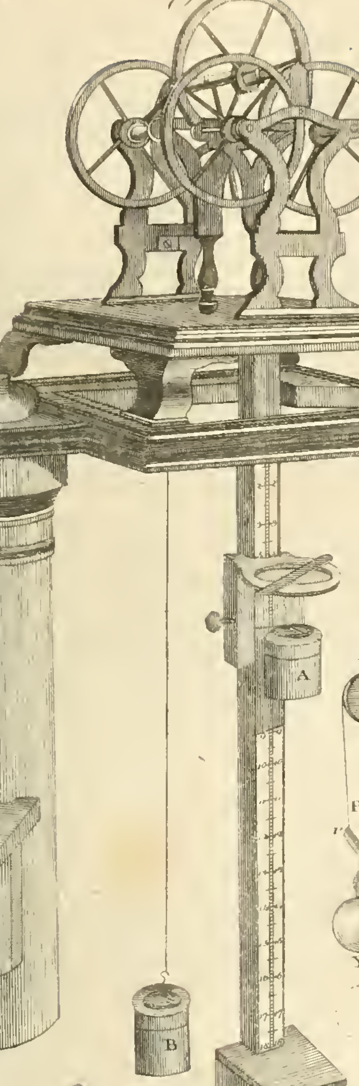


Fig. 3.

Fig. 4.

Fig. 1.

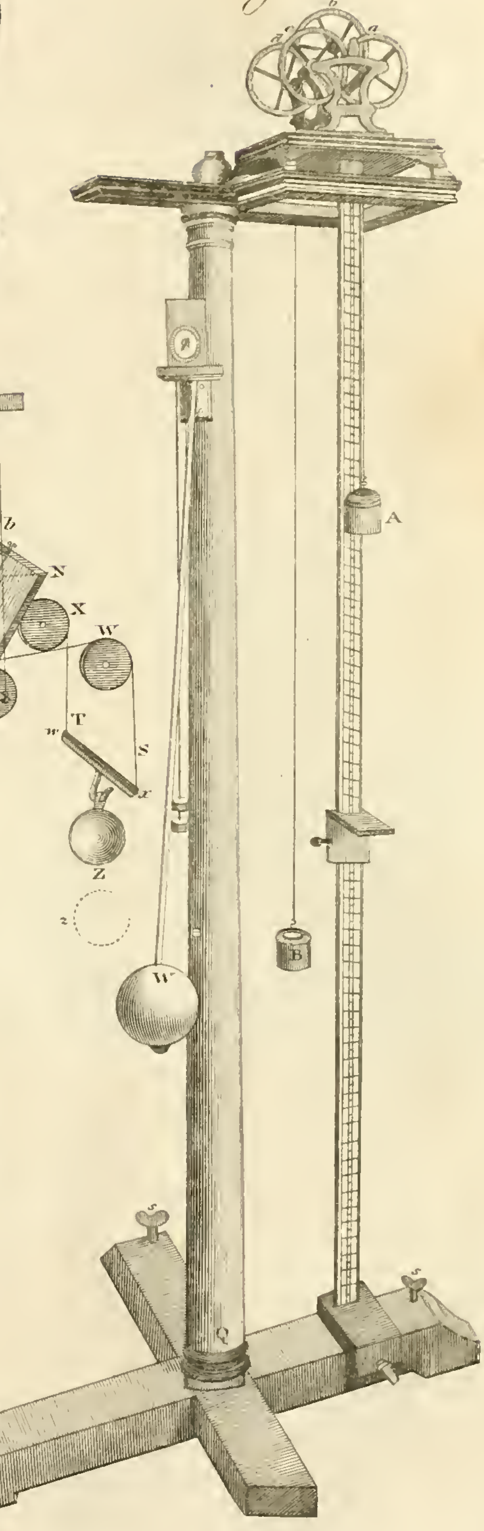


Fig. 7.

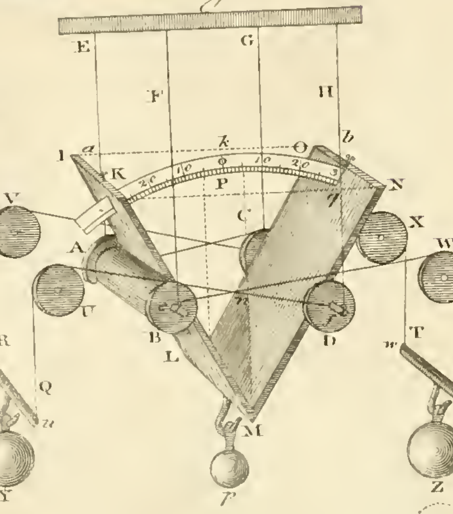

E
F
G
H
I
a
K
k
O
b
20
10
0
10
20
30
P
N
q
V
C
X
W
A
U
B
n
D
L
T
w
S
R
r
Q
u
x
M
Y
p
Z
z

Fig. 8.

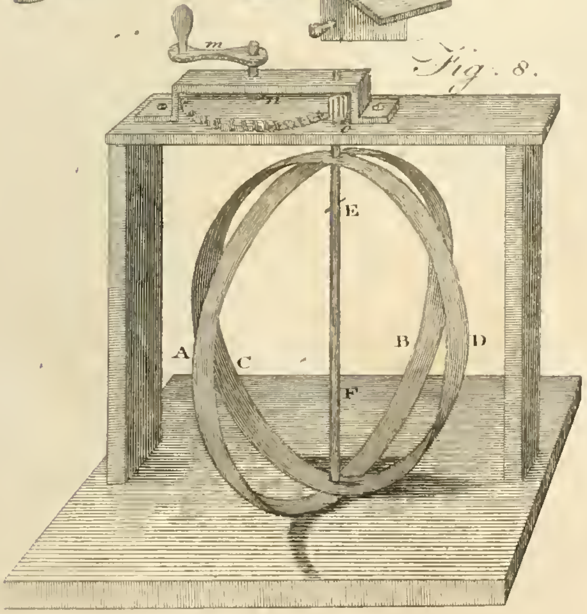
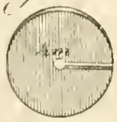


Fig. 5.



A. Bell Prin. Hal. Sculptor, fecit

MECHANICS.

Plate CCCXXVII.

Fig. 1.

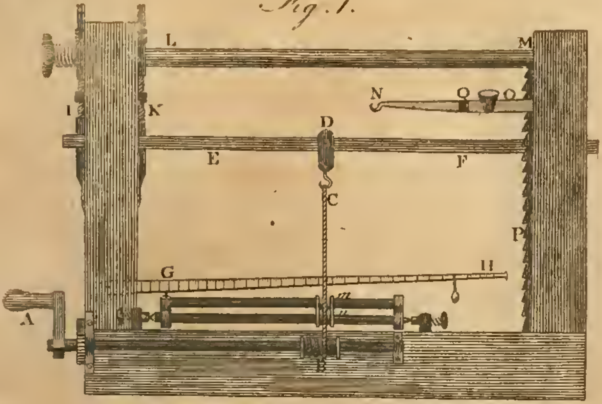

L
M
N
O
O
I
K
D
E
F
C
P
G
H
A
m
B

Fig. 2.

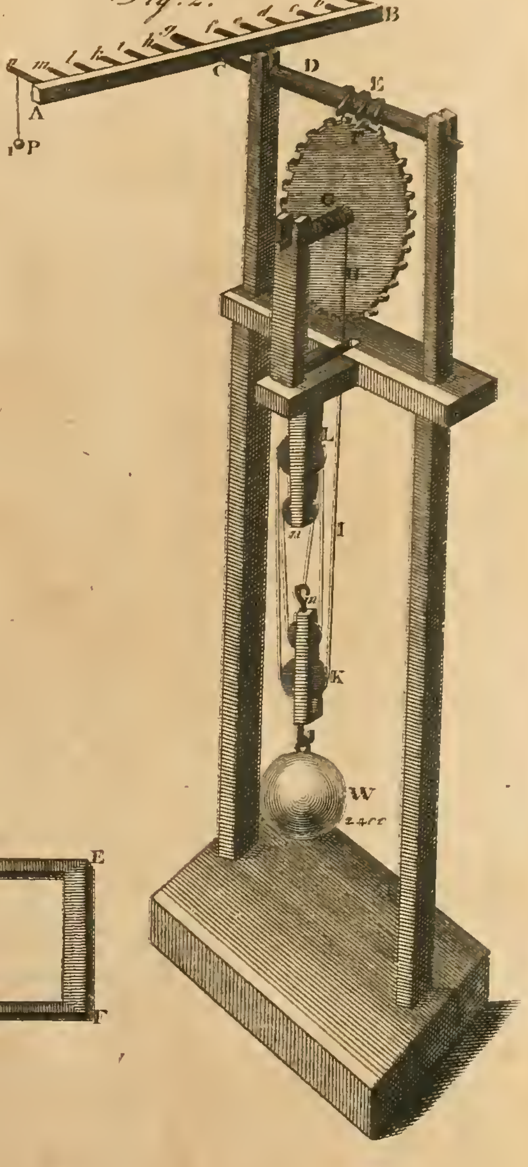

B
m
C
D
A
P
E
F
G
H
L
n
I
K
W
2400

Fig. 3.

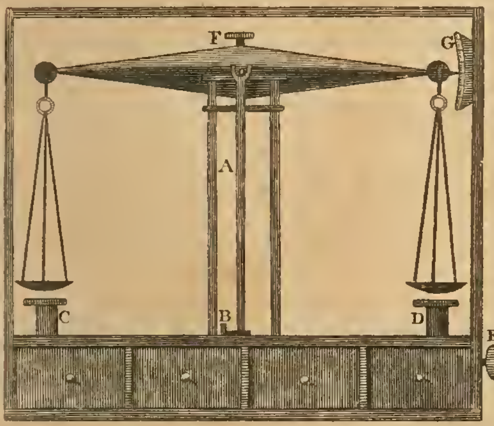


Fig. 4.

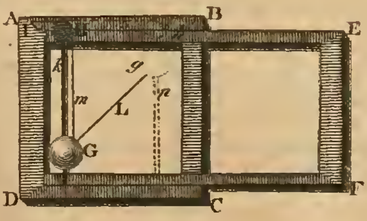

A
B
E
I
H
k
g
m
L
n
G
D
C
F

Fig. 6.

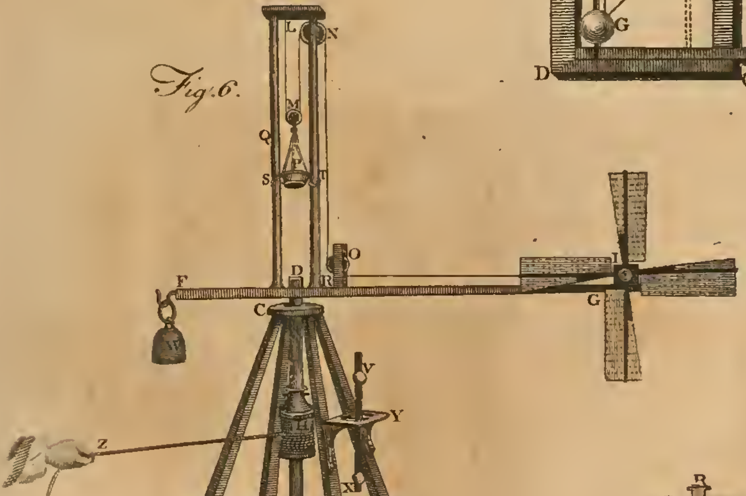
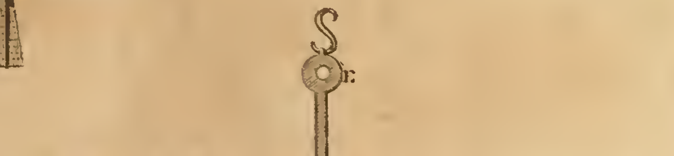

L
N
M
Q
P
S
T
O
D
R
F
C
I
G
W
V
Y
Z
H
X
E
A
B

Fig. 5.


S
E
R
S
C
D
A
F
B
30
20
10
0

A.Bell. Prin. Wal. Sculptor fecit.

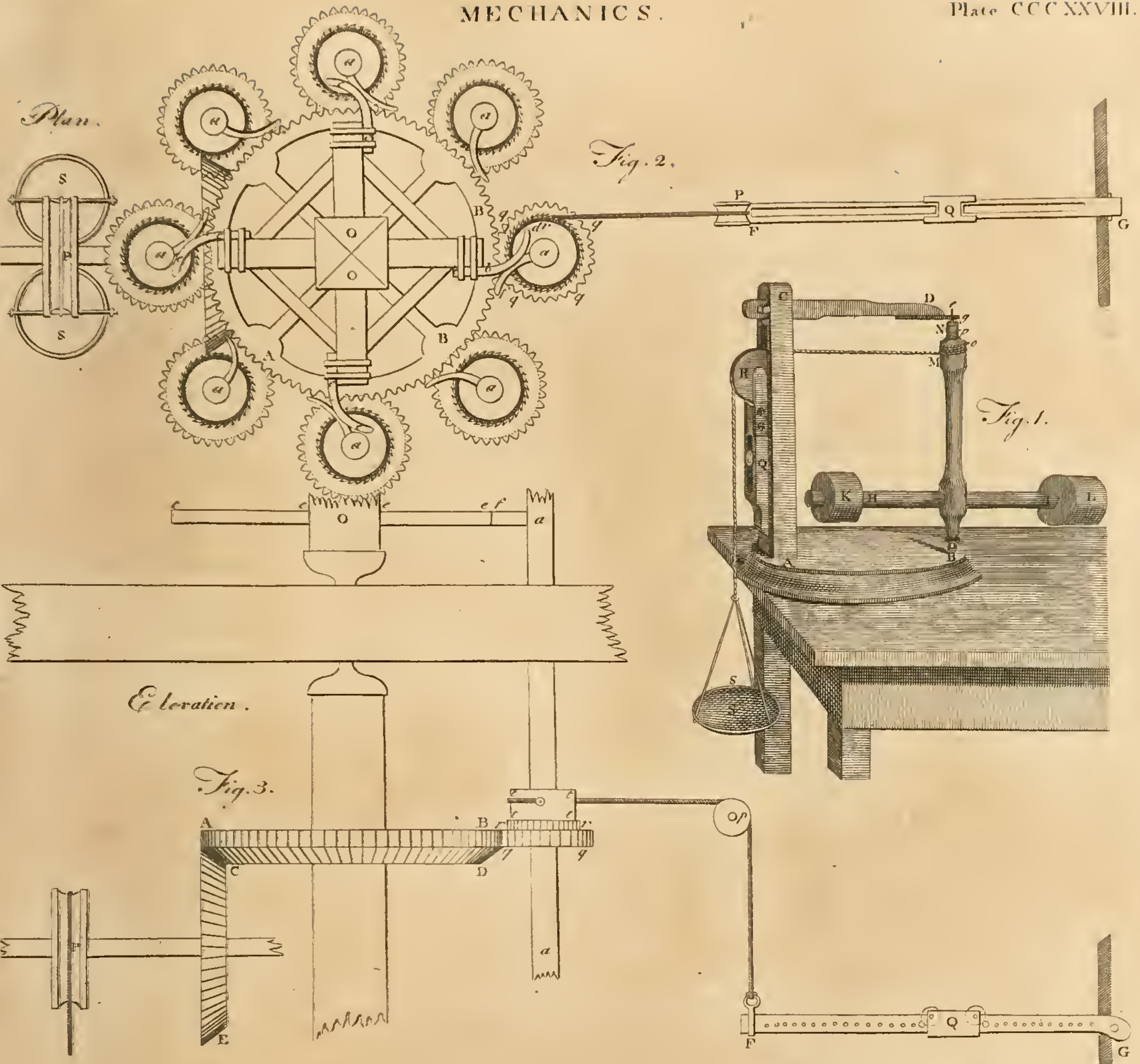

Plan.
Fig. 2.
S
S
P
O
A
B
B
a
q
P
F
Q
G
Fig. 1.
C
D
N
M
R
Q
K
H
L
A
B
S
S
e f
O
a
Elevation.
Fig. 3.
A
B
C
D
E
q
q
a
p
F
Q
G

Fig. 4.

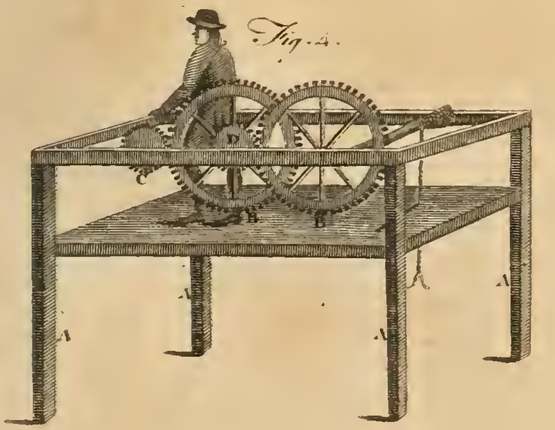
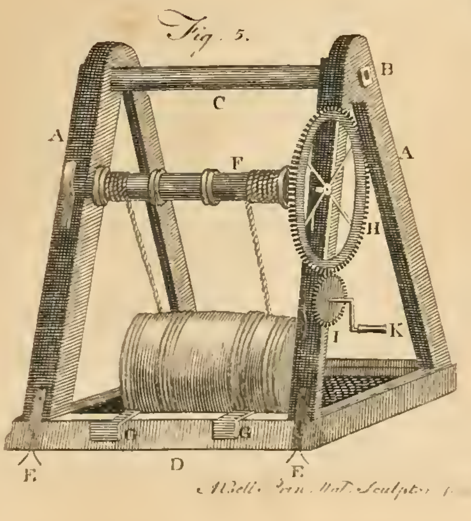


Fig. 5.


B
C
A
A
F
H
I
K
G
G
D
E
E

A. Bell. Prin. Wal. Sculptor fecit

MECHANICS.

Plate CCCXXIX.

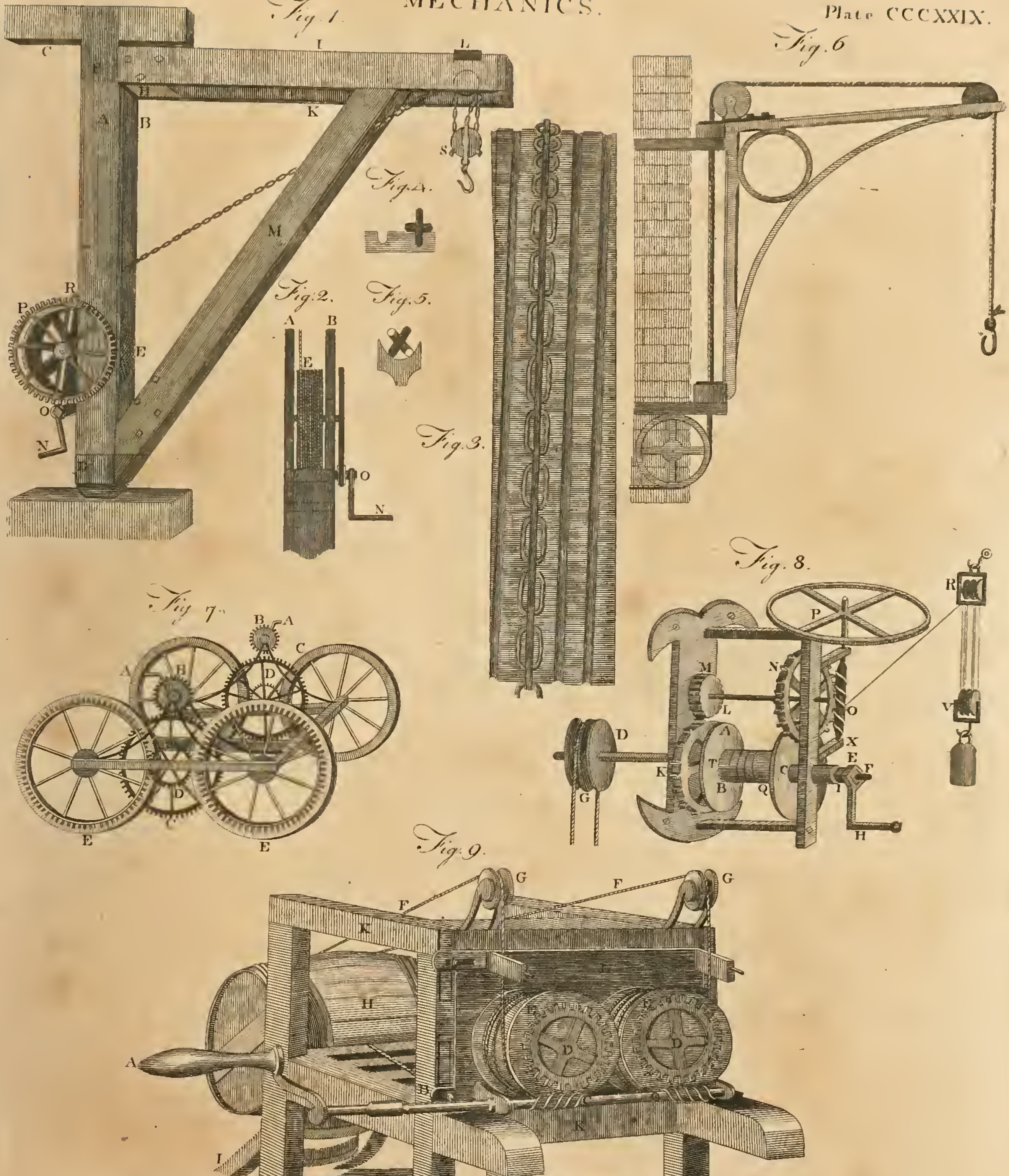
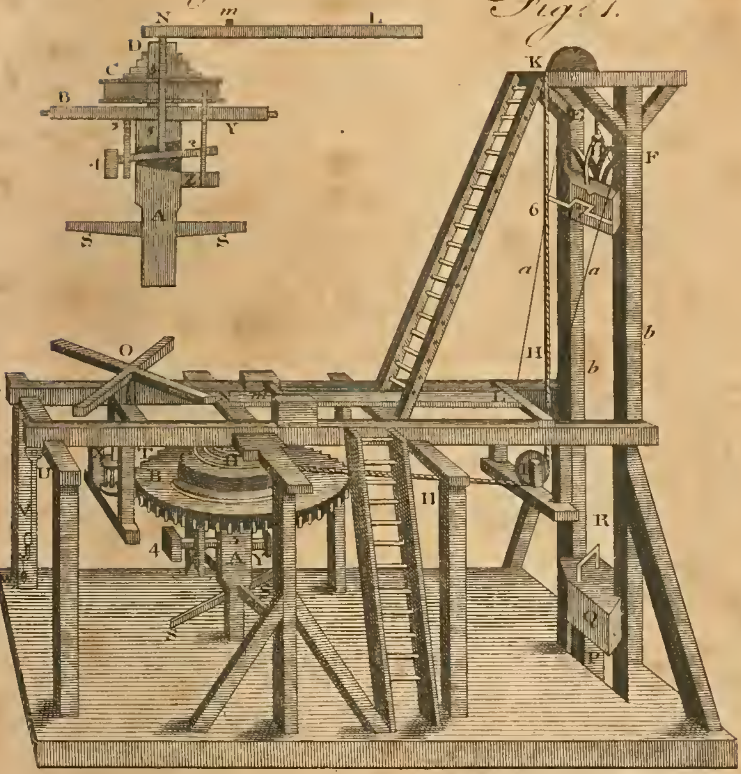


Fig. 1
C
I
L
F
H
K
A
B
S
M
R
P
E
O
N
D
Fig. 4
Fig. 2
A
B
E
O
N
Fig. 5
Fig. 3
Fig. 6
Fig. 7
B
A
A
B
C
D
D
E
E
C
Fig. 8
R
P
M
N
L
O
D
A
X
T
E
K
C
F
B
Q
I
G
V
H
Fig. 9
G
G
F
F
K
L
H
E
E
D
D
A
B
K
I

A. Bell Prin. Wal. Sculptor fecit.

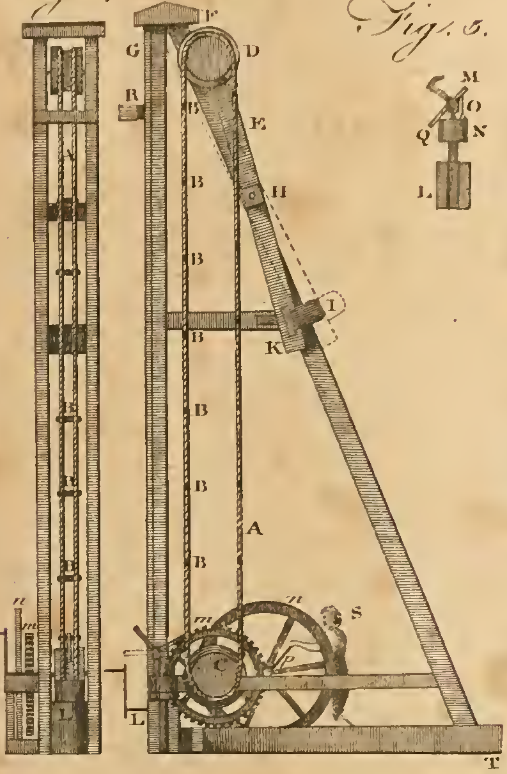
Vaulone's Pile Engine.

Fig. 2. Fig. 1.


N
m
L
D
C
B
Y
Z
A
S
S
K
E
F
6
a
a
H
b
b
O
7
U
T
B
G
H
R
Q
P
4
A
Y

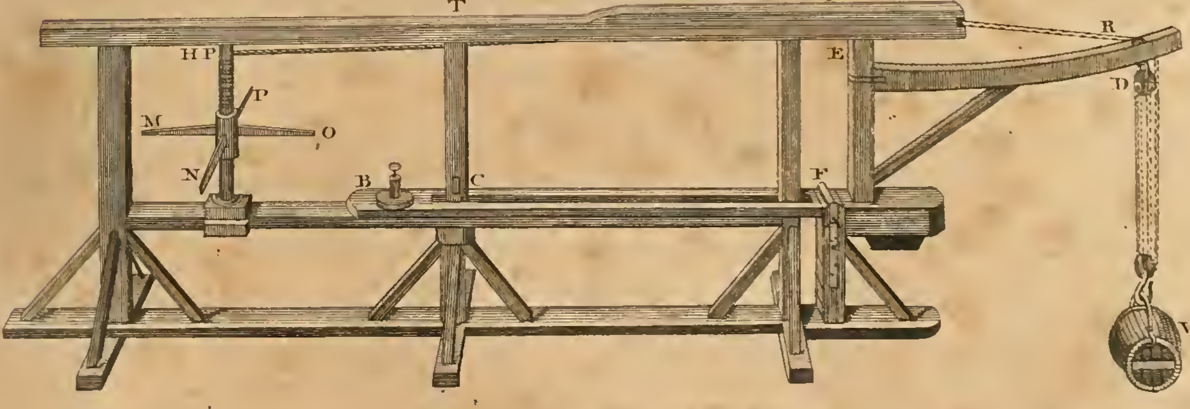
Bunce's Pile Engine.

Fig. 4. Fig. 3. Fig. 5.


F
G
D
R
B
E
H
I
K
A
n
m
S
C
p
L
T
M
O
Q
N
L
S
n
m

Andrew's Weighing Crane.

Fig. 6.


T
H P
P
M
O
N
B
C
F
E
R
D
W

A. Bell Prin. Wal. Sculptor fecit.

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 ſouthweſt; 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. 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."

3
Method uſed by Auguſtus to ſecure his power.

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.

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, bearing 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 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. 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. 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.

5
In natural hiſtory.

6
In architecture.

7
In the fine arts.

8
Latin medals of uſe to a poet.

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. 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 ſhewn by her holding a little image of

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 ſailing 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.

Entertainment from ſtudying them.

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."

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."

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 repreſentations 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 Grolierii, et amicorum.*

15 Number of cabinets

Contemporary 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 580 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

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(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.

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.

23
Corinthian braſs.

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 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.

27 Its firſt rude ſtate.

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.

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 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.

31 Moſt ancient Greek coins deſcribed.

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.

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, 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 15½ 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. Χελωνη, *the ſhell*, was the name of another coin, from its type. A Sicilian coin was named Δημαρετιον, from Gelon's wife. A tetradrachm was named Κεπταταγους, and had eight ευθυας or hemidrachms. The τροιζηνιον, 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."

34 Coins of Cyzicus.

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 Αρυανδικον 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.

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 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.

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 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.

42 Roman money.

In Rome, as well as in Greece, the money was at 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.

43 Of the Roman pound.

The weights made 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.

44 Seſtertius, as, &c.

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 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 λιρτα; 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.

46 Origin of the Sicilian coins.

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.

47 Of the moſt ancient Roman 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.

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 Jupiter

48 Subdiviſions of the as.

49 Larger denominations of it ſtruck.

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 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.

51 Coins on the Greek ſcale marked as Roman.

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 æræi, 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.

52 Of the ſeſtertius.

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 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

med *trichalcum*, 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. 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 of the lower empire. The principal coin of the lower empire was the follis, which was divided into an half and quarter, named ημιτοφολλιον 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."

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 62 Roman ſilver.

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 went 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 æræi* inſtead of the *ſeſtertii*. The *argenteus*, though reduced more than one third in ſize, contained ſix denarii æræi, 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* 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 $70\frac{8}{17}$ 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 ↆX or 60; the ↆ 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 ↆ 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 $17\frac{1}{2}$; 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 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;" *cruſinos,* 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, 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 *calatores*; 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. 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. "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 *blood ſtone*. 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."

75
Different kinds of this ruſt.

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. IROBUS, &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

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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 Harcarville. 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 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.

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82
Coins forged by excellent artiſts.

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

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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 hair ſtrokes 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.

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87
Letters the principal criterion of medals.

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.

88
Vico's account of falſe patina.

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."

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.

89
Medals caſt from the Paduan forgeries.

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 ſand-holes 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

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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 ſhews that at that time they had reverſes ready fabricated, to be applied as occaſion might require.

93 Plated medals, &c.

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.

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 BABYLONIS 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

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 Antichi*, 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.*

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.*

Purchaſe. 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 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.

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 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. In 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 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 medaliſts. 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

Arrangement, &c. 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. Arrangement, &c.

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.

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 friſe,	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.

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. IΔ 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 than

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(A) This appears on the early coins of Byzantium, with the legend BYZANTIN. ΣΩT. "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 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."

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.

Ancient Coins.

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 workmen.

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.

Ancient Coins.

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 theſe 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, Ancient Coins.

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 ærei 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.

Ancient Coins.

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 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.

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

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.

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 over-

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, OLAW. DEI GRA. ARCEP. NIDREN, 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 DILIGIT.—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$\frac{}{31}$; 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 *gold penny*, 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 two-pence, 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

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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 Croker 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 time 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.

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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 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 his 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.

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 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. Προτοι 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. Γνωριμον, 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, Iſthæa

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. Cephalœdis
ΚΙ. Cianus, Cibæum
ΚΙΛ. Cilbiani
ΚΛ. Clæonæ, Claudius
ΚΛΑ. Clazomene
ΚΝΙ. Cnidus
ΚΟ. Corinth
ΚΟΙΝ. Κοινον, Community
ΚΟΛ. Κολονιας, 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

Abbreviations.

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)

Y.

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.
ς. 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.	ϙ.	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 ſelix
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

Abbreviations.

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

Abbreviations.

M. M. I. V. Municipes Municipii Julii Uticenſis
MON. or MONET. Moneta

N.

N. Nepos or Noſter
N. C. Nobiliſſimus Cæſar
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. Poteſtate
PAC. ORB. TER. Pacatori Orbis Terrarum
PAPI. Papius or Papirius
PARTH. Parthicus
PERP. Perpetuus
PERT. or PERTIN. Pertinax
PESC. Peſcennius
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 Claſſis et Oræ Maritimæ
PRINC. IVVENT. Princeps Juventutis
PRIV. Privernum
PROC. Proconſul
PRON. Pronepos
PROP. Proprætor
PROQ. Proquæſtor
PROV. DEOR. Providentia Deorum
PVPIEN. Pupienus

Q

Q. Quintus, or Quæſtor
Q. C. M. P I. Quintus Cæcilius Metellus Pius Imperator
Q. DESIG. Quæſtor Deſignatus
Q. P. Quæſtor Prætorius
Q. PR. Quæſtor Provincialis

R.

R. ROMA, Reſtituit
RECEP. Receptis, or Receptus
REST. Reſtituti
ROM. ET AVG. Romæ et Auguſto
R. P. Reſpublica

S.

SAEC. AVR. Sæculum Aureum
SAEC. FEL. Sæculi Felicitas
SAL. Salus
SALL. Salluſtia
SARM. Sarmaticus
S. C. Senatus Conſulto
SCIP. ASIA. Scipio Aſiaticus
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, ſic Decennalia
SIG. Signis
S. M. Signata Moneta
S. P. Q. R. Senatus Populuſque 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 Poteſtate

V.

V. Quintum
V. C. Vir Clariſſimus
VESP. Veſpaſianus
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.

4

Abbreviations.

Abbreviations on the Exergue; from Bouduri and Monaldini. Pinkerton.

A. Officina Prima
ALE. Alexandria
AMB. Antiochenſis Moneta Secundæ Officinæ
AN. ANT. ANTI. Antiochia
ANB. Antiochiæ Secunda Officina: to ANH. Antiochiæ Octavia Officina
A. P. L. (In officina) Prima percuſſa 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) Siſciæ
B. SIRM. Secunda Sirmii
B. S. L. C. Secunda Signata Lugduni
C. Θ. Conſtantinopoli Nona
COMOB. Conflata Moneta Obryzo. Only on gold or ſilver from a gold die
CON. Conſtantinopoli
CONOB. Conflata Obryzo. Only on gold.
CONS. Conſtantinopoli
KART. Carthago
K. O. Carthaginenſis Officina
L. LC. LVC. LVG. Lucduni, Lugduni
L. LON. Londini
L. P. Lugdunenſis vel Londinenſis Pecunia
LVC. P. S. Lugduni Pecunia Signata
MDPS. Mediolani Pecunia Signata
M. K. V. T. Moneta Kartaginenſis Urbs (in officina) Tertia
M. L. Moneta Lugdunenſis vel Londinenſis
MOSTT. Moneta Officinæ Secundæ Treverorum
MSTR. Moneta Signata Treveris
Θ. Officina
OFF. III. CONST. Officina Tertia Conſtantinopoli
PARL. Percuſſa or Pecunia Arelate
PLON. Pecunia Londinenſis
PLVG. Pecunia Lugdunenſis
P. R. Pecunia Romana, or Percuſſa Romæ
P. T. Pecunia Treverenſis
Q. AR. Quincta Arelatenſis (officina)
R. RO. ROM. Romæ
RA. Ravennæ
ROPS. Romæ Pecunia Signata
S. AR. Signata Arelate
S. CONST. Signata Conſtantinopoli
SIS. Siſciæ
SS. P. Siſcienſis Pecunia
SISC. V. Siſcia 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. Teſſalonicæ Officina Secunda
THEOPO. Theopoli
TR. Treveris
TROB. Treveris Officina Secunda

A Liſt of Roman Colonies whoſe Coins remain; and Abbreviations on theſe Coins.

Abdera in Spain
Acci in Spain
Achulla in Africa
Ælia Capitolina in Judæa
Agrippina in Germany
Antiochia in Piſidia
———— in Syria
Apamea in Bithynia
Arna in Theſſaly
Aſtigi in Spain
Babba in Mauritania Tingitana
Berytus in Phœnicia
Bilbilis in Spain
Boſtra in Arabia
Bracara Auguſta in Spain
Buthrotum in Epirus
Cabellio in Gaul
Cæſar-Auguſta in Spain
Cæſarea in Paleſtine

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*

Abbreviations.

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, *Tréves 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*

Explanation of Plates.

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, *Cruana 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.

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

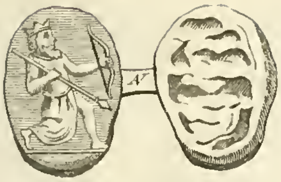
21. A penny of Robert the Great

22. An Iriſh penny

23. The

MEDALS. Plate CCCXXXI.

1.



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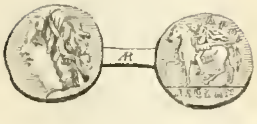

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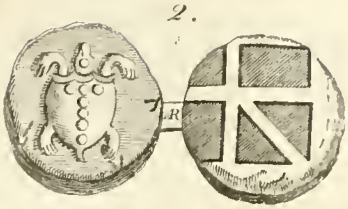

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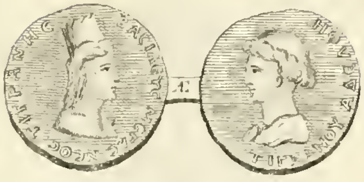

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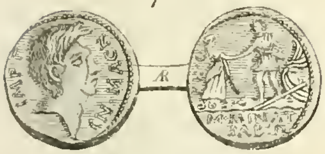

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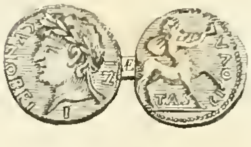

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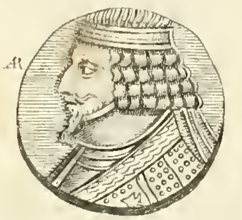

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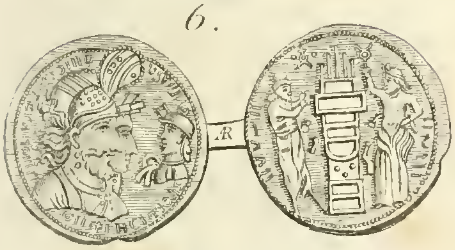

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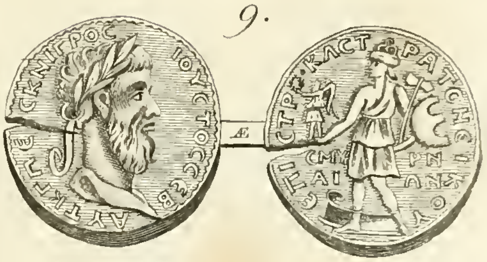
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ΕΠΙ ΣΤΡ ΚΑΣΤ ΠΑΤΡΩΝΟΣ
ΣΜΥΡΝΑΙΩΝ
Æ

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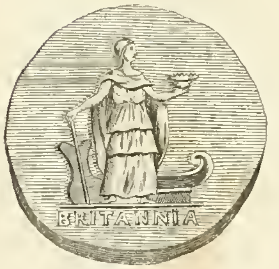

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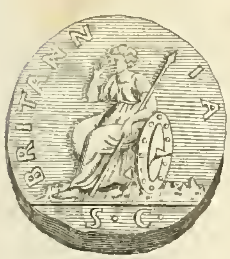
BRITANNIA
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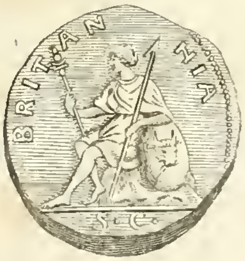
BRITANNIA
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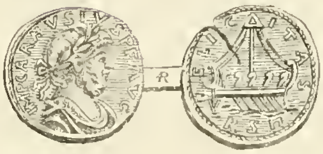
10.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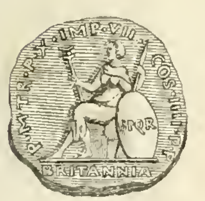
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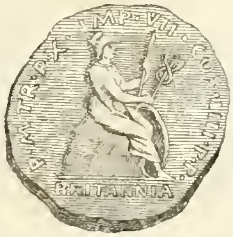
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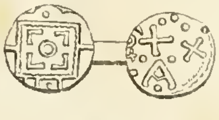

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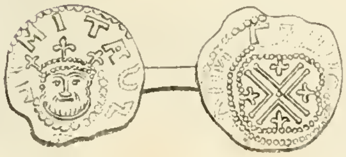

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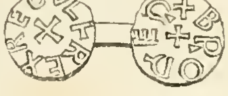

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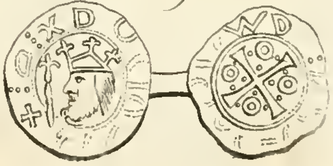

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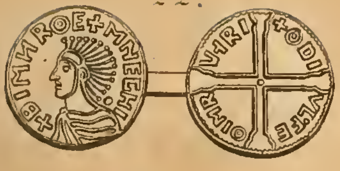
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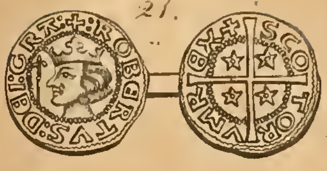
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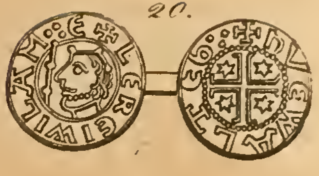
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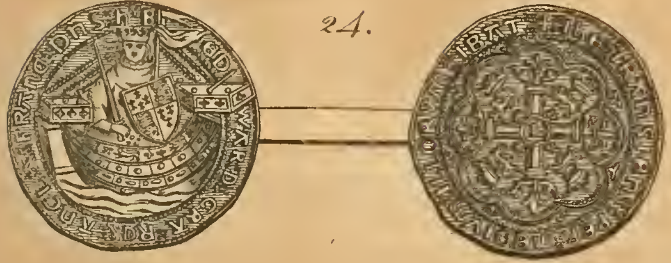
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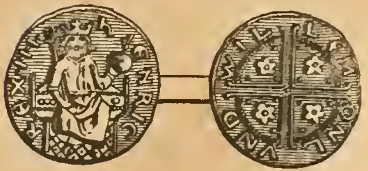
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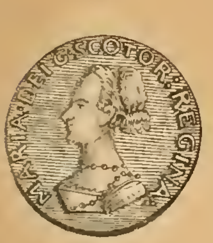
MARIA DEI G SCOTOR REGINA

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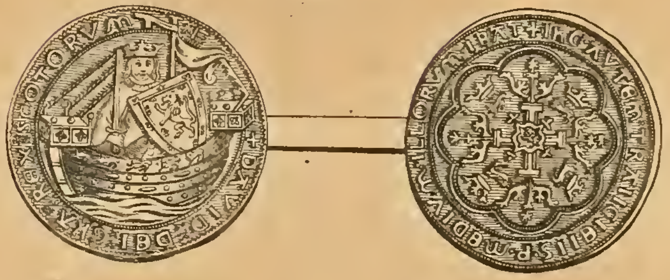
DAVID DEI GRA REX SCOTORVM
IHC AVTEM TRANSIENS PER MEDIVM ILLORVM IBAT

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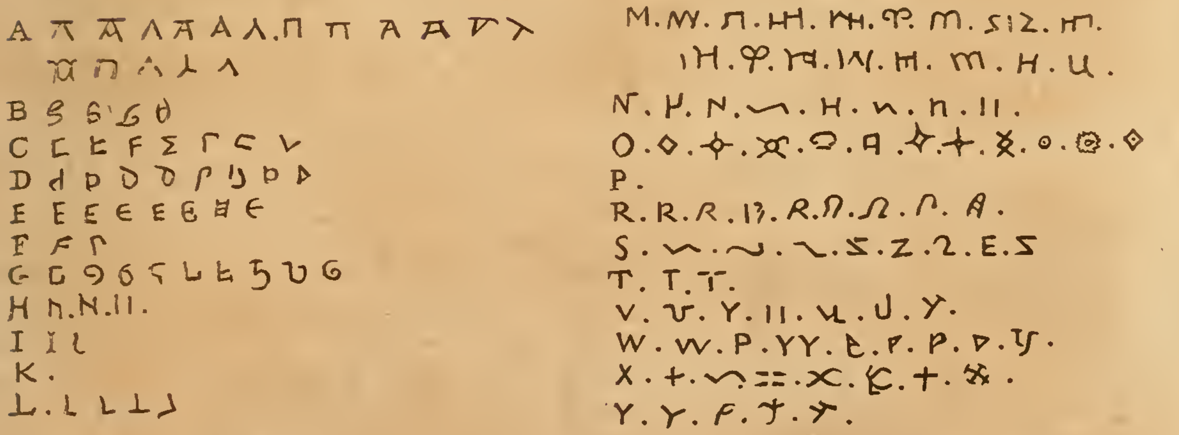
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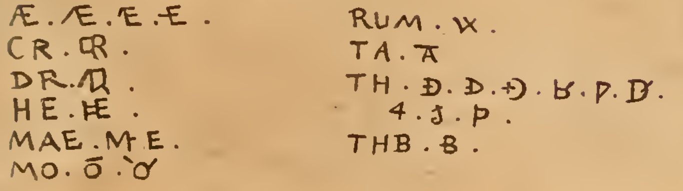
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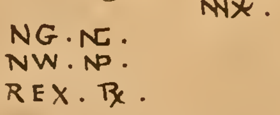

A. Bell Prin. Wal. Sculptor fecit.

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. Munetarius

Medallion.

Medallion ‖ Media.

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*.

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, Da-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.

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

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, 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.

10
His opinion of a criſis.

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.

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 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.

From excrementitious diſcharges.

Hippocrates alſo drew ſigns from all excrements, whatever they are, that are ſeparated from the body of man. His moſt remarkable prognoſtics, however, were from the urine. The patient's urine, in his opinion, is beſt when the ſediment is white, ſoft to the touch, and of an equal conſiſtence. If it continue ſo during the courſe of the diſtemper, and till the time of the criſis, the patient is in no danger, and will ſoon be well.

Urine.

This is what Hippocrates called *concocted urine*, or what denotes the concoction of the humours; and he obſerved, that this concoction of the urine ſeldom appeared thoroughly, but on the days of the criſis which happily put an end to the diſtemper. "We ought (ſaid Hippocrates) to compare the urine with the purulent matter which runs from ulcers. As the pus, which is white, and of the ſame quality with the ſediment of the urine we are now ſpeaking of, is a ſign that the ulcer is on the point of cloſing; ſo that which is clear, and of another colour than white, and of an ill ſmell, is a ſign that the ulcer is virulent, and in the ſame manner difficult to be cured: the urines that are like this we have deſcribed are only thoſe which may be named good; all the reſt are ill, and differ from one another only in the degrees of more and leſs. The firſt never appear but when nature has overcome the diſeaſe; and are a ſign of the concoction of humours, without which you cannot hope for a certain cure. On the contrary, the laſt are made as long as the crudity remains, and the humours continue unconcocted. Among the urines of this laſt ſort, the beſt are reddiſh, with a ſediment that is ſoft and of an equal conſiſtence; which denotes, that the diſeaſe will be ſomewhat tedious, but without danger. The worſt are thoſe which are very red, and at the ſame time clear and without ſediment; or that are muddy and troubled in the making. In urine there is often a ſort of cloud hanging in the veſſel in which it is received; the higher this riſes, or the farther diſtant it is from the bottom, or the more different from the colour of the laudable ſediment abovementioned, the more there is of crudity. That which is yellow, or of a ſandy colour, denotes abundance of bile; that which is black is the worſt, eſpecially if it has an ill ſmell, and is either altogether muddy or altogether clear. That whoſe ſediment is like large ground wheat, or little flakes or ſcales ſpread one upon another, or bran, preſages ill, eſpecially the laſt. The fat or oil that ſometimes ſwims upon the top of the urine, and appears in a form ſomething like a ſpider's web, is a ſign of a conſumption of the fleſh and ſolid parts. The making of a great quantity of urine is the ſign of a criſis, and ſometimes the quality of it ſhows how the bladder is affected. We muſt alſo obſerve, that Hippocrates compared the ſtate of the tongue with the urine; that is to ſay, when the tongue was yellow, and charged with bile, the urine he knew muſt of courſe be of the ſame colour; and when the tongue was red and moiſt, the urine was of its natural colour.

Fæces.

Among his prognoſtics from the excretions by ſtool are the following. Thoſe that are ſoft, yellowiſh, of ſome conſiſtence, and not of an extraordinary ill ſmell, that anſwer to the quantity of what is taken inwardly, and that are voided at the uſual hours, are the beſt of all. They ought alſo to be of a thicker conſiſtence when the diſtemper is near the criſis; and it ought to be taken for a good prognoſtic, when ſome worms, particularly the round and long, are evacuated at the ſame time with them. The prognoſis, however, may ſtill be favourable, though the matter excreted be thin and liquid, provided it make not too much noiſe in coming out, and the evacuation be not in a ſmall quantity nor too often; nor in ſo great abundance, nor ſo often, as to make the patient faint. All matter that is watery, white, of a pale green or red colour, or frothy and viſcous, is bad. That which is blackiſh, or of a livid hue, is the moſt pernicious. That which is pure black, and nothing elſe but a diſcharge of black bile, always prognoſticates very ill; this humour, from what part ſoever it comes, ſhowing the ill diſpoſition of the inteſtines. The matter that is of ſeveral different colours, denotes the length of the diſtemper; and, at the ſame time, that it may be of dangerous conſequence. Hippocrates places in the ſame claſs the matter that is bilious or yellow, and mixed with blood, or green and black, or like the dregs or ſcrapings of the guts. The ſtools that conſiſt of pure bile, or entirely of phlegm, he alſo looks upon to be very bad.

Matter ejected by vomiting ought to be mixed with bile and phlegm; where one of theſe humours only is obſerved, it is worſe. That which is black, livid, green, or of the colour of a leek, indicates alarming conſequences. The ſame is to be ſaid of that which ſmells very ill; and if at the ſame time it be livid, death is not far off. The vomiting of blood is very often a mortal ſymptom.

Expectoration.

The ſpittings which give eaſe in diſeaſes of the lungs and in pleuriſies, are thoſe 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 ſame colour, or are red, a great while after the beginning of the diſtemper, if they are ſalt and acrimonious, and cauſe violent coughings, they are not good. Spittings purely yellow are bad; and thoſe that are white, viſcous, and frothy, give no eaſe. Whiteneſs is a good ſign of concoction in regard to ſpittings; but they ought not at all to be viſcous, nor too thick, nor too clear. We may make the ſame judgment of the excrements of the noſe according to their concoction and crudity. Spittings that are black, green, and red, are of very bad conſequence. In inflammations of the lungs, thoſe that are mixed with bile and blood preſage well if they appear at the beginning, but are bad if they ariſe not about the ſeventh day. But the worſt ſign in theſe diſtempers is, when there is no expectoration at all, and the too great quantity of matter that is ready to be diſcharged this way makes a rattling in the breaſt. After ſpitting of blood, the diſcharge of purulent matter often follows, which brings on a conſumption, and at laſt death.

Sweat.

A kind good ſweat is that which ariſes on the day of the criſis, and is diſcharged in abundance all over the body, and at the ſame time from all parts of the body, and thus carries off the fever: A cold ſweat is alarming, eſpecially in acute fevers, for in others it is only a ſign of long continuance. When the patient ſweats no where but on the head and neck, it is a ſign that the diſeaſe will be long and dangerous. A gentle ſweat in ſome particular part, of the head and breaſt, for inſtance, gives no relief, but denotes the ſeat of the diſtemper, or the weakneſs of the part.

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 inflammatory 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 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 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 further, 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 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, 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.

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.

30 Praxagoras. The firſt phyſician of eminence who differed conſiderably in his practice from Hippocrates was 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.

31 Eraſiſtratus. Eraſiſtratus was a phyſician of great eminence, and flouriſhed in the time of Seleucus, one of the ſucceſſors of Alexander the Great. According to

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.

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 ἀρχιτεκτονικοι, 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. 34 Serapion. The diviſion into dogmatiſts and empirics had indeed ſubſiſted before; but about this time the latter party began to grow ſtrong, and to have cham-

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* See Anatomy, *Hiſt.*

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.

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 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.

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.

37 Themiſon. 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

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. 38 Theſſalus. 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 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 moſt ſkilful of all the methodic ſect, and he who put 39 Soranus. 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.

41 Galen. 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

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.

42 Oribaſius.

Oribaſius flouriſhed about the year 360, and was 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."

43 Ætius.

Ætius lived very near the end of the fifth, or in the 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.

47 Rhaſes.

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.

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 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.

48 College of Salernum.

49 Conſtantine.

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 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 time in Europe. Conſtantine the African flouriſhed there toward 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.

51 Sweating ſickneſs in England.

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 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.

52 Paracelſus.

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 from the Weſt Indies by the companions of Chriſtopher Columbus.

53 Appearance of the venereal diſeaſe.

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.

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.

55 Diſcovery of the circulation.

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.

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, 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 repairing 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.

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.

61
Proximate cauſe.

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.—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. 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. 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

63
Diſeaſes from age and ſex.

64
Diſeaſes from climate.

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.

65 Diſeaſes from accidents.

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.

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.

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. 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 abovementioned 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.

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

External Senſes.

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 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.

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.

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 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, 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, 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.

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.

83 Memory. 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.

84 Delirium. 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.

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,

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.

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 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 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.

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 inteſtines, and irritating them; any acrid matter infecting the blood, or much affecting the ſtomach and inteſtines; the irritation of any nerve, or of the brain itſelf, by an exoſtoſis, ſwelling, too great fulneſs of the veſſels, pain, vehement affections of the mind, ſudden evacuation, or poiſons admitted into the body. Frequently, however, the malady originates from ſlight cauſes, little known, and not eaſily obſerved.

Spaſm is both the cauſe and effect, and frequently conſtitutes the greateſt part, of many diſeaſes. It is often very difficult either to be known or cured; becauſe it is ſo multiform, and produces as many different ſymptoms as there are organs affected; of which it ſurpriſingly diſturbs, impedes, or increaſes the functions. It is a diſeaſe ſeated in the original ſtamina of the conſtitution; and neither to be removed by ſlight remedies, nor in a ſhort time.

94 Sleep. With regard to ſleep, its uſe is ſufficiently apparent from the effects which it produces in the body. It reſtores the powers both of mind and body when exhauſted by exerciſe, giving vigour to the one, and reſtoring its wonted alacrity to the other. It renders the muſcles again active and moveable, after they have become wearied, rigid, painful, and trembling by hard labour. It moderates the quickneſs of the pulſe, which uſually increaſes at night, and brings it back to its morning ſtandard. It ſeems alſo to aſſiſt the digeſtion of the aliment; leſſens both the ſecretions and excretions; and renders the fluids thicker than otherwiſe they would be, eſpecially in a body endowed with much ſenſibility or mobility. Hence ſleep is not only uſeful, but abſolutely neceſſary for preſerving life and health; and is a moſt excellent remedy both for alleviating, and totally removing, many diſeaſes.

Want of ſleep is hurtful in many different ways, eſpecially to the nervous ſyſtem. It renders the organs of ſenſe both external and internal, as well as thoſe of every kind of motion, unfit for performing their offices. Hence the ſenſations are either aboliſhed, or become imperfect or depraved; and hence imbecility of mind, defect of memory, a kind of delirium, mania itſelf, pain of the head, weakneſs of the joints, an imperfect or inordinate action of the vital organs, quickneſs of pulſe, heat, fever, depraved digeſtion, atrophy, leanneſs, and an increaſe or perturbation of the ſecretions and excretions.

Sleep may be prevented both in healthy and ſick people from various cauſes; ſuch as ſtrong light, noiſe, pain, anger, joy, grief, fear, anxiety, hunger, thirſt, vehement deſire, motion of the body, memory, imagination, intenſe thought, &c. On the other hand, ſleep is brought on by a ſlight impreſſion on the organs of ſenſe, or none at all; by the humming of bees, the noiſe of falling water, cold and inſipid diſcourſe; or laſtly, by ſuch an exerciſe of the memory as is neither too laborious nor diſturbing to the mind.—Too great an impulſe of the blood towards the head, ſuch as often happens in fevers, prevents ſleep; but a free and equal diſtribution of the blood through the whole body, eſpecially the extreme parts, frequently brings it on. Whatever weakens the body alſo favours ſleep; and hence various kinds of evacuations, the warm bath, fomentations, ſometimes heat itſelf, are uſeful for promoting it. It alſo comes on eaſily after taking food, or indulging venery; the violent ſenſation being then quieted, and the body itſelf ſomewhat weakened. Cold produces a deep ſleep of long continuance, not eaſily diſturbed, and often terminating in death. Laſtly, There are certain ſubſtances which, when applied to the body, not only do not excite the nervous ſyſtem, but plainly lay us aſleep, and render us unfit for ſenſation; of this kind are thoſe called *narcotics*, as opium and the like, among which alſo we may reckon wine taken in too great quantity. Laſtly, Watching itſelf is often the cauſe of ſleep; becauſe while a man is awake he always more or leſs exerciſes the organs of his body, by which the nervous influence is diminiſhed, and thus the more violently the body is exerciſed, in the ſame proportion is the perſon under a neceſſity of ſleeping.

Sleep is deficient in many diſeaſes; for there are few which do not excite pain, anxiety, or uneaſineſs, ſufficient to prevent the approach of ſleep, or to diſturb it. Fevers generally cauſe thoſe who labour under them to ſleep ill; as well on account of the uneaſineſs which accompanies this kind of diſeaſe, as by reaſon of the impetus of the blood towards the head being frequently increaſed; and likewiſe from the ſtomach being diſordered, loaded with meat, or diſtended with drink. Hence alſo we may ſee the reaſon why many hypochondriac and hyſteric patients ſleep ſo ill; becauſe they have a bad digeſtion, and their ſtomach is diſpoſed to receive many though frequently ſlight diſorders; the ſlighteſt of which, however, is ſufficient to deprive the patient of reſt, provided the body be already irritable, and endowed with too great a ſhare of mobility.

Want of ſleep will hurt in diſeaſes as well as in health; and for the ſame reaſon; but in a greater degree, and more quickly, in the former than in the latter; and is therefore not only a very troubleſome ſymptom of itſelf, but often produces other very dangerous ones.

Too much ſleep, on the other hand, produces many miſchiefs, rendering the whole body languid, torpid, and lazy; and it even almoſt takes away the judgement. It alſo diſturbs the circulation, and diminiſhes moſt of the ſecretions and excretions. Hence plethora, fatneſs, flaccidity, and an inability for the common offices of life.—The cauſes of this exceſs are, either the uſual cauſes of ſleep above mentioned increaſed beyond meaſure, or ſome fault in the brain, or a compreſſion of it by an extravaſation of the humours; or ſometimes, as it would ſeem, from great debility produced by an unuſual cauſe, as in thoſe who are recovering from typhous fevers and other diſeaſes. In theſe examples, however, this exceſs of ſleep is by no means hurtful; nor even, perhaps, in thoſe caſes where an exceſs of grief continued for a long time, or a great fright, have produced a ſurpriſing and unexpected ſomnolency. Laſtly, Many people have accuſtomed themſelves, and that not without a great deal of hurt to their conſtitutions, to ſleep too much. Nor are there examples wanting of ſome who have paſſed whole days, and even months, in ſleep almoſt uninterrupted.

95 Circulation. With regard to the manner in which the circulation of the blood is performed, and the various principles of which it is compoſed, ſee the articles BLOOD, and ANATOMY. As for the diſorders to which the blood and its circulation are ſubject, it has been obſerved,

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.

95
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 ſmartly, and excites them alſo to ſudden and violent contractions.

A hard pulſe therefore denotes too great an action of the heart and arteries. It may ariſe from various cauſes: in the firſt place, from too great a tenſion of the veſſels; for inſtance, from their being too full, and by that means more prone to motion, and the more fit for receiving violent motions. It may ariſe alſo from too great a denſity and firmneſs of the ſolids; and hence it is moſt frequent in cold countries, among ſtrong robuſt people, and ſuch as are accuſtomed to hard labour. It may likewiſe ariſe from various cauſes irritating the whole nervous ſyſtem, or only the heart and arteries. Laſtly, It accompanies many fevers, as well as moſt inflammatory diſorders, whether the inflammation ariſes from a general ſtimulus applied to the whole body, or from the irritation of particular parts, by degrees extended over the whole body. In ſuch a ſtate of the circulation, the patient frequently ſtands in need of blood-letting, and almoſt always bears it well.

A ſmall, weak, and ſoft pulſe is generally owing to cauſes oppoſite to the former, and indicates a contrary ſtate of the circulation and nervous ſyſtem. It frequently requires ſtimulants; nor does it generally require blood-letting, or eaſily bear it. Sometimes, however, a pulſe of this kind is obſerved even in the caſe of a dangerous inflammation, of the ſtomach for inſtance, or inteſtines. But in theſe and the like examples we ought to attend to the nature of the malady, much more than to the ſtate of the pulſe.

The pulſe is ſaid to intermit, when the ſtroke does not return after the uſual interval, and perhaps not till after twice, thrice, or four times the uſual ſpace. A pulſe of this kind ſeems to be almoſt natural and conſtant in ſome animals, and is common to ſome men even in the moſt perfect health; and if theſe happen to be ſeized with a fever, the pulſe ſometimes becomes regular, nor can the diſeaſe be removed before the intermiſſion has returned.

Moreover, in ſome people, though their pulſe beats equally while in health, yet the ſlighteſt illneſs makes it intermit; and in others, eſpecially thoſe who have a great deal of mobility in their conſtitution, ſuch as hypochondriac and hyſteric people, the intermiſſion of the pulſe is felt, without applying the finger to the artery, merely by the uneaſineſs which they perceive in their breaſts during thoſe intervals in which the pulſe is deficient. An intermittent pulſe likewiſe occurs in many diſeaſes of the breaſt, eſpecially when water is collected in it; and the like happens in the end of all diſeaſes, eſpecially fevers, when the ſtrength is nearly exhauſted, and death approaches, of which it is frequently the forerunner.

An intermitting pulſe therefore ſeems to ariſe from an unequal influx of the nervous power into the heart, or from the decay and exhauſtion of the nervous power, by which means the heart is not able to contract till it has been diſtended beyond its due pitch. Or laſtly, It may ariſe from diſeaſes of the organ itſelf, or the neighbouring parts; from ſwellings, water, &c. preſſing upon them, and impeding the action of the heart: which indeed is a very dangerous diſorder, and almoſt always mortal.

Many other variations of the pulſe are enumerated by phyſicians, but moſt of them are uncertain, and not confirmed by experience. We ſhall therefore now conſider the motion of the blood, which may be either too great, too ſmall, or irregular.

A quick pulſe, *cæteris paribus*, produces a more rapid circulation, becauſe the ſooner that the ventricle of the heart is emptied, the more quickly is the blood thrown into the arteries; and their actions muſt anſwer to this ſtronger ſtimulus. Hence exerciſe, heat, ſtimulants, plethora, every kind of irritation, paſſions of the mind, and fever, increaſe the circulation. The effect of this increaſe is a diſtention of the veſſels, a ſtimulus applied to the whole body, an increaſe of heat, and often a debility. The ſecretion of ſweat is increaſed while the other ſecretions are diminiſhed, and the various functions of the body impeded; thirſt comes on, the appetite is loſt, the fat conſumed, and a diſpoſition to putreſcency introduced. Sometimes the ſmaller veſſels are burſt; whence effuſions of blood and hæmorrhages. But we are by no means to forget, that this violent motion of the blood, however hurtful it may ſeem, is among the beſt remedies made uſe of by nature in curing many diſeaſes.

The motion of the blood is diminiſhed, eſpecially by debility, torpor, the want of irritation or of exerciſe: the ſame thing happens to all the fluids, if there be any obſtruction in the veſſels, or any cauſe by which their return is hindered or rendered more difficult. Thus, from the very weight of the blood itſelf, if a perſon has ſtood long on his feet, the humours return more ſlowly from the inferior extremities. Any diſeaſe of the heart and arteries alſo, as an aneuriſm, contraction, oſſification, muſt neceſſarily obſtruct the circulation. The ſame thing happens from obſtructions of the veins, or interrupted reſpiration, by which the paſſage of the blood through the lungs to the left ſide of the heart is impeded.

But, from whatever cauſes this diminution of the circulation takes place, the bad conſequences are perceived chiefly in the veins, becauſe in them the blood always moves more ſlowly than in the arteries. Hence varices, and congeſtions of blood, eſpecially in thoſe parts of the body where the veins are deſtitute of valves, and of conſequence where the motion of the muſcles cannot aſſiſt the circulation. Hence alſo ariſe dropſies from an impeded or languid motion of the blood; becauſe the reſiſtance of the veins being increaſed, the blood is received into them with the greater difficulty, and more of the thin humour is driven into the exhaling veſſels, and by them depoſited in ſuch quantities as cannot be reabſorbed by the lymphatics. Theſe diſeaſes, as well as all others proceeding from defects of the circulation, are alſo more difficult of cure than others, becauſe all the vital powers are weakened at the ſame time.

Another diſorder 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 diſtribution of the vital fluid frequently ariſes from a ſtimulus applied to the part itſelf, or to the brain, or at length acting on the mind, which, according to the laws of ſympathy, produces a certain definite diſtribution of the blood. It ariſes alſo not unfrequently from a ſpaſm taking place in ſome other parts, which drives the blood out of its ordinary courſe.

In proportion to this irregularity of the circulation are the conſequences; heat, ſwelling, redneſs, inflammation, rupture of veſſels, hæmorrhages, effuſions, deſtruction, corruption, and ſuppuration of the cellular texture and adjoining parts, &c. Even this evil, however, nature often converts into an excellent remedy; and phyſicians, following her ſteps, frequently attempt to direct the diſtribution of the blood in particular diſeaſes, well knowing that a change in the diſtribution of the blood is frequently efficacious either for radically curing ſome diſeaſes, or relieving their moſt urgent ſymptoms.

97
Palpitation.

Laſtly, Some diſorders in the motion of the heart itſelf, and thoſe of no ſmall conſequence, remain yet to be taken notice of, namely, palpitation and ſyncope. A palpitation is a violent and irregular action of the heart, ſuch as for the moſt part is perceived by the patient himſelf, and that not without a great deal of uneaſineſs and oppreſſion at his breaſt; and it is alſo manifeſt to the by-ſtanders, if they apply their hands, or look at his naked breaſt; the pulſe of the arteries in the mean time being weak, unequal, and intermittent. This is a ſpaſmodic diſorder; and is induced by various cauſes affecting either the nervous ſyſtem in general, or the heart in particular. Every diſeaſe of the organ itſelf, ſuch as a conſtriction of its valves and blood-veſſels, an oſſification, enlargement, or polypus, hindering the free action of the heart, and evacuation of blood from it, are capable of exciting it to violent and unuſual contractions. The ſame effect will alſo follow plethora, or too violent an impulſe of the blood. The heart will likewiſe frequently palpitate from a violent excitement of the nervous ſyſtem, eſpecially where the conſtitution is endowed with a great deal of mobility. Hence palpitations ariſe from any affection of the mind, and in hyſteric women. Palpitation may likewiſe ariſe from an affection of the ſtomach, occaſioned by worms, a ſurfeit, flatus, or ſtimulation by various acrid ſubſtances. It frequently alſo accompanies the gout when repelled, or even when a fit is coming on. Sometimes it ariſes from debility, whatever may be the cauſe; frequently from any difficulty in breathing; and many of theſe cauſes may be joined at the ſame time, or ſome of them produce others.

Hence we may ſee why the evil is ſometimes ſlight and of ſhort continuance; at other times altogether incurable, and certainly mortal in a longer or ſhorter time; why it ſometimes returns at intervals, often coming on and being increaſed by every kind of irritation and exerciſe, and ſometimes relieved or totally removed by ſtimulants or exerciſe.

98
Syncope.

A ſyncope takes place when the action of the heart, and along with it that of the arteries, is ſuddenly and very much leſſened; whence the animal powers, the ſenſes, and voluntary motions, immediately ceaſe. This may be produced by almoſt all the cauſes of palpitation; becauſe whatever can diſturb and diſorder the motion of the heart, may alſo weaken or ſuſpend it. The vitiated ſtructure of the heart itſelf therefore, violent paſſions of the mind, whether of the depreſſing kind, or thoſe which ſuddenly and vehemently excite, various kinds of nervous diſeaſes, thoſe of the ſtomach, every kind of debility and evacuation, eſpecially a great loſs of blood, exceſſive and unremitting labour, long watching, heat, pain, many kinds of poiſons, &c. produce fainting.

Hence we ſee, 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, alſo tends to refreſh, and to prevent the perſon from fainting. Hence alſo we ſee how the mere poſture of the body may either bring on or keep off fainting, or remove it after it has already come on. We likewiſe ſee how this diſorder may ſometimes be of little conſequence and eaſily removed; at others very dangerous, not only as a ſymptom, but even of itſelf, as ſometimes terminating in death; and laſtly, how it may be uſed as a remedy by a ſkilful phyſician, and artificially induced, either to free the patient from violent pain, or to ſtop an immoderate effuſion of blood ſcarce to be reſtrained by any other method.

99
Buff-coloured cruſt on the blood.

With regard to the diſorders of the blood itſelf, the glutinous part of it, or, more properly, its fibrine ſeparated from the red particles, produces that buff-coloured appearance often ſeen upon blood drawn from people afflicted with inflammatory diſorders, and even ſometimes when no ſuch diſeaſes are preſent. This cruſt indeed is nothing elſe than the fibrine of the blood taking longer time than uſual to coagulate, by which means the red particles have an opportunity of falling to the bottom. This indicates no lentor, denſity, thickneſs, or tenacity of the blood, as was formerly thought; but rather its thinneſs, or at leaſt a leſs tendency in it to coagulate. It ariſes for the moſt part from a violent agitation and conquaſſation of the blood within the body; and hence it accompanies many fevers, all inflammations, ſometimes hæmorrhages, exanthemata, plethora, pain, and many irritations. It muſt, however, be allowed, that in ſeveral of theſe diſeaſes it is rendered highly probable at leaſt, from experiments apparently accurate, that the quantity of the fibrine of the blood is really increaſed in the proportion which it bears to the other parts. This cruſt, however, is not always to be accounted morbid, as it often happens to the moſt healthy; and may even be produced or deſtroyed by the ſlighteſt cauſes while the blood is running from the vein, ſo that frequently we ſhall ſee a very thick and tenacious cruſt 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 cruſt ſhows, that the patient will bear blood-letting well, though thoſe have been in a great miſtake who have directed this operation to be repeated till no more cruſt appeared on the blood.

The coagulable part of the blood alſo frequently produces thoſe maſſes called *polypi*, which ſometimes take place during life, but more frequently after death, in the large veſſels near the heart, or even in the cavities of that organ. Similar maſſes alſo 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 aſcertained. Many diſeaſes, however, may ariſe from its being either too ſcanty or too abundant. Too great a quantity of blood is produced by the uſe of rich, nouriſhing diet, ſtrong drink, accompanied with a good digeſtion; from a lazy, ſedentary life, or much ſleep, eſpecially 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

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 acid 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 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.

108 Digeſtion. 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. The firſt of theſe are ſometimes very troubleſome, though ſeldom dangerous. The principal ſymptoms are oppreſſion, anxiety, pain at the ſtomach; eructations, 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.

109 Coſtiveneſs. 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.

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. 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

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, 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.

120 Strangury. 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.

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 treatting, 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.
2. Febres.
3. Phlegmaſiæ.
4. Spaſmi.
5. Anhelationes.
6. Debilitates.
7. Dolores.
8. Veſaniæ.
9. Fluxus.
10. Cachexiæ.

The Claſſes of Linnæus are,

1. Exanthematici.
2. Critici.
3. Phlogiſtici.
4. Doloroſi.
5. Mentales.
6. Quietales.
7. Motorii.
8. Suppreſſorii.
9. Evacuatorii.
10. Deformes.
11. Vitia.

The Claſſes of Vogel are,

1. Febres.
2. Profluvia.
3. Epiſcheſes.
4. Dolores.
5. Spaſmi.
6. Adynamiæ.
7. Hyperæſtheſes.
8. Cachexiæ.
9. Paranoiæ.
10. Vitia.
11. Deformitates.

The Claſſes of Sagar are,

1. Vitia.
2. Palgæ.
3. Cachexiæ.
4. Dolores.
5. Fluxus.
6. Suppreſſiones.
7. Spaſmi.
8. Anhelationes.
9. Debilitates.
10. Exanthemata.
11. Phlegmaſiæ.
12. Febres.
13. Veſaniæ.

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.

Cullen's *Arrangement.*

Ge: Arrange-ment of Diſea

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 efloreſcence 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, returning 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 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 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 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 ſmallpox, 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*.

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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 diminutien 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,

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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 wearineſs 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.

General Arrangement of Diſeaſes.

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 (*venenata*), 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

General Arrangement of Diſeaſes.

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.

General Arrangement of Diſeaſes.

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 according to the change perceived in the objects, and according to the remote cauſe.

Genus XCV. Dyſecœa. A diminution or total abolition of the ſenſe of hearing. The ſpecies are,

1. Dyſecœa (*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. Dyſecœa (*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 (*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, General Arrangement of Diſeaſe.

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 ſlow, 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.

General Arrangement of Diſeaſes.

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 *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.

126 (Tertiana legitima, *Senert. Hoffm. Cleghorn*, Minorc. *Sauv.* Sp. I.)

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.

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 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.

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; 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.

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 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.

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,

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ſolution, which he has found very ſucceſsful in affections of this kind, and which is probably very nearly the ſame with the taſteleſs 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, bloodletting, 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 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.

Tertiana.

"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

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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."

Tertiana.

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 fit was over, he complained of a moſt torturing pain of the bowels. His tongue was generally moiſt, and he had a ſuppreſſion of urine.—This formidable diſeaſe, however, was totally ſubdued by the uſe of cinchona, mercurials, antiſpaſmodics, opiates, and ſaline draughts.

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. *Valcſ. 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 abovementioned powder.

137 The TERTIAN *varied* from its *Origin.* Sp. I. var. 5.
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.

138 Remittent tertian.

The TERTIAN with only a *remiſſion* between the fits. Sp. II.
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 perniciofæ 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.

Tertiana.

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 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.

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. 14

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 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 portholes 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 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 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, 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. Lancifius, 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.

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 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 of all ages; namely, from robuſt adults, 10 or 12 ounces; from others a ſmaller quantity, in proportion to their ſtrength and years. And farther, 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.

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 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 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.

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 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 preſerved by the times of acceſſion; that is, the time of the fourth paroxyſm's coming on anſwers to that of the firſt, the fifth to the ſecond, the ſixth to the third, &c.

The QUARTAN, accompanied with *Symptoms* of other diſeaſes. Sp. I. var. 2.

157 Quartana cataleptica, *Sauv.* ſp. 7. *Bonet.* polyalth. vol. i. p. 805.
Quartana comatoſa, *Sauv.* ſp. 15. *Werholf.* de febr. *C. Piſonis* Obſerv. de morbis à colluvie ſeroſ. obſ. 166, 167, 168, 169, 171, 172. 173, 174.
Quartana epileptica, *Sauv.* ſp. 8. *Scholzii* Conſ. 379, 380.
Quartana hyſterica, *Sauv.* ſp. 10. *Morton*, Pyret. exerc. 1. cap. ix. H. 10, 11.
Quartana nephralgica, *Sauv.* ſp. 9.
Quartana metaſtatica, *Sauv.* ſp. 17.
Quartana amens, *Sauv.* ſp. 12. *Sydenham* de morb. acut. cap. v.
Quartana ſplenetica, *Sauv.* ſp. 2. *Etmuller*, Coll. conſult. caſ. 25.

The QUARTAN *complicated* with other *Diſeaſes*. Sp. I. var. 3.

158 Quartana ſyphilitica, *Sauv.* ſp. 6. *Plateri*, obſerv. L. III. p. 676. Edin. Eſſ. art. xlvii. obſ. 8.
Quartana arthriticia, *Sauv.* ſp. 11. *Muſgr. de Arthr.* ſympt. cap. ix. H. 4. et 5.
Arthritis febriſequa, *Sauv.* ſp. 10.
Arthritis febricoſa, *Sauv.* ſp. 10. *Werlhof.* de febr. *Cockburn* de morbis navigantium, obſ. 19.
Quartana ſcorbutica, *Sauv.* ſp. 14. *Barthol.* de med. Dan. diſſ. iv. *Tim.* L. VIII. caſ. 18.

The *Remitting* QUARTAN. Sp. II.

159 Tetartophya, *Sauv.* gen. 85. *Sag.* 699. *Lin.* 21.
Quartana remittens auctorum.

Var. 1. Tetartophya ſimplex, *Sauv.* ſp. 1.
2. Amphimerina ſemiquartana, *Sauv.* ſp. 23.
3. Tetartophya ſemitertiana, *Sauv.* ſp. 5.
4. Tetartophya maligna, *Sauv.* ſp. 6. *Lautter.* Hiſt. med. caſ. 21. *M. Donat.* L. III. cap. 14. ex *M. Gatenaria Horſt.* L. I. obſ. 15.
5. Tetartophya carotica *Sauv.* ſp. 4. *Werlhof.* de febr. *Bianchi* Hiſt. hep. pars III. conſt. ann. 1718, p. 751.
6. Tetartophya ſplenalgica, *Sauv.* ſp. 2.
7. Tetartophya hepatalgica, *Sauv.* 3. *Car. Piſ.* in prefat. p. 33.
8. Amphimerina ſpaſmodica, *Sauv.* ſp. 16.

To the tertian or quartan fevers alſo belong the *Erraticæ* of authors. As all thoſe above mentioned differ only in the ſlight circumſtance of the type from the intermitting and remitting tertians already deſcribed at length, it is unneceſſary here to take up time in deſcribing every minute circumſtance related by phyſicians concerning them, eſpecially as it could contribute nothing towards the laying down a better method of cure than what hath been already ſuggeſted.

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 ſimplex, *Sauv.* ſp. 1. 160
Quotidiana legitima, *Sennert.* de febr. cap. 18.

Deſcription. This kind of fever generally comes on about ſix or ſeven o'clock in the morning, beginning with a conſiderable degree of cold and ſhivering, which laſts for about an hour; and is often accompanied with vomiting or ſpontaneous diarrhœa, or both. It is ſucceeded by a pretty ſtrong heat, accompanied with thirſt, reſtleſſneſs, and pain of the head. When the heat abates a little, a ſpontaneous ſweat commonly follows, and the whole paroxyſm rarely exceeds ſix hours. It returns, however, every day almoſt always at the ſame hour, unleſs it be evidently diſturbed.

Cauſes of, and perſons ſubject to, the diſeaſe. The ſame general cauſes are to be aſſigned for the quotidian as for other intermittents. This kind occurs but rarely; and is ſaid to attack people of a phlegmatic temperament rather than any other: alſo old people rather than young, and women rather than men.

The prognoſis and method of cure are not different from thoſe of tertians and quartans.

The *Partial* QUOTIDIAN. Sp. I. var. 1. B.

Quotidiana partialis, *Sauv.* ſp. 16. *Cnoffel*, E. N. C. D. I. A. III. obſ. 205. Edin. Med. Eſſ. vol. i. art. 31. vol. ii. art. 16. 161
Quotidiana cephalalgica, *Sauv.* ſp. 6. *Mort.* pyretol. exerc. i. hiſt. 27. *Van Swieten in Boerh.* p. 534.
Cephalalgia intermittens, *Sauv.* ſp. 7.
Cephalæa febricoſa, *Sauv.* ſp. 4.
Quotidiana ophthalmica, *Morton*, ibid. hiſt. 17. *Van Swieten*, ibid.
Ophthalmia febricoſa, *Sauv.* ſp. 23.

Theſe diſtempers attack only ſome particular part of the body, as the head, the eye, arm, &c. producing periodical affections of thoſe parts returning once in 24 hours; they are to be cured by cinchona, as other intermittents. They are known to belong to this claſs, by the evident intermiſſion of the pain or other affection of the part. The *quotidiana hyſterica*, *Sauv.* ſp. 3. *quotidiana catarrhalis*, *Sauv.* ſp. 9. and *quotidiana ſtranguríoſa*, *Sauv.* ſp. 11. ſeem to be ſymptomatic diſorders.

The *Remitting* QUOTIDIAN. Sp. II.

Amphimerina, *Sauv.* gen. 84. *Lin.* 20. 162
Quotidiana continua, *Vog.* 15.
Quotidianæ remittentes et continuæ auctorum.
Amphimerina latica, *Sauv.* ſp. 1.
Febris continua lymphatica, *Etmuller*, Coll. conſ. caſ. 32. *River.* Obſ. cent. 1. obſ. 57.
Amphimerina ſingultuoſa, *Sauv.* ſp. 14.
Febris continua Lyngodes, *Vog.* 26.

Concerning theſe alſo nothing remains neceſſary to be mentioned in this place, having already ſo fully diſcuſſed the remitting fevers in all the different parts of the world. Many other varieties of theſe fevers mentioned by different authors are to be accounted merely ſymptomatic.

Sect. II. CONTINUED FEVERS.

Continuæ, *Sauv.* claſs ii. ord. 1. *Vog.* claſs i. ord. 2. *Sag.* 666. *Boerh.* 727.
Continentes, *Lin.* claſs ii. ord. 1. *Stahl.* Caſ. mag. 35. Caſ. min. 87. *Junck.* 58. *Sennert.* de febr. L. ii. cap. 2. et 10.

Genus IV. SYNOCHA.

363 Synocha, *Sauv.* gen. 80. *Lin.* 12. *Junck.* 58.
Synocha, ſive febris acuta ſanguinea, *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.

Deſcription. The moſt ſimple kind of ſynocha is the ephemera or diary fever. It begins without any ſenſation of cold or ſhivering, unleſs there be ſome internal inflammation, or the ſmall-pox or meaſles happen to be preſent. A continual heat without any intermiſſion conſtitutes the eſſence of this diſeaſe. The heat, however, is more tolerable than in the ſynocha properly ſo called. In ſome, the pains of the head are pungent and throbbing, anſwering to the pulſations of the arteries; but in others they are dull and heavy. The face is red and bloated; and there is a remarkable laſſitude of the limbs, with a ſtrong, full, and frequent pulſe. The urine is red, and depoſits a ſediment almoſt of the colour of orange-peel; and in the very firſt day of the diſeaſe, ſigns of concoction (according to the Hippocratic phraſe) appear. The fever commonly goes off with a gentle ſweat; but ſometimes, though more rarely, with a hemorrhagy by the noſe. Its ſhorteſt period is 24 hours; but if it goes beyond the fourth day, it is then a *ſynocha* properly ſo called.

The ſimple ſynocha, according to Vogel, begins with cold and ſhivering, ſucceeded by vehement heat, redneſs, and dryneſs of the ſkin. The face, eſpecially, is very red, and the thirſt intenſe. The head is either pained or heavy. The patient either doth not ſleep at all, or is diſturbed with dreams. A moiſt ſweat then breaks out all over the ſkin. The pulſe is full, quick, and frequent: the judgement is ſometimes a little diſturbed; young people are apt to be terrified with imaginations; and they for the moſt part incline to ſleep: the reſpiration is difficult, and the belly coſtive; at the ſame time that a tenſive kind of laſſitude is perceived over the whole body. A complete criſis takes place either on the fourth or at the fartheſt on the eleventh day. The characteriſtic marks of the ſimple ſynocha, therefore, are, A redneſs of the face, moiſture of the ſkin, a ſtrong and frequent pulſe.

Cauſes of, and perſons ſubject to, this diſeaſe. As we have already remarked of intermittents, ſo muſt we alſo now remark of continued fevers, that it is impoſſible to diſcover thoſe minute cauſes which occaſion the difference of type betwixt one inflammatory fever and another, though moſt authors pretend to enumerate theſe with great certainty. Thus Juncker tells us, that the cauſe of the ſimple ephemera is plethora, together with any immoderate agitation and commotion of the fluids while in that ſtate. Vogel reckons among the cauſes of his *febris diaria*, paſſions of the mind, pain, want, expoſure to the ſun, &c.; a repulſion or abſorption of certain humours; wounds, fractures, luxations, &c.; ſo that in general we may reckon every thing tending to increaſe the action of the arterial ſyſtem to be in certain circumſtances a cauſe of inflammatory fever.—Hence we find thoſe are moſt ſubject to the ſynocha whoſe conſtitution is either naturally robuſt, or who are expoſed to thoſe cauſes which tend to produce an increaſed action of the arterial ſyſtem; ſuch as hard labour, high living, &c.

Prognoſis. The moſt ſimple kind of ſynocha, that is, the ephemera or diary fever, is commonly cured without the aſſiſtance of medicine, and therefore the prognoſis is for the moſt part favourable: yet, if it be improperly treated by heating medicines, it may eaſily be converted into the other kind; or, if there be a putrid diſpoſition of the fluids, into a fever of a very dangerous nature. The ſame thing is to be underſtood even of the moſt violent kind; for ſimple inflammatory fevers are not dangerous unleſs complicated with an affection of ſome particular part, as the pleura, ſtomach, &c.

Cure. Dr Cullen objects to the plan of thoſe who are for leaving the cure of continued fevers to the operations of nature; becauſe theſe operations are neither certain in themſelves, nor are they ſo well underſtood as to enable us to regulate them properly; and it is likewiſe poſſible to ſuperſede 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 theſe he reduces to three. 1. To moderate the violence of re-action.—2. To remove or obviate the cauſes of debility; and, 3. To obviate or correct the tendency of the fluids to putrefaction.

The *firſt* indication may be anſwered, 1. By all thoſe means which diminiſh the action of the heart and arteries. 2. By thoſe which take off the ſpaſm of the extreme veſſels, which, according to his theory, is the chief cauſe of violent re-action.

I. The action of the heart and arteries may be diminiſhed, 1. By avoiding or moderating thoſe irritations which, in one degree or other, are almoſt conſtantly applied to the body. 2. By the uſe of certain ſedative powers. 3. By diminiſhing the tenſion or tone of the arterial ſyſtem.

[1.] The irritations above-mentioned are the impreſſions made upon our ſenſes, the exerciſe of the body and mind, and the taking in of aliments. The avoiding of theſe as much as poſſible, or the moderating their force, makes what is properly called the *antiphlogiſtic regimen*, proper to be employed in *almoſt* every continued fever. This regimen is to be directed in the following manner.

1. Impreſſions on the external ſenſes, as ſtimulant to the ſyſtem, and a chief ſupport of its activity, ſhould be avoided as much as poſſible; eſpecially ſuch as are of a ſtronger kind, and which give pain and uneaſineſs. No impreſſion is to be more carefully guarded againſt than that of external heat; and at the

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 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.

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-

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 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 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. I.

Febris maligna hectica convulſiva, ſive lues νευρώδης, *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. Noſoleg. 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, 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.

tations. What theſe limitations ſhould be, and what are all the circumſtances which may forbid the uſe of cold drink, it is difficult to determine; but it ſeems clearly forbidden in all caſes where a phlogiſtic diatheſis prevails in the ſyſtem, and more eſpecially when there are topical affections of an inflammatory nature.

The other method of employing cold as a tonic, is by applying it to the ſurface of the body, as a refrigerant power fit to moderate the violence of reaction; but probably it may here alſo be conſidered properly as a tonic, and uſeful in caſes of debility.—Not only cool air, but cold water alſo may be applied to the ſurface of the body as a tonic. The ancients frequently applied it with advantage to particular parts as a tonic; but it is a diſcovery of modern times, that, in the caſe of putrid fevers attended with much debility, the body may be waſhed all over with cold water. This was firſt practiſed at Breſlaw in Sileſia, as appears from a diſſertation under the title of *Epidemia Verna, quæ Wratiſlaviam anno* 1737 *afflixit*, to be found in the *Acta Nat. Curioſ.* vol. x. And from other writers it appears, that the practice has paſſed into ſome of the neighbouring countries. But in Britain the uſe of cold water externally applied has of late been more extenſively 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 daſhing cold water over the whole ſurface of the body, as a means not only of obviating heat, delirium, and other ſymptoms moſt urgent; but of putting an immediate ſtop to the diſeaſe. And there can be no doubt that the practice has often been attended with the moſt ſalutary conſequences. But it is by no means ſo generally advantageous as Dr Currie and ſome others are inclined to believe. It is in but very rare inſtances that an artificial termination of fever can thus be obtained; and even as obviating ſymptoms, it is not unfrequently attended with bad conſequences. It can never be employed with ſafety unleſs where the heat is very urgent. And perhaps all the advantages of cold immerſion may be obtained merely from cold waſhing, 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 uſeful, 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 epilepſy, are preſumed to poſſeſs a tonic power; but whether their uſe in fevers be founded on their tonic or emetic powers, is uncertain. And upon the whole there may no doubt occur ſome inſtances of fevers being cured by tonics taken from the foſſil kingdom; but the vegetable tonics are the moſt efficacious, and among theſe the cinchona certainly holds the firſt place.

The cinchona has commonly been conſidered as a ſpecific, or a remedy of which the operation was not underſtood. We muſt obſerve, however, that, as in many caſes the effects of the bark are perceived ſoon after its being taken into the ſtomach, and before it can poſſibly be conveyed to the maſs of blood, we may conclude, that its effects do not ariſe from its operating on the fluids; and muſt therefore depend upon its acting on the nerves of the ſtomach, and being thereby communicated to the reſt of the nervous ſyſtem. This operation ſeems to be a tonic power, the bark being a remedy in many caſes of debility, particularly in gangrene; and if its operation may be explained from its poſſeſſing a tonic power, we may eaſily perceive why it is improper when a phlogiſtic diatheſis prevails; and from the ſame view we can aſcertain in what caſes of continued fever it may be admitted. Theſe caſes are either where conſiderable remiſſions have appeared, when it may be employed to prevent the return of exacerbations, on the ſame footing as it is uſed in intermitting fevers; or in the advanced ſtate of fevers, when all ſuſpicion of an inflammatory condition is removed, and a general debility prevails in the ſyſtem; and its being then employed is ſufficiently agreeable to the preſent practice.

Another ſet of medicines to be employed for obviating debility and its effects, are the direct ſtimulants. Theſe, in ſome meaſure, increaſe the tone of the moving fibres; but are different from the tonics, as they more directly excite and increaſe the action of the heart and arteries. This mode of operation renders their uſe ambiguous; and when an inflammatory diatheſis is preſent, the effects of the ſtimulants may be very hurtful; but it is ſtill probable, that in the advanced ſtate of theſe fevers, when debility prevails, they may be uſeful.

Of all the ſtimulants which may be properly employed, wine ſeems to be the moſt eligible. It has the advantage of being grateful to the palate and ſtomach, and of having its ſtimulant parts ſo much diluted, that it can be conveniently given in ſmall doſes; and therefore it may be employed with ſufficient ſafety. —It may be ſuſpected that wine has an operation analogous to that of opium; and on good grounds. But we can diſtinctly remark its ſtimulant power only; which renders its effects in the phrenetic delirium manifeſtly hurtful; and in the mild delirium depending on debility, as remarkably uſeful.

[2.] We muſt 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 putreſcent matter. 2. By evacuating the putrid or putreſcent matter already preſent in the body. 3. By correcting the putrid or putreſcent matter remaining in the body by diluents and antiſeptics. 4. By ſupporting the tone of the veſſels, and thereby reſiſting further putrefaction, or obviating its effects. 5. By moderating the violence of reaction, conſidered as a means of increaſing putrefaction.

The further application of putrid or putreſcent 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 conſtant ventilation, and by a frequent change of bedclothes and body linen. 3. By the careful and ſpeedy removal of all excremental matters from the patient's chamber. 4. By avoiding animal food.

The putrid or putreſcent matter already preſent in the body, may be evacuated partly by frequent evacuations of the contents of the inteſtines; and more effectually ſtill by ſupporting the excretions of perſpiration and urine by the plentiful uſe of diluents. That which remains in the body may be rendered more mild and innocent by the uſe of diluents, or may be corrected by the uſe of antiſeptics. Theſe laſt are of many and various kinds; but which of them are conveniently applicable, or more particularly ſuited to the caſe of fevers, is not well aſcertained. Thoſe moſt certainly applicable and uſeful are aceſcent aliments, particularly fruits, acids of all kinds, and neutral ſalts.

The progreſs of putrefaction may be conſiderably retarded, and its effects obviated, by ſupporting the tone of the veſſels; 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 increaſing the tendency to putrefaction, may be moderated by the means already mentioned under *Synocha*.

Theſe are the proper indications to be obſerved in the cure of the ſlow nervous fever; and they are chiefly fulfilled by cleanlineſs, cool air, and diluents; which, perhaps upon the whole are more uſeful in fevers, than all other practices put together. Dr Huxham obſerves, that evacuations (eſpecially bleeding), are improper even at the beginning. Even a common purgative given at this time hath been followed by ſurpriſing languors, ſyncope, and a train of other ill ſymptoms. It may, however, ſometimes be neceſſary to cleanſe the ſtomach and primæ viæ by a gentle emetic, or a mild laxative. Indeed, where nauſea, ſickneſs and load at ſtomach are urgent, as is frequently the caſe in the beginning of this fever, a vomit is neceſſary. Clyſters of milk, ſugar, and ſalt, may be injected with ſafety and advantage every ſecond or third day, if nature wants to be prompted to ſtool. The temperate, cordial, diaphoretic medicines, are certainly, according to our author, moſt proper in theſe fevers; and a well-regulated, ſupporting, diluting diet is neceſſary. The latter of itſelf, judiciouſly managed, will go a great way in the cure, eſpecially if aſſiſted by well-timed and well-applied bliſters, and a due care to keep the patient as quiet as poſſible both in body and mind. But it ſhould be noted, that ſtrong opiates are commonly very pernicious, however much the want of ſleep and reſtleſſneſs may ſeem to demand them. Mild diaphoretics, ſuch as neutral draughts or elixir paregoricum, have much better effects; which, by raiſing a gentle eaſy ſweat, or at leaſt a plentiful perſpiration, calm the hurry of the ſpirits, and a refreſhing ſleep enſues. Where the confuſion and dejection of ſpirits are very conſiderable, bliſters have been adviſed to be applied to the neck, occiput, or behind the ears; and during all this a free uſe of thin wine whey, ſome pleaſant ptiſan or gruel, with a little pure wine, muſt be directed. Indeed the patients, in this caſe ſhould drink frequently: though ſuch quantities may not be neceſſary as in the ardent or even putrid malignant fevers; yet they ſhould be ſufficient to carry on the work of dilution, ſupport the ſweats, and ſupply the blood with freſh and wholeſome fluids, in place of that noxious matter which is continually paſſing off. In this view alſo a thin chicken-broth is of ſervice, both as food and phyſic, eſpecially towards the decline of the diſeaſe; and for the ſame reaſon thin jellies of hartſhorn, ſago, and panada, are uſeful, adding a little wine to them, and the juice of orange or lemon.

It is obſervable, that the ſick are never ſo eaſy as when they are in a gentle ſweat; for this ſoon removes the hurry of ſpirits, exacerbations of heat, &c. But profuſe ſweats ſhould never be encouraged, much leſs induced, by very ſtrong heating medicines, eſpecially in the beginning or advance of the fever; for they too much exhauſt the vital powers, and are followed by a vaſt dejection of ſpirits, tremors, ſtartings of the tendons, and ſometimes end in rigors, cold clammy ſweats, ſyncope, or a comatoſe diſpoſition. Sometimes irregular partial heats and fluſhes ſucceed, with great anxiety, reſtleſſneſs, delirium, difficulty of breathing, and a vaſt load and oppreſſion in the præcordia, ſo as to incline the leſs cautious obſerver to think there may be ſomething pneumonic in it; but even here we muſt beware of bleeding, as the pulſe will be found very ſmall and unequal, though very quick. Nor is bleeding contraindicated only by the weakneſs and fluttering of the pulſe, but alſo by the pale, limpid, and watery urine which is commonly attendant. Theſe ſymptoms denote the load, anxiety, and oppreſſion on the præcordia to proceed from an affection of the nervous ſyſtem, and not from a pneumonic obſtruction or inflammation. The breathing in this caſe, though thick and laborious, is not hot, but a kind of ſighing or ſobbing reſpiration, nor is there often any kind of cough concomitant; ſo that it has been conjectured to proceed from ſome ſpaſm on the vitals. Here therefore the nervous cordial medicines are indicated, and bliſters to the thighs, legs, or arms.

The above-mentioned difficulty of breathing, anxiety, and oppreſſion, many times precede a miliary eruption, which often appears on the ſeventh, ninth, or eleventh day of the fever, and ſometimes later. Indeed great anxiety and oppreſſion on the præcordia always precede puſtular eruptions of any kind in all ſorts of fevers. This eruption ſhould be promoted by ſoft eaſy cordials and proper diluents; to which ſhould be ſometimes added ſome gentle aromatics. Theſe tend to calm the univerſal uneaſineſs commonly complained of, and alſo very effectually promote a diaphoreſis, with which the miliary eruptions freely and eaſily advance. But however advantageous theſe commonly are, profuſe ſweats are ſeldom or never ſo, even though attended with a very large eruption. Two or three crops of theſe miliary puſtules have been known to ſucceed one another, following profuſe ſweats, not only without advantage, but with great detriment to the patients, as they were thereby reduced to an extreme degree of weakneſs; ſo that they may juſtly be reckoned ſymptomatic rather than any thing elſe, and the conſequent eruption is often merely the ſymptom of a ſymptom.

In theſe profuſe colliquative ſweatings a little generous red wine (diluted ſomewhat, if neceſſary) may be given with the greateſt advantage; as it preſently moderates the ſweats, ſupports the patient, and keeps up the miliary papulæ if they happen at attend. Towards the decline of the fever alſo, where the ſweats are abundant and weakening, ſmall doſes of the tincture of cinchona with ſaffron and ſnakeroot may be given with the greateſt advantage, frequently interpoſing a doſe of rhubarb to carry off the putrid colluvies in the firſt paſſages; which withal makes the remiſſions or intermiſſions 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*, Maladiēs 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.
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. *Luduvig.* Adverſar. tom. i. pars 1.
Febris petechialis epidemica variis Germaniæ locis ab ann. 1755 ad 1761. *Strack* de morbo cum petechiis.

Typhus.

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,

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 effloreſcence 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.

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 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 efflореſcence 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 approach to purple, the more they are to be dreaded. In a few caſes, inſtead of ſpots, purple ſtreaks and blotches were obſerved. Sometimes the petechiæ did not appear till after death; and there was one caſe in which, after bleeding, the petechiæ were ſeen only on the arm below the ligature, and nowhere elſe on the ſkin.

The hoſpital fever, though accounted one of the continued kind, yet has generally ſome exacerbation at night, with a remiſſion and often partial ſweats in the day; and after a long continuance it is apt to change into a hectic, or an intermitting form. The length of the diſeaſe is uncertain. Sometimes it was terminated, either in death or recovery, in ſeven days after the patient took to his bed; but in the hoſpitals it generally continued from 14 to 20, and ſome died or recovered after four weeks. From the time of the ſinking of the pulſe until death or a favourable criſis, there is perhaps leſs change to be ſeen from day to day in this than in moſt other fevers. When its courſe is long, it ſometimes terminates in ſuppurations of the parotid or axillary glands; and when theſe do not appear, it is probable that the fever is kept up by the formation of ſome internal abſceſs. The parotid glands themſelves do not ſuppurate, but only ſome of the lymphatic glands that lie over them. Sir John Pringle obſerved one inſtance of a ſwelling of this kind on both ſides, without any previous indiſpoſition, when the perſon, not ſuſpecting the cauſe, and applying diſcutient cataplaſms, was, upon the tumor ſubſiding, ſeized with the hoſpital-fever. Many patients after the criſis of this fever complain of a pain in the limbs and want of reſt; and almoſt all of them mention great weakneſs, confuſion in their head, vertigo, and a noiſe in their ears.

Ten of the bodies of thoſe who died of this diſtemper in Houghton's regiment were opened. In ſome, all the cavities were examined; in others, only the brain and the bowels. In ſome of them, the brain appeared to be ſuppurated. The firſt of this kind Sir John Pringle met with at Ghent; but the man being brought into the hoſpital from the barracks no earlier than two days before he died, he could only conjecture from the ſymptoms 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 ſubſtance was uncommonly flaccid and tender; nay, ſome of t[illegible]e kind of matter was found in the ſubſtance of the upper part of the cerebellum: yet this perſon, with ſome ſtupor and deafneſs, had his ſenſes till the night before he died; ſo far, at leaſt, that he anſwered diſtinctly when rouſed and ſpoken to; but about that time the muſcles of his face began to be convulſed. Of two other inſtances of men who undoubtedly died of this fever, in one the cerebrum was ſuppurated, in the other the cerebellum. In the former caſe, the patient was under a ſtupor, with deafneſs from the beginning; but was never delirious, nor altogether inſenſible. His pulſe ſunk early; and about ten days before his death his head began to ſwell, and continued very large till within two days before he died, when it ſubſided a little. For ſeveral days before his end, he would taſte nothing but cold water, and during his illneſs he lay conſtantly upon one ſide. The head being opened, an abſceſs as large as an egg was found in the ſubſtance of the fore-part of the right hemiſphere of the brain, full of thin matter like whey. At that time five more, ill of the ſame fever, had the like ſwelling of their heads, but recovered. In the other caſe, the abſceſs in the cerebellum was about the ſize of a ſmall pigeon's egg, and contained alſo a thin ichorous matter; nor had this patient ever been ſo thoroughly inſenſible as not to anſwer reaſonably when ſpoken to. Two days before he died his urine turned pale.

Theſe ſuppurations, however, were not conſtant; for another who died about the ſame time, and had been ill about the ſame number of days with the like ſymptoms, the pale water excepted, had no abſceſs either in the brain or cerebellum. Two were opened afterwards, in whom the cortical ſubſtance of the brain had an inflammatory appearance, but no ſuppuration. In one of them the large inteſtines were corrupted: that man went off with a looſeneſs; and juſt before he died, an ichorous matter was diſcharged from his noſe. In the military hoſpital at Ipſwich, one who unexpectedly died of this fever after having been ſeemingly in a fair way of recovery, had no ſuppuration in his brain; but in another, who died after an abſceſs in both orbits, the brain was found flaccid, and about two ounces of a thin ſerum in the ventricles.

Cauſes of, and perſons ſubject to, this diſorder. The cauſe of this fever, as well as that of the ſlow nervous fever, is an infection or contagion from ſome diſeaſed animal-body, or from corrupted vegetables; and therefore is very little, if at all, different from thoſe peſtilential diſorders which have ariſen 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 obſervation of Foreſtus, who was eye-witneſs to a diſtemper of this kind (which indeed he calls a *plague*) owing to the ſame cauſe, attended with buboes and a high degree of contagion. The ſame author alſo gives an account of a malignant fever breaking out at Egmont in North-Holland, occaſioned by the rotting of a whale which had been left on the ſhore. We have a like obſervation of a fever affecting the crew of a French ſhip, by the putrefaction of ſome cattle which they had killed on the iſland of Nevis in the Weſt Indies. Theſe men were ſeized with a pain in their head and loins, great weakneſs, and a diſorder of the ſtomach, accompanied with fever. Some had carbuncles; and on others purple ſpots appeared after death.

Galen aſſigns two cauſes for peſtilential fevers: 1. The great heat of the weather, when the humours happen to be in a more putreſcent ſtate than uſual. 2. A putrid ſtate of the air, ariſing either from a multitude of dead bodies left unburied, as after a battle, or from the evaporation of corrupted lakes and marſhes.

One of the moſt remarkable diſeaſes incident to an army is related by Diodorus, as breaking out among the Carthaginians at the ſiege of Syracuſe. That author not only relates ſome of its moſt diſtinguiſhing ſymptoms, but reaſons well about its cauſe. He obſerves, that pains in the back and eruptions (φλυκταιναι) were common; that ſome had bloody ſtools; that others were ſeized with a delirium, ſo as to run about and beat all that came in their way; that the phyſicians 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.

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 fogs may be compared to that of a new-cleaned ditch. Diſeaſes therefore, ariſing from this cauſe, generally take place in the night, or before ſunriſing.

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 day-time, 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.

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

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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 unhealthimeſs 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.

Typhus.

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 a low nervous or malignant fever. If they happen to paſs them at night, or lie near them in an open boat, the air from thoſe ſwamps is perceived to be quite chill and cold; in ſo much that warm thick clothing becomes abſolutely requiſite to guard the body againſt the impreſſions of ſo great an alteration in the air, and againſt its cold and inclement quality: for the effects of it then, even on the moſt healthy and vigorous conſtitution, is frequently a chilling cold fit of an ague, terminating in a fever with delirium, bilious vomitings, and purging, or even death itſelf.

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. 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.

Typhus.

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 mangeneſe 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 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 be 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, 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 efferveſcence 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 fomentations 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 hectic 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.
267 *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 ſuddenly ſunk, and death ſoon after enſued. Yet in others, who ſeemed to be of a plethoric habit, the tongue has been moiſt all along, though they have been delirious moſt of the time, and the heat of their ſkin and the ſtrength and quickneſs of their pulſe have continued, after the firſt ſtage of the diſeaſe was over, pretty near to that of their natural ſtate 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 diſeaſe would, from the pulſe, heat, breathing, and other ſymptoms, have taken them to be in a natural ſleep. Others, when the pulſe has begun to ſink, and the fatal period ſeemed to be juſt approaching, to the great ſurpriſe of all preſent have recovered their ſenſes, ſat up and talked pretty cheerfully for an hour or two, and in the midſt of this ſeeming ſecurity have been ſuddenly ſeized with convulſions which carried them off immediately.

In the latter ſtage of this fever, the blood is ſo attenuated and diſſolved, that we frequently ſee it flowing not only out of the noſe and mouth, but from the eyes, and even through the pores of the ſkin; great quantities alſo of black, half-baked, or half-mortified blood, are frequently voided both by vomiting and by ſtool, with great quantities of yellow and blackiſh putrid bile by the ſame paſſages; and the urine, which was before of a high icteritious colour, is now almoſt black, and is frequently mixed with a conſiderable quantity of half-diſſolved blood. The pulſe, which was much ſunk before, now becomes very low, unequal, and intermitting; the breathing difficult and laborious; and the anxiety inexpreſſible; an oppreſſion with a burning heat about the præcordia comes on, though the extremities are cold, and often covered with cold clammy ſweats: a conſtant delirium follows; and then a total loſs of the outward ſenſes as well as the judgement, with livid ſpots in many parts of the body, eſpecially about the præcordia; and ſometimes gangrenes in other parts of the body, which are very ſoon ſucceeded by death.

In a ſhort time after death, the body appears much more full of livid, large, mortified ſpots, particularly about the præcordia and hypochondres, eſpecially the right; which parts ſeem, even from the firſt ſeizure, to be the principal ſeat of this terrible diſeaſe; and, upon opening the bodies of thoſe who die of it, we generally find the gall-bladder and biliary ducts turgid, and filled with a putrid blackiſh bile; and the liver, ſtomach, and adjoining parts, full of livid or blackiſh mortified ſpots; and the whole corpſe ſoon putrefies after death, and can be kept but a few hours above ground.

Dr Lind is of opinion, that the remarkable diſſolution of the blood, the violent hæmorrhages, black vomit, and the other ſymptoms which characterize the yellow fever, are only accidental appearances in the common fever of the Weſt Indies; that they are to be eſteemed merely as adventitious, in the ſame manner as purple ſpots and bloody urine are in the ſmallpox, or as an hiccough in the dyſentery: like theſe they only appear when the diſeaſe is attended with a high degree of malignity, and therefore always indicate great danger. This opinion, he thinks, is confirmed by an obſervation of Dr Wind's, that in 1750 the crew of a Dutch ſhip of war were diſtreſſed by the yellow fever, accompanied with the black vomit; but when the ſhip left the harbour, and changed the noxious land air for one more healthy, the fever continued, but was not accompanied with the black vomit.

Diſeaſes ſimilar to this fever, Dr Lind informs us, may ariſe in any part of the world where the air is intenſely hot and unwholeſome; 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 exceſſive heat, and want of rain for ſome months, gave riſe to violent, epidemic, bilious diſorders, reſembling thoſe of the Weſt Indies, of which 100 perſons often died in a day. At this time the winds blew principally from the ſouth, and after ſunſet there fell an unuſual and very heavy dew. But his opinion on this ſubject is liable to ſtrong objections. And however the diſeaſe may originate, yet the late introduction of it from Spain into the fortreſs of Gibraltar, from which, by proper attention, it had been excluded in former epidemics, demonſtrates the contagious nature of this fever beyond all poſſibility of doubt.

It has been a matter of much diſpute, whether the yellow fever is of an infectious nature or not. Some time ago it became an object of conſideration before the Right Hon. the Lords Commiſſioners of Trade and Plantations, where it was urged among other reaſons, for not removing the ſeat of government and juſtice in the iſland of Jamaica from Spaniſh Town to Kingſton, that there was danger from Greenwich hoſpital, ſituated near Kingſton, of an infection from the yellow fever being frequently communicated to that town. On this affair a phyſician was conſulted, who had long practiſed in that iſland, and who gave it as his opinion, that from the yellow fever in that iſland 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 aroſe from theſe practitioners having confounded the ordinary remittent fever of the Weſt Indies, which is often accompanied with bilious ſymptoms, and is from thence often denominated the yellow fever, with the typhus icteroides, a diſeaſe eſſentially different from the bilious remittent which often prevails both in the Weſt and Eaſt Indies. Dr Lind gives a remarkable inſtance 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 cheſt, were ſent to his friends at Philadelphia; where, upon opening the cheſt, the family was taken ill; and the clothes being unluckily hung abroad to be aired, they preſently diffuſed the contagion of the yellow fever over the whole town, by which 200 perſons died.

In the deſcription of the ſame fever by Dr Lining, as it appeared in South Carolina, there are ſeveral particulars conſiderably 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, eſpecially in the knees and calves of the legs, loſs of appetite, debility, and a ſpontaneous laſſitude. Some, however, were ſeized ſuddenly, without any ſuch previous ſymptoms. After a chillineſs and horror, with which this diſeaſe generally invades, a fever ſucceeded. The pulſe was very frequent, till near the termination of the fever, and was generally 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 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, when the weather grew conſiderably warmer, as frequently to become fatal. In cool days, the ſymptoms were not only milder, but many who were apparently in great danger in hot days were ſaved from the very jaws of death by the weather becoming happily cooler. 3. The diſeaſe was generally more fatal to thoſe who lay in ſmall chambers not conveniently ſituated for the admiſſion of freſh air, to thoſe of an athletic and full habit, to ſtrangers who were natives of a cold climate, to thoſe who had the greateſt dread of it, and to thoſe who before the attack of the diſeaſe had overheated themſelves by exerciſe in the ſun, or by exceſſive drinking of ſtrong liquors; either of which indeed ſeemed to render the body more ſuſceptible of the infection. Laſtly, The diſeaſe proved moſt certainly fatal to valetudinarians, or to thoſe who had been weakened by any previous diſeaſe.

Cauſes of, and perſons ſubject to, this diſeaſe. The yellow fever attacks principally Europeans, eſpecially thoſe 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 ſeized with it as the whites themſelves. The cauſe of the diſeaſe ſeems to be a particular kind of contagion; but Dr Lind ſeems to be of opinion, that the immediate cauſe of the ſymptoms is a diſpoſition in the glutinous part of the blood to ſeparate from the others, and to become putreſcent. In ſome perſons who have been bled in the yellow fever, the blood has been obſerved very viſcid; the craſſamentum covered with a yellow gluten half an inch in thickneſs, and impenetrable to the finger unleſs cut by the nail; the ſerum being at the ſame time of the conſiſtence of a thin ſyrup, and of a deep yellow tinct. This ſerum taſted bitter, and reſembled a compoſition of ſoot. The appearances on diſſection, with his concluſions from them, we ſhall give in his own words: "In a man who died on the eleventh day of a yellow fever, whoſe body emitted no bad ſmell 36 hours after death, and was ſtill yellow, I found all the bowels of the abdomen ſound; the liver and ſpleen were remarkably ſo; as alſo the ſtomach and inteſtines. There was no ſuffuſion of the bile either in the inteſtines or ſtomach. The gall-bladder, of the natural ſize, contained the uſual quantity of bile, ſomewhat thicker than common, and grumous (B).

"Upon examining further, this diſeaſe was found to have lain wholly on the left ſide, where, within the breaſt, was found near a quart of yellowiſh water, in which were many large flakes of yellowiſh gluten, appearing, by compariſon, preciſely the ſame with the thick pellicle which had covered the blood taken from his arm. Theſe flakes bore in ſeveral places a reſemblance to a membranous ſubſtance beginning to be converted into a purulent jelly. The pleura, both on its inſide and outſide, as alſo its continuation, the inveſting membrane of the lungs, were covered with cakes of this gluten, hanging in ſome places looſely, in others adhering more ſtrongly: and all in different ſtates of yellow or purulent corruption. The right cavity of the breaſt, and all the other parts of his body, were found entirely free from diſeaſe.

"His complaints had been chiefly in his breaſt; and a ſmall 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 looſe.

"In thoſe fevers, I have alſo ſeen (ſays Dr Lind) the diſeaſe 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 cruſts were found mixed with the water of the pericardium. The heart in different places was excoriated; and, together with the inſide of the pericardium, was lined with a thick membranous cake, ſimilar to that already mentioned on the lungs and pleura. In ſome places this cake had a purulent, in others a gelatinous appearance, exactly reſembling the coagulum of the blood. His complaints had been, a great oppreſſion on the breaſt, and an extreme difficulty of breathing. In a third perſon, 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 ſource of ſuch an extraordinary quantity of matter was not from any preceding inflammation, nor any impoſthume, that we could diſcover; but from innumerable ulcerations on the ſurface of the inteſtines, omentum, meſentery, and peritoneum. Neither did thoſe ulcerations (or excoriations, as they rather appeared in ſeveral places) ſeem to be the primary fountains of the matter, but to have been occaſioned by its acrimony.

"This purulent appearance ſeems to ariſe merely from an extravaſation of one of the component parts of the blood, the gluten or fibrine as it is now called. Blood taken from perſons in a fever, and frequently even from perſons in perfect health, after ſtanding in a clean veſſel for a ſhort time, commonly ſeparates into three diſtinct portions; viz. the ſerum, or water of the blood, the red concreted maſs, and a viſcid pellicle termed the *ſize*, which ſpreads itſelf on the top of the red concretion. Some time ago, when making experiments with the blood taken from perſons in the ſcurvy, I was ſurpriſed to find it often covered with that ſizy cruſt. This induced me to extend my experiments to large quantities of blood from different ſubjects, which I had opportunities of inſpecting at once in ſo large an hoſpital. For this purpoſe I one morning ordered ten patients in the ſcurvy to be bled, taking two ounces from each. A larger quantity was taken, for its inſpection, from two men in health. That day I had occaſion to preſcribe bleeding to a woman in labour, two hours before her delivery; to a girl of ſixteen years of age afflicted with a lunacy proceeding from the chloroſis; to three patients in the rheumatiſm; and to a perſon labouring under an obſtruction of the liver.

"From a nice compariſon, and an examination of the blood in theſe caſes, I found in general, that the more

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(B) In others who died in this yellow ſtate, the bile in the gall-bladder was found of a thick ropy conſiſtence like pitch, but the liver never appeared in the leaſt affected. Dr Lind at firſt in ſeveral bodies opened the head only; but afterwards judged that all the cavities ought to be inſpected.

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, 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 and the diſtemper goes off. But if, after taking this a little while, we find that the pulſe does not riſe, but on the contrary that a coldneſs of the extreme parts comes on, the medicines muſt be made more warming, by increaſing the quantity of the ſnakeroot and ſaffron, or by adding *vinum croceum*, *confectio cardiaca*, or the like, but not by the uſe of volatile ſpirits and ſalts, which hurt by their ſtimulating and diſſolving qualities. Bliſters Dr Hilary reprobates in the ſtrongeſt terms, and affirms that he has ſeen the place where a bliſter was applied turned perfectly black and ſphacelated; ſo that if the ſpine and end of the ribs had not hindered, a large ſquare paſſage would have been opened into the cavity of the thorax, had the patient lived a few hours after it.

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.*

168 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. 169

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 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.

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 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.

170 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.

171 GENUS VII. PHLOGOSIS.

172 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:

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 reſacea, *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 farther 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 bloodveſſels, 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 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 puncturâ, *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.

174 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.

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 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 potaſs 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 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.

175 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.

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

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.

176 GENUS X. CYNANCHE.

Cynanche, *Sauv.* gen. 110. *Lin.* 33. *Sag.* gen. 300.
Angina, *Vog.* 49. *Hoffm.* II. 125. *Junck.* 30.
Angina inflammatoria, *Boerh.* 798.

177 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 it is often acquired by habit. It occurs eſpecially in the ſpring and autumn, when viciſſitudes of heat and cold frequently take place.

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.

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 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 efloreſcence 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 efloreſcence 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; if the pulſe grew very ſmall and quick, and the ſkin remained hot and parched as it were, the breathing more difficult, the eyes dead and glaſſy, the urine pale and limpid, a phrenſy or coma ſucceeded, with a coldiſh clammy ſweat on the face or extremities; life was deſpaired of, eſpecially if a ſingultus and choaking or gulping in the throat attended, with ſudden, liquid, involuntary, livid ſtools, intolerably fetid. In ſome few patients Dr Huxham obſerved, ſome time before the fatal period, not only the face bloated, ſallow, ſhining and greaſy as it were, but the whole neck very much ſwollen, and of a cadaverous look; and even the whole body became in ſome degree œdematous; and the impreſſion of a finger would remain fixed in a part, the ſkin not riſing again as uſual; an indication that the blood ſtagnated in the capillaries, and that the elaſticity of the fibres was quite loſt.

Medical writers are ſtill much divided in opinion, whether the cynanche maligna is to be conſidered as the ſame diſeaſe with the ſcarlatina anginoſa, afterwards to be treated of, or not. This queſtion will afterwards come to be more fully diſcuſſed. At preſent we may only obſerve, that although ulcerous ſore throats of a malignant nature often appear ſporadically, yet that the diſeaſe above deſcribed appears only as an epidemic, and is always the conſequence of contagion.

We have, therefore, no doubt that the cynanche maligna of Huxham, Fothergill, and Cullen, is preciſely the ſame diſeaſe with the ſcarlatina anginoſa of Sauvage, Withering, and other late writers. This is abundantly demonſtrated by the diverſities which take place in the appearance of the diſeaſe among children of the ſame family during the ſame epidemic.

Prognoſis. This may be eaſily gathered from the above deſcription. The malignant and putrid tendency of the diſeaſe is evident, and an increaſe of the ſymptoms which ariſe from that putreſcent diſpoſition of the body muſt give an unfavourable prognoſtic. On the contrary, a decreaſe of theſe, and an apparent increaſe of the *vis vitæ*, are favourable: in general, what is obſerved to be favourable in the nervous and putrid malignant fevers, is alſo favourable in this, and *vice verſa*.

Cauſes. Since the accurate accounts given by Dr Fothergill and Huxham of the epidemics which prevailed about 50 years ago, this diſeaſe has frequently been obſerved at times epidemic in almoſt every different part of Britain. Like ſmall-pox, meaſles, and chincough, it ſeems in every caſe to be the effect of a peculiar and ſpecific contagion. It has been obſerved to prevail, equally generally in every ſituation, and at every ſeaſon; and on expoſure to the contagion, no age, ſex, or condition, is exempted from it. But the having once had the diſeaſe, ſeems in this affection to afford the ſame ſecurity againſt future contagion as in the ſmall-pox: at leaſt inſtances, where it can be ſaid that the ſame individual has been twice affected with it, are both very rare and very doubtful, as well as in ſmall pox.

Cure. Like other febrile contagions, the malignant ulcerous ſore throat is terminated only by a natural courſe; and the chief buſineſs of the practitioner is to combat unfavourable occurrences. In this the ſeptic tendency of the diſeaſe 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 inſtances where the debility is leſs, and the inflammatory ſymptoms more conſiderable. The fauces are to be preſerved from the effects of the acrid matter poured out upon them, and are therefore to be frequently waſhed out by antiſeptic gargles or injections; and the putreſcent ſtate of the whole ſyſtem ſhould be guarded againſt and corrected by internal antiſeptics, eſpecially by the Peruvian bark given in the beginning and continued through the courſe of the diſeaſe. Great benefit is alſo often derived from the liberal uſe of the mineral acids. Both the ſulphuric and muriatic, in a ſtate of proper dilution, have been highly extolled by different medical writers, and are productive of the beſt effects in actual practice, when they can be introduced to a ſufficient extent. In particular, the oxygenated muriatic acid, as recommended by Mr Braithwaite, has been found productive of the greateſt advantages. Emetics, both by vomiting and nauſeating, prove uſeful. When any conſiderable tumor occurs, bliſters applied externally will be of ſervice, and in any caſe may be proper to moderate the inflammation.

Very lately, the internal uſe of the capſicum annuum, or Cayenne pepper as it is commonly called, has been highly celebrated in this affection; and it is particularly ſaid to have been employed with ſingular ſucceſs in the Weſt Indies.

But of all the remedies lately propoſed, none has been more highly extolled than the external uſe of cold water. It has even been contended by ſome that by daſhing cold water on the ſurface of the body, an immediate artificial cure of this diſeaſe may be obtained. We are, however, fully perſuaded, that cold water will no more deſtroy the contagion of this diſeaſe than of ſmallpox; and we cannot help thinking that the practice is ſeldom neceſſary, and ſometimes hurtful.

Sp. III. CYNANCHE TRACHEALIS. 179

The CROUP.

Cynanche trachealis, *Sauv.* ſp. 5.
Cynanche laryngea auctorum, *Eller* de cogn. et curand. morb. ſect. 7.
Anginæ inflammatoriæ, ſp. 1. *Boerh.* 801.
Angina latens et difficilis, *Dodon.* obſ. 18.
Angina interna, *Tulp.* l. 1. obſ. 51.
Angina pernicioſa, *Greg. Horſt.* Obſ. l. iii. obſ. 1.
Suffocatio ſtridula, *Home* on the Croup.
Aſthma infantum, *Millar* on the Aſthma and Chincough.
Aſthma infantum ſpaſmodicum, *Ruſh*, Diſſertation, Lond. 1770.
Cynanche ſtridula, *Crawford* Diſſert. Inaug. Edin. 1771.
Angina epidemica anno 1743. *Molloy* apud *Rutty's* Hiſtory of the weather.
Morbus ſtrangulatorius, *Starr*, Phil. Tranſ. N° 495.
Morbus truculentus infantum, *Francof.* ad Viadrum et in vicinia graſſans ann. 1758. C. a Bergen. A nova. N. C. tom. ii. p. 157.
Catarrhus ſuffocativus Barbadenſis ann. 1758. *Hillary's* Diſeaſes of Barbadoes.

Angina inflammatoria infantum, *Ruſſel*, Occon. 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.

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, 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.

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*, Raccolta 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.

Phlegmaſiæ.

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.

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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*, Diſſert. 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.

Pneumonia.

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.

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 every acute inflammation begins in membranous parts; and in every diſſection of perſons who have died of peripneumony, the external membrane of the lungs, or ſome part of the pleura, has appeared to have been conſiderably affected. An inflammation of the pleura covering the upper ſurface of the diaphragm, has been diſtinguiſhed by the appellation of *paraphrenitis*, as ſuppoſed to be attended with the peculiar ſymptoms of delirium, *riſus ſardonicus*, and other convulſive motions: but it is certain, that an inflammation of that portion of the pleura, and affecting alſo even the muſcular ſubſtance of the diaphragm, has often taken place without any of the ſymptoms above-mentioned; and neither the diſſections which have fallen under Dr Cullen's obſervation, nor any accounts of diſſections, ſupport 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 obſerved, 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 reſolution, ſuppuration, or gangrene: but it has alſo a termination peculiar to itſelf; namely, when it is attended with an effuſion of blood into the cellular texture of the lungs, which, ſoon interrupting the circulation of the blood through the viſcus, produces a fatal ſuffocation. This indeed appears to be the moſt common termination of pneumonic inflammation when it ends fatally; for upon the diſſection of almoſt every perſon who has died of this diſeaſe, it appears that ſuch an effuſion had happened. From the ſame diſſections we learn, that pneumonic inflammation commonly produces an exſudation from the internal ſurface of the pleura, which appears partly as a ſoft viſcid cruſt, often of a compact membranous form, covering every where the ſurface of the pleura, and particularly thoſe parts where the lungs adhere to the pleura coſtalis, or mediaſtinum; and this cruſt ſeems always to be the cement of ſuch adheſion. The ſame exſudation ſhows itſelf alſo by a quantity of a ſerous fluid commonly found in the cavity of the thorax; and ſome exſudation or effuſion is uſually found to have been made into the cavity of the pericardium. It ſeems likewiſe probable, that an effuſion of this kind is ſometimes made into the cavity of the bronchiæ; for in ſome perſons who have died after labouring under a pneumonic inflammation for a few days only, the bronchiæ have been found filled with a conſiderable quantity of ſerous and thickiſh fluid, which muſt be conſidered rather as the effuſion abovementioned, having had its thinner parts taken off by reſpiration, than as a pus ſo ſuddenly formed in the inflamed part. It is, however, not improbable, that this effuſion, as well as that made into the cavities of the thorax and pericardium, may be a matter of the ſame 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, becauſe the cruſt covering the ſurface prevents the abſorption of the thinner part. This abſorption, however, may be compenſated in the bronchiæ, by the drying power of the air; and therefore the effuſion into them may aſſume a more purulent appearance. In many caſes of pneumonic inflammation, when the expectoration is very copious, it is difficult to ſuppoſe that the whole proceeds from the mucous follicles of the bronchiæ; and it ſeems probable that a great part of it may come from the effuſed ſerous fluid juſt mentioned; and this too will account for the appearance of the expectoration being ſo often purulent. Perhaps the ſame thing will account for that purulent matter found in the bronchiæ, which Mr de Haen ſays he had often obſerved when there was no ulceration in the lungs, and which he accounts for in a very ſtrange manner, namely, by ſuppoſing a pus formed in the circulating blood.

Dr Cullen is of opinion, that the effuſion into the bronchiæ above-mentioned often concurs with the effuſion of red blood into the cellular ſubſtance of the lungs to occaſion the fatal ſuffocation which frequently terminates peripneumony: that the effuſion of ſerum alone may have this effect: and that the ſerum poured out in a certain quantity, rather than any debility in the powers of expectoration, is the cauſe of that ceſſation of ſpitting which precedes the fatal event; for in many caſes the expectoration has ceaſed, when no other ſymptoms of debility have appeared, and when, upon diſſection the bronchiæ have been full of liquid matter. Nay, it is even probable, that in ſome caſes ſuch an effuſion may take place without any ſymptoms of violent inflammation; and in other caſes the effuſion taking place may ſeem to remove the ſymptoms of inflammation which had appeared before, and thus account for thoſe unexpected fatal terminations which have ſometimes happened.

Pneumonic inflammation ſeldom terminates by reſolution, without being attended with ſome evident evacuation. An hæmorrhagy from the noſe happening on ſome of the firſt days of the diſeaſe has ſometimes put an end to it; and it is ſaid, that an evacuation from the hæmorrhoidal veins, a bilious evacuation by ſtool, and an evacuation of urine with a copious ſediment, have ſeverally had the ſame effect; but ſuch occurrences have been rare. The evacuatiom moſt frequently attending, and ſeeming to have the greateſt effect in promoting reſolution, is an expectoration of a thick, white, or yellowiſh matter, a little ſtreaked with blood, copious, and brought up without much or violent coughing. Very frequently the reſolution of this diſeaſe is attended with, and perhaps produced by, a ſweat, if it be warm, fluid, copious, over the whole body, and attended with an abatement of the frequency of the pulſe, heat of the body, and other febrile ſymptoms. Although, from the hiſtory now given, it appears that pleuriſy and peripneumony cannot with propriety be conſidered as different diſeaſes, yet it is certain that in different caſes this affection occurs with an aſſemblage of ſymptoms ſeparate and diſtinct. Thus even Dr Cullen himſelf, in his Noſology, has defined pleuritis to conſiſt in pyrexia, attended with pungent pain of the ſide, painful reſpiration, difficulty of lying down, particularly on the affected ſide, and diſtreſſing cough, in the beginning dry, but afterwards humid, and often with bloody expectoration. While again he has defined peripneumony to conſiſt in pyrexia, attended with a dull pain under the ſternum and between the ſhoulders, anxiety, difficulty of breathing, humid 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 cert in 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. 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 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. 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 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.

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. 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.

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,

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.

394 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 will 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

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.

198 GENUS XVII. HEPATITIS.

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.

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 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. 260

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.

201 GENUS XX. CYSTITIS.

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.

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.

Rheumatiſmus necroſeos, *Sauv.* ſp. 14.
Rheumatiſmus dorſalis, *Sauv.* ſp. 11.
Lumbago à ſatyriali, *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.

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.

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 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 from a particular part; but will be of little uſe, except where the pains are much confined to one place.

209 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.

GENUS XXIII. ODONTALGIA, the TOOTHACH.

210 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 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 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 diſpoſition, 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 morbific matter always preſent in the body; and that this matter, by certain cauſes, thrown upon the joints or other parts, produces the ſeveral phenomena of the diſeaſe.

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.

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 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 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 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.

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 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.

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.

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.

216 GENUS XXV. ARTHROPUOSIS.

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.
Eebris 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 parrs 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

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.

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*. 221

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 ſhews 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. 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.

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 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 in 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.

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 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.

For an account of the progreſs of this diſcovery, we muſt refer our readers to Dr Jenner's publication. Here we ſhall only obſerve, that it had long been remarked in ſome parts of England, particularly in the neighbourhood of Berkley, where Dr Jenner reſided, that cows were liable to a puſtular diſeaſe on their udders, ſomewhat reſembling ſmallpox; that this diſeaſe was communicated by contact to the fingers of thoſe employed in milking the cows; and, finally, that thoſe thus infected with cowpox, were completely protected againſt the contagion of ſmallpox.

Founding on theſe obſervations, Dr Jenner aſcertained by experiment, that the inoculation of vaccine matter was an infallible preventive of ſmallpox; and that this vaccine matter had equal power in preventing variola, when transferred from one human ſubject to another, as when obtained immediately from the cow. It is not therefore wonderful that this practice of vaccine inoculation ſhould ſoon have become general, both in Britain and in every quarter of the world. Nor is it perhaps ſurpriſing, that it ſhould have been violently oppoſed by ignorant and obſtinate men. Hence numerous publications have of late appeared both for and againſt this practice. Many miſtakes have undoubtedly been committed by ignorance and inattention; and thus the preventive has been ſuppoſed to fail. For the beſt account both of the method of performing the operation, of conveying the vaccine matter from one place to another, and of the teſts of conſtitutional affection in thoſe caſes in which the inflammation is ſlight, and in which no fever is perceptible, we may refer our readers to a treatiſe publiſhed at Edinburgh in 1802, by Mr James Bryce, entitled Practical Obſervations on the Inoculation of Cowpox.

Of the efficacy of vaccine inoculation as a preventive of ſmallpox few candid men will entertain any doubt, after the following report on vaccination, from the Royal College of Phyſicians in London, ordered to be printed on the 8th of July 1807, by the Britiſh parliament.

REPORT, &c.

The Royal College of Phyſicians of London, having received his majeſty's commands, in compliance with an addreſs from the houſe of commons, "to inquire into the ſtate of vaccine inoculation in the united kingdom, to report their opinion and obſervations upon that practice, upon the evidence which has been adduced in its ſupport, and upon the cauſes which have hitherto retarded its general adoption;"—have applied themſelves diligently to the buſineſs referred to them.

Deeply impreſſed with the importance of an inquiry which equally involves the lives of individuals, and the public proſperity, they have made every exertion to inveſtigate the ſubject fully and impartially. In aid of the knowledge and experience of the members of their own body, they have applied ſeparately to each of the licentiates of the college; they have correſponded with the colleges of phyſicians of Dublin and Edinburgh; with the colleges of ſurgeons of London, Edinburgh, and Dublin; they have called upon the ſocieties eſtabliſhed for vaccination, for an account of their practice, to what extent it has been carried on, and what has been the reſult of their experience; and they have, by public notice, invited individuals to contribute whatever information they had ſeverally collected. They have in conſequence been furniſhed with a maſs of evidence communicated with the greateſt readineſs and candour, which enables them to ſpeak with confidence upon all the principal points referred to them.

I. During eight years which have elapſed ſince Dr Jenner made his diſcovery public, the progreſs of vaccination has been rapid, not only in all parts of the united kingdom, but in every quarter of the civilized world. In the Britiſh iſlands ſome hundred thouſands have been vaccinated, in our poſſeſſions in the Eaſt Indies upwards of 800,000, and among the nations of Europe the practice has become general. Profeſſional men have ſubmitted it to the faireſt trials, and the public have, for the moſt part, received it without prejudice. A few indeed have ſtood forth the adverſaries of vaccination, on the ſame grounds as their predeceſſors who oppoſed the inoculation for the ſmallpox, falſely led by hypothetical reaſoning in the inveſtigation of a ſubject which muſt be ſupported, or rejected, upon facts and obſervation only. With theſe few exceptions, the teſtimony in favour of vaccination has been moſt ſtrong and ſatisfactory, and the practice of it, though it has received a check in ſome quarters, appears ſtill to be upon the increaſe in moſt parts of the united kingdom.

II. The college of phyſicians, in giving their obſervations and opinions on the practice of vaccination, think it right to premiſe, that they advance nothing but what is ſupported by the multiplied and unequivocal evidence which has been brought before them, and they have not conſidered any facts as proved but what have been ſtated from actual obſervation.

Vaccination appears to be in general perfectly ſafe; the inſtances to the contrary being extremely rare. The diſeaſe excited by it is ſlight, and ſeldom prevents thoſe under it from following their ordinary occupations. It has been communicated with ſafety to pregnant women, to children during dentition, and in their earlieſt infancy; in all which reſpects it poſſeſſes material advantages over inoculation for the ſmallpox; which, though productive of a diſeaſe generally mild, yet ſometimes occaſions alarming ſymptoms, and is in a few caſes fatal.

The ſecurity derived from vaccination againſt the ſmallpox, if not abſolutely perfect, is as nearly ſo as can perhaps be expected from any human diſcovery; for amongſt ſeveral hundred thouſand caſes, with the reſults of which the college have been made acquainted, the number of alledged failures has been ſurpriſingly ſmall, ſo much ſo, as to form certainly no reaſonable objection to the general adoption of vaccination; for it appears that there are not nearly ſo many failures, in a given number of vaccinated perſons, as there are deaths in an equal number of perſons inoculated for the ſmallpox. Nothing can more clearly demonſtrate the ſuperiority of vaccination over the inoculation of the ſmallpox, than this conſideration; and it is a moſt important fact, which has been confirmed in the courſe of this inquiry, that in almoſt every caſe, where the ſmallpox has ſucceeded vaccination, whether by inoculation or by caſual infection, the diſeaſe has varied much from its ordinary courſe; it has neither been the ſame in the violence, nor in the duration of its ſymptoms, but has, 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.

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 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 Phy-
ſicians in Ireland.

Dublin, 11*th Nov.* 1806.

" The practice of vaccination was introduced into this

Exanthemata.

this city about the beginning of the year 1801, and appears to have made inconſiderable progreſs at firſt. A variety of cauſes operated to retard its general adoption, amongſt which the novelty of the practice, and the extraordinary effects attributed to vaccination, would naturally take the lead.

"Variolous inoculation had been long, almoſt excluſively, in the hands of a particular branch of the profeſſion, whoſe prejudices and intereſts were ſtrongly oppoſed to the new practice; and by their being the uſual medical attendants in families, and eſpecially employed in the diſeaſes of children, their opinions had greater effect upon the minds of parents. The ſmallpox is rendered a much leſs formidable diſeaſe in this country by the frequency of inoculation for it, than it is in other parts of his majeſty's dominions, where prejudices againſt inoculation have prevailed; hence parents, not unnaturally, objected to the introduction of a new diſeaſe, rather than not recur to that, with the mildneſs and ſafety of which they were well acquainted.

"In the beginning of the year 1804, the cowpox inſtitution was eſtabliſhed 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 ſucceſs of the inſtitution, in forwarding the new practice, is to be attributed in a great meaſure to the reſpectability of the gentlemen who ſuperintend it, and to the diligence, zeal, and attention of Dr Labatt, their ſecretary and inoculator. In order to ſhew the progreſs which has been made in extending vaccination, your committee refer to the reports of the Cowpox Inſtitution for the laſt two years, and to extracts from their regiſter for the preſent year.

	Patients Inoculated.	*Packets iſſued 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 ſtatement, the numbers are averaged to the end of the preſent year, on the ſuppoſition of patients reſorting to the inſtitution as uſual. The correſpondence of the inſtitution appears to be very general throughout every part of Ireland, and by the accounts received, as well from medical practitioners as others, the ſucceſs of vaccination ſeems to be uniform and effectual. At the preſent period, in the opinion of your committee, there are few individuals in any branch of the profeſſion, who oppoſe the practice of vaccination in this part of his majeſty's dominions.

"It is the opinion of your committee, that the practice of cowpox inoculation is ſafe, and that it fully anſwers all the purpoſes that have been intended by its introduction. At the ſame time, your committee is willing to allow that doubtful caſes have been reported to them as having occurred, of perſons ſuffering from ſmallpox, who had been previouſly vaccinated. Upon minute inveſtigation, however, it has been found, that theſe ſuppoſed inſtances originated generally in error, miſrepreſentation, or the difficulty of diſcriminating between ſmallpox and other eruptions, no caſe having come to the knowledge of your committee, duly authenticated by reſpectable and competent judges, of genuine ſmallpox ſucceeding the regular vaccine diſeaſe.

Variola.

"The practice of vaccination becomes every day more extended; and, when it is conſidered that the period at which it came into general uſe in Ireland is to be reckoned from ſo late a date, your committee is of opinion, that it has made already as rapid a progreſs as could be expected.

(Signed) "JAMES CLEGHORN.
"DANIEL MILLS.
"HUGH FERGUSON."

N°. II.

Phyſicians Hall, Edinburgh, 26th Nov. 1806.

GENTLEMEN,

THE Royal College of Phyſicians of Edinburgh have but little opportunity themſelves of making obſervations on vaccination, as that practice is entirely conducted by ſurgeon apothecaries, and other medical practitioners not of their college, and as the effects produced by it are ſo inconſiderable and ſlight, that the aid of a phyſician is never required.

The College know that in Edinburgh it is univerſally approved of by the profeſſion, 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 ſmallpox was, and they believe the ſame to obtain all over Scotland.

With regard to any cauſes 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 miſtaken ideas of the impropriety or criminality of being acceſſary to the production of any diſeaſe among their children, or the difficulty or impoſſibility, in ſome of our country diſtricts, of procuring vaccine matter, or a proper perſon to inoculate.

The evidence in favour of vaccination appeared to the Royal College of Phyſicians of Edinburgh ſo ſtrong and deciſive, that in May laſt, they ſpontaneouſly and unanimouſly elected Dr Jenner an honorary fellow of their college;—a mark of diſtinction which they very rarely confer, and which they confine almoſt excluſively to foreign phyſicians of the firſt eminence.

They did this with a view to publiſh their opinion with regard to vaccination, and in teſtimony of their conviction of the immenſe 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 ſenſe of Dr Jenner's very great merits and ability in introducing and promoting this invaluable practice.

I have the honour to be
Gentlemen,
Your moſt obedient humble ſervant,
TH. SPENS, *C. R. M. Ed. Pr.*

To the Royal College of
Phyſicians of London.

N°. III.

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 although providence has thus furniſhed mankind with an eaſy mode of preſerving their offspring from the danger of ſmallpox, by the inoculation of the cowpox 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.

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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.

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,

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.

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,

Exanthemata.

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 benigna, *Sauv.* ſp. 1.
Miliaris maligna, *Sauv.* ſp. 2.
Miliaris recidivans, *Sauv.* ſp. 3.
Miliaris Germanica, *Sauv.* ſp. 5.
Miliaris Boia, *Sauv.* ſp. *a.*
Miliaris Britannica, *Sauv.* ſp. *i.*
Miliaris nova febris, *Sydenh.* Sched. monit. *Sauv.* ſp. *d.*
Miliaris ſudatoria, *Sauv.* ſp. *e.*
Miliaris nautica, *Sauv.* ſp. *g.*
Miliaris purpurata, *Sauv.* ſp. *h.*
Miliaris lactea, *Sauv.* ſp. *c.*
Miliaris puerperarum, *Sauv.* ſp. *k.*
Miliaris ſcorbutica, *Sauv.* ſp. *l.*
Miliaris critica, *Sauv.* ſp. *b.*

Hiſtory and Deſcription. This diſeaſe is ſaid to have been unknown to the ancients, and that it appeared for the firſt time in Saxony about the middle of the laſt century. It is ſaid to have ſince ſpread from thence into all the other countries of Europe; and ſince the period mentioned, to have appeared in many countries in which it had never appeared before.

From the time of its having been firſt taken notice of, it has been deſcribed and treated of by many different writers; and by all of them, till very lately, has been conſidered as a peculiar idiopathic diſeaſe. It is ſaid to have been conſtantly attended with peculiar ſymptoms. It comes on with a cold ſtage, which is often conſiderable. The hot ſtage, which follows, is attended with great anxiety, and frequent ſighing. The heat of the body becomes great, and ſoon produces profuſe ſweating, preceded, however, with a ſenſe of pricking, as of pin points in the ſkin; and the ſweat is of a peculiar rank and diſagreeable odour. The eruption appears ſooner or later in different perſons, but at no determined period of the diſeaſe. It ſeldom or never appears upon the face; but appears firſt upon the neck and breaſt, and from thence often ſpreads over the whole body.

The eruption named *miliary*, is ſaid to be of two kinds; the one named the *red*, the other the *white miliary*. The former, which in Engliſh is ſtrictly named a *raſh*, is commonly allowed to be a ſymptomatic affection; and as the latter is the only one that has any pretenſions to be conſidered as an idiopathic diſeaſe, it is this only that we ſhall more particularly deſcribe and treat of under this genus.

What is then called the *white miliary eruption*, appears at firſt like the red, in very ſmall red pimples, for the moſt part diſtinct, but ſometimes cluſtered together. Their little prominence is better diſtinguiſhed by the finger than by the eye. Soon after the appearance of this eruption, and, at leaſt, on the ſecond day, a ſmall veſicle is viſible upon the top of the pimples. At firſt the veſicle is whey-coloured: but ſoon becomes white, and ſtands out like a little globule. In two or three days, theſe globules break, or are rubbed off; and are ſucceeded by ſmall cruſts, which ſoon after fall off in ſmall ſcales. While one ſet of pimples takes this courſe, another ſet ariſes to run the ſame; ſo that the diſeaſe often continues upon the ſkin for many days together. Sometimes when one crop of this eruption has diſappeared, another, after ſome interval, is produced. And it has been further obſerved, that in ſome perſons there is ſuch a diſpoſition to this diſeaſe, that they have been affected with it ſeveral times in the courſe of their lives.

This diſeaſe is ſaid to affect both ſexes, and perſons of all ages and conſtitutions: but it has been obſerved at all times, to affect eſpecially, and moſt frequently, lying-in women.

It is often accompanied with violent ſymptoms, and has frequently proved fatal. The ſymptoms, however, attending it are very various; but no ſymptom, or concourſe of ſymptoms, are ſteadily the ſame in different perſons, ſo as to give any ſpecific character to the diſeaſe. When the diſeaſe is violent, the moſt common ſymptoms are phrenetic, comatoſe, and convulſive affections, which are alſo ſymptoms of all fevers treated by a very warm regimen.

While there is ſuch a variety of ſymptoms appearing in this diſeaſe, it is not to be expected that any one particular method of cure can be propoſed; and, accordingly, we find in different writers different methods and remedies preſcribed; frequent diſputes about the moſt proper; and thoſe received and recommended by ſome oppoſed and deſerted by others.

It appears, however, to Dr Cullen, very improbable, that this was really a new diſeaſe, when it was firſt conſidered as ſuch. There are very clear traces of it in authors who wrote long before that period; and though there were not, we know that ancient deſcriptions were often inaccurate and imperfect, particularly with reſpect to cutaneous affections; and we know alſo that thoſe affections which commonly appeared as ſymptomatic only, were often neglected, or confounded together under a general appellation.

The antecedent ſymptoms of anxiety, ſighing, and pricking of the ſkin, which have been ſpoken of as peculiar to this diſeaſe, are, however, common to many others; and perhaps to all thoſe in which ſweatings are forced out by a warm regimen. Of the ſymptoms ſaid to be concomitant of this eruption, there are none which can be affirmed to be conſtant and peculiar but that of ſweating. This, indeed, always precedes and accompanies the eruption: and, while the miliary eruption attends many different diſeaſes, it never, however, appears in any of theſe but after ſweating; and in perſons labouring under the ſame diſeaſes it does not appear, if in ſuch perſons ſweating be avoided. It is therefore probable, that the eruption is the effect of ſweating: and that it is the effect of a matter not before prevailing in the maſs of blood, but generated under particular circumſtances in the ſkin itſelf. That it depends upon particular circumſtances of the ſkin, is alſo probable from its being obſerved that the eruption ſeldom or never appears upon the face, although it affects the whole of the body beſides; and that it comes upon thoſe places eſpecially which are more cloſely covered; and that it can be brought out upon particular places by external applications.

It is to be obſerved, that this eruptive diſeaſe differs from the other exanthemata in many circumſtances, eſpecially the following; that it is not contagious, and therefore never epidemic; that the eruption appears at no determined period of the diſeaſe; that the eruption has no determined duration; that ſucceſſive eruptions frequently appear in the courſe of the ſame 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 by 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.

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 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.

33
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.

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; 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.

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 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.

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 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 paſting 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

Exanthemata.

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, high-ſeaſoned 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.

Urticaria.

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.

GENUS XXXIII. URTICARIA. 231

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, 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.

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 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.

232 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 pémphygodes, *Ephem. Germ.* D. I. A. viii. Obſ. 56.
Pemphigus caſtrenſis, *Sauv.* ſp. 2.
  Febres ſynoches, 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. 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 ſublivid appearance. They were dreſſed afreſh with cerate, and he was ordered the following medicines:

℞ Decoct, Cort. Peruvian. ℥vj. Vini rubr. Luſitan. ʒiij. M. Hujus mixturæ capiat ℥ß. tertia quaque hora.

"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.

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GENUS XXXV. APHTHA.

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; 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.

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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.

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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 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.

236 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 noſe, 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 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.

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,

luted, both as an aſtringent and refrigerant, is often employed with very good effects.

237 PHTHISIS.

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 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

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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; whiſe 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.

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 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 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 in general have been little regarded. For inſtance, he has known a perſon who, by a ride of an hour or two in the morning, was very much recruited, and who, at another time, in the afternoon and evening, without undergoing more bodily motion, has returned faint and languid, and apparently worſe. This obſervation on the ſame perſon has been ſo frequently made, as to point out clearly the times when this exerciſe ſhall not do hurt in conſumptive caſes. In this diſeaſe, the pulſe, however calm in the morning, becomes more frequent in the afternoon and night, attended with heat and other feveriſh ſymptoms. Exerciſe therefore, at this time, can only add to the miſchief of the fever. For this reaſon he prudently recommends to all hectic perſons, eſpecially thoſe who ſhall travel to diſtant places on account of a better air, or the benefit expected from any particular water, that their travelling ſhould be ſlow, confined to a very few hours, and only in the morning.

Exerciſe on horſeback ſeems to be chiefly beneficial in thoſe caſes where conſumption is a ſecondary diſeaſe. For example, in the nervous atrophy; in the hypochondriacal conſumption; or when it is the effect of long-continued intermittents, or of congeſtions in any of the abdominal viſcera; or, in a word, whenever the conſumption is not attended with an inflamed or ulcerated ſtate of the lungs, long journeys on horſeback will be beneficial. Such a practice may likewiſe be highly uſeful in obviating an attack of phthiſis, or in carrying off a dry huſky cough in a perſon of a conſumptive habit, when there is reaſon to ſuppoſe that no tubercles are as yet formed. On the other hand, in the confirmed phthiſis, when the lungs are inflamed or ulcerated, much or violent exerciſe will be improper; and there have been inſtances where the death of the patient was evidently accelerated by it. The exerciſe therefore ſhould be gentle, proportioned to the ſtrength of the patient, and employed only in the morning. In fine weather, an eaſy open carriage is perhaps the moſt eligible, not only on account of its being open to the air, but becauſe it affords that kind of agitation which is moſt wanted in theſe caſes. For if we conſider the different modes of exerciſe, we ſhall find that walking, though the beſt exerciſe in health, as it employs the moſt muſcles, is the worſt for the ſickly, who ſhould have the benefit of exerciſe without fatigue. Riding on horſeback agitates the viſcera more than walking, and is therefore preferable to it in many chronic diſeaſes; but when a preternatural determination to the lungs has taken place, it will be liable to increaſe the evil, and may likewiſe be hurtful by the fatigue that attends it. For theſe reaſons it will be prudent to begin with a carriage; and if the patient gain ſtrength, and the diſeaſe abates, recourſe may afterwards be had to horſe-exerciſe.

The gentle motion of a coach has been often found of great utility in pulmonary complaints. Its efficacy ſeems to depend chiefly on its increaſing the determination to the ſurface of the body. The nauſea which this motion excites in ſome perſons is an effect of this increaſed determination. It has therefore been found beneficial in hæmoptyſis; and Dr Simmons mentions the caſe of a lady, who, after trying various remedies to no purpoſe, was cured of this complaint by travelling ſeveral hundred miles through different parts of England in her own coach. At firſt, whenever ſhe remained three or four days in any place, the diſorder began to return again; but at length by perſevering in her journeys, it gradually went off. Deſſault, who practiſed at Bourdeaux about 40 years ago, tells us, he ſent ſeveral conſumptive patients to Bareges, and with good ſucceſs; but that in theſe caſes his reliance was not ſo 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.

It is now pretty generally acknowledged, that the good effects of ſea voyages in conſumptive caſes depend more upon the conſtant and uniform motion of the ſhip, than upon any particular impregnation of the ſea air; although this from its coolneſs and purity may likewiſe be of great uſe, eſpecially in the hot months, when ſea voyages are generally undertaken by conſumptive patients. The ancients were no ſtrangers to this remedy; and amongſt the Romans it was no unuſual thing for conſumptive perſons to ſail to Egypt. Pliny obſerves, that this was done not for the ſake of the climate, but merely on account of the length of the voyage.

Many of our Engliſh phyſicians have recommended a voyage to Liſbon in theſe caſes. When this is done, the proper ſeaſon of the year ſhould be carefully attended to. Dr Simmons knew a gentleman who went thither with ſymptoms of incipient phthiſis, and who experienced ſome relief during the courſe of the voyage; but happening to arrive at Liſbon at the beginning of the rainy ſeaſon, the diſeaſe was ſoon greatly increaſed, and terminated fatally.

Another ſpecies of motion has of late been extolled as highly uſeful in conſumptive caſes. Dr James Carmichael Smyth of London, has lately publiſhed an account of the effects of ſwinging, employed as a remedy in the pulmonary conſumption and hectic fever. In this treatiſe Dr Smyth contends, that ſea air, in place of being of advantage, is conſtantly prejudicial to hectic and conſumptive patients, and even to thoſe who have a tendency to ſuch complaints. He thinks, therefore, that the benefit derived from ſea voyages muſt certainly be referred to ſome other cauſe. In ſtating his ſentiments on this ſubject, he attempts to eſtabliſh a diſtinction between exerciſe and motion. By exerciſe, he underſtands muſcular action, or the exertion of the locomotive powers of the body either alone or combined. This he repreſents as increaſing the force and frequency of the heart's contraction, the velocity and momentum of the blood, the quickneſs of breathing, the heat, the irritability, and the tranſpiration of the whole body. By motion, in contr. diſtinction to exerciſe, he means ſuch motion as is not neceſſarily accompanied with any agitation or ſucuſſion of the body, and which is totally independent of any muſcular exertion. The effects of this, both on the heart, the lungs, and indeed on the ſyſtem in general, he conſiders as of the ſedative kind; thus it ſuſpends the action of coughing, and leſſens the frequency of the pulſe. He is, therefore, led to refer the good effects of ſea voyages entirely to this cauſe. And on theſe grounds he was led to conclude, that the motion given by ſwinging might be of equal if not greater ſervice. This concluſion, we are told, in the treatiſe above alluded to, experience in many 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.

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 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.

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 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.

240 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.

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

Hæmorrhagiæ.

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 laxity of the cellular texture about the anus. It is to be particularly obſerved, that when an hæmorrhoidal affection has either been originally or has become a diſeaſe of the ſyſtem, it then acquires a particular connexion with the ſtomach; ſo that certain affections of the ſtomach excite the hæmorrhoidal diſeaſe, and certain ſtates of this diſeaſe excite the diſorders of the ſtomach.

It has been an almoſt univerſally received opinion, that the hæmorrhoidal flux is a ſalutary evacuation, which prevents many diſeaſes which would otherwiſe have happened; and that it even contributes to give long life: and as this opinion has been ſtrenuouſly adopted by Dr Stahl, it has had a very conſiderable influence on the practice of phyſic in Germany. But Dr Cullen maintains that we can never expect to reap much benefit from this flux, which at firſt is purely topical; and, granting that it ſhould become habitual, it is never, he thinks, proper to be encouraged. It is a diſagreeable diſeaſe; ready to go to exceſs, and thereby to prove hurtful, and ſometimes even fatal: at beſt it is liable to accidents, and thus to unhappy conſequences. He is therefore of opinion, that even the firſt approaches of the diſeaſe are to be guarded againſt; and that, though it ſhould have proceeded for ſome time, it ought always to be moderated, and the neceſſity of it ſuperſeded.

Cure. The general intentions of cure in caſes of hæmorrhois are much varied, according to the circumſtances of the affection at the time. When hæmorrhois exiſts in the ſtate of tumor, the principal objects are to counteract inflammation, and to promote a diſcharge of blood from the part. When it is in the ſtate of evacuation, the chief intentions of cure are, to diminiſh the impetus of blood at the part affected, and to increaſe the reſiſtance to the paſſage of blood through the ruptured veſſels. And finally, when the diſeaſe exiſts in the ſtate of ſuppreſſion, the aims of the practitioner muſt chiefly be, to obviate the particular affections which are induced in conſequence of the ſuppreſſion; to reſtore the diſcharge, as a means of mitigating theſe and preventing others; or, when the diſcharge cannot with propriety or advantage be reſtored, to compenſate the want of it by vicarious evacuations.

With theſe various intentions in different caſes, a variety of different remedies may be employed with advantage.

When any evident cauſe for this diſeaſe is perceived, we ought immediately to attempt a removal of that cauſe. One of the moſt frequent remote cauſes is an habitual coſtiveneſs; which muſt be obviated by a proper diet, ſuch as the perſon's own experience will beſt direct; or if the management of diet be not effectual, the belly muſt be kept open by medicines, which may prove gently laxative, without irritating the rectum. In moſt caſes it will be of advantage to acquire a habit with regard to the time of diſcharge, and to obſerve it exactly. Another cauſe of the hæmorrhois to be eſpecially attended to is the prolapſus ani, which is apt to happen on a perſon's having a ſtool. If this ſhall occur to any conſiderable degree, and be not at the ſame time eaſily and immediately replaced, it moſt certainly produces piles, or increaſes them when otherwiſe produced. Perſons therefore who are liable to this prolapſus, ſhould, after having been at ſtool, take great pains to have the inteſtine immediately replaced, by lying down in a horizontal poſture, and preſſing gently upon the anus, till the reduction ſhall be completely obtained. When this prolapſus is occaſioned only by the voiding of hard and bulky fæces, it is to be removed by obviating the coſtiveneſs which occaſions it. But in ſome perſons it is owing to a laxity of the rectum; and in thoſe it is often moſt conſiderable on occaſion of a looſe ſtool. In theſe caſes, it is to be treated by aſtringents, and proper artifices are to be employed to keep the gut in its place.

When the diſeaſe has frequently recurred from neglect, and is thus in ſome meaſure eſtabliſhed, the methods above mentioned are no leſs proper; but in this caſe ſome other meaſures muſt alſo be uſed. It is eſpecially proper to guard againſt a plethoric ſtate of the body; and therefore to avoid a ſedentary life, full diet, and intemperance in the uſe of ſtrong liquor, which in all caſes of hæmorrhage is of the moſt pernicious conſequence.

Exerciſe of all kinds is of great ſervice in obviating and removing a plethoric ſtate of the body; but upon occaſion of the hæmorrhoidal flux, when this is immediately to come on, both walking and riding, as increaſing the determination of the blood into the hæmorrhoidal veſſels, are to be avoided. At other times, when no ſuch determination is already formed, theſe modes of exerciſe may be very properly employed.

Another method of removing plethora is by cold bathing; but this muſt be employed with caution. When the hæmorrhoidal flux is approaching, it may be dangerous to divert it; but during the intervals of the diſeaſe, cold bathing may be employed with ſafety and advantage; and in thoſe who are liable to a prolapſus ani, the frequent waſhing of the anus with cold water may be uſeful.

Beſides general antiphlogiſtic regimen, in ſome caſes where the inflammation runs high, recourſe may be had with great advantage both to general blood-letting and to leeches applied at the anus. Relief is alſo often obtained from the external application of emollients, either alone or combined with different articles of the ſedative kind, as acetite of lead or opium, by which it is well known that pain in general, particularly when depending on increaſed ſenſibility, or augmented action of the veſſels, is powerfully allayed.

When the flux has actually come on, we are to moderate it as much as poſſible, by cauſing the patient lie in a horizontal poſture on a hard bed; by avoiding exerciſe in an erect poſture, uſing a cool diet, and avoiding external heat. But with reſpect to the further cure of this diſeaſe, we muſt obſerve, that there are only two caſes in which it is common for hæmorrhoidal perſons to call for medical aſſiſtance. The one is, when the affection is accompanied with much pain; and the other, when the piles are accompanied with exceſſive bleeding. In the firſt caſe, we muſt conſider whether the piles be external or internal. The pain of the external piles happens eſpecially when a conſiderable protruſion of the rectum has taken place; and while it remains unreduced, it is ſtrangled by the conſtriction of the ſphincter; and at the ſame time no bleeding happens to take off the ſwelling of the protruded 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.

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 principally 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.

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 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.

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 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.

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.

253 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 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 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.

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,

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 expiration, 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.

"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, 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 ſucceſsful, 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 ʒſs or ℈ij of *balſ. ſulph. 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.”

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, 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.

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 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, 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,

ever, follow, that the extravaſated ſerum above mentioned in the ventricles of the brain is always the cauſe of the diſeaſe, ſince the animal fluids are very frequently obſerved to ooze out in plenty through the coats of the containing veſſels after death, though no extravaſation took place during life.

Prognoſis. This ſpecies is equally fatal with the other; and what hath been ſaid of the prognoſis of the ſanguineous, may alſo be ſaid of that of the ſerous apoplexy.

Cure. In this ſpecies veneſection can ſcarcely be admitted: acrid purgatives, emetics, and ſtimulating clyſters, are recommended to carry off the ſuperabundant ſerum; but in bodies already debilitated, they may perhaps be liable to the ſame exceptions with veneſection itſelf. Volatile ſalts, cephalic elixirs, and cordials, are alſo preſcribed; and in caſe of a hemiplegia ſupervening, the cure is to be attempted by aperient ptiſans, cathartics, and ſudorifics; gentle exerciſe, as riding in a carriage; with bliſters and ſuch ſtimulating medicines as are in general had recourſe to in affections originally of the paralytic kind.

258 Sp. III. *Hydrocephalic Apoplexy*, or *Dropſy* of the *Brain*.

Hydrocephalus interior, *Sauv.* ſp. 1.
Hydrocephalus internus, *Whytt's* works, page 725.
London Med. Obſ. vol. iv. art. 3, 6, and 25.
Gaudelius de hydrocephalo, apud *Sandifort* Theſaur. vol. ii.
Hydrocephalus acutus, *Quin. Diſſ.* de hydrocephalo, 1779.
Aſthenia à hydrocephalo, *Sauv.* ſp. 3.

Hiſtory and deſcription. This diſeaſe has been accurately treated within theſe few years by ſeveral eminent phyſicians, particularly the late Dr Whytt, Dr Fothergill, and Dr Watſon; who concur in opinion, with reſpect to the ſeat of the complaint, the moſt of its ſymptoms, and its general fatality. Out of twenty patients that had fallen under Dr Whytt's obſervation, he candidly owns that he had been ſo unfortunate as to cure only one who laboured under the characteriſtic ſymptoms of the hydrocephalus; and he ſuſpects that thoſe who imagine they have been more ſucceſsful, had miſtaken another diſtemper for this. It is by all ſuppoſed to conſiſt in a dropſy of the ventricles of the brain; and this opinion is fully eſtabliſhed by diſſections. It is obſerved to happen more commonly to healthy, active, lively children, than to thoſe of a different diſpoſition.

Dr Whytt ſuppoſes that the commencement of this diſeaſe is obſcure; that it is generally ſome months in forming; and that, after ſome obvious urgent ſymptoms rendering aſſiſtance neceſſary, it continues ſome weeks before its fatal termination. This, in general, differs from what has hitherto been obſerved by Dr Fothergill; the latter informing us, that he has ſeen children, who, from all appearance, were healthy and active, ſeized with this diſtemper, and carried off in about 14 days. He has ſeldom been able to trace the commencement of it above three weeks.

Though the hydrocephalus be moſt incident to children, it has been ſometimes obſerved in adults; as appears from a caſe related by Dr Huck, and from ſome others.

When the diſeaſe appears under its moſt common form, the ſymptoms at different periods are ſo various as to lead Dr Whytt to divide the diſeaſe into three ſtages, which are chiefly marked by changes occurring in the condition of the pulſe. At the beginning it is quicker than natural; afterwards it becomes uncommonly ſlow; and towards the concluſion of the diſeaſe it becomes again quicker than natural, but at the ſame time often very irregular.

Thoſe who are ſeized with this diſtemper uſually complain firſt of a pain in ſome part below the head; moſt commonly about the nape of the neck and ſhoulders; often in the legs; and ſometimes, but more rarely, in the arms. The pain is not uniformly acute, nor always fixed to one place; and ſometimes does not affect the limbs. In the latter caſe, the head and ſtomach have been found to be moſt diſordered; ſo that when the pain occupied the limbs, the ſickneſs or headach was leſs conſiderable; and when the head became the ſeat of the complaint, the pain in the limbs was ſeldom or never mentioned. Some had very violent ſickneſſes and violent headachs alternately. From being perfectly well and ſportive, ſome were in a few hours ſeized with thoſe pains in the limbs, or with ſickneſs, or headach, in a ſlight degree, commonly after dinner; but ſome were obſerved to droop a few days before they complained of any local indiſpoſition. In this manner they continued three, four, or five days, more or leſs, as the children were healthy and vigorous. They then commonly complain of an acute deep-ſeated pain in the head, extending acroſs the forehead from temple to temple; of which, and a ſickneſs, they alternately complain in ſhort and affecting exclamations; doſing a little in the intervals, breathing irregularly, and ſighing much while awake. Sometimes their ſighs, for the ſpace of a few minutes, are inceſſant.

As the diſeaſe advances, the pulſe becomes ſlower and irregular, the ſtrokes being made both with unequal force and in unequal times, till within a day or two of the fatal termination of the diſorder, when it becomes exceeding quick; the breathing being at the ſame time deep, irregular, and laborious. After the firſt attack, which is often attended with feveriſh heats, eſpecially towards evening, the heat of the body is for the moſt part temperate, till at laſt it keeps pace with the increaſing quickneſs of the pulſe. The head and præcordia are always hot from the firſt attack. The ſleeps are ſhort and diſturbed, ſometimes interrupted by watchfulneſs; beſides which there are ſtartings.

In the firſt ſtage of the diſeaſe there ſeems to be a peculiar ſenſibility of the eyes, as appears from the intolerance of light. But in the progreſs of the diſeaſe a very oppoſite ſtate occurs: The pupil is remarkably dilated, and cannot be made to contract by the action even of ſtrong light; ſuch, for example, as by bringing a candle very near to it. In many caſes there is reaſon to believe that total blindneſs occurs: Often alſo the pupil of one eye is more dilated than that of another, and the power of moving the eyes is alſo morbidly affected. Thoſe children, who were never obſerved to ſquint before, often become affected 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.

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 à frigore, *Sauv.* ſp. 15.
Lethargus à frigore, *Sauv.* ſp. 6.
Aſphyxia congelatorum, *Sauv.* ſp. 5.

The poiſons which bring on an apoplexy when taken internally may be either of the ſtimulant or ſedative kind, as ſpirituous liquors, opium, and the more virulent kinds of vegetable poiſons. The vapours of mercury, or of lead, in great quantity, will ſometimes produce a ſimilar effect; though commonly they produce rather a paralyſis, and operate ſlowly. The vapours of charcoal, or fixed air, in any form, breathed in great quantity, alſo produce an apoplexy, or a ſtate very ſimilar to it; and even cold itſelf produces a fatal ſleep, though without the apoplectic ſtertor.—To enumerate all the different ſymptoms which affect the unhappy perſons who have ſwallowed opium, or any of the ſtronger vegetable narcotics, is impoſſible, as they are ſcarcely to be found the ſame in any two patients. The ſtate induced by them ſeems to differ ſomewhat from that of a true apoplexy; as it is commonly attended with convulſions, but has the particular diſtinguiſhing ſign of apoplexy, namely, a very difficult breathing or ſnorting, more or leſs violent according to the quantity of poiſonous matter ſwallowed.

Of the poiſonous effects of fixed air, Dr Percival gives the following account. "All theſe noxious vapours, whether ariſing from burning charcoal, the fermenting grape, the Grotti di Cani, or the cavern of Pyrmont, operate nearly in the ſame manner. When accumulated and confined, their effects are often inſtantaneous: they immediately deſtroy the action of the brain and nerves, and in a moment arreſt the vital motions. When more diffuſed, their effects are ſlower, but ſtill evidently mark out a direct affection of the nervous ſyſtem.

"Thoſe who are expoſed to the vapours of the fermenting grape, are as inſtantly deſtroyed as they would be by the ſtrongeſt electrical ſhock. A ſtate of inſenſibility is the immediate effect upon thoſe animals which are thruſt 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 freſh air, is irrecoverable. And if we attend to the hiſtories of thoſe who have ſuffered from the vapours of burning charcoal, we ſhall in like manner find, that the brain and moving powers are the parts primarily affected.

"A cook who had been accuſtomed to make uſe of lighted charcoal more than his buſineſs required, and to ſtand with his head over theſe fires, complained for a year of very acute pain in the head; and after this was ſeized with a paralytic affection of the lower limbs, and a ſlow fever.

"A perſon was left reading in bed with a pan of charcoal in a corner of the room. On being viſited early the next morning, he was found with his eyes ſhut, his book open and laid on one ſide, his candle extinguiſhed, and to appearance like one in a deep ſleep. Stimulants and cupping-glaſſes gave no relief; but he was ſoon recovered by the free acceſs of freſh air.

"Four priſoners, in order to make their eſcape, attempted to deſtroy the iron work of their windows, by the means of burning charcoal. As ſoon as they commenced their operations, the fumes of the charcoal being confined by the cloſeneſs of the priſon, one of them was ſtruck dead; another was found pale, ſpeechleſs, and without motion; afterwards he ſpoke incoherently, was ſeized with a fever, and died. The other two were with great difficulty recovered.

"Two boys went to warm themſelves in a ſtove heated with charcoal. In the morning they were found deſtitute of ſenſe and motion, with countenances as compoſed as in a placid ſleep. There were ſome remains of pulſe, but they died in a ſhort time.

"A fiſherman depoſited a large quantity of charcoal in a deep cellar. Same time afterwards his ſon, a healthy ſtrong man, went down into the cellar with a pan of burning charcoal and a light in his hand. He had ſcarcely deſcended to the bottom, when his candle went out. He returned, lighted his candle, and again deſcended. Soon after, he called aloud for aſſiſtance. His mother, brother, and a ſervant, haſted to give him relief; but none of them returned. Two others of the village ſhared the ſame fate. It was then determined to throw large quantities of water into the cellar; and after two or three days, they had acceſs to the dead bodies.

"Cœlius Aurelianus ſays, that thoſe who are injured by the fumes of charcoal become cataleptic. And Hoffman enumerates a train of ſymptoms, which in no reſpect correſpond with his idea of ſuffocation. Thoſe who ſuffer from the fumes of burning charcoal, ſays he, have ſevere pains in the head, great debility, faintneſs, ſtupor, and lethargy.

"It appears from the above hiſtories and obſervations, that theſe vapours exert their noxious effects on the brain and nerves. Sometimes they occaſion ſudden death; at other times, the various ſymptoms of a debilitated nervous ſyſtem, according as the poiſon is more or leſs concentrated. The olfactory nerves are firſt and principally affected, and the brain and nervous ſyſtem by ſympathy or conſent of parts. It is well known, that there is a ſtrong and ready conſent between the olfactory nerves and many other parts of the nervous ſyſtem. The effluvia of flowers and perfumes, in delicate or irritable habits, produce a train of ſymptoms, which, though tranſient, are analogous to thoſe which are produced by the vapours of charcoal; viz. vertigo, ſickneſs, faintneſs, and ſometimes a total inſenſibility. The female malefactor, whom Dr Mead inoculated by putting into the noſtrils doſſils of cotton impregnated with variolous matter, was, immediately on the introduction, afflicted with an excruciating headach, and had a conſtant fever till after the eruption.

"The vapours of burning charcoal, and other poiſonous effluvia, frequently produce their prejudicial, and even fatal effects, without being either offenſive to the ſmell or oppreſſive to the lungs. It is a matter of importance, therefore, that the common opinion ſhould be more agreeable to truth; for where ſuffocation is ſuppoſed to be the effect, there will be little apprehenſion of danger, ſo long as the breaſt keeps free from pain or oppreſſion.

"It may be well to remember, that the poiſon itſelf is diſtinct from that groſs matter which is offenſive to the ſmell; and that this is frequently in its moſt active ſtate when undiſtinguiſhed by the ſenſe. Were 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.

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 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.

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 and 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.

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.

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 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.

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.

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.

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 ſucceſsful, that we can hardly doubt of its efficacy in ſlighter degrees of the diſorder.

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.

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 ſtimulating;

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;

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 fore-part 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.

“ 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

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releaſes them; oftener a continued and ſevere ſpaſm finiſhes the tragedy, when it was before almoſt at an end: but moſt frequently a general convulſion puts a period to their ſufferings; and whichever way this happens, they for the moſt part relax juſt before death.

"In the *tetanus*, the general ſymptoms are nearly the ſame as in the opiſthotonos, except that from the firſt attack, the lateral, abdominal, and other anterior muſcles, are equally contracted with the poſterior ones; and the arms become rigid as well as the lower extremities. The abdomen is always flat and rigid as in the laſt ſtage of the opiſthotonos; and its contents ſeem to be thruſt up into the thorax, which at the ſame time appears to be much dilated. There are here alſo ſome intervals between the ſpaſms, in the time of which the cheeks are drawn towards the ears, ſo that all the teeth may be ſeen as in the ſpaſmus cynicus. Deglutition is more free in this than in the other diſeaſe; yet ſo far is the ſick from being equally balanced between the contractions of the oppoſite muſcles, that the head is retracted and the ſpine is recurvated, although not quite ſo much as in the opiſthotonos. And the ſpaſm, which commences under the ſternum, is likewiſe common to the tetanus, which terminates as the other, and on the ſame fatal days. But whoever recovers from either, labours long under a general atonia; and they cannot for ſome months raiſe themſelves from a ſupine or recumbent poſture without pain, nor without help for ſome time."

Prognoſis and Cure. There has never been any thing like a criſis obſerved in theſe frightful caſes, or favourable termination from the mere efforts of nature; and therefore all the phyſician's dependence muſt be upon art. As in caſes of tetanic affections, the diſeaſe often ariſes from ſome particular irritation, the removal of this muſt neceſſarily 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 diminiſhing and obviating it. This is principally brought about by the uſe either of thoſe means which have a general tendency to diminiſh action, or of thoſe which induce a different ſtate of action. On theſe grounds the operation of thoſe remedies which are employed with greateſt ſucceſs in this affection, may, we apprehend, be explained. Fortunately it has been found, that opium is capable of giving ſome relief, if adminiſtered in proper time, and if the diſeaſe happens not to be in the moſt violent degree: the warm bath muſt alſo be brought in aid; and the patients ſhould 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 ſofteſt blankets; and while they remain there, the belly ought either to be ſtuped, or two or three bladders filled with warm water kept conſtantly lying on it. The bowels at the ſame time muſt, if poſſible, be kept open, by ſolutions of manna and *ſal polychreſt*, or ſome other purging ſalt, mixed with *oleum ricini*; or if that ſhould not be at hand, with oil of ſweet almonds and a little tincture of ſena. The opiates are to be given in large and frequently repeated doſes; ſuch as a grain of the *extractum thebaicum*, or 20 drops of the tincture, every ſecond or third hour; and it will be ſafeſt not to truſt to the thebaic tincture which is kept ready prepared in the ſhops, but to order the neceſſary doſe of ſolid opium, and either give it in pills or diſſolve it in ſome convenient liquid. If ſwallowing ſhould be difficult, or the jaws cloſed up, the opium muſt be given in clyſters; for during the whole courſe of the diſeaſe it will be of ſervice to order emollient clyſters to be injected from time to time, ſince theſe will anſwer not only as a relaxing fomentation, but alſo contribute to keep the inteſtinal canal perfectly free.

When the patients recover, they continue for a long time very relaxed and weak: and no wonder, ſince it is the nature of all ſpaſmodic affections to leave behind them extreme weakneſs and relaxation of the muſcular fibres. In order to perfect the recovery, a courſe of the cinchona and the Peruvian balſam is to be tried; and the ſpine may be rubbed with ſpirituous liniments, or with a mixture of rum and Barbadoes tar: but theſe and all other ſtimulating things, either internally or externally, during the violence of the ſpaſms, muſt, in the opinion of ſome practitioners, be omitted, ſince all of them as well as bliſters have been alleged to exaſperate the diſeaſe.

This, in general, is the plan of treatment recommended by Dr Chalmers.

The ſame dreadful diſorders frequently attack young children in the warm climates. Dr Hillary tells us, that they will there ariſe from the ſame cauſes which uſually produce convulſions with children in Britain, viz. from a retention of the meconium or firſt excrement after birth; or from a glutinous matter which is too often found in the inteſtines of young children ſoon after the other is diſcharged; or from a cheeſy matter from the coagulation of the milk by an acid in the ſtomach; or from hard excrements; or from ſomething taken in by the mouth which is over acrid, or too hard to digeſt, which irritates their tender bowels, and ſo produces ſtartings and convulſive ſpaſms, with all the other ſymptoms which precede and accompany convulſions in young children in Britain. And this ſhows how much more readily and eaſily the nerves are affected and irritated in that warm climate, and the *tetanus* produced from a much leſs cauſe there, than it is in Britain, where it is but ſeldom ſeen. But theſe cauſes not being timely removed, their acrimony is increaſed, partly by the heat of the climate, and partly by the fever which they produce, which ſtill renders them more acrid, and ſo increaſes the irritation of their bowels, that it firſt brings on ſtartings, then convulſive ſpaſms, and regular convulſion fits; which, if not ſoon removed, uſually end in a perfect *tetanus*, and the diſeaſe is but ſeldom cured in ſuch young children when it arrives at that ſtate: for when the child lies in this miſerable, rigid, immoveable condition, upon moving its hands or feet in the moſt gentle manner, or ſoftly touching any part of its body, or giving it the leaſt motion, even feeling its pulſe in the moſt tender manner, or the leaſt noiſe, or even touching its clothes, will bring on the convulſive ſpaſms, and cauſe it to be ſtrongly convulſed backwards, or drawn into a rigid ſtraight line, ſtrongly extended and immoveable like a ſtatue, and will ſo remain immoveable out of either of thoſe poſtures for a conſiderable time, a minute or two; and when the diſeaſe is arrived at this degree, Dr Hillary thinks

Spaſmi.

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* ʒj. *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.

Tetanus.

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

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. As 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 cathartico*, 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 in St Euſtatia and St Kitt's, and in another letter mentions his having uſed the cold bath in other caſes of tetanus with ſucceſs. But ſince Dr Cochrane's publication, a more full and ſatisfactory account of the benefit of this practice has been communicated in a paper publiſhed by Dr Wright, in the ſixth volume of the London Medical Obſervations. Dr Wright gives a particular account of ſix caſes, in which the beſt effects were obtained from daſhing cold water upon the patient; and he obſerves, that ſince he firſt uſed this method of cure he never failed in one inſtance to effect a recovery, and that in a ſhorter time than by any other method hitherto propoſed. This practice has on ſome occaſions been adopted by practitioners in Britain, although here the diſeaſe is a much leſs frequent occurrence. It has particularly been employed with ſucceſs by Dr Currie of Liverpool; and we hope that ſtill more extenſive practice will confirm the benefit to be derived from it, although not in every inſtance, yet in many caſes of this affection. We are, however, ſorry to ſay that we have of late heard of ſeveral caſes in which it has been tried in Britain, and which, notwithſtanding the uſe of it, had a fatal termination.

Very lately a different mode of cure in this affection has been recommended by Dr Ruſh, profeſſor of medicine in Philadelphia, in a paper entitled Obſervations on the Cauſe and Cure of Tetanus, publiſhed in the ſecond volume of the Tranſactions of the American Philoſophical Society. Dr Ruſh, viewing tetanus as being a diſeaſe occaſioned by relaxation, thinks the medicines indicated to cure it are ſuch only as are calculated to remove this relaxation, and to reſtore tone to the ſyſtem. On this ground he recommends the liberal uſe of wine and cinchona; and tells us, that he has employed them with ſucceſs in actual practice. When the diſeaſe ariſes from an wound of any particular place, he recommends ſtimulants to the part affected; ſuch as dilatation of the wound, and filling it with oil of turpentine. How far this practice will be confirmed by more extenſive experience, we cannot take upon us to determine. We may only obſerve, that a very contrary practice has been recommended as highly ſucceſsful by ſome practitioners in Spain, where tetanic affections are a very frequent occurrence in conſequence of ſlight accidents. There gentle emollients are ſtrongly recommended, particularly immerſing the wounded part in tepid oil for the ſpace of an hour or ſo at a time, and repeating this application at ſhort intervals. By this mode many caſes, after very alarming appearances had taken place, are ſaid to have been completely and ſpeedily removed. While the practice is very ſimple, it appears at the ſame time in many reſpects very rational, and may perhaps be conſidered as well deſerving a trial in the firſt inſtance.

Amongſt other remedies employed in tetanus it has been ſaid that the ſpaſms have ſometimes been allayed by a ſtrong electric ſhock. And in obſtinate caſes electricity or galvaniſm certainly well deſerve a trial.

280 GENUS XLIX. TRISMUS.

The *Locked Jaw*.

Triſmus, *Sauv.* gen. 117. *Lin.* 124. *Sag.* gen. 223. Capiſtrum, *Vog.* 208.

281 Sp. I. *TRISMUS NASCENTIUM.*

Locked Jaw in children under two months old.

Triſmus naſcentium, *Sauv.* ſp. 1. *Heiſter Comp.* Med. Pract. cap. xv. § 10. *Cleghorn* on the Diſeaſes of Minorca, Introd. p. 33. *Hoſer.* in Act. Helvet. tom. i. p. 65.

This diſtemper is ſo cloſely connected with the tetanus, that it ought rather to be accounted a ſymptom of the tetanus than a primary diſeaſe. And nothing need now be added to what has been ſaid reſpecting tetanus.

282 Sp. II. The *TRISMUS* from *Wounds* or *Cold.*

Triſmus traumaticus, *Sauv.* ſp. 2. *Lond. Med. Obſ.* vol. i. art. 1, 7. Vol. ii. 34. Vol. iii. 31. Vol. iv. 7.
Angina ſpaſmodica, *Sauv.* ſp. 18. *Zwingeri*, Act. Helvet. tom. iii. p. 319.
Convulſio à nervi punctura, *Sauv.* ſp. 2.
Triſmus catarrhalis, *Sauv.* ſp. 15. *Hillary's* Barbadoes, 221. *Lond. Med. Obſ.* vol. iv. 7.

The internal remedies proper in all caſes of the locked jaw, from whatever cauſe it may proceed, have been already mentioned under TETANUS: the external treatment of wounded parts which may give occaſion to it belongs to the article SURGERY. But of this alſo we have offered ſome obſervations under the head of Tetanus; and, indeed, triſmus may be conſidered as being merely an incipient tetanus, or rather a ſlight degree of that diſeaſe.

283 GENUS L. CONVULSIO.

CONVULSIONS.

Convulſio, *Sauv.* gen. 128. *Lin.* 142. *Vog.* 191. *Sag.* gen. 235.
Convulſio univerſalis, *Sauv.* ſp. 11.
Hieranoſos, *Lin.* 144. *Vog.* 190.
Convulſio habitualis, ſp. 12.
Convulſio intermittens, *Sauv.* ſp. 16.
Convulſio hemitotonos, *Sauv.* ſp. 15.
Convulſio abdominis, *Sauv.* ſp. 10.
Convulſio ab inanitione, *Sauv.* ſp. 1.
Convulſio ab onaniſmo, *Sauv.* ſp. 13.
Scelotyrbe feſtinans, *Sauv.* ſp. 2.

Deſcription. When convulſions attack only particular parts of the body, they are generally attended with ſome kind of paralyſis at the ſame time, by which means the affected parts are alternately convulſed and relaxed; a permanent convulſion, or unnatural contraction of particular muſcles, is called a *ſpaſm* or *cramp.* Theſe partial convulſions may attack almoſt any part of the body; and are not unfrequently ſymptomatic, in fevers, the cholera morbus, &c. The involuntary ſtartings of the tendons, the picking of the bedclothes, &c. in acute diſeaſes, are all of them convulſive diſorders. Convulſions, even when moſt generally extended, differ from epilepſy in not being attended with any mental affection or abolition of ſenſe, and not followed by the ſame torpid ſtate.

Cauſes. Convulſions, not only of particular parts, but alſo over the whole body, often take place from cauſes not very evident. Sometimes they ſeem to depend

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.

284 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, hyoſciamus, 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.

GENUS LII. RAPHANIA. 285

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.

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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 neophytoram, *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 the tone of the moving fibres. It muſt, however be allowed, that in all convulſive diſorders, excepting thoſe which are cured by nature about the time of puberty, the cure by artificial means is very difficult. Numberleſs ſpecifics have been recommended, but all of them have failed of anſwering the expectation. When the cauſe can be diſcovered, that muſt be removed. In other caſes, the cold bath, valerian root, caſtor, muſk, opium, the fetid gums, cinchona, with the whole tribe of nervous and antiſpaſmodic medicines, have been recommended: but none of theſe, or indeed any combination of them, have been found generally uſeful; though the ſlighter, or ſymptomatic caſes, may often be removed by them.

Of late the *calx* or *oxide*, improperly called the *flowers*, of zinc, have obtained ſuch reputation in convulſive diſorders as to be received into the Edinburgh Pharmacopœia under the title of *oxidum zinci*. They were propoſed by Dr Gaubius as an antiſpaſmodic, in his *Adverſaria*; and their efficacy has ſince been confirmed by various obſervations. In an inaugural diſſertation publiſhed by Dr Hart at Leyden, the medical virtues of the flowers of zinc are conſidered. He obſerves, that they have long been uſed externally, chiefly for inflammations of the eyes from acrid lymph. Glauber firſt propoſed the internal uſe of them; and Gaubius diſcovered them to be the remedy of a celebrated empiric Luddemannus, which he ſtyled his *luna fixata*. After this he exhibited them with ſucceſs in convulſive and ſpaſmodic diſeaſes. Dr Hart ſuppoſes, that they act either as abſorbents, or as poſſeſſing a ſpecific virtue: but is a ſtrong advocate for their efficacy, on whatever principles they may operate; and, in favour of his opinion, relates ſeven caſes in which they proved ſucceſsful. A girl of 17 years of age was ſeized with a ſlight *chorea* from a fright; and when the diſeaſe had continued ſix days, ſhe began to take the flowers of zinc, by which her diſorder was removed in leſs than three weeks. Her cure required only 16 grains of the zinc. In a few months the complaints returned, from the ſame cauſe; and were removed by four grains of the medicine divided into ten doſes. A boy of about four years old, labouring under a real epilepſy, ſuſpected to be hereditary, was cured by a grain of the flowers of zinc taken every day for ſome time.—A man 50 years old, thrown into convulſions from a violent paſſion, was cured by a grain of the calx taken every two hours. The diſeaſe had gone off upon veneſection and the uſe of ſome other remedies; but returned again in two weeks, when it was finally removed by the zinc. The two laſt caſes are related from Dr Gaubius, who affirms that he has uſed the flowers of zinc in caſes of the chincough, hyſteric hiccough, and ſpaſmus cynicus; that they frequently did more than other medicines, but were by no means ſucceſsful in every caſe. The other cures mentioned by Dr Hart are ſimilar to thoſe above mentioned. But it does not appear that he ever ſaw a confirmed epilepſy cured by this medicine.

In the firſt volume of the Edinburgh Medical Commentaries, we have an account by Mr Benjamin Bell, of a man afflicted with a confirmed epilepſy, who was conſiderably relieved by the flowers of zinc.

In a young man labouring under the epilepſy, in whom the fits were preceded by an *aura epileptica*, or ſenſation like air ariſing from the inſide of the knee-joint, the diſeaſe was alſo relieved, but not cured.

Dr Percival relates ſome caſes of epilepſy which ſeem to have been cured by the flowers of zinc; and in other caſes, where the diſeaſe was not entirely removed by it, the ſpaſms were nevertheleſs much mitigated. He did not obſerve that it promoted any evacuation; excepting that in ſome, upon being firſt taken, it occaſioned a little ſickneſs, which went off with a ſtool. He adds, that thoſe apothecaries who do not prepare this medicine themſelves, are in great danger of being impoſed upon, as it is ſometimes a mere corroſion of the zinc by an acid, and even imperfectly waſhed.

The good effects of the oxide of zinc as an antiſpaſmodic are alſo atteſted by Dr Haygarth of Cheſter and Dr White of York. The former gives a teſt of their goodneſs which may be of uſe to thoſe who do not prepare them, namely, that the true flowers of zinc, when ſtrongly heated, become yellow, but reaſſume their white colour on being allowed to cool. The latter gives a caſe of hieranoſos, or ſtrange convulſions of almoſt all the muſcles of the body, cured by zinc, after a number of other remedies had failed. But, although from theſe and other reſpectable authorities, there can be no doubt that zinc has often been ſucceſsful in epilepſy; 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 hiſtories, alſo, oxide of zinc is mentioned as having been found ſerviceable upon trial in the Royal Infirmary of Edinburgh. Of the other principal remedies which have been recommended for the epilepſy and other convulſive diſorders allied to it, we have the following account by the ſame author.

1. *The cold-bath* was tried in one who had a convulſive diſorder of one ſide, but the ſymptoms were rendered much worſe by it.

2. *Veneſection.* Not to be depended on in convulſions.

3. *Electricity.* In two convulſive caſes was of no ſervice.

4. *Epiſpaſtics.* Do not ſeem to be powerful antiſpaſmodics.

5. *Valerian.* In nine convulſive caſes, for which this remedy has been reckoned almoſt a ſpecific, it not only made no cure, but could ſcarcely be reckoned to do any good. Dr Home ſuppoſes that it acts as a bitter tonic, ſomething like the *ſerpentaria Virginiana*. Though much uſed at preſent, he tells us it has always appeared to him a weak, often a hurtful, medicine.

6. *Muſk.* Six convulſive patients treated with large doſes of this remedy, were neither cured nor in the leaſt relieved.

7. *Caſtor* ſeems to be unworthy of the confidence formerly put in it. It is indeed poſſeſſed of a ſedative power, and therefore may be uſeful in ſpaſmodic feveriſh caſes.

8. *Aſafœtida* has conſiderable antiſpaſmodic powers, but is not always ſucceſsful. It heats and quickens the pulſe; and is therefore improper in caſes attended with inflammation. It diſagrees with ſome from a peculiarity of conſtitution; exciting pain in the ſtomach,

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.

290 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.

291 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 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 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 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 expreſsly 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.

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

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.

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 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 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 aſa fœtida, 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 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 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.

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.

311 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 ſtercoroſa et vulgaris, *Sauv.* ſp. 1. 2.

This is occaſioned by too great a quantity of matter thrown into the alimentary canal; and what is diſcharged has not the appearance of excrements, but is much whiter, and of a thinner conſiſtence. Voracious people who do not ſufficiently chew their food, gormandizers, and even thoſe who ſtammer in their ſpeech, are ſaid to be liable to this diſeaſe. In ſlighter caſes it is removed without any medicine, or by a doſe of rhubarb; but where the matters have acquired a putrid taint, the diſorder may be much protracted and become dangerous. In this caſe lenient and antiſeptic purgatives are to be made uſe of, after which the cure is to be completed by aſtringents.

313 Sp. II. The *Bilious* Diarrhoea.

(*Sauv.* ſp. 8.)

This diſtemper ſhows itſelf by copious ſtools of a very yellow colour, attended with gripes and heat of the bowels, thirſt, bitterneſs, and dryneſs of the mouth, yellowneſs 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 ſmall doſes of nitre.

314 Sp. III. The *Mucous* Diarrhoea.

Diarrhœa lactentium, *Sauv.* ſp. 19.
Dyſenteria Pariſiaca, *Sauv.* ſp. 3.
Diarrhœa ab hypercatharſi, *Sauv.* ſp. 16.
Dyſenteria à catharticis, *Sauv.* ſp. 12.
Pituitaria, *Vog.* 111.
Leucorrhois, *Vog.* 112.
Diarrhœa pituitoſa, *Sauv.* ſp. 4.
Cœliaca mucoſa, *Sauv.* ſp. 3.
Diarrhœa ſeroſa, *Sauv.* ſp. 10.
a. Diarrhœa urinoſa.

This kind of diarrhœa, beſides the matters uſually excreted, is attended with a copious dejection of the mucus of the inteſtines with great pain; while the patient daily pines away, but without any fever.—Perſons of all ages are liable to it, and it comes on uſually in the winter-time; but is ſo obſtinate, that it will ſometimes continue for years. In obſtinate looſeneſſes of this kind, vomits frequently repeated are of the greateſt ſervice. It is alſo very beneficial to keep the body warm, and rub the belly with ſtimulating ointments; at the ſame time that aſtringent clyſters, rhubarb, and ſtomachic medicines, are to be exhibited. Starch clyſters are very often efficacious.—Some kinds of looſeneſs are contagious; and Sir John Pringle mentions a ſoldier who laboured under an obſtinate diarrhœa, who infected all thoſe that uſed the ſame privy with himſelf. In the looſeneſs which frequently followed a dyſentery, the ſame author tells us that he began the cure with giving a vomit of ipecacuanha, after which he put the patients on a courſe of aſtringents. He uſed a mixture of three drachms of extract of logwood, diſſolved in an ounce and a half of ſpirit of cinnamon, to which was added ſeven ounces of common water, and two drachms of tincture of catechu. Of this the patient took two ſpoonfuls once in four or five hours, and ſometimes alſo an opiate at bedtime. He recommends the ſame medicine in obſtinate diarrhœas of all kinds. A decoction of ſimarauba bark was alſo found effectual, when the dyſenteric ſymptoms had gone off. Dr Huck, who uſed this article in North-America, alſo recommends it in diarrhœas. Two or three ounces of the ſimarauba 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 weakeſt decoction; and, when the ſtomach of the patient could eaſily bear it, he then ordered the ſtrongeſt: but at the ſame time he acknowledges, that, unleſs the ſick found themſelves ſenſibly better within three days from the time they began the medicine, they ſeldom afterwards received any benefit from it. But when all aſtringents have failed, Sir John Pringle informs us, he hath known a cure effected by a milk and farinaceous diet; and he thinks in all caſes the diſorder would be much more eaſily removed, if the patients could be prevailed on to abſtain entirely from ſpirituous liquors and animal-food. If the milk by itſelf ſhould turn ſour on the ſtomach, a third part of lime-water may be added. In one caſe he found a patient receive more benefit from good butter-milk than from ſweet-milk. The chief drinks are decoctions of barley, rice, calcined hartſhorn, toaſt and water, or milk and water.

315 Sp. IV. The Coeliac Passion.

Cœlica chyloſa, *Sauv.* ſp. 1.
Cœlica lactea, *Sauv.* ſp. 4.

There are very great differences among phyſicians concerning the nature of this diſeaſe. Sauvages ſays, from Aretæus, it is a chronic flux, in which the aliment is diſcharged half digeſted. It is attended with great pains of the ſtomach, reſembling the pricking of pins; rumbling and flatus in the inteſtines; white ſtools, becauſe deprived of bile, while the patient becomes weak and lean. The diſeaſe is tedious, periodical, and difficult to be cured. Sauvages adds, that none of the moderns ſeem to have obſerved the diſeaſe 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 ſays there is a dejection of a milky liquid of the nature of chyle; but this is treated by Vogel as a vulgar error. He accuſes the moderns of copying from Aretæus, who mentions white fæces as a ſymptom of the diſtemper; from whence authors have readily fallen into the notion that they never appeared of any other colour in 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.

320 Sp. II. Diabetes with *inſipid Urine.*

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 covered with a thick inflammatory cruſt. In one of theſe patients the urine yielded an ounce and a half, and in the other an ounce, of ſaccharine matter from each pound. It had, however, an urinous ſmell, and a ſaline taſte mixed with the ſweet one; and the urine of one fermented with yeaſt, we are told, into "tolerable ſmall-beer." Both theſe patients had a voracious appetite, and perpetual gnawing ſenſe of hunger; as had alſo Dr Dobſon's patient. The inſipid urine of thoſe affected with diabetes has not been examined by phyſicians with ſufficient accuracy to enable us to ſpeak with confidence of its contents.

Cauſes. Theſe are exceedingly obſcure and uncertain; ſpaſms of the nervous ſyſtem, debility, and every thing inducing it, but eſpecially ſtrong diuretics and immoderate venery, have been accuſed as bringing on the diabetes. It has, however, occurred in perſons where none of theſe cauſes could be ſuſpected; nor have the beſt phyſicians been able to determine it.—Diſſections have only ſhown that the kidneys were in an enlarged and lax ſtate. In one of Dr Home's patients who died, they ſmelled ſour; which ſhowed that the urine peculiar to diabetes came from the kidneys, and was not ſent directly from the inteſtines by a retrograde motion of the lymphatics, as ſome imagine.

Prognoſis. The diabetes is rarely cured, unleſs when taken at the very beginning, which is ſeldom done; and in a confirmed diabetes the prognoſis muſt therefore be unfavourable.

Cure. As there is reaſon to believe that in this affection the morbid ſecretion of urine, which is both preternatural in point of quantity and of quality, ariſes from a morbid diminution of tone in the kidney, the great object in the cure muſt be the reſtoration of due tone to the ſecreting veſſels of the kidney. But as even this diminiſhed tone would not give riſe to the peculiar vitiated ſecretion without a morbid ſenſibility of that organ, it is neceſſarily a ſecond object to remove this morbid ſenſibility. But beſides this, the morbid ſecretion of urine may alſo be counteracted both by a diminution of the determination of fluids to the kidney, and by preventing the occurrence of ſuperfluous water in the general maſs of blood.

On theſe grounds the principal hopes of a cure in this diſtemper are from aſtringent and ſtrengthening medicines. Dr Dobſon's patient was relieved by the following remedies; which, however, were frequently varied, as none of them produced their good effects for any length of time: Cinchona in ſubſtance, with ſmall doſes of rhubarb; decoction of the bark, with the acid elixir of vitriol; the cold infuſion of the bark, of which he drank from a quart to two quarts daily; Dover's powder; alum-whey; lime-water; antimonials combined with *tinctura thebaica*. The warm bath was uſed occaſionally when the ſkin was remarkably hot and dry, and the patient complained of reſtleſſneſs and anxiety. The tincture of cantharides was likewiſe tried; but he could never take more than 25 drops for a doſe, without exciting great uneaſineſs in his bowels. The body was kept conſtantly open, either with rhubarb or the infuſion of ſena joined with rhubarb. His common drinks were rice water, barley-water, lime-water, and milk; lime-water alone; ſage, balm, or mint tea; ſmall-beer, ſimple water, and water acidulated with the ſulphuric acid. In ſeven months, theſe remedies, in whatever manner varied, made no further progreſs in removing the diſeaſe. In Dr Home's patients, all theſe medicines, and many others, were tried without the leaſt good effect; inſomuch that he uſes this remarkable expreſſion: "Thus, theſe two patients have exhauſted all that experience had ever recommended, and almoſt all that theory could ſuggeſt; yet in both caſes, the diſeaſe has reſiſted all the means of cure uſed." It is remarkable, that though ſeptics were given to both, in ſuch quantity as evidently to produce a putreſcency in the *primæ viæ*, the urine remained unaltered both in quantity and quality.

But although this diſeaſe be frequently in its nature ſo obſtinate as to reſiſt every mode of cure, yet there can be no doubt that particular remedies have ſucceeded in different caſes. Dr Briſbane relates ſeveral caſes cured by the uſe of tincture of cantharides: and Dr M'Cormick has related ſome in the 9th volume of the Edinburgh Medical Commentaries, which yielded to Dover's powder after a variety of other remedies had been tried in vain.

But of all the modes of cure lately propoſed, that which has been moſt celebrated, is the treatment recommended by Dr Rollo of the Royal Artillery. In a valuable work lately publiſhed, entitled *Caſes of the Diabetes Mellitus*, he has recorded two remarkable examples of the good effects of a peculiar regimen in this diſeaſe. He conſiders diabetes as being a diſeaſe not of the kidney but of the alimentary canal, and as ariſing from the formation of an uncommon quantity of ſugar. He therefore ſtrictly forbids the uſe of every article of diet which can furniſh ſugar, even of bread; and by a diet conſiſting entirely of animal and alkaleſcent food his patients were much benefited. The experience of ſome other practitioners has to a certain degree confirmed the obſervations of Dr Rollo. But we are ſorry to add, that we have met with many other inſtances of diabetes mellitus, in which a diet conſiſting ſolely of animal food, had a fair trial, without producing any material benefit. And we may conclude with obſerving, that the cure of diabetes ſtill remains to be diſcovered. As allaying the exceſſive thirſt, and producing a temporary reſtoration of urinous ſmell, or the urea which it ought naturally to contain, we have found nothing equal in efficacy to a large proportion of fat meat, ſuch as pork ſteaks or butter.

GENUS LXIII. HYSTERIA. 321

HYSTERICS.

Hyſteria, *Sauv.* gen. 135. *Lin.* 126. *Vog.* 219. *Sag.* gen. 242.
Malum hyſtericum, *Hoffm.* III. 50. *Junck.* 36.
Affectio hyſterica, *Willis* de Morb. Convulſiv. cap. 5. 10. 11. *Sydenham* Diſſ. Epiſt. ad G. Cole, *Whytt* on Nervous Diſorders.

Deſcription. The hyſteria is a convulſive diſeaſe, which comes on at uncertain intervals, ſometimes longer and ſometimes ſhorter, but at no ſtated time. The paroxyſms commonly begin with a languor and debility of the whole body; yawning, ſtretching, and reſtleſſneſs. A ſenſe of coldneſs alſo in the extremities, almoſt always precedes, and for the moſt part remains during the whole time of the paroxyſm. To this ſometimes

times ſucceeds a ſenſe of heat; and the two ſenſations alternate with each other in different parts of the body. The face is ſometimes fluſhed and ſometimes pale: and ſometimes the paleneſs and fluſhing come alternately. There is a violent pain in the head; the eyes become dim, and pour out tears; there is a rumbling and inflation of the inteſtines; a ſenſation is felt like that of a globe aſcending from the lower part of the abdomen or hypogaſtrium, which ſometimes ſeems to roll along the whole alimentary canal. It aſcends to the ſtomach, ſometimes ſuddenly, ſometimes ſlowly; and there produces a ſenſe of inflation and weight, together with anxiety, nauſea, and vomiting. At laſt it comes up to the throat, where it produces a ſenſe of ſuffocation, and difficulty of breathing or ſwallowing. During this time there are the moſt violent pains both in the external and internal parts of the abdomen; the muſcles are convulſed; the umbilicus is drawn inwards; and there are frequently ſuch ſpaſms of the inteſtines, that neither clyſters can be injected, nor even flatus paſs downwards. Sometimes the paroxyſm remits after theſe ſymptoms have continued for a certain time, but more frequently the patients fall into fainting fits; ſometimes they lie without motion, as if they were in a deep ſleep; ſometimes they beat their breaſts violently and continually with their hands, and ſometimes they are ſeized with general convulſions, and the diſeaſe puts on the appearance of an epilepſy. In ſome patients the extremities become cold and ſtiff, and the body has the appearance of one in a catalepſy. Sometimes a moſt violent beating pain takes place in ſome part of the head, as if a nail was driven into it, and all viſible objects ſeem to turn round; grievous pains attack the loins, back, and bladder, and the patients diſcharge a ſurpriſing quantity of urine as limpid as water; which laſt is one of the ſureſt ſigns of the diſeaſe. The mind is very much affected as well as the body. Sometimes the patients are tormented with vain fears: ſometimes they will laugh, at other times cry immoderately; and ſometimes their temper becomes ſo peeviſh and fretful, that they cannot enjoy a moment's quiet. The appearances which take place in this affection are indeed ſo much varied, that they can hardly be enumerated: they may, however, with propriety, be divided into hyſteric fits, which very much reſemble thoſe of epilepſy, excepting that they are not attended with an abolition of the internal ſenſes; and hyſteric ſymptoms, ſuch as the *globus hyſtericus*, *clavus hyſtericus*, and the like, which are chiefly known to conſtitute a part of this diſeaſe from being obſerved to alternate with fits.

Cauſes, &c. The general cauſe of hyſteria is thought by the beſt phyſicians to conſiſt in a too great mobility and irritability of the nervous ſyſtem, and of conſequence the diſeaſe may be brought on by whatever debilitates and renders the body irritable. Hence it moſt frequently attacks females of a weak and lax habit of body, though there are ſome inſtances of men alſo attacked by it. It generally comes on between the time of puberty and the age of 35, and makes its attacks during the time of menſtruation more frequently than at any other. It alſo more frequently ſeizes barren women and young widows, than ſuch as are bearing children.

Prognoſis. Though the appearance of this diſeaſe be ſo very terrible, it ſeldom proves mortal unleſs by wrong treatment: but notwithſtanding this, it is extremely difficult of cure, and rarely admits of any thing elſe than being palliated; for though it ſhould ſeem to be conquered by medicine for a time, it very quickly returns, and that from the ſlighteſt cauſes.

Cure. The ends principally to be aimed at in the cure of this diſeaſe are, in the firſt place, the removal of particular convulſive or ſpaſmodic affections immediately producing various appearances in the diſeaſe, whether under the form of proper hyſteric fits, or merely of what may be called hyſteric ſymptoms; and in the ſecond place, the prevention of the return of ſymptoms after they have been removed, by the employment of proper remedies during thoſe intervals from complaints which patients often have when labouring under this affection.

The moſt powerful remedy hitherto diſcovered in hyſteric caſes is opium, or the tincture of it. By this commonly the moſt violent paroxyſms are ſtopped, though it be inſufficient to accompliſh a radical cure. In Dr Home's Clinical Experiments we find an inſtance of a cure performed by veneſection, though this remedy has been generally condemned in hyſterical caſes. Aſafœtida ſeems to ſtand next in virtue to opium; though with ſome it diſagrees, and occaſions pains in the ſtomach and vomiting. Sulphuric æther will alſo frequently remove an hyſteric fit: but its effects are of ſhort duration; and if it do not effect a cure ſoon after its exhibition, no ſervice is to be expected either by perſeverance in the uſe of it or by increaſing the doſe; and with ſome conſtitutions it diſagrees to ſuch a degree as to occaſion convulſions. If the patient be ſeized with a violent fit, ſo that ſhe can ſwallow nothing, which is frequently the caſe, it will be proper to apply ſome ſtrong volatile alkali to her noſe; or if that be not at hand, the vapour of burning feathers is ſometimes very efficacious. In ſome inſtances benefit is derived from the ſudden application of cold water to the face or hands; but ſtill more frequently the application of water in a tepid ſtate, particularly the warm pediluvium, is found to be of very great ſervice in bringing about a favourable termination of different violent hyſteric ſymptoms. A plaſter of galbanum and aſafœtida will alſo prove ſerviceable: but it muſt be remembered, that none of theſe things will prevent the return of the diſeaſe; and therefore a radical cure is to be attempted by exerciſe, cinchona, chalybeates, mineral waters, and other tonics; but particularly, where the ſtate of the patient is ſuch as to be able to bear it, by the uſe of the cold bath, which, where it does not diſagree with the conſtitution, is often of the greateſt ſervice in preventing returns of this affection.

In hyſteria as well as in chorea Dr Hamilton has found, that in ſome inſtances very great benefit has been obtained from copious evacuations of the alimentary canal, by cathartics frequently repeated.

GENUS LXIV. HYDROPHOBIA. 332

The *Dread* of WATER.

Hydrophobia, *Sauv.* gen. 231. *Lin.* 86. *Vog.* 30. *Sag.* gen. 343. *Boerh.* 1138. *Junck.* 124. *Mead* on poiſons. *Deſſault* ſur la rage. *Sauv.* diſſ. ſur la rage. *James* on canine madneſs. *Dalby*, Virtues of cinnabar and muſk againſt the bite of a mad dog. *Nugent* on the hydrophobia. *Choiſel*, Nouvelle methode pour le traitement de la rage. *Journal de Medicine*, paſſim. *Medical Obſ. and Inquiries*, vol. iii. art. 34. vol. v. art. 20. 26. and App. *Med. Tranſact.* vol. ii. art. 5. 12. and 15. *Heyſham*, Diſſ. inaug. de rab. canin. Edinb. 1777. *Parry*, Diſſ. inaug. de rab. contagioſ. ſive canin. Edinb. 1778. *Andry*, Recherches ſur la rage, 1778. *Vaughan*, Caſes of hydrophobia, ſecond edit. 1778. *Arnold*, Caſe of hydrophobia, 1795.

323 Sp. I. *HYDROPHOBIA Rabioſa*, or Hydrophoby conſequent on the *Bite* of a *Mad Animal*.

Hydrophobia vulgaris, *Sauv.* ſp. 1.

It is the opinion of ſome, that Dr Cullen has done wrong in employing the term *hydrophobia* as a generic name, under which canine madneſs is included: and it muſt be allowed, that the dread of water, while it is not univerſal, is alſo a ſymptom occurring only late in the diſeaſe, at leaſt in the greater part of caſes. Perhaps his arrangement would have been leſs exceptionable, if, following Linnæus, he had adopted *rabies* as a generic term, and had diſtinguiſhed this particular ſpecies by the epithet of *canina*, *contagioſa*, or the like. Diſputes, however, about names, are in general not very important; and it is ſufficient to obſerve, that the affection now to be treated of is canine madneſs, or that diſeaſe which ariſes from the bite of a mad animal.

Deſcription. This diſeaſe commonly does not make its attack till a conſiderable time after the bite. In ſome few inſtances it has commenced in ſeven or eight days from the accident; but generally the patient continues in health for 20, 30, or 40 days, or even much longer. The bite, if not prevented, will in general be healed long before that time, frequently with the greateſt eaſe; though ſometimes it reſiſts all kinds of healing applications, and forms a running ulcer which diſcharges a quantity of matter for many days. It has been ſaid, that the nearer the wounded place is to the ſalivary glands, the ſooner the ſymptoms of hydrophobia appear. The approach of the diſeaſe is known by the cicatrix of the wound becoming high, hard, and elevated, and by a peculiar ſenſe of prickling at the part; pains ſhoot from it towards the throat: ſometimes it is ſurrounded with livid or red ſtreaks, and ſeems to be in a ſtate of inflammation; though frequently there is nothing remarkable to be obſerved about it. The patient becomes melancholy, loves ſolitude, and has ſickneſs at ſtomach. Sometimes the peculiar ſymptom of the diſeaſe, *the dread of water*, comes on all at once. We have an inſtance of one who, having taken a vomit of ipecacuanha for the ſickneſs he felt at his ſtomach, was ſeized with the hydrophobia in the time he was drinking the warm water. Sometimes the diſeaſe begins like a common ſore throat; and the ſoreneſs daily increaſing, the hydrophobic ſymptoms ſhow themſelves like a convulſive ſpaſm of the muſcles of the fauces. In others, the mind ſeems to be primarily affected, and they are ſubject to deſpondency and melancholy for ſome time prior to any dread of water. And when that dread commences, it is with an evident mental affection. Dr James, in his Treatiſe on Canine Madneſs, mentions a boy ſent out to fill two bottles with water, who was ſo terrified by the noiſe of the liquid running into them, that he fled into the houſe crying out that he was bewitched. He mentions alſo the caſe of a farmer, who, going to draw ſome ale from a caſk, was terrified to ſuch a degree at its running into the veſſel, that he ran out in a great haſte with the ſpigot in his hand. But in whatever manner this ſymptom comes on, it is certain that the moſt painful ſenſations accompany every attempt to ſwallow liquids. Nay, the bare ſight of water, of a looking-glaſs, of any thing clear or pellucid, will give the utmoſt uneaſineſs, or even throws the patient into convulſions.

With regard to the affection of the mind itſelf in this diſeaſe, it does not appear that the patients are deprived of reaſon. Some have, merely by the dint of reſolution, conquered the dread of water, though they never could conquer the convulſive motions which the contact of liquids occaſioned: while this reſolution has been of no avail; for the convulſions and other ſymptoms increaſing, have almoſt always deſtroyed the unhappy patients.

In this diſeaſe there ſeems to be an extreme ſenſibility and irritability of the nervous ſyſtem. The eyes cannot bear the light, or the ſight of any thing white; the leaſt touch or motion offends them, and they want to be kept as quiet and in as dark a place as poſſible. Some complain of the coldneſs of the air, frequently when it is really warm. Others complain of violent heat; and have a great deſire for cold air, which yet never fails to increaſe the ſymptoms. In all there is a great flow of viſcid ſaliva into the mouth; which is exceedingly troubleſome to the patients, as it has the ſame effect upon their fauces that other liquids have. This therefore they perpetually blow off with violence, which in a patient of Dr Fothergill's occaſioned a noiſe not unlike the hollow barking of a dog, and which he conjectures might have given riſe to the common notion that hydrophobous patients bark like dogs. They have an inſatiable thirſt; but are unable to get down any drink, except with the utmoſt difficulty; though ſometimes they can ſwallow bread ſoaked in liquids, ſlices of oranges, or other fruits. There is a pain under the *ſcrobiculus cordis*, as in the tetanus; and the patients mournfully point to that place as the ſeat of the diſeaſe. Dr Vaughan is of opinion that it is this pain, rather than any difficulty in ſwallowing, which diſtreſſes the patient on every attempt to drink. The voice is commonly plaintive and mournful; but Dr Vaughan tells us there is a mixture of fierceneſs and timidity in the countenance which he cannot deſcribe, but by which he could know a hydrophobous perſon without aſking any queſtions.

In this diſtemper, indeed, the ſymptoms are ſo various, that they cannot be enumerated; for we will ſeldom read two caſes of hydrophobia which do not differ very remarkably in this reſpect. Some ſeem to have at times a furious delirium, and an inclination to ſpit at or bite the byſtanders; while others ſhow no ſuch inclination, but will even ſuffer people to wipe the inſide of their mouths with the corner of a handkerchief in order to clear away the viſcid ſaliva which

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is ready to ſuffocate them. In ſome male patients there is an involuntary erection of the penis, and emiſſion of the ſemen; and the urine is forced away by the frequent return of the ſpaſms. In a letter from Dr Wolf of Warſaw to Henry Baker, F. R. S. dated Warſaw Sept. 26th, 1767, we have the following melancholy account of the caſes of five perſons who died of the hydrophobia: "None of them quite loſt their right ſenſes; but they were all talking without intermiſſion, praying, lamenting, deſpairing, curſing, ſighing, ſpitting a frothy ſaliva, ſcreeching, ſometimes belching, retching, but rarely vomiting. Every member is convulſed by fits, but moſt violently from the navel up to the breaſt and œſophagus. The fit comes on every quarter of an hour; the fauces are not red, nor the tongue dry. The pulſe is not at all feveriſh; and when the fit is over nearly like a ſound pulſe. The face grows pale, then brown, and during the fit almoſt black; the lips livid; the head is drowſy, and the ears tingling; the urine limpid. At laſt they grow weary; the fits are leſs violent, and ceaſe towards the end; the pulſe becomes weak, intermittent, and not very quick; they ſweat, and at laſt the whole body becomes cold. They compoſe themſelves quietly as if to get ſleep, and ſo they expire. The blood drawn a few hours before death appears good in every reſpect. A general obſervation was, that the lint and dreſſings of the wounds, even when dry, were always black, and that when the pus was very good in colour and appearance." In one of Dr Wolf's patients who recovered, the blood ſtunk intolerably as it was drawn from a vein; and one of Mr Vaughan's patients complained of an intolerable fetid ſmell proceeding from the wounded part, though nobody but himſelf could perceive it. In general, the violent convulſions ceaſe a ſhort time before death; and even the hydrophobia goes off, ſo that the patients can drink freely. But this does not always happen; for Mr Vaughan mentions the caſe of a patient, in whom, "when he had in appearance ceaſed to breathe, the ſpaſmus cynicus was obſervable, with an odd convulſive motion in the muſcles of the face; and the ſtrange contrariety which took place in the action of theſe produced the moſt horrid aſſemblage of features that can well be conceived. Of this patient alſo it was remarkable, that in the laſt hours of his life he ceaſed to call for drink, which had been his conſtant requeſt; but was perpetually aſking for ſomething to eat."

The hydrophobia ſeems to be a ſymptom peculiar to the human race; for the mad animals which communicate the infection, do not ſeem to have any dread of water. Dr Wolf, in the letter above quoted, ſays in general, that cattle bit at the ſame time and by the ſame animal (a mad wolf) which bit the perſons whoſe caſes he related, died nearly with the ſame frightful raging as the men; but ſays nothing of their having any hydrophobia: nay, Dr James and ſome others aſſert, that the hydrophobia is not always an attendant on rabies canina in the human race; and indeed it is certain that the diſeaſe has proved mortal after this terrible ſymptom has been removed. With regard to the ſymptoms of madneſs in dogs, they are very equivocal; and thoſe particularly enumerated by ſome authors, are only ſuch as might be expected in dogs much heated or agitated by being violently purſued and ſtruck. One ſymptom indeed, if it could be depended upon, would determine the matter; namely, that all other dogs avoid and run away from one that is mad; and even large dogs will not attack one of the ſmalleſt ſize who is infected with this diſeaſe. Upon this ſuppoſition they point out a method of diſcovering whether a dog who has been killed was really mad or not; namely, by rubbing a piece of meat along the inſide of his mouth, and then offering it to a ſound dog. If the latter eats it, it is a ſign the dog was not mad; but if the other rejects it with a kind of howling noiſe, it is certain that he was. Dr James tells us, that among dogs the diſeaſe is infectious by ſtaying in the ſame place; and that after a kennel has been once infected, the dogs put into it will be for a conſiderable time afterwards in danger of going mad alſo. A remedy for this, he ſays, is, to keep geeſe for ſome time in the kennel. He rejects as falſe the opinion that dogs when going mad will not bark; though he owns that there is a very conſiderable change in their bark, which becomes hoarſe and hollow.

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Of all the accounts that have been publiſhed on the characteriſtics of rabies in dogs, the beſt is to be found in Dr Arnold's late treatiſe: the characteriſtics there mentioned are given on the authority of Mr Meynell, a gentleman who has paid particular attention to this ſubject. From Mr Meynell's obſervations it appears, that moſt of the characteriſtics which have been commonly mentioned, are mere vulgar errors; and, according to him, the beſt marks are from their peculiar dull look, and the peculiar ſound which they utter. "Mad dogs (ſays Mr Meynell) never bark, but occaſionally utter a moſt diſmal and plaintive howl, expreſſive of extreme diſtreſs, and which, they who have once heard it, can never forget; ſo that dogs may be known to be going mad without being ſeen, when only this diſmal howl is heard.

Cauſes, &c. In no diſeaſe whatever are we more at a loſs to diſcover the cauſes than in the hydrophobia. In dogs, foxes, and wolves, it ſeems to come on ſpontaneouſly; though this is conteſted by ſome authors. It is ſaid, that the cauſes commonly aſſigned, viz. heat, feeding upon putrid fleſh, want of water, &c. are not ſufficient for producing the diſtemper. It does not appear that madneſs is more frequent among dogs in the warm than in the cold climates; nay, in the iſland of Antigua, where the climate is very hot, and the water very ſcarce, this diſtemper has never, it is ſaid, been obſerved. As to putrid aliment, it ſeems natural for dogs to prefer this to any other, and they have been known to ſubſiſt upon it for a long time without any detriment. For theſe reaſons, they think the diſeaſe ariſes from a ſpecific contagion, like the ſmallpox and meaſles among the human race, which, being once produced by cauſes unknown, continues to be propagated by the intercourſe which dogs have with each other, as the diſeaſes juſt mentioned continue to be propagated among the human race.

With regard to the immediate cauſe among mankind, there is not the leaſt doubt that the hydrophobia is occaſioned by the ſaliva of the mad animal being mixed with the blood. It does not appear that this can operate through the cuticula; but, when that is rubbed off, the ſmalleſt quantity is ſufficient to communicate

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municate the diſeaſe, and a ſlight ſcratch with the teeth of a mad animal has been found as pernicious as a large wound. It is certain alſo, that the infection has been communicated by the bites of dogs, cats, wolves, foxes, weaſels, ſwine, and even cocks and hens, when in a ſtate of madneſs. But it does not appear that the diſtemper is communicable from one hydrophobous perſon to another, by means of the bite, or any other way. Dr Vaughan inoculated a dog with the ſaliva of a hydrophobous child, but the animal continued free from diſeaſe for two months: and though the doctor promiſed to inform the public if it ſhould happen to occur afterwards, nothing has hitherto appeared on that ſubject. A nurſe alſo frequently kiſſed the child during this time of his diſorder, but no bad conſequence enſued.

When we attempt to inveſtigate the nature of the cauſe of the hydrophobia by diſſections, our inquiries are commonly diſappointed. In two bodies opened by Dr Vaughan, there was not the leaſt morbid appearance; in the very fauces, where we might have expected that the diſeaſe would have ſhown itſelf moſt evidently, there was not the leaſt appearance even of inflammation. The ſtomach, inteſtines, diaphragm, œſophagus, &c. were all in a natural ſtate: neither do we find in authors of credit any certain accounts of morbid appearances in the bodies of hydrophobous perſons after death. Dr Vaughan therefore concludes, that the poiſon acts upon the nervous ſyſtem; and is ſo wholly confined to it, that it may be doubted whether the qualities of the blood are altered by it or not; and that it acts upon the nerves by impairing and diſturbing their functions to ſuch a degree as ſpeedily to end in a total extinction of the vital principle. As to the difficulty in ſwallowing generally believed to accompany dread of the water, he treats it as a miſrepreſentation, as well as that the œſophagus with the muſcles ſubſervient to deglutition are eſpecially concerned in this diſeaſe. The principal foundation of the evil, he thinks, reſts on a morbid ſenſibility both of the external and internal fauces. For the ſight of a liquid, or the application of any ſubſtance to the internal fauces, but more eſpecially of a fluid, inſtantly excites the moſt painful feelings. Nay, the ſame ſymptoms are produced by touching the external fauces with a fluid, or by the contact of cold air with theſe parts; and nearly in as great a degree. But a ſolid or fluid ſubſtance being conveyed into the œſophagus, the tranſit into the ſtomach is accompliſhed with little or no impediment; ſo that in fact the difficulty is ſurmounted before the patient is engaged in the action of ſwallowing. Nor is the excruciating pain, which never fails to be the companion of every attempt to drink, felt in the *fauces* and *throat*: it is, he ſays, at the *ſcrobiculus cordis*; to which the ſufferer applies his hand. From this laſt circumſtance, therefore, from the preſence of the *riſus ſardonicus*, from the muſcles of the abdomen being forcibly contracted, and from the ſenſe of ſuffocation which ſeems to threaten the patient with immediate death, Dr Vaughan has been led to think that in the hydrophobia a new ſympathy was eſtabliſhed between the fauces, the diaphragm, and the abdominal muſcles.

Prognoſis. When a perſon is bit, the prognoſis with regard to the enſuing hydrophobia is very uncertain. All thoſe who are bit do not fall into the diſeaſe; nay, Dr Vaughan relates, that out of 30 bit by a mad dog, only one was ſeized with the hydrophobia. During the interval betwixt the bite and the time the diſeaſe comes on, there are no ſymptoms by which we can judge whether it will appear or not. When once it has made its appearance, the prognoſis is exceedingly fatal, though there are certainly ſome well authenticated caſes of complete recovery, particularly one recorded by Dr Arnold.

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Prevention and Cure. It has been generally allowed by practitioners, that though the hydrophobia may be prevented, yet it can ſeldom if ever be cured after it has made its appearance. The moſt eſſential part of the treatment therefore depends on the proper uſe of means of prevention. The great objects to be aimed at in prevention, are, in the firſt place, the complete removal of the contagious matter as ſoon as poſſible; or, ſecondly, means of deſtroying it at the part, where there is even the ſlighteſt reaſon to believe that it has not been completely removed. Of all the means of removal, the complete cutting out the part to which the tooth has been applied, is unqueſtionably the moſt to be depended upon. This practice, therefore, ſhould be had recourſe to as ſoon as poſſible. The ſooner it can be accompliſhed, the better. But it has been obſerved, that as a peculiar ſenſation at the part affected always precedes the acceſſion of the diſeaſe, even when it takes place at a late period after the bite, there is good ground for believing that the removal of the part may be of advantage even after a conſiderable interval. But beſides removal of the contagious matter, by cutting away the part to which it is attached, this ſhould alſo be attempted by careful and long-continued waſhing. This may be done, in moſt inſtances, before a proper opportunity can be had of having recourſe to the knife. Cold water ſhould particularly be poured upon the wound from a conſiderable height, that the matter may be waſhed away with ſome force. Even after removal by the knife, careful waſhing is ſtill a neceſſary and proper precaution. And after both theſe, to prevent as far as can be the poſſibility of any contagious matter lurking about the wounded part, it ſhould not be allowed to heal, but a diſcharge of matter ſhould be ſupported for the ſpace of ſeveral weeks, by ointment with cantharides, or ſimilar applications. By theſe means there is at leaſt the beſt chance of removing the matter at a ſufficiently early period. And this mode of prevention ſeems to be of more conſequence than all others put together which have hitherto been diſcovered. But beſides removal, prevention may alſo be obtained by the deſtruction of the contagious matter at the part; and where there is the leaſt reaſon to think that a complete removal has not been obtained, this ſhould always be had recourſe to. With this intention the actual cautery and burning with gun-powder have been employed. And the action of fire is probably one of the moſt powerful agents that can be uſed for this purpoſe. But recourſe has alſo been had to waſhing both with acids and with alkalies. Of the former kind, vinegar has been chiefly uſed, but more may probably be expected from the latter; and particularly from the cauſtic alkali, ſo far diluted that it can be applied with ſafety: for from its influence as a ſolvent of animal mucus, it gives the

Specifi. the beſt chance of a complete removal of the matter, independent of any influence in changing its nature. It has been thought alſo, that oil applied to the part may be of ſervice. But if recourſe be had to it, more active meaſures ſhould at leaſt be previouſly employed; and even then, ſome are of opinion that it is of advantage to increaſe the activity of the unctuous matter by combining it with mercury.

On theſe grounds, and by theſe means, we are inclined to think that the action of this contagion on the ſyſtem, after it has been applied by the bite of a rabid animal, may be moſt effectually prevented. But after this action has once taken place, no remedy has yet been diſcovered on which much dependence can be put. A very great variety of articles indeed have at different periods been held forth as infallible, both in the prevention and cure of this affection; but their reputation has, perhaps, univerſally been founded on their being given to people, who, though really bit by a mad dog, were yet not infected with the contagion. And this happily, either from the tooth being cleaned in making the bite, or not being covered with contagious matter, is by no means an unfrequent occurrence. Mankind, however, even from the earlieſt ages, have never been without ſome boaſted ſpecific, which has been held forth as an infallible remedy for this affection till fatal experience demonſtrated the contrary. Dr Boerhaave has given a pretty full catalogue of thoſe ſpecifics from the days of Galen to his own time; and concludes, that no dependence is to be put in any of them. It is now, therefore, altogether unneceſſary to take notice of burnt crabs, the hyæna's ſkin, mithridate with tin, liver of the rabid animal, or a variety of other pretended remedies for this diſeaſe, proved by experience to be totally inefficacious. But although no greater confidence is perhaps to be put in ſpecifics of modern date, it will be proper that theſe ſhould be mentioned.

Bathing in cold water, eſpecially in the ſea, and drinking ſea-water for a certain time, have been preſcribed, and by ſome accounted a certain preventive. When this was known to fail, a long courſe of antiphlogiſtic regimen, violent ſubmerſion in water, even to danger of drowning, and keeping the wounded place open with cauteries, were recommended.—To this extreme ſeverity Dr Mead objected; and in his treatiſe on this ſubject endeavours to ſhow, that in all ages the greateſt ſucceſs has been reaped from diuretics, for which reaſon he propoſes the following powder: "Take aſh-coloured ground-liverwort, half an ounce; black-pepper, two drams: reduce them ſeparately to powder, then mix them together." This powder was firſt publiſhed in the Philoſophical Tranſactions, by Mr Dampier, in whoſe family it had been kept as a ſecret for many years. But this medicine, which was inſerted in former editions of the London and Edinburgh pharmacopœias, under the name of *Pulvis Antilyſſus*. has long loſt its credit.

There is a famous Eaſt India medicine, compoſed of 24 grains of native and as much factitious cinnabar, made into a powder with 16 grains of muſk. This is called the *Tonquin* medicine, and muſt be taken in a tea cupful of arrac or brandy; and is ſaid to ſecure the patient for 30 days, at the expiration of which it is to be repeated; but if he has any ſymptoms of the diſeaſe, it muſt be repeated in three hours, which is ſaid to be a ſufficient for a cure. The firſt doſe is to be taken as ſoon after the bite as poſſible. Hydrophobia.

Another celebrated remedy is Palmarius's powder, compoſed of the leaves of rue, vervain, ſage, polypody, wormwood, mint, mugwort, balm, betony, St John's-wort, and leſſer centaury. Theſe herbs muſt be gathered in their prime, dried ſeparately in the ſhade, and then powdered. The doſe is a dram, or a dram and an half, taken every day.

A remedy which might promiſe to be more efficacious than any of thoſe hitherto mentioned is mercury. This has been recommended in frictions, and to be taken inwardly in the form of calomel and turbith mineral, in order if poſſible to raiſe a ſlight ſalivation, on which the efficacy was thought to depend. Beſides this, veneſection, opium, cinchona, and camphor, have been tried in very large quantities; the warm bath; and, in ſhort, every thing which human invention could ſuggeſt; but with how little ſucceſs, can be judged from many well authenticated caſes.

Dr Wolf, after detailing a number of intereſting caſes, makes the following obſervations.—"Thus we ſee, that the mercury, the acids, the muſk, the feeding on the moſt famous herbs, the ſweating, the *cura antiphlogiſtica*, &c. are no ſpecifics."

The following caſe by Dr Raymond of Marſeilles ſhows the inefficacy of mercury even as a *preventive.*—On the 19th of July 1765, Mr Boyer, aged 25, of a bloated cachectic habit, was bit by a mad dog in the inferior part of the leg: the wound extended half way round, bled freely, and was like a great ſcratch. The patient's legs had been ſwelled for a conſiderable time before the accident; and there were alſo two ulcers in the other leg. Some hours after the accident, the actual cautery was applied to the wound. The doctor was not preſent at this operation; but the part around the bite was rubbed with mercurial ointment immediately after, and the eſchar was dreſſed with the ſame ointment. The eſchar was ſeparated on the firſt day, but the dreſſing was continued till the wound was cicatriſed. The ſecond day a bolus of four grains of turbith and eight grains of camphor was exhibited. This procured a conſiderable evacuation both by vomit and ſtool, and a ſpitting alſo came on. The third day the bitten leg was rubbed with mercurial ointment: in the ſpace of a month the frictions were repeated five times on both legs, three drams of mercurial ointment being uſed in each friction. During the ſame time the bolus was five times repeated; and this treatment kept up a ſlight ſalivation to the 40th day. The evening of the third day he took the *Tonquin medicine*, called alſo *Sir George Cobb's powder*, in a bolus; which vomited him briſkly. This powder was repeated ſeven or eight times in the month, generally with the ſame effect. During the firſt ſeven or eight days he got four times, in the morning, a dram of the *anagallis flore puniceo*, freſh gathered and powdered. The 41ſt day, the turbith bolus was preſcribed for the ſeventh time: he was bathed in the ſea, and continued the bathing for two days more. On the 74th he was ſeized with the diſtemper; and died on the 76th, ſeemingly ſuffocated or ſtrangled, his mouth covered with ſlaver, and his face bloated. He loſt his ſenſes not above half a quarter of an hour before his death. The pulſe was quiet the whole time.

Another inſtance is mentioned by the ſame author, of a pregnant woman bit by the ſame dog and on the ſame day with Mr Boyer, who was never ſeized with the diſtemper. She was treated in much the ſame manner with him, and ſalivated a little more. But ſhe was bit through a ſhamoy leather ſhoe, which muſt neceſſarily have cleaned the animal's teeth of the poiſonous ſaliva before they reached her ſkin, and to this we are naturally led to aſcribe her ſafety, One of Dr Wolf's patients alſo was a pregnant woman, and was not ſeized with the diſtemper. Perhaps women in a ſtate of pregnancy may be leſs liable to this diſtemper than others; but it is more probable that the contagion was not communicated.

The ſame author tells us, "there are many examples of the inefficacy of mercurial frictions. A ſurgeon of Marſeilles treated a girl about 12 years of age bit by a mad dog, with mercurial frictions; applying them as in the *lues venerea:* yet ſhe died of the hydrophobia on the 55th day. Her wound was not cauterized."

In the following caſe all the moſt powerful remedies were tried.—In the afternoon of the 29th of Aug. 1777, Dr Vaughan was called to a boy of eight years of age labouring under a hydrophobia. He had been bit on the wriſt by a cat about a month before; of which the marks remained, but without any ulcer, or even the ſmalleſt appearance of inflammation. About the middle of the day before Dr Vaughan ſaw him, he began to complain of a pain in the part bitten, which aſcended up the arm, and affected the temple on that ſide; ſoon after which he ſwallowed liquids with reluctance and difficulty. He was put into the warm bath for three quarters of an hour, during which time he was eaſier: he had a clyſter of five ounces of freſh broth, and 30 drops of laudanum, injected immediately after his coming out of it; a liniment conſiſting of three drams of ſtrong mercurial ointment, with the ſame quantity of oil of amber, was rubbed upon the ſhoulders and back; two pills of a grain of flowers of zinc, and half a grain of *cuprum ammoniacum*, were taken every three or four hours: and a medicated atmoſphere was prepared for him, by burning gum ammoniac in his room. As theſe remedies were not attended with any good effect, each doſe of pills was ordered to contain two grains of *cuprum ammoniacum*, the ſame quantity of opium, three grains of flowers of zinc, and ten grains of aſafœtida; whilſt a ſolution of that fetid gum, with a dram of laudanum, was adminiſtered as a clyſter. Theſe pills, though repeated every four hours, afforded not the ſmalleſt relief, nor did they ſhow the leaſt action on the frame. At laſt the doctor reſolved to put in practice the deſperate remedy mentioned by Van Helmont, of throwing the patient into cold water, and keeping him there till he is almoſt drowned. With this view a large tub of cold water, well ſaturated with common ſalt, was prepared, into which the poor boy was plunged over head and ears, and there held until he ceaſed to ſtruggle. He was then taken out again, and the ſame operation repeated until he became ſo quiet that the doctor was under apprehenſions that a total extinction of life would take place. He was then wrapped up in a blanket and put to bed, and he remained more quiet than he had formerly been; but all his former reſtleſsneſs ſoon returned, his pulſe ſunk, and he died about two o'clock in the morning.

Another celebrated antidote againſt the poiſon of a mad dog has been known for ſome years by the name of the *Ormſkirk medicine*. The true compoſition of this is kept a ſecret by the proprietors: however, it has been analyſed, and the following compoſition publiſhed by Dr Heyſham as perfectly ſimilar to it in all reſpects.

"Take half an ounce of chalk, three drams of Armenian bole, 10 grains of alum, one dram of elecampane in powder; mix them all together, and add ſix drops of oil of aniſe."

They muſt certainly be very credulous who can put confidence in ſuch an inſignificant medicine as a preſervative againſt the hydrophobia: however, there is a poſſibility that there may be ſome unknown ingredient in the genuine powder; for it is difficult to analyſe powders after the ingredients are thoroughly mixed together. The efficacy of the medicine therefore muſt depend on the virtues of that unknown ingredient, if any ſuch there be. The following, caſes, however, too well determine that it is not *infallible*, as was at firſt pretended. In all probability, as well as many others, its reputation alſo is ſolely reſted on its being exhibited in many caſes where no contagion was communicated to the perſon bit, and while of courſe no diſeaſe could take place.

On the 14th of February 1774, Mr Bellamy of Holborn, aged 40, was bit by a cat affected with rabies, which was killed the ſame morning. The following day he took the celebrated Ormſkirk medicine, ſold by Hill and Berry in Hill-Street, Berkeley-Square, and conformed in every reſpect to the directions given by the vender. A ſervant maid, who was bitten in the leg before her maſter was bitten, likewiſe took the ſame remedy. About the middle of April Mr Bellamy complained of a pain in his right knee, which he ſuppoſed to be rheumatic, and which continued and increaſed till the 7th of June, when he got ſome pills of calomel, ipecacuanha, and *pil. ſapon.* from an apothecary, with Huxham's tincture of the bark in ſmall doſes. In ſix days more he had a titillation in the urethra, a contraction of the ſcrotum and penis to a degree of pain, and an emiſſion of ſemen after making water, to which he had frequent calls. The medicines were diſcontinued; and on the 16th of that month the hydrophobia came on, and Dr Fothergill was called. Six ounces of blood were taken from his arm, and a bolus of a ſcruple of native cinnabar and half a ſcruple of muſk was given every four hours. The diſtemper manifeſtly increaſed through the day. In the evening a clyſter was injected, and ſeveral times repeated during the night; he had been put into the warm bath, and two drams of ſtrong mercurial ointment rubbed into his legs and thighs by himſelf. He was greatly relieved by the warm bath while he continued in it, but the ſymptoms returned with increaſed violence in the night. The next day being greatly worſe, he was blooded to as great a quantity as he could bear, had the warm bath and clyſters repeated, and half an ounce of mercurial ointment rubbed into his thighs and legs. Pills of opium were preſcribed, but he did not take them. He died the ſame night, at half an hour after 12. This patient was a man of great reſolution, and could in part conquer his averſion at water. He ſeemed to have totally forgot the accident of the bite: and caſually ſaid, that he thought this diſorder reſembled the hydrophobia, without ſuppoſing that he was afflicted with that diſtemper at the time.—The bite on the girl's leg refuſed to heal, baffled the art of a young ſurgeon who attempted to cure it, and continued a running ulcer for a long time. She did not fall into the hydrophobia. Hence Dr Fothergill thinks it probable, that keeping the wounds made by the teeth of mad animals open for a long time, would probably be of ſervice as a preventive; but in ſome of Dr Wolf's patients, theſe artificial drains appear not to have been attended with ſucceſs.

On the 16th of November 1773, Thomas Nourſe, a ſtrong healthy boy of 14, was admitted into the Leiceſter infirmary; having been that day month bitten by a mad fox-hound. The wound was a large lacerated one on the cheek, and bled very freely on being inflicted. The day after he was bit he went to the ſea, where he was dipped with all the ſeverity uſually practiſed under ſo diſagreeable an operation. The *Ormſkirk medicine* was alſo adminiſtered with all due care. It was bought of the perſon in Leiceſter who is deputed by the proprietor to ſell it for him. A common adheſive plaſter was applied to the part after ſea-bathing; and in the courſe of a month, without any further trouble, the wound was healed; excepting a ſmall portion, ſomewhat more than an inch in length, and in breadth about one-tenth. This yielded no diſcharge, and was quite in a cicatrizing ſtate. Five days before his admiſſion into the infirmary, he began to complain of a tightneſs over his temples, and a pain in his head: in two days the hydrophobia began to appear; and at its commencement he complained of a *boiling heat* in his ſtomach, which was continually aſcending to the fauces. The diſeaſe was pretty ſtrong when he came to the infirmary. He got a bolus of a ſcruple of muſk with two grains of opium; then a compoſition of 15 grains of muſk, one of turbith mineral, and five grains of opium, was directed to be taken every third hour; an ounce of the ſtronger mercurial ointment was to be rubbed on the cervical vertebræ and ſhoulders, and an embrocation of two ounces of laudanum, and half an ounce of *acetum ſaturninum*, was directed to be applied to the throat. But by this laſt he was thrown into convulſions, and the ſame effect followed though his eyes were firſt covered with a napkin. The embrocation was therefore changed for a plaſter of three drams of powdered camphor, half an ounce of opium, and ſix drams *confectio Damocritis*. By theſe medicines the diſeaſe ſeemed to be ſomewhat ſuſpended, but the ſymptoms returned with violence in the evening. His medicine was repeated at ſeven; and at eight five grains of opium were exhibited without muſk or turbith. At nine, another ounce of mercurial ointment was rubbed upon the ſhoulders, and half an ounce of laudanum with ſix ounces of mutton-broth was injected into the inteſtines, but to no purpoſe. A larger doſe of opium was then given, but with as little effect as the former, and he died the ſame night.

In the month of September 1774, a farmer, aged 25, was bit by a mad dog, whoſe teeth made a ſlight wound in the fore finger of the left hand. He was dipped, as uſual, in the ſea; and drank the ſea-water for ſome time on the ſpot, which operated briſkly as a purge. He continued well till the 6th of June following, when he firſt felt a pain in that hand and arm; for which he bathed in a river that evening, ſuppoſing that it had been a rheumatic complaint. The next day he was ſick; and in the evening was ſeized with a violent vomiting, which continued all that night and till the middle of the next day, when it was ſucceeded by the hydrophobia. He was treated with the warm bath; had a purgative clyſter injected; and as ſoon as it had operated, a ſecond was given, conſiſting of four ounces of oil, and half an ounce of laudanum: half an ounce of ſtrong mercurial ointment was rubbed on the fauces, and the part was afterwards covered with the *cataplaſma è cymino*, to which was added an ounce of opium. An embrocation was applied to the region of the ſtomach with continued friction, conſiſting of half an ounce of ſpirit of ſal ammoniac, ten drams of olive oil, ſix drams of oil of amber, and ten drams of laudanum. Two ounces of ſtrong mercurial ointment were rubbed upon the ſhoulders and back; and as a further means of inducing a ptyaliſm ſpeedily, he received the ſmoke of cinnabar into the mouth by throwing a dram of that ſubſtance now and then upon a hot iron: he was alſo directed to take every four hours a bolus of 15 grains of muſk, three grains of turbith mineral, and four grains of opium. He was eaſier while in the warm bath, and during the application of the ointment; but died the ſame night about two o'clock.

Many other inſtances might be adduced of the inefficacy of this pretended ſpecific: which will, it is hoped, create a due degree of caution in thoſe to whom they who are ſo unfortunate as to be bit by a mad animal may commit themſelves. Another remedy may alſo be mentioned as having had the reputation of being ſometimes ſucceſsful in this diſeaſe; which is chiefly employed in different parts of India, particularly in the territory of Tanjore. The medicine to which we now allude contains indeed ſeveral articles which are altogether unknown in our materia medica: but it contains at leaſt one very powerful ſubſtance well known to us, viz. arſenic. This medicine, known by the name of the Snake Pills, as being principally employed againſt the bite of the moſt venomous ſnakes, is directed to be prepared in the following manner:

Take white arſenic, of the roots of nelli navi, of nevi viſham, of the kernels of the ner valum, of pepper, of quickſilver, each an equal quantity. The quickſilver is to be rubbed with the juice of the wild cotton till the globules are perfectly extinguiſhed. The arſenic being firſt levigated, the other ingredients, reduced to a powder, are then to be added, and the whole beat together with the juice of the wild cotton to a conſiſtence fit to be divided into pills.

Though theſe pills are principally uſed againſt the bite of the cobra de capello, yet they are ſaid alſo to be ſucceſsful in the cure of other venomous bites; and, for the prevention of rabies canina, one is taken every morning for ſome length of time. Of this remedy European practitioners have, we believe, as yet no experience; and if, in the accounts tranſmitted by Eaſt India practitioners, it cannot be ſaid that we have authentic evidence of its want of ſucceſs, it can as little be pretended that there is indubitable evidence of its efficacy in any inſtance; and it is by no means improbable, that it will be found equally inefficacious with others at one time conſidered as infallible.

Of the great variety of remedies which have had their day of reputation, there is not one which has not poſſeſſed the credit, ſome time or other, of preventing the noxious effects ariſing from the bite of a mad dog. A more adequate experience has with all of them diſcovered the deception. It was above obſerved, that rabies is by no means the infallible conſequence of being bit by a mad animal; and that of between 20 and 30 perſons who were bit by the dog which gave the fatal wound to one of Dr Vaughan's patients, not one felt the leaſt ill effect but himſelf. "In the above number (ſays the doctor) were ſome who took the Ormſkirk medicine; others went to the ſalt water; and a part of them uſed no remedy, who yet fared equally well with the moſt attentive to their injury. The ſame thing has often happened before; and much merit, I doubt not, has been attributed to the medicine taken, from that celebrated one of *Sir George Cobb* down to the *infallible* one which my good *Lady Bountiful*'s receipt-book furniſhes."

From all that has been ſaid, the reader will judge how far the hydrophobia is capable of being ſubdued by any of the medicinal powers which have yet been tried. Some eminent phyſicians aſſert that it is totally incurable; and allege that the inſtances recorded by different authors of its cure have not been the genuine kind, but that which comes on ſpontaneouſly, and which is by no means ſo dangerous. Indeed two of Dr Wolf's patients recovered, where the diſeaſe ſeems to have been perfectly genuine: but in theſe the poiſon ſeemed to vent itſelf partly on ſome other place beſides the nervous ſyſtem. In one the blood was evidently infected, as it had an abominable fœtor; and the other had a violent pain and ſwelling in the belly. In all the others, it ſeemed to have attacked only the nervous ſyſtem; which perhaps has not the ſame ability to throw off any offending matter as the vaſcular ſyſtem.

There is, however, a poſſibility that the prodigious affections of the nerves may ariſe only from a vitiated ſtate of the gaſtric juices; for it is well known, that the moſt terrible convulſions, nay the hydrophobia itſelf, will ariſe from an affection of the ſtomach, without any bite of a mad animal. This ſeems to be ſomewhat confirmed from one of Dr Wolf's patients, who, though he vomited more than 50 times, yet ſtill threw up a frothy matter, which was therefore evidently ſecreted into the ſtomach, juſt as a continual vomiting of bilious matter ſhows a continual and extraordinary ſecretion of bile. Dr Wolf himſelf adopts this hypotheſis ſo far as to ſay, that perhaps the *ſerum* may become frothy; but in blood drawn from a vein not the leaſt fault appears either in the ſerum or craſſamentum. He affirms, however, that the duodenum appears to be one of the parts firſt and principally affected; and as it is not inflamed, it would ſeem that the affection it ſuſtains muſt ariſe from the vitiated ſtate of its juices.

Be this as it will, however, in the hydrophobia, the ſtomach ſeems totally, or in a great meaſure, to loſe the power which at other times it poſſeſſes. Two grains of *cuprum ammoniacum* were repeatedly given to a child of eight years of age without effect; but this doſe would occaſion violent vomiting in a ſtrong healthy man. Something or other therefore muſt have prevented this ſubſtance from acting on the nervous coat of the ſtomach; and this we can only ſuppoſe to have been the exceedingly diſordered ſtate of the gaſtric juice, which occaſioned ſuch violent irritation through the whole body, that the weaker ſtimulus of the medicine was entirely loſt. It would ſeem proper therefore to conſider the ſtomach in hydrophobic caſes as really containing a poiſonous matter, which could not be expelled by vomiting, becauſe it is renewed as faſt as evacuated. The indication therefore muſt be, to change its nature by ſuch medicines as are certainly more powerful than the poiſon; and this indication will naturally lead us to think of large doſes of alkaline ſalts. Theſe, it is certain, will deſtroy any animal ſubſtance with which they come in contact, and render even the poiſon of ſerpents inactive. By exhibiting a few doſes of them, larger no doubt than what could be ſafely done on other occaſions, we would be certain to change the ſtate of the ſtomachic juices; and thus might free the patient from thoſe intolerable ſpaſms which always occaſion death in ſuch a ſhort time. Dr Wolf ſeems inclined to think that volatile alkalies were of ſervice; but the above hypotheſis would incline us to uſe rather the fixed kind. At any rate, it ſeems vain for phyſicians to truſt much to the power of opium, mercury, muſk, or cinnabar, either ſingly or combined in any poſſible way. Cinchona has alſo failed, and the moſt celebrated ſpecifics have been found ineffectual. Alkalies are the next moſt powerful remedies which the *materia* medica affords, and they cannot be more unſucceſsful than the others have generally been.

Another remedy which ſeems adapted to change the nature of the gaſtric juices is ardent ſpirits. In one of Dr Wolf's patients two bottles of brandy ſeem to have effected a cure. The oil mixed with it was of no efficacy in other caſes, and the opium and turbith ſeem not to have been exhibited till the worſt was paſt. In this caſe the diſeaſe ſeems to have attacked the vaſcular as well as the nervous ſyſtem.

In all the patients the warm bath ſeems to have been a palliative, and a very powerful one, and as ſuch it ought never to be omitted, though we can by no means truſt to it as a radical cure; and the above hiſtories abundantly ſhow, that though the warm bath and opium may palliate for a ſhort time, the cauſe on which the ſpaſms depend is ſtill going on and increaſing, till at laſt the ſymptoms become too ſtrong to be palliated even for a moment by any medicine however powerful. At any rate, the above-mentioned hypotheſis ſuggeſts a new indication, which, if attended to, may perhaps lead to uſeful diſcoveries. In caſes where putreſcent bile is abundantly ſecreted, columbo root and vegetable acids are recommended to change the nature of the poiſon which the body is perpetually producing in itſelf. Where corroſive mercury has been ſwallowed, alkaline ſalt is recommended to deſtroy the poiſon which nature cannot expel by vomiting; and why ſhould not ſomething be attempted to deſtroy the poiſon which the ſtomach ſeems to ſecrete in the hydrophobia, and which nature attempts to expel, though in vain, by violent efforts to vomit?

But whatever plan may be purſued in the hopes of curing this dreadful malady after any of the ſymptoms have made their appearance, we ought, in every inſtance, to direct our immediate care to *prevention*, as being perhaps the only real ground of hope: And the moſt certain and efficacious way of preventing the ill conſequences, is inſtantly (if it can be done) to cut out the piece that happens to be bitten. Dr James, indeed, ſays, that he would have little opinion of cutting or cauterizing, if ten minutes were ſuffered to elapſe from the receiving of the bite before the operation was performed. But in an inaugural diſſertation lately publiſhed at Edinburgh by Dr Parry, the author is of opinion that exciſion will be of uſe a conſiderable time after the bite is received. He adopts this opinion from what happens in the ſmallpox, where the blood does not ſeem to receive the infection till ſome days after inoculation has been performed. A ſecond inflammation, he tells us, then takes place, and the infection is conveyed into the blood. In like manner, when the hydrophobous infection is about to be conveyed into the blood, according to him, the wound, or its cicatrix, begins again to be inflamed; and it is this ſecond inflammation which does all the miſchief. Exciſion, or the cautery, will therefore be effectual any time between the bite and the ſecond inflammation of the wound. Without implicitly truſting to this doctrine, however, or conſidering it as in any degree aſcertained in what manner the poiſon diffuſes itſelf, by what marks its progreſs may be known, or how ſoon the ſyſtem may be irremediably tainted with its malignity, it is undoubtedly ſafeſt not to loſe unneceſſarily a moment's time in applying the knife. This, or a dilation of the wound if it be ſmall, Dr Vaughan conſiders as the only prophylactics that can be depended upon. In the latter caſe, he directs to fill the wound with gunpowder, and ſet fire to it; which would produce a laceration of the part, and poſſibly the action of ignited powder upon the poiſon may have its uſe. In all caſes, likewiſe, after theſe practices have been employed, the wound ſhould be prevented from healing for ſome length of time.

324 Sp. II. The *Spontaneous* HYDROPHOBIA.

Hydrophobia ſpontanea, *Sauv.* ſp. 2.

This diſeaſe very much reſembles the former, ſo that it has undoubtedly been often miſtaken for it. It has been known to come on from an inflammation of the ſtomach, where it was cured by repeated and large bloodletting; in hyſteria, where it was cured by opium, muſk, or other antiſpaſmodics; and in putrid fevers, where it was cured by evacuating the inteſtinal canal of the putrid matters by repeated clyſters. A very good method of diſtinguiſhing the two is, that in the ſpontaneous hydrophobia the patient is much more delirious than in the genuine ſpecies. In the inſtance mentioned in the Medical Eſſays of this ſymptom attending the inflammation of the ſtomach, the patient *raved in the moſt extraordinary manner*. Dr Raymond ſays he remembers a ſpontaneous hydrophobia *attended with madneſs*; and in almoſt all the caſes of hydrophobia which are ſaid to have been cured, the patient was very delirious. Dr Nugent's patient was very frequently delirious, and dreaded *dogs* as well as water. In the Medical Tranſactions a caſe is communicated by W. Wrightſon ſurgeon in Sedgefield, Durham, of *canine madneſs* ſucceſsfully treated. This madneſs indeed came on after the bite of a dog ſaid to be mad: but it appeared only four days after the accident happened, and was attended with ſymptoms very unlike any of thoſe above mentioned; for he ſuddenly ſtarted up in a fit of delirium, and ran out of the houſe, and after being brought in, caught hold of the hot bars of the grate which held the fire: Whereas, in the true hydrophobia, the patients dread the fire, light, or any thing which makes a ſtrong impreſſion on the ſenſes. It is probable, therefore, that this was only a ſpontaneous hydrophobia, eſpecially as it readily yielded to veneſection, 30 drops of laudanum, and pills of a grain and an half of opium given every three hours, ſome boluſes of muſk and cinnabar, &c. while in ſome of the former caſes as much opium was given to a boy as would have deprived of life the ſtrongeſt healthy man had he ſwallowed it; and yet this amazing quantity produced ſcarcely any effect. This patient alſo dreaded the ſight of a dog.

ORDER IV. VESANIÆ. 325

Paranoiæ, *Vog.* Claſs IX.
Deliria, *Sauv.* Claſs VIII. Ord. III. *Sag.* Claſs XI. Ord. III.
Ideales, *Lin.* Claſs V. Ord. I.

GENUS LXV. AMENTIA. 326

FOLLY, or *Idiotiſm*.

Amentia, *Sauv.* gen. 233. *Vog.* 337. *Sag.* 346.
Moroſis, *Lin.* 106.
Stupiditas, Moroſis, Fatuitas, *Vog.* 336.
Amneſia, *Sauv.* gen. 237. *Sag.* 347.
Oblivio, *Lin.* 107. *Vog.* 338.
Memoriæ debilitas, *Junck.* 120.

GENUS LXVI. MELANCHOLIA. 327

MELANCHOLY, *Madneſs*.

Melancholia, *Sauv.* gen. 234. *Lin.* 71. *Vog.* 332. *Sag.* 347. *Boerh.* 1089. *Junck.* 121.
Dæmonomania, *Sauv.* gen. 236. *Sag.* 348.
Dæmonia, *Lin.* 69.
Veſania, *Lin.* 70.
Paraphobia, *Lin.* 75.
Athymia, *Vog.* 329.
Delirium melancholicum, *Hoffm.* III. 251.
Erotomania, *Lin.* 82.
Noſtalgia, *Sauv.* gen. 226. *Lin.* 83. *Sag.* 338. *Junck.* 125.
Melancholia nervea, *Cl. Lorry* de melancholia, P. I.

GENUS LXVII. MANIA. 328

RAVING or FURIOUS *Madneſs*.

Mania, *Sauv.* gen. 235. *Lin.* 68. *Vog.* 331. *Sag.* 349. *Boerh.* 1118. *Junck.* 122. *Battie* on Madneſs.
Paraphroſyne, *Lin.* 66.

Amentia, *Lin.* 67.
Delirium maniacum, *Hoffm.* III. 251.

Although theſe diſtempers may be conſidered as diſtinct genera, yet they are ſo nearly allied, and ſo readily change into each other, that it ſufficiently juſtifies the treating all of them together.

The diſtinguiſhing characteriſtic of madneſs, according to Dr Battie, is a *falſe perception;* and under this general character may be comprehended all kinds of what is called *madneſs*, from the moſt ſilly ſtupidity and idiotiſm to the moſt furious lunacy. Frequently the different kinds of madneſs are changed into each other by the caſual excitement of ſome paſſion: thus, an idiot may become furiouſly mad, by being put in a violent paſſion; though this does not ſo often happen as the change of melancholy into the raving madneſs, and *vice verſa*.

It is a very ſurpriſing circumſtance, that mad people are not only leſs liable to be ſeized with infectious diſorders than thoſe who are in perfect health; but even when labouring under other diſeaſes, if the patients chance to be ſeized with madneſs, they are ſometimes freed from their former complaints. Of this kind Dr Mead relates two very remarkable inſtances.

On the other hand, it has been known, that an intermittent fever, ſupervening upon madneſs of long ſtanding, has proved a cure for the madneſs; the ſenſes having returned when the fever terminated. Dr Monro ſaw two inſtances of this himſelf; and mentions it as an obſervation made alſo by his predeceſſor in the care of Bethlehem hoſpital.

Another remarkable circumſtance is, that immoderate joy, long continued, as effectually diſorders the mind as anxiety and grief. For it was obſervable in the famous South Sea year, when ſo many immenſe fortunes were ſuddenly gained, and as ſuddenly loſt, that more people had their heads turned, from the prodigious flow of unexpected riches, than from the entire loſs of their whole ſubſtance.

Mad people, eſpecially of the melancholic kind, ſometimes obſtinately perſevere in doing things which muſt excite great pain; whence it ſhould ſeem as if their minds were troubled with ſome diſtracting notions, which make them patiently bear the preſent diſtreſs, leſt more ſevere tortures ſhould be inflicted; or poſſibly they may think, that, by thus tormenting the body, they render themſelves more acceptable to the divine Being, and expiate the heinous ſins of which they may imagine themſelves to have been guilty.

It, is, however, alſo highly probable, that their feelings differ exceedingly from what they are in a natural ſtate; at leaſt they are every day obſerved to endure, apparently without the ſmalleſt uneaſineſs, watching, hunger, and cold, to an extent which in a ſtate of health would not only be highly diſtreſſing, but to the greater part of individuals would even prove fatal. And this reſiſtance of hunger, cold, and ſleep, affords perhaps the beſt teſt for diſtinguiſhing caſes of real inſanity, from caſes where the diſeaſe is only feigned, and appearances of it put on, to anſwer particular purpoſes; at leaſt where this power of reſiſtance is preſent, we have good reaſon to conclude that the affection is not feigned.

Cure. Although we be well acquainted with many of the remote cauſes of this diſeaſe, ſome of the principal of which have already been mentioned, yet we are ſtill ſo ignorant of the influence of theſe upon the ſyſtem, as giving a derangement of the mental faculties, that no general principles on which the cure may be conducted, can with any confidence be pointed out.

It may, however, be obſerved, that while ſome remedies ſeem to operate by producing an artificial termination of this complaint, many others have effect only as aiding a natural termination. And where a recovery from this diſeaſe does take place, it moſt frequently happens in conſequence of a natural convaleſcence. All the ſpecies and degrees of madneſs which are hereditary, or that grow up with people from their early youth, are out of the power of phyſic; and ſo, for the moſt part, are all maniacal caſes of more than one year's ſtanding, from whatever ſource they may ariſe. Very often mere debility, the dregs of ſome particular diſeaſe. ſuch as an ague, the ſmall-pox, or a nervous fever, ſhall occaſion different degrees of fooliſhneſs or madneſs. In theſe caſes, the cure muſt not be attempted by evacuations; but, on the contrary, by nouriſhing diet, clear air, moderate exerciſe, and the uſe of wine: whereas, in almoſt all the other maniacal caſes, which ariſe from different ſources, and which come on in conſequence of intemperate living, violent paſſions, or intenſe thinking, it is generally held, that evacuations of every kind are neceſſary, unleſs the conſtitution of the patient be ſuch as abſolutely forbids them.

Blood is moſt conveniently drawn either from the arm or jugulars; and if the weakneſs be ſuch as renders it improper to take away much blood, we may apply cupping-glaſſes to the occiput.

Vomiting, in weakly people, muſt be excited by the vinum ipecacuanhæ; but in the more robuſt by emetic tartar or antimonial wine: the moſt efficacious cathartics are the infuſion or tincture of black hellebore, or infuſion of ſenna quickened with tincture of jalap; but if there be ſuppreſſion of the menſes, or of an habitual hæmorrhoidal diſcharge, then aloetic purges will be more proper; and in ſome inſtances cooling ſaline purgatives, ſuch as lixiviated tartar, are of great ſervice. In general, mad people require very large doſes, both of the emetics and cathartics, before any conſiderable operation enſues.

Dr Monro aſſures us, that the evacuation by vomiting is infinitely preferable to any other: the prodigious quantity of phlegm with which the patients in this diſeaſe abound, he ſays, is not to be overcome but by repeated emetics; and he obſerves, that the purges have not their right effect, or do not operate to ſo good purpoſe, until the phlegm be broken and attenuated by frequent emetics. He mentions the caſe of a gentleman who had laboured under a melancholy for three years, from which he was relieved entirely by the uſe of vomits and a proper regimen. Increaſing the diſcharge by urine, is alſo of the greateſt moment, eſpecially when any degree of fever is preſent. The cutaneous diſcharges are alſo to be promoted; for which purpoſe the hot bath is of the higheſt ſervice in maniacal caſes. Hoffman aſſerts, that he has ſeen numerous inſtances, both of inveterate melancholy and raging madneſs, happily cured by means of warm bathing;

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bleeding and nitrous medicines having been premiſed. Camphor has alſo been highly commended; but, if we can believe Dr Locker of Vienna, not very deſervedly. Having found very good effects from a ſolution of this medicine in vinegar, he took it for granted that all the ſucceſs was owing to the camphor; therefore, in order to give it a fair trial, he ſelected ſeven patients, and gave it in large doſes of half a dram twice a-day. This was continued for two months, and the doctor was ſurpriſed to find that only one of his patients received any benefit. He then returned the other ſix back to the camphorated julep made with vinegar, and in a few weeks four of them recovered the uſe of their reaſon. This inclined him to think that the virtue depended ſolely on the vinegar, and accordingly he began to make the trial. Common vinegar was firſt given: but after a little while he fixed on that which had been diſtilled, and gave about an ounce and a half of it every day; the patients having been previouſly prepared by bleeding and purging, which was repeated according as it was found neceſſary. He gives a liſt of eight patients who were cured by this method; ſome in ſix weeks, others in two months, and none of them took up more than three months in perfecting the cure. He does not indeed give the ages of the patients, nor mention the circumſtances of the caſes; he only mentions the day on which the uſe of the vinegar was begun and the day on which they were diſcharged; and he adds, that they all continued well at the time of his writing.

Dr Locker informs us, that this medicine acts chiefly as a ſudorific; and he obſerved, that the more the patients ſweated, the ſooner they were cured: it was alſo found to promote the menſtrual diſcharge in ſuch as had been obſtructed, or had too little of this ſalutary evacuation.

Both reaſon and experience ſhow the neceſſity of confining ſuch as are deprived of their ſenſes; and no ſmall ſhare of the management conſiſts in preventing them from hurting either themſelves or others. It has ſometimes been uſual to chain and to beat them: but this is both cruel and abſurd; ſince the contrivance called the *ſtrait waiſtcoat* anſwers every purpoſe of reſtraining the patients without hurting them.

Theſe waiſtcoats are made of ticken, or ſome ſuch ſtrong ſtuff; are open at the back, and laced on like a pair of ſtays; the ſleeves are made tight, and long enough to cover the ends of the fingers, where they are drawn cloſe with a ſtring like a purſe mouth, by which contrivance the patient has no power of his fingers; and when laid on his back in bed, and the arms brought acroſs the cheſt, and faſtened in that poſition by tying the ſleeve-ſtrings round the waiſt, he has no uſe of his hands. A broad ſtrap of girth-web is then carried acroſs the breaſt, and faſtened to the bedſtead, by which means the patient is confined on his back; and if he ſhould be ſo outrageous as to require further reſtraint, the legs are ſecured by ligatures to the foot of the bed; or they may be ſecured by being both put into one bag not very wide, which may be more eaſily fixed than the feet themſelves, at leaſt without giving pain.

It is of great uſe in practice to bear in mind, that all mad people are cowardly, and can be awed even by the menacing look of a very expreſſive countenance; and when thoſe who have charge of them once impreſs them with the notion of fear, they eaſily ſubmit to any thing that is required. The phyſician, however, ſhould never deceive them in any thing, but more eſpecially with regard to their diſtemper: for as they are generally conſcious of it themſelves, they acquire a kind of reverence for thoſe who know it; and by letting them ſee that he is thoroughly acquainted with their complaint, he may very often gain ſuch an aſcendant over them that they will readily follow his directions.

Mania.

It is a more difficult matter to manage thoſe whoſe madneſs is accompanied either with exceſſive joy or with great dejection and deſpondency, than thoſe who are agitated with rage: and all that can be done is to endeavour to excite contrary ideas, by repreſſing the immoderate fits of laughter in the one kind by chiding or threatening (taking care, however, not abſolutely to terrify them, which can never be done without danger, and has often added to the miſery of the unhappy ſufferer); and diſpelling the gloomy thoughts in the other, by introducing pleaſing concerts of muſic, or any other ſpecies of entertainment which the patients have been known to delight in while they had the uſe of their reaſon. Upon the whole, in the cure of inſanity, more is perhaps to be effected by moral than by medical treatment. And this moral treatment ſhould be as gentle as is conſiſtent with ſafety. Chains, bolts, and ſeverity of every kind are to be avoided as much as poſſible. But while great benefit is often derived from company and amuſement, ſo alſo on the other hand, ſolitary confinement is in not a few caſes productive of the beſt effects.

Though bliſtering the head has generally been directed, Dr Mead ſays he has oftener found it to do harm than ſervice: but he recommends iſſues in the back; and adviſes to keep the head always cloſe ſhaved, and to waſh it from time to time with warm vinegar. Opium has by many been forbidden in maniacal caſes, from a ſuppoſition that it always increaſes the diſturbance; but there are inſtances where large doſes of this medicine have been found to prove a cure, and perhaps if it were tried oftener we ſhould find powerful effects from it: there certainly cannot much harm enſue from a few doſes, which may be immediately diſuſed if they ſhould be found to exaſperate the diſeaſe.

The diet of maniacal patients ought to be perfectly light and thin: their meals ſhould be moderate; but they ſhould never be ſuffered to live too low, eſpecially while they are under a courſe of phyſic: they ſhould be obliged to obſerve great regularity in their hours: even their amuſements ſhould be ſuch as are beſt ſuited to their diſpoſition. After the diſeaſe appears to be ſubdued, chalybeate waters and the cold bath will be highly proper to ſtrengthen their whole frame and ſecure them againſt a relapſe.

Genus LXVIII. ONEIRODYNIA. 329

Uneaſiness in Sleep.

Somnium, *Vog.* 309.
Somnambuliſmus, *Sauv.* gen. 221. *Lin.* 77. *Sag.* 333.
Hypnobataſis, *Vog.* 310.

Noctambulatio, *Junck.* 124.
Ephialtes, *Sauv.* gen. 138. *Lin.* 163. *Sag.* 245.
Incubus, *Vog.* 221. *Junck.* 50.

The greateſt uneaſineſs which people feel in ſleep is that commonly called the *incubus* or *night-mare.* Thoſe ſeized with it ſeem to have a weight on their breaſts and about their præcordia. Sometimes they imagine they ſee ſpectres of various kinds which oppreſs or threaten them with ſuffocation. Neither does this uneaſineſs continue only while they are aſleep; for it is ſome time after they awake before they can turn themſelves in their beds, or ſpeak; nay, ſometimes, though rarely, the diſtemper has proved mortal.—The incubus rarely ſeizes people except when the ſtomach is oppreſſed with aliments of hard digeſtion, and the patient lies on his back. It is to be cured by eating light ſuppers, and raiſing the head high; or, if it become very troubleſome, antiſpaſmodic medicines are to be adminiſtered, and the body ſtrengthened by chalybeates. The ſame method is to be followed by thoſe who are ſubject to walking in their ſleep; a practice which muſt neceſſarily be attended with the greateſt danger: and ſomnambuliſm may juſtly be conſidered as merely a different modification of this diſeaſe. Accordingly Dr Cullen has diſtinguiſhed the one by the title of *oneirodynia activa,* and the other by that of *oneirodynia gravans.*

330 CLASS III. CACHEXIÆ.

Cachexiæ, *Sauv.* Claſs X. and Claſs VIII. *Sag.* Claſs III.
Deformes, *Lin.* Claſs. X.

331 ORDER I. MARCORES.

Macies, *Sauv.* Claſs X. Order I. *Sag.* Claſs III. Order I.
Emaciantes, *Lin.* Claſs X. Order I.

332 GENUS LXIX. TABES.

WASTING of the *Body.*

Tabes, *Sauv.* gen. 275. *Lin.* 209. *Vog.* 306. *Sag.* 100.

This diſorder is occaſioned by the abſorption of pus from ſome ulcer, external or internal, which produces an hectic fever. The primary indication therefore muſt be to heal the ulcer, and thus take away the cauſe of the diſeaſe. If the ulcer cannot be healed, the patient will certainly die in an emaciated ſtate. But the proper treatment of the tabes proceeding from this cauſe, falls to be conſidered under the head of *Ulcer* in SURGERY, and likewiſe under the genera SIPHYLIS, SCROFULA, SCORBUTICS, &c. diſeaſes in which ulcers are at leaſt a very common ſymptom.

333 GENUS LXX. ATROPHIA.

NERVOUS CONSUMPTION.

Deſcription. This affection conſiſts principally in a waſting of the body, without any remarkable fever, cough, or difficulty of breathing; but attended with want of appetite and a bad digeſtion, whence the whole body grows languid, and waſtes by degrees.—Dr Cullen, however, aſſerts, that ſome degree of fever, or at leaſt of increaſed quickneſs of the pulſe, always attends this diſeaſe.

Cauſes. Sometimes this diſtemper will come on without any evident cauſe. Sometimes it will ariſe from paſſions of the mind; from an abuſe of ſpirituous liquors; from exceſſive evacuations, eſpecially of the ſemen, in which caſe the diſtemper has got the name of *tabes dorſalis.* It may ariſe from mere old age, or from famine.

Prognoſis. This diſtemper, from whatever cauſe it may ariſe, is very difficult to cure, and often terminates in a fatal dropſy.

Cure. The general principles on which the treatment of this diſeaſe is to be regulated, very much depend on the cauſe by which it is induced; and it is unneceſſary to add, that this muſt be removed as far as poſſible. Next to this, the diſeaſe is moſt effectually combated by the introduction of nutritious aliment into the ſyſtem, and by obtaining the proper aſſimilation and digeſtion of this. With the firſt of theſe intentions, recourſe muſt be had to the diet which is moſt nutritious, and at the ſame time of eaſieſt digeſtion. But from the condition of the ſtomach commonly attending this diſeaſe, it is neceſſary that ſmall quantities only ſhould be taken at a time, and that it ſhould be frequently repeated. With the ſecond intention, ſtomachic and nervous medicines are the articles chiefly at leaſt to be depended upon in this caſe. The Peruvian bark, ſulphuric acid, and chalybeates, are excellent; and theſe ſhould be conjoined with gentle exerciſe, as far as the ſtrength and other circumſtances of the patient will admit. In that ſpecies of the diſtemper occaſioned by venereal exceſſes, it is ſo eſſentially neceſſary to abſtain from them, that without it the beſt remedies will prove altogether uſeleſs.

ORDER II. INTUMESCENTIÆ. 334

Intumeſcentiæ, *Sauv.* Claſs X. Ord. II. *Sag.* Claſs III. Ord. II.
Tumidoſi, *Lin.* Claſs X. Ord. II.

GENUS LXXI. POLYSARCIA. 335

CORPULENCY.

Polyſarcia, *Sauv.* gen. 279. *Lin.* 213. *Vog.* 540. *Sag.* 160. Steatites, *Vog.* 390.

In a natural and healthy ſtate, the fat, or animal oil, is not allowed to diffuſe itſelf throughout the cellular interſtices at large, but is confined to the places where ſuch an oily fluid is neceſſary, by a particular apparatus of diſtinct veſicles. But in ſome conſtitutions the oily part of the blood appears to exceed the requiſite proportion, and eaſily ſeparates from the other conſtituent parts; or there is an uncommon tendency to the ſeparation of oily matter. In theſe caſes it is apt to accumulate in ſuch quantities, that we may ſuppoſe it to burſt thoſe veſicles which were originally deſtined to hinder it from ſpreading too far; or almoſt every cell of the membrana adipoſa, many of which are in ordinary caſes altogether empty, may be completely filled and diſtended with fat.

The increaſe of the omentum particularly, and the accumulation of fat about the kidneys and meſentery, ſwell the abdomen, and obſtruct the motions of the diaphragm; whence one reaſon of the difficulty of breathing which is peculiar to corpulent people; while the heart, and the large veſſels connected with it, are in like manner ſo encumbered, that neither the ſyſtaltic nor ſubſultory motion can be performed with ſufficient freedom, whence weakneſs and ſlowneſs of the pulſe: but when the whole habit is in a manner overwhelmed with an oily fluid, the enlargement of the cellular interſtices will neceſſarily interrupt the general diſtribution and circulation throughout the nervous and vaſcular ſyſtems; impeding the action of the muſcular fibres, and producing inſenſibility, ſomnolency, and death.

Theſe caſes are the more deplorable, as there is but little proſpect of a cure. For the animal oil is of too groſs a nature to be eaſily taken up by abſorption; and we know, that when fluids are accumulated in the cellular ſyſtem, there are only two ways in which they can be carried off or eſcape; namely, by the abſorbents, which take their riſe from the cellular interſtices, and through the pores of the ſkin by tranſudation.

Another misfortune is, that the diſeaſe ſteals on ſo imperceptibly, that it becomes inveterate before people begin to think of purſuing the proper means of relief.

In this diſeaſe the cure muſt turn upon two points: Firſt, on preventing the farther depoſition of fat, by avoiding the introduction of ſuperfluous aliment, particularly of fatty matters, into the ſyſtem; and, ſecondly, on promoting and forwarding the abſorption of fat. On theſe grounds, beſides what may be done by proper regimen, a variety of articles have been recommended in the way of medicine.

Soap has been propoſed as a remedy to melt down and facilitate the abſorption of the fat in corpulent people; and Dr Fleming ſome years ago publiſhed a little treatiſe, wherein he recommends this medicine, and relates the caſe of a gentleman who is ſaid to have received conſiderable benefit from it. But perhaps the ſoap-leys would be more powerful, and might be more eaſily taken ſheathed, in the manner directed when uſed as a diſſolvent of the ſtone.

Lieutaud adviſes to take *acetum ſcilliticum* in ſmall doſes, with frequent purging and briſk exerciſe. But it will ſeldom happen that the patients will be found ſufficiently ſteady to perſiſt in any of theſe courſes, it being the nature of the diſorder to render them irreſolute and inattentive to their condition. Therefore the principal uſe of rules muſt be with a view to prevention; and perſons who are diſpoſed to corpulency ſhould take care in time to prevent it from becoming an abſolute diſeaſe, by uſing a great deal of exerciſe, not indulging in ſleep, and abridging their meals, eſpecially that of ſupper. Salted meats are leſs fattening than ſuch as are freſh; and drinking freely of coffee is recommended to corpulent people.

But Dr Fothergill obſerves, that a ſtrict adherence to vegetable diet reduces exuberant fat more certainly than any other means that he knows; and gives two caſes in which this regimen ſucceeded remarkably well. The famous Dr Cheyne brought himſelf down in this way, from a moſt unwieldy bulk to a reaſonable degree of weight; as he himſelf informs us. It deſerves, however, to be remarked, that every practice for the removal or prevention of fatneſs muſt be uſed with great caution and prudence: for not a few, anxious to prevent this affection, have had recourſe to a regimen and to medicine which have proved fatal. This has particularly ariſen from the exceſſive uſe of acids, probably operating by entirely deſtroying the action of the chylopoietic viſcera.

GENUS LXXII. PNEUMATOSIS. 336

EMPHYSEMA, or *Windy Swelling*.

Pneumatoſis, *Sauv.* gen. 280. *Vog.* 291. *Sag.* 107.
Emphyſema, *Sauv.* gen. 13. *Lin.* 288. *Vog.* 392.
Leucophlegmatia, *Lin.* 214.

The emphyſema ſometimes comes on ſpontaneouſly; but more frequently is occaſioned by wounds of the lungs, which, giving vent to the air, that fluid inſinuates itſelf into the cellular texture, and often blows it up to a ſurpriſing degree. It muſt be obſerved, however, that it is only in caſes of laceration of the lungs where this diſeaſe can take place; for in a ſimple wound, the effuſion of blood always prevents the air from getting out. The cure is to be accompliſhed by ſcarifications and compreſſes; but in ſome caſes only by the paracenteſis of the thorax. When air introduced from the lungs is collected in a conſiderable quantity in the cavity of the thorax, the operation of the paracenteſis is perhaps the only means of cure. Upon an opening being thus made, the air ſometimes ruſhes out with incredible violence; and the patient receives at leaſt immediate relief from circumſtances the moſt diſtreſſing imaginable. In ſome inſtances it is followed even by a complete cure.

GENUS LXXIII. TYMPANITES. 337

TYMPANY.

Tympanites, *Sauv.* gen. 291. *Lin.* 219. *Vog.* 316. *Sag.* 118. *Boerh.* 226. *Junck.* 87.
Affectio tympanitica, *Hoffm.* III. 339.
Meteoriſmus, *Sauv.* gen. 292.

This in an inflation of the abdomen, and is of two kinds: 1. That in which the flatus is contained in the inteſtines, in which the patient has frequent exploſions of wind, with a ſwelling of the belly commonly unequal. 2. When the flatus is contained in the cavity of the abdomen; in which caſe the ſwelling is more equal, and the belly ſounds when ſtruck, without any conſiderable emiſſion of flatus. Of theſe two, however, the former diſeaſe is by much the moſt common; inſomuch, that many, even extenſively engaged in practice, have never met with an inſtance of true abdominal tympanites. In both caſes the reſt of the body falls away.

Cauſes, &c. The tympany ſometimes takes place in thoſe who have been long troubled with flatulencies in the ſtomach and inteſtines. It happens frequently to women after abortion; to both ſexes after the ſuppreſſion of the hæmorrhoids; and ſometimes from tedious febrile diſorders injudiciouſly treated.

Prognoſis. This diſeaſe is generally very obſtinate, and for the moſt part proves fatal by degenerating into to an aſcites. Sometimes, if the patient be healthy and ſtrong, the diſeaſe may terminate favourably, and that the more readily if it has followed from ſome diſorder. A hectic conſumption, dry cough, and emaciated countenance in a tympany, with a ſwelling of the feet, denote approaching death in a very ſhort time.

Cure. With a view to the prevention of this affection, it is neceſſary, in the firſt place, to avoid, as far as it can be done, cauſes giving riſe to an uncommon extrication of air, by preſerving the proper tone of the alimentary canal. After the affection has taken place, the indications are, firſt, to expel the air already extricated and confined in different cavities; and, ſecondly, to prevent further accumulation. On theſe grounds different remedies are employed. The cure, however, is principally attempted by carminative, reſolvent, and ſtomachic medicines, gentle laxatives, and at laſt tonics, eſpecially chalybeates. In the Edinburgh Medical Eſſays, vol. i. we have a very remarkable hiſtory of a tympany by Dr Monro ſenior. The patient was a young woman of 22 years of age, who fell into the diſtemper after a tertian ague, in which ſhe was badly treated. She became a patient in the Edinburgh Infirmary the 24th of March 1730; took ſeveral purgatives, and ſome doſes of calomel; uſed the warm bath; and had an antihyſteric plaſter applied over the whole belly, but with very little effect. She was monſtrouſly diſtended, inſomuch that the ſkin ſeemed to be in danger of burſting: her breathing was much ſtraitened; but the ſwelling ſometimes gradually decreaſed without any evacuation. The returns and degree of this ſwelling were very uncertain; and when the belly was moſt detumefied, ſeveral unequal and protuberant balls could be felt over the whole abdomen, but eſpecially at its ſides. Her ſtomach was good, ſhe had no thirſt, and her urine was in proportion to the quantity ſhe drank. She was very coſtive, had her menſes at irregular periods, but no œdematous ſwellings appeared in the feet or any where elſe. In this ſituation ſhe continued from the time of her admiſſion till the 21ſt of June, during which interval ſhe had only menſtruated twice. Throughout this ſpace of time, the following circumſtances were obſerved, 1. Several times, upon the falling of the ſwelling, ſhe complained of a headach; once of pains throughout all her body, once of a giddineſs, twice of a nauſea and vomiting, and the laſt time threw up green bile; and once her ſtomach ſwelled greatly, whilſt the reſt of the abdomen ſubſided. 2. During the flowing of the menſes ſhe did not ſwell, but became very big upon their ſtopping. 3. Blood-letting and emetics, which were made uſe of for ſome accidental urgent ſymptoms, had no very ſenſible effect in making the tympany either better or worſe. 4. She never had paſſage of wind either way, except a little belching ſome days before the monthly evacuation.

Some time before the laſt eruption of the menſes, the purgatives were given more ſparingly; and antihyſterics of the ſtrongeſt kinds, ſuch as aſafœtida, oleum corn. cerv. &c. mixed with ſoap, were given in large doſes, accompanied with the hotter antiſcorbutics as they are called, as horſeradiſh and ginger-root infuſed in ſtrong-ale with ſteel. The patient was ordered to uſe frequent and ſtrong frictions to all the trunk of her body and extremities, and to uſe moderate exerciſe. Immediately before the menſes began to flow, clyſters of the ſame kind of medicines were injected. The menſes were in ſufficient quantity; but as ſoon as they ceaſed, her belly increaſed in its circumference four inches and a half, but ſoon ſubſided. She then complained of pains, which a gentle ſweat carried off. Borborygmi were for the firſt time obſerved on the ſame day, June 25th; and having taken ſome *tinctura ſacra* at night, ſhe paſſed a ſmall quantity of blood next day by ſtool. This was the firſt appearance of the return of the hæmorrhoids, to which ſhe had been formerly ſubject.

The two following days her ſaponaceous, antihyſteric, and antiſcorbutic medicines being ſtill continued, ſhe had ſuch exploſions of wind upwards and downwards, that none of the other patients would remain in the ſame room, nay ſcarce on the ſame floor with her. Her belly became leſs and ſofter than it had been from the firſt attack of the diſeaſe; her medicines, with a doſe of ſyrup of buckthorn at proper intervals, ſtill were continued, only the proportion of ſteel was increaſed; her flatulent diſcharge went on ſucceſsfully, and ſhe gradually recovered her former health.

Genus LXXIV. PHYSOMETRA. 338

Windy Swelling of the Uterus.

Phyſometra, *Sauv.* gen. 290. *Sag.* 119.
Hyſterophyſe, *Vog.* 317.

The treatment of this is not different from that of the tympany. It is however, upon the whole, a very rare diſeaſe; and when it takes place, very ſeldom if ever admits of a cure.

Genus LXXV. ANASARCA. 339

Watery Swelling over the Whole Body.

Anaſarca, *Sauv.* gen. 281. *Lin.* 215. *Vog.* 313. *Sag.* 108. *Boerh.* 1225. *Hoffm.* III. 322. *Junck.* 87. *Monro* on the Dropſy. *Millman* Animadverſiones de hydrope 1779.
Phlegmatia, *Sauv.* gen. 282.
Angina aquoſa, *Boerh.* 791.

In this diſeaſe the feet firſt begin to ſwell, eſpecially in the evening, after exerciſe, and when the patient has ſtood or ſat long; this ſwelling riſes frequently to the thighs. By lying in bed, the ſwelling becomes leſs, or even almoſt diſappears. In the progreſs of the diſeaſe, the ſwelling often riſes to the hips, loins, and belly, and at laſt covers the whole body. This diſeaſe, beſides the other ſymptoms afterwards mentioned under Ascites, is attended with a remarkable difficulty of breathing. In the cure of this, as well as other ſpecies of dropſy, the general intentions are, firſt, the evacuation of the water already effuſed either by natural or artificial outlets; and, ſecondly, the prevention of freſh accumulation, which is chiefly to be expected from ſupporting a due action of the abſorbents, and from keeping up a proper diſcharge by the ſerous excretories.

The remedies employed with theſe intentions are much the ſame with what are employed againſt the more

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more important genus of aſcites. Only it may be here noticed, that in anaſarca it has by many been recommended to ſcarify the feet and legs. By this means the water is often diſcharged: but the operator muſt be cautious not to make the inciſions too deep; they ought barely to penetrate through the ſkin; and eſpecial care muſt be taken, by ſpirituous fomentations and proper digeſtives, to prevent a gangrene. Dr Fothergill obſerves, that the ſafeſt and moſt efficacious way of making theſe drains is by the inſtrument uſed for cupping, called a *ſcarificator;* and he always orders it to be ſo applied as to make the little wounds tranſverſely; as they not only diſcharge better, but are alſo longer in healing, than when made longitudinally.

Notwithſtanding every precaution, however, gangrene will often enſue; and it is upon the whole a much ſafer practice to evacuate the water by the natural outlets, the valvular lymphatic abſorbents; and with this intention emetics and cathartics, but particularly diuretics, are often employed with ſucceſs.

340 Genus LXXVI. HYDROCEPHALUS.

Water in the Head.

External or *Chronic* Hydrocephalus.

Hydrocephalus, *Sauv.* gen. 285. *Lin.* 216. *Boerh.* 1217.
Hydrocephalum, *Vog.* 384.

This differs from the hydrocephalus formerly treated of at ſome length under the title of Apoplexia Hydrocephalica, chiefly in the water being collected in the external parts of the head, whereas the former is entirely within the ſkull. In the fifth volume of the Medical Obſervations we have an account of a very extraordinary caſe of this kind. The patient was a child only of a few days old, and had a tumor on his head about the ſize of a common tea-cup, which had the appearance of a bladder diſtended with water; near the apex was a ſmall opening, through which a bloody ſerum was diſcharged. In other reſpects the child was healthy. No application was uſed but a piece of linen dipt in brandy. The tumor continued to increaſe for many months; at the end of which time the membrane containing the water appeared equally thick with the other part of the ſcalp, except at one place about the ſize of a ſhilling, which continued thin, and at times appeared as if it would burſt. He remained in this ſituation for about 17 months, when the circumference of the head was 20 inches, the baſe 16½, the middle 18¼, and from the baſe to the apex near 8½. The water was then drawn off, and the child died in two days. Almoſt all other caſes of this diſtemper have proved fatal; the ſutures of the ſkull generally give way, and the whole external part of the head is equally enlarged: but in the inſtance juſt now given there was a deficiency of part of the bones. Although, however, in ſome inſtances where the head is thus enlarged to an enormous ſize, the water is exterior to the brain, and therefore entitled to the appellation of hydrocephalus exterior, yet much more frequently in thoſe inſtances where there is a manifeſt ſeparation of the bones of the cranium at the ſutures, the water is ſtill contained within the ventricles; and accordingly the diſeaſe may be much more properly diſtinguiſhed into the *acute* and *chronic* hydrocephalus, than as is commonly done into the *internal* and *external.* Although the latter be much ſlower in its progreſs, ſometimes ſubſiſting even for years, yet it is equally difficult of cure with the former, and very often it proves fatal in a few days if the water be drawn off by an artificial opening, which may be very eaſily performed by a mere puncture with a common lancet, without either pain or any immediate hazard from the operation itſelf, although the water be lodged in the ventricles; for theſe are diſtended to an enormous ſize, and the ſubſtance of the brain almoſt totally deſtroyed, ſo that hardly any thing is to be punctured but membrane.

Hydrorachitis.

Genus LXXVII. HYDRORACHITIS. 341

Spina Bifida.

Hydrorachitis, *Sauv.* gen. 287. *Morgagn.* de ſed. XII. 9. *et ſeq.*
Spinola, *Lin.* 289.
Spina bifida, *Vog.* 386.

This diſeaſe, which conſiſts in a ſoft tumor on the lumbar vertebræ, attended with a ſeparation of the vertebræ themſelves, though generally conſidered as approaching to the nature of rachitis, is commonly referred to the article Surgery, which may be conſulted with regard to this affection.

Genus LXXVIII. HYDROTHORAX. 342

Dropsy of the Breast.

Hydrothorax, *Sauv.* gen. 150. *Vog.* 311. *Boerh.* 1219.

This affection, particularly with reſpect to its cauſes, is in many circumſtances ſimilar to other kinds of dropſy, particularly to aſcites. But from the ſituation of the water, which is here depoſited in the cavity of the thorax, it may naturally be ſuppoſed that ſome peculiar ſymptoms will occur. Beſides the common ſymptoms of dropſy, paleneſs of the countenance, ſcarcity of urine, and the like, this diſeaſe is, in ſome inſtances, attended with a fluctuation of water within the breaſt; which when it does occur may be conſidered as a certain diſtinguiſhing mark of this affection. But beſides this, it is alſo diſtinguiſhed by the remarkable affections of circulation and reſpiration with which it is attended.

The breathing is peculiarly difficult, eſpecially in a recumbent poſture; and in many inſtances patients cannot breath with tolerable eaſe, unleſs when ſitting erect, or even ſtooping ſomewhat forwards. The pulſe is very irregular, and has often remarkable intermiſſions. But the diſeaſe has been thought to be principally characterized by a ſudden ſtarting from ſleep, in conſequence of an almoſt inexpreſſible uneaſy ſenſation referred to the breaſt, and attended with ſtrong palpitation, which may probably ariſe from an affection either of circulation or of reſpiration.

That theſe ſymptoms are common attendants of this diſeaſe, is undeniable; and they are certainly the beſt characteriſtics of this affection with which we are yet acquainted: but it muſt be allowed that they are preſent in ſome caſes where there is no water in the breaſt; and

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and that in other inſtances where the diſeaſe exiſts, they are either altogether wanting, or occur only to a very ſlight degree. Certain diagnoſtics, therefore, of this diſeaſe ſtill remain to be diſcovered.

When hydrothorax is preſent, from the affection of the vital functions with which it is attended, it may readily be concluded that it is a dangerous diſeaſe, and in many inſtances it proves fatal. The cure, as far as it can be accompliſhed, is obtained very much on the ſame principles as in other dropſies. Here, however, probably from the uncertainty of the diagnoſtics, the artificial abſtraction of water, by paracenteſis of the thorax, is leſs frequently had recourſe to than in aſcites; though in ſome inſtances, after other means have failed, it has been ſaid not only to give relief of ſymptoms highly urgent, particularly dyſpnœa, but even to produce a complete cure. Benefit is often obtained from an artificial diſcharge of water by the application of bliſters to the breaſt: but in this, as well as other dropſies, a diſcharge is chiefly effected by the natural outlets, particularly from the uſe of cathartics and diuretics. In this ſpecies of dropſy, more perhaps than in any other, recourſe has been had to the uſe of the digitalis purpurea, or foxglove, ſo ſtrongly recommended as a diuretic by Dr Withering in his treatiſe reſpecting the uſe of it. There can be no doubt that this article, though ſometimes productive of inconvenience from the diſtreſſing ſickneſs and ſevere vomiting which it not unfrequently excites, though uſed even but in ſmall doſes, often operates as a powerful diuretic, and produces a complete evacuation of water, after other articles have failed. From the effects mentioned above, however, as well as from its influence on the pulſe, which it renders much ſlower, it is neceſſary that it ſhould be employed with great caution, and in ſmall doſes. A dram of the dried leaves of the digitalis, macerated for four hours in half a pint of warm water, forms an infuſion which may be given in doſes of an ounce, and the dried powder of the leaves in doſes of one or two grains: theſe doſes may be gradually increaſed, and repeated twice or oftener in the day; but this requires to be done with great caution, leſt ſevere vomiting, or other diſtreſſing ſymptoms, ſhould take place.

343 Genus LXXIX. ASCITES.

Dropsy of the *Abdomen*.

Aſcites, *Sauv.* gen. 288. *Lin.* 217. *Vog.* 314. *Sag.* gen. 115. *Boerh.* 1226. *Hoffm.* III. 322. *Junck.* 87. *Dr Monro* on the Dropſy, 1765. *Milman*, Animadverſiones de Hydrope, 1779.

Deſcription. This diſeaſe aſſumes three different forms: 1. When the water immediately waſhes the inteſtines. 2. When it is interpoſed between the abdominal muſcles and peritonæum; or, 3. When it is contained in facs and hollow veſicles; in which caſe it is called the *encyſted dropſy*. Some phyſicians of great reputation have aſſerted, that the water was often placed within the duplicature of the peritonæum: but this is alleged by Dr Milman to be a miſtake, as that membrane is looked upon by the beſt anatomiſts to be ſingle; and he thinks that the above-mentioned phyſicians have been led into this error from obſerving the water collected in the cellular ſubſtance of the peritonæum.

Aſcites.

In the beginning of an aſcites the patient becomes languid, breathleſs, and has an averſion to motion: his belly ſwells; and, when ſtruck, the ſound of fluctuating water is perceptible; there is a difficulty of breathing when the belly is preſſed. There is an almoſt continual thirſt, which in the progreſs of the diſeaſe becomes very urgent; the urine is thick, in ſmall quantity, and high coloured. The pulſe is ſmall and frequent; and as the belly ſwells, the other parts waſte away. A fever at laſt ariſes, which, conſtantly increaſing, in the end carries off the patient. Theſe ſymptoms are moſt urgent where the waters are in immediate contact with the inteſtines: in the other kinds the reſt of the body is leſs waſted; nor is there ſo great thirſt or difficulty of breathing.

Cauſes, &c. The immediate cauſe of dropſy is a greater effuſion of ſerum by the exhalant arteries than the abſorbents take up. This may be occaſioned either by too great a quantity of liquid thrown out by the former, or by an inability of the latter to perform their office. This commonly happens in people whoſe bodies are of a weak and lax texture, and hence women are more ſubject to this malady than men; chlorotic girls eſpecially are very apt to become dropſical.

Sometimes, however, this diſeaſe is occaſioned by a debility of the vital powers, by great evacuations of blood, or by acute diſeaſes accidentally protracted beyond their uſual period; and although this cauſe ſeems very different from a laxity of fibres, yet the dropſy ſeems to be produced in a ſimilar manner by both. For the vital powers being debilitated by either of theſe cauſes, naturally bring on a certain debility and laxity of the ſolids; and, on the other hand, a debility of the ſolids always brings on a debility of the vital powers; and from this debility of the vital powers in both caſes it happens, that thoſe humours which ought to be expelled from the body are not diſcharged, but accumulate by degrees in its cavities. There, is, however, this difference between the two kinds of dropſy ariſing from theſe two different cauſes: That in the one which ariſes from laxity the ſolid parts are more injured that in that which ariſes from a debility of the vital powers. In the former, therefore, the water ſeems to flow out from every quarter, and the body ſwells all over. But when the diſeaſe is occaſioned by a debility of the vital powers, though the ſolids be leſs diſeaſed, yet the power of the heart being much diminiſhed, and the humours ſcarce propelled through the extreme veſſels, the thin liquids, by which in a healthy ſtate the body is daily recruited, are carried by their own weight either into the cavities or into the cellular texture. Hence thoſe aqueous effuſions which follow great evacuations of blood, or violent looſeneſſes, begin in the more depending parts of the body, gradually aſcending, till they arrive at the cavity of the abdomen, or even the thorax.

But another and much more ſufficient cauſe for the production of dropſy is an obſtruction of the circulation; and this may take place from polypi in the heart or large veſſels, and hard ſwellings in the abdomen. Inſtances have been obſerved of a dropſy ariſing from ſteatomatous tumors in the omentum, and many more from a ſcirrhous liver or ſpleen, and from an infarction and obſtruction of the meſenteric glands, by which means the lymph coming from the extremities is prevented from arriving at the heart. Scirrhoſity of the liver, the moſt common cauſe of aſcites, probably operates by augmenting effuſion, in conſequence of its preventing the return of the venous blood, the greater part of the veins from the abdomen going to the formation of the vena portarum.

Laſtly, Whatever, either within or without the veſſels, contracts or ſhuts up their cavities, produces a more copious and eaſy tranſmiſſion of the thin humours through the exhalant arteries, at the ſame time that it prevents their return by the abſorbent veins. This has been eſtabliſhed by experiment: For Lower having perforated the right ſide of the thorax in a dog, tied the *vena cava*, and ſewed up the wound. The animal languiſhed for a few hours, and then died. On diſſection, a great quantity of ſerum was found in the abdomen, as if he had long laboured under an aſcites. In like manner, having tied the jugular veins of another dog, a ſurpriſing ſwelling took place in thoſe parts above the ligatures, and in two days the animal died. On diſſection, all the muſcles and glands were vaſtly diſtended, and quite pellucid, with limpid ſerum. From theſe experiments, and ſome caſes of the diſeaſe mentioned by different authors, it appears, that when the veins are obſtructed ſo that they cannot receive the arterial blood, the ſerum is ſeparated as by a filtre into the more open cavities and laxer parts of the body, while the thicker part ſtagnates and is collected in the proper blood veſſels.

The too great tenuity of the humours is very frequently accuſed as the cauſe of dropſy, and many authors have aſſerted that dropſy might ariſe merely from a ſuperabundance of water in the blood. For this, ſome experiments are quoted, from which they would infer, that when a great quantity of aqueous fluid is introduced into the blood, the ſuperfluous fluid ought by no means to paſs through the extremities of the ſanguiferous arteries into the veins in the common courſe of circulation, but by being effuſed into the cavities ſhould produce a dropſy. But this can only happen when the vital powers are very much diminiſhed; for, in a natural ſtate, the ſuperfluous quantity is immediately thrown out by the ſkin or the kidneys: and agreeable to this we have an experiment of Schultzius, who induced a dropſy in a dog by cauſing him drink a great quantity of water; but he had firſt bled him almoſt *ad deliquium*, ſo that the vital powers were in a manner oppreſſed by the deluge of water. In this manner do thoſe become hydropic who are ſeized with the diſeaſe on drinking large quantities of water either when wearied with labour, or weakened by ſome kinds of diſeaſes. Dr Fothergill relates an inſtance of a perſon who, being adviſed to drink plentifully of barley water, in order to remove a fever, raſhly drunk 12 pounds of that liquor every day for a month, and thus fell into an almoſt incurable dropſy. But if this quantity had been taken only during the prevalence of the fever, he would, in all probability, have ſuffered no inconvenience, as may be inferred from what has been related concerning the *dieta aquea* uſed by the Italians.

It is moreover evident from experiments, that, in a healthy ſtate, not only water is not depoſited in the cavities, but that if it is injected into them it will be abſorbed, unleſs ſome laxity of the ſolids has already taken place. Dr Muſgrave injected into the right ſide of the thorax of a dog four ounces of warm water; whence a difficulty of breathing and weakneſs immediately followed. But theſe ſymptoms continually leſſened, and in the ſpace of a week the animal ſeemed to be in as good health as before. Afterwards he injected 16 ounces of warm water into the left cavity of the thorax in the ſame dog; the ſame effects followed, together with great heat, and ſtrong pulſation of the heart; but he again recovered in the ſpace of a week. Laſtly, He injected 18 ounces of water into one ſide of the thorax, and only ſix into the other: the ſame ſymptoms followed, but vaniſhed in a much ſhorter time; for within five days the dog was reſtored to perfect health. During this time, however, he obſerved that the dog made a greater quantity of urine than uſual.

The remote cauſes of dropſy are many and various. Whatever relaxes the ſolids in ſuch a manner as to give an occaſion of accumulation to the ſerous fluids, diſpoſes to the dropſy. A lazy indolent life, rainy wet weather, a ſwampy or low ſoil, and every thing which conduces to vitiate the viſcera, or inſenſibly to produce obſtructions in them, paves the way for a dropſy. Hence thoſe are ready to fall into the diſeaſe who uſe hard and viſcid aliments, ſuch as poor people in ſome countries who uſe coarſe brown bread, and children who are fed with unwholeſome aliments; and the ſame thing happens to thoſe who drink immoderately of ſpirituous liquors.

Prognoſis. When the dropſy ariſes from a ſcirrhus of the liver or ſpleen, or any of the other viſcera, the prognoſis muſt always be unfavourable, and alſo when it ariſes from diſorders of the lungs. Neither is the caſe more favourable to thoſe in whom the ſmall veſſels are ruptured, and pour out their liquids into the cavity of the abdomen. Thoſe certainly die who have polypi in the veſſels, or tumors compreſſing the veins and veſſels of the abdomen. A dropſy ariſing from obſtructions in the meſenteric glands is likewiſe difficult to cure, whether ſuch obſtructions ariſe from a bad habit of body, or from any other cauſe; if we can, however, by any means remove the diſeaſe of the glands, the dropſy ſoon ceaſes. But in thoſe who fall into dropſy without any diſeaſe preceding, it is not quite ſo dangerous; and even though a diſeaſe has preceded, if the patient's ſtrength be not greatly weakened, if the reſpiration be free, and the perſon be not affected with any particular pain, we may entertain great hopes of a cure. But where a great loſs of blood is followed by a fever, and that by a dropſy, the patients almoſt always die, and that in a ſhort time: thoſe, however, are very frequently cured who fall into this diſeaſe without any preceding hæmorrhage.

Cure. In the cure of this diſeaſe authors chiefly mention two indications: 1. To expel the effuſed water; and, 2. To prevent its being again collected. But before we proceed to ſpeak of the remedies, it is neceſſary to take notice, that by the laws of the animal economy, if a great evacuation of a fluid takes place in any part of the body, all the other fluids in the body are directed towards that part, and thoſe which lie, as it were, lurking in different parts will be immediately abſorbed, and thrown out by the ſame paſſage. Hence the humours which in hydropic per-

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ſons are extravaſated into the different cavities of the body will be thrown into the inteſtines, and evacuated by purgatives; or by diuretics will be thrown upon the kidneys, and evacuated by urine. It is, however, not only neceſſary to excite theſe evacuations in order to remove this malady, but they muſt be aſſiduouſly promoted and kept up till the abundant humour is totally expelled. For this reaſon Sydenham has adviſed purgatives to be adminiſtered every day, unleſs, either through the too great weakneſs of the body, or the violent operation of the purgative, it ſhall be neceſſary to interpoſe a day or two now and then; becauſe if any conſiderable intervals be allowed to take place between the exhibition of the purgatives, an opportunity is given to the waters of collecting again. In this method, however, there is the following inconvenience, that, when the waters are totally evacuated, the ſtrength is at the ſame time ſo much exhauſted, that the diſtemper commonly returns in a very ſhort time. Hence our chief hopes of curing a dropſy conſiſt in gently evacuating the waters by means of diuretics. But the efficacy of theſe is generally very doubtful. Dr Freind has long ago obſerved, that this part of medicine is of all others the moſt lame and imperfect; but a French phyſician, Mr Bacher, lately diſcovered, as he alleges, a method of making the diuretics much more ſucceſsful. His reputation became at laſt ſo great, that the French king thought proper to purchaſe his ſecret for a great ſum of money. The baſis of his medicine was the black hellebore root, the malignant qualities of which he pretended to correct in the following manner: A quantity of the dried roots of black hellebore were pounded, and then put into a glazed earthen veſſel, and afterwards ſprinkled with ſpirit of wine. They were ſuffered to ſtand for twelve hours, ſtirring them about twice or thrice during that ſpace of time. They were then ſprinkled again, and at laſt good Rheniſh wine was poured on till it ſtood ſix fingers above the roots. The mixture was frequently agitated with a wooden ſpatula; and as the wine was imbibed by the roots, more was poured on, ſo as to keep it always at the ſame height for 48 hours. The whole was then put on the fire and boiled for half an hour, after which the decoction was violently preſſed out; the ſame quantity of wine was added as at firſt, and the mixture boiled as before. After the ſecond expreſſion the woody reſiduum was thrown away as uſeleſs. Both the ſtrained liquors were then mixed together with two parts of boiling water to one of the decoction. The whole is afterwards evaporated in a ſilver veſſel to the conſiſtence of a ſyrup. One part of the extract is again mixed with two parts of boiling water, and the whole inſpiſſated as before.—By this means, ſays he, the volatile nauſeous acrid particles are ſeparated by evaporation, and the fixed ones remain corrected and prepared for medicinal uſes; adding, towards the end, a ninth part of old brandy, and evaporating to the conſiſtence of turpentine. Mr Bacher reaſons a good deal on the way in which this proceſs corrects the medicine; but tells us, that notwithſtanding the improvement, his pills will not have the deſired effect unleſs properly made up. For forming them, they ought to be mixed with matters both of an inviſcating and indurating nature; yet ſo prepared that it will be readily ſoluble in the ſtomach, even of a perſon much debilitated. For anſwering theſe purpoſes, he choſe myrrh and carduus benedictus, and he gives the following receipt for the formation of his pills:—

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"Take of the extract of hellebore prepared as above directed, and of ſolution of myrrh, each one ounce; of powdered carduus benedictus, three drams and a ſcruple. Mix them together, and form into a maſs, dividing it into pills of a grain and a half each." To theſe pills Mr Bacher gives the name of the *pilulæ tonicæ*, from an idea, that while they evacuate the water, they at the ſame time act as tonics; and thus, from augmenting the action of the lymphatics, prevent the return of the diſeaſe. And if both theſe intentions could be effectually anſwered by the uſe of the ſame remedy, it would unqueſtionably be of great importance in practice.

The effects of theſe pills were, we are told, very ſurpriſing. Dr Daignan relates, that he gave them to 18 hydropic patients at once; and theſe he divided into three claſſes, according to the degree of the diſeaſe with which they were affected. The firſt claſs contained thoſe who laboured under an anaſarca following intermittent fevers. The ſecond claſs contained thoſe who had an anaſarca, together with ſome degree of aſcites, ariſing from tedious febrile diſorders. All theſe were cured; but theſe two claſſes conſiſted of ſuch caſes as are moſt eaſily removed. But the third contained ſix who were ſeized with a moſt violent anaſarca and aſcites, after being much weakened by tedious diſorders, and of conſequence in whom the diſeaſe was very difficult to be cured. Even of theſe, however, four were cured, and the other two died. The body of one of theſe being diſſected, both ſides of the cavity of the thorax were found to be full of a blackiſh-red water. The lungs were unſound; there was a polypous concretion in the right ventricle of the heart; the liver and ſpleen were hard, and of a preternatural bulk; and the glands of the meſentery were obſtructed and infarcted. In the other, the liver and pancreas were ſcirrhous, and the ſpleen very hard.

The ſame medicines were given by De Horne to eight perſons, ſix of whom had both an anaſarca and aſcites, but the other two only an aſcites. Four of theſe recovered; three died without being freed from the dropſy; one in whom the dropſy was cured died in a ſhort time after, having for ſome time before his death become ſpeechleſs.

By theſe patients 10 of the pills were taken at once; and the ſame doſe repeated to the third time, with an interval of an hour betwixt each doſe. At firſt they proved purgative, and then diuretic: by which laſt evacuation they finally cured the diſeaſe. But though Mr Bacher was firmly of opinion that his pills cured the dropſy by reaſon of the above-related correction, yet it is certain that, in the hands of other practitioners, theſe very pills have failed, unleſs they alſo made uſe of the ſame regimen recommended by that phyſician; while, on the other hand, it is alſo certain, that different medicines will prove equally efficacious in dropſical caſes, provided this regimen is made uſe of.

For a great number of ages it has been recommended to dropſical patients to abſtain as much as poſſible from drink, and thus to the torments of their diſeaſe was added that of an intolerable thirſt; and how great this torment was, we may underſtand from an example of a friend of King Antigonus, who, having been cloſely watched both by order of the phyſicians and alſo of the king, was ſo unable to bear the raging thirſt occaſioned by his diſeaſe, that he ſwallowed his own excrements and urine, and thus ſpeedily put an end to his life. Dr Milman ſhows at great length the pernicious tendency of this practice. He maintains that it is quite contrary to the ſentiments of Hippocrates and the beſt ancient phyſicians. He aſſerts, that unleſs plenty of diluting drink be given, the beſt diuretics can have no effect. He condemns alſo in the ſtrongeſt terms the practice of giving dropſical patients only dry, hard, and indigeſtible aliments. Theſe would oppreſs the ſtomach even of the moſt healthy; and how much more muſt they do ſo to thoſe who are already debilitated by labouring under a tedious diſorder! By what means alſo are theſe aliments to be diſſolved in the ſtomach when drink is withheld? In this diſeaſe the ſaliva is viſcid, and in ſmall quantity; from whence it may be reaſonably conjectured, that the reſt of the fluids are of the ſame nature, and the gaſtric juices likewiſe depraved. Thus the aliments lie long in the ſtomach; and if the viſcera were formerly free of obſtructions, they are now generated; the ſtrength fails; perſpiration and other excretions are obſtructed; the viſcid and pituitous humours produced by theſe kinds of food float about the præcordia, and increaſe the diſeaſe, while the ſurface of the body becomes quite dry. Nay, ſo much does this kind of diet conſpire with the diſeaſe, that 100 pounds of fluid will ſometimes be imbibed in a few days by hydropic perſons who take no drink. Even in health, if the body from any cauſe becomes dry, or deprived of a conſiderable part of its juices, as by hunger, labour, &c. it will imbibe a conſiderable quantity of moiſture from the air; ſo that we muſt impute the above-mentioned extraordinary inhalation, in part at leaſt, to the denial of drink, and to the nature of the aliment given to the ſick. The following is the account given by Sir Francis Milman of his practice in the Middleſex hoſpital.

If the patient be not very much debilitated, he is ſometimes treated with the purging waters, and a doſe of jalap and calomel alternately. On the intermediate days he gets a ſaline mixture, with 40 or 60 drops of *acetum ſcilliticum* every ſixth hour; drinking with the purgatives oat-gruel and ſome thin broths. That he might the better aſcertain what ſhare the liquids given along with the medicines had in producing a copious flow of urine, he ſometimes gave the medicines in the beginning of the diſtemper without allowing the drink: but though the ſwellings were uſually diminiſhed a little by the purgatives, the urine ſtill continued ſcanty, and the patients were greatly weakened. Fearing, therefore, leſt, by following this courſe, the ſtrength of the ſick might be too much reduced, he then began his courſe of diuretic medicines, giving large quantities of barley water with a little *ſal diureticus;* by which means, ſometimes in the ſhort ſpace of 48 hours after the courſe was begun, the urine flowed out in very large quanttiy: but as ſaline drinks are very diſagreeable to the taſte, a drink was compoſed purpoſely for hydropic perſons, of half an ounce of ſupertartrite of potaſh, diſſolved in two pounds of barley water, made agreeably ſweet with ſyrup, adding one or two ounces of French brandy.

To this compoſition Sir Francis Milman was induced by the great praiſes given to ſupertartrite of potaſh by ſome phyſicians in hydropic caſes. In the *Acta Bononienſia*, 15 caſes of hydropic patients are related who were cured only by taking half an ounce of cream of tartar daily. But it is remarkable, that by theſe very patients the cream of tartar was taken for 20, 30, nay 40 days, often without any perceptible effect; yet when diſſolved in a large quantity of water, it ſhowed its ſalutary effects frequently within as many hours, by producing a plentiful flow of urine. This liquor is now the common drink of hydropic patients in the hoſpital above mentioned, of which they drink at pleaſure along with their medicines.

Among purgative medicines Sir Francis Milman recommends the *radix ſenekæ;* but ſays the decoction of it, according to the Edinburgh Pharmacopœia is too ſtrong, as he always found it excite vomiting when prepared as there directed, and thus greatly to diſtreſs the patients: but when only half an ounce or ſix drams of the root are uſed to a pound of decoction, inſtead of a whole ounce as directed by the Edinburgh college, he finds it an excellent remedy; and though it may ſometimes induce a little vomiting, and frequently a nauſea, yet it ſeldom failed to procure nine or ten ſtools a-day, and ſometimes alſo proved diuretic. But we muſt take care not to be too free in the uſe of ſeneka, or any other purgative, if the patients be very weak; and therefore, after having uſed purgatives for ſome time, it will be proper to depend upon diuretics entirely for perfecting the cure; and of the ſucceſs of this method our author gives ſome very remarkable inſtances. But he obſerves, that after the dropſy is removed, the patients will ſometimes die without any evident cauſe; and of this it is proper that the phyſicians ſhould be aware. It is remarkable with what eaſe a flux of urine is induced in thoſe who have a ſcirrhous liver; while, on the other hand, in one who had the meſenteric glands obſtructed, along with a ſcirrhoſity of the liver and vitiated ſtate of the lungs, the moſt powerful diuretics proved ineffectual. In ſome caſes Sir Francis Milman thinks the kidneys may be ſo preſſed with the weight of the water, as to be unable to perform their office. With regard, however, to diuretics in general, it may be remarked, that the operation of none of them can be certainly depended upon. In particular conſtitutions, and at particular times, one will be obſerved to ſucceed, after another, though commonly much more powerful, has been tried in vain. Accordingly various articles of this kind are often uſed in ſucceſſion. Recourſe is particularly often had to the root of taraxacum, of colchicum, and of ſquills; the latter, eſpecially when combined with calomel, is often found to be a very powerful diuretic. And indeed mercury in different forms, probably from acting as a deobſtruent, is often of very great uſe in dropſical complaints. Among other diuretics, the lactuca viroſa has of late been highly extolled by Dr Collins of Vienna, and the nicotiana tabaccum by Dr Fowler of York: but neither has been extenſively introduced into practice, although we have known ſome inſtances in which the latter, in particular, has been uſed with great advantage.

The water having been drawn off, we are to put the patient on a courſe of ſtrengtheners; ſuch as cinchona, with ſome of the warm aromatics, and a due proportion

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of rhubarb infuſed in wine and chalybeates. Gentle exerciſe, and frictions on the belly, with ſuch a courſe of diet as ſhall be light and nouriſhing, are alſo to be enjoined: and it may be obſerved, that the uſe of tonic medicines is by no means to be delayed till a complete evacuation of the water can be obtained. On the contrary, by alternating, and even combining the uſe of evacuants and tonics, the influence of both is often very much promoted.

When the patient can by no other means be relieved, the operation of paracenteſis muſt be had recourſe to, which is deſcribed under the article SURGERY.

344 GENUS LXXX. HYDROMETRA.

DROPSY of the *Uterus.*

Hydrometra, *Sauv.* gen. 289. *Sag.* 116. *Boerh.* 1224.

345 GENUS LXXXI. HYDROCELE.

DROPSY of the *Scrotum.*

Oſcheocele, *Sauv.* gen. 41. *Vog.* 388.
Oſcheophyma, *Sag.* 44.
Hydrops ſcroti, *Vog.* 389.
Hydrops teſtium, *Boerh.* 1227.

For the treatment of theſe two diſeaſes, we may refer the reader to what has already been ſaid of other ſpecies of dropſy, particularly Aſcites. But both are chiefly to be combated by chirurgical operation, eſpecially the latter, in which it ſeldom fails to produce a complete cure.

346 GENUS LXXXII. PHYSCONIA.

SWELLING of the *Belly.*

Phyſconia, *Sauv.* gen. 283. *Vog.* 325. *Sag.* gen. 110.
Hypoſarca, *Lin.* 218.

This diſeaſe may ariſe from a variety of cauſes, as from a ſwelling of the liver, ſpleen, kidneys, uterus, omentum, ovarium, meſentery, inteſtines, &c. and ſometimes it ariſes merely from fat. In the former caſes, as the viſcera are generally ſcirrhous and indurated, the diſtemper is for the moſt part incurable; neither is the proſpect much better where the diſeaſe is occaſioned by a great quantity of fat.

347 GENUS LXXXIII. RACHITIS.

The *RICKETS.*

Rachitis, *Sauv.* gen. 294. *Lin.* 212. *Vog.* 312. *Sag.* gen. 125. *Boerh.* 1480. *Hoffm.* III. 487. *Zeviani* della Rachitide. *Gliſſon* de Rachitide.

Deſcription. This is one of the diſeaſes peculiar to infancy. It ſeldom attacks children till they are nine months, nor after they are two years old; but it frequently happens in the intermediate ſpace between theſe two periods. The diſeaſe ſhows itſelf by a flaccid tumor of the head and face, a looſe flabby ſkin, a ſwelling of the abdomen, and falling away of the other parts, eſpecially of the muſcles. There are protuberances of the epiphyſes of the joints; the jugular veins ſwell, while the reſt decreaſe; and the legs grow crooked. If the child has begun to walk before he be ſeized with this diſeaſe, there is a ſlowneſs, debility, and tottering in his motion, which ſoon brings on a conſtant deſire of ſitting, and afterwards of lying down; inſomuch that nothing at laſt is moveable but the neck and head. As they grow older, the head is greatly enlarged, with ample ſutures; the thorax is compreſſed on the ſides, and the ſternum riſes up ſharp, while the extremities of the ribs are knotty. The abdomen is protuberant, and the teeth black and carious. In ſuch patients as have died of this diſeaſe, all the ſolids appear ſoft and flaccid, and the fluids diſſolved and mucous.

Rachitis.

Cauſes. The rickets may proceed from ſcrophulous or venereal taints in the parents, and may be increaſed by thoſe of the nurſe. It is likewiſe promoted by feeding the child with aqueous and mucous ſubſtances, crude ſummer fruits, fiſh, unleavened farinaceous aliment, and too great a quantity of ſweet things.—Sometimes it follows intermittent fevers and chronic diſorders; and in ſhort, is cauſed by any thing which tends to debilitate the body, and induce a viſcid and unhealthy ſtate of the juices.

Prognoſis. The rickets do not uſually prove fatal by themſelves, but if not cured in time, they make the perſon throughout life deformed in various ways; and often produce very pernicious diſorders, ſuch as carious bones in different parts of the body.

Cure. This is to be effected by mild cathartics, alteratives, and tonics, ſuch as are uſed in other diſeaſes attended with a debility of the ſyſtem and a vitiated ſtate of the blood and juices. In the Weſtern iſlands of Scotland, the medicine uſed for the cure of the rickets is an oil extracted from the liver of the ſkate-fiſh. The method of application is as follows: Firſt, the wriſts and ankles are rubbed with the oil in the evening: this immediately raiſes a fever of ſeveral hours duration. When the fever from the firſt rubbing ſubſides, the ſame parts are rubbed again the night following; and repeatedly as long as the rubbing of theſe parts continues to excite the fever.—When no fever can be excited by rubbing the wriſts and ankles alone, they are rubbed again along with the knees and elbows. This increaſed unction brings on the fever again; and is practiſed as before, till it no longer has that effect. Then the vertebræ and ſides are rubbed, along with the former parts; and this unction, which again brings on the ferver, is repeated as the former. When no fever can be any longer excited by this unction, a flannel ſhirt dipped in the oil is put upon the body of the patient: this brings on a more violent and ſenſible fever than any of the former unctions; and is continued till the cure be completed, which it commonly is in a ſhort time.

A German phyſician, Dr Strack, has lately publiſhed a paper, in which he recommends the filings of iron as a certain remedy in the rickets. This diſeaſe, he obſerves, in general begins with children when they are about 16 months old. It is ſeldom obſerved with children before they be one year old, and ſeldom attacks them after they paſs two; and it is very generally worſe where it begins early than where it begins late.

Impetigines.

For effecting a cure, it is, he affirms, a matter of the utmoſt conſequence to be able to diſtinguiſh, very early, whether a child will be afflicted with rickets or not. And this, he aſſures us, may be determined by the following ſymptoms: Paleneſs and ſwelling of the countenance; and in that part of the cheeks which ſhould naturally be red, a yellow colour approaching to that of ſulphur. When that is the caſe, he directs that a medicine ſhould be immediately had recourſe to which will retard the further progreſs of the diſeaſe, and remove what has already taken place. For this purpoſe, he adviſes that five grains of the filings of iron, and as much rhubarb, ſhould be rubbed up with ten grains of ſugar, and given for a doſe every morning faſting, and every evening an hour before ſupper. But if conſiderable looſeneſs ſhould be produced, it will be neceſſary, at firſt, to perſiſt in the uſe of one doſe only every day.

After a month's continuance in this courſe, according to Dr Strack, there in general enſues a keen appetite for food, quick digeſtion, and a copious flow of urine; by means of which the fulneſs of the face and yellowneſs of the complexion are by degrees removed, while the natural colour of the countenance and firmneſs of the body in general are gradually reſtored. This practice, he aſſures us, has never failed of ſucceſs in any one inſtance; not even in thoſe children born of parents greatly afflicted with the rickets.

In addition to the uſe of chalybeates, great benefit is often alſo obtained in this diſeaſe from the uſe of the cold bath; which under prudent adminiſtration, is perhaps one of the moſt effectual remedies for this complaint with which we are yet acquainted.

Mr Bonhome of Paris, in a late treatiſe on the ſubject of rachitis, has endeavoured to prove, that the diſeaſe ariſes from a peculiar acid, and in the cure he particularly recommends phoſphate of ſoda, phoſphate and muriate of lime; but above all other articles alkaline lotions. The efficacy of theſe remedies, however, is not yet confirmed by experience. And we may conclude with obſerving, that both in the prevention and cure nothing has been found ſo ſucceſsful as cold bathing.

When the bones of rickety children begin to bend, they may ſometimes be reſtored to their natural ſhape by compreſſes, bolſters, and proper ſupports. See the article SURGERY.

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ORDER III. IMPETIGINES.

Impetigines, *Sauv.* Claſs X. Ord. V. *Sag.* Claſs III. Ord. V.

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GENUS LXXXIV. SCROPHULA.

KING's EVIL.

Scrophula, *Sauv.* gen. 285. *Vog.* 397. *Sag.* 121.
Struma, *Lin.* 284.

Deſcription. This diſeaſe ſhows itſelf by hard, ſcirrhous, and often indolent tumors, which ariſe by degrees in the glands of the neck, under the chin, armpits, and different parts of the body, but moſt commonly in the neck, and behind the ears. In proceſs of time, the cellular ſubſtance, ligaments of the joints, and even the bones themſelves, are affected. In ſcrophula the ſwellings are much more moveable than thoſe of the ſcirrhous kind; they are generally ſofter, and ſeldom attended with much pain; they are tedious in coming to ſuppuration; are very apt to diſappear ſuddenly, and again to riſe in ſome other part of the body. We may likewiſe mention as characteriſtic circumſtances of this diſeaſe, a remarkable ſoftneſs of the ſkin, a kind of fulneſs of the face, generally with large eyes, and a very delicate complexion.

Scrophula.

Cauſes. A variety of cauſes have been mentioned as tending to produce ſcrophula, viz. a crude indigeſtible food; bad water; living in damp, low ſituations; its being an hereditary diſeaſe, and in ſome countries endemic, &c. But whatever may in different circumſtances be the exciting or prediſpoſing cauſes of the ſcrophula, the diſeaſe itſelf either depends upon, or is at leaſt much connected with, a debility of the conſtitution in general, and probably of the lymphatic ſyſtem in particular, the complaint always ſhowing itſelf by ſome affections of the latter. And that debility has at leaſt a conſiderable influence in its production is probable, not only from the manifeſt nature of ſome of the cauſes ſaid to be productive of ſcrophula, but likewiſe from ſuch remedies as are found moſt ſerviceable in the cure, which are all of a tonic invigorating nature.

Prognoſis. The ſcrophula is a diſtemper which often eludes the moſt powerful medicines, and therefore phyſicians cannot with any certainty promiſe a cure. It is ſeldom, however, that it proves mortal in a ſhort time, unleſs it attacks the internal parts, ſuch as the lungs, where it frequently produces tubercles that bring on a fatal conſumption. When it attacks the joints, it frequently produces ulcers, which continue for a long time, and gradually waſte the patient; while in the mean time the bones become foul and corroded, and death enſues after a long ſcene of miſery. The prognoſis in this reſpect muſt be regulated entirely by the nature of the ſymptoms.

Cure. It was long ſuppoſed that ſcrophula depended upon an acid acrimony of the fluids; and this, it is probable, gave riſe to the uſe of burnt ſponge, different kinds of ſoap, and other alkaline ſubſtances, as the beſt remedies for acidity. But although a ſourneſs of the ſtomach and *primæ viæ* does no doubt frequently occur in theſe complaints, yet this ſymptom ſeems to be entirely the conſequence of that general relaxation which in ſcrophula ſo univerſally prevails, and which does not render it in the leaſt neceſſary to ſuppoſe a general aceſcency of the fluids to take place; as the one very frequently, it is well known, even in other complaints, occurs without the leaſt ſuſpicion of any acid acrimony exiſting in the other. This is alſo rendered very probable from the indolent nature of ſcrophulous tumors, which have been known to ſubſiſt for years without giving any uneaſineſs; which could not have been the caſe, if an acid, or any other acrimony, had prevailed in them.

In the treatment of ſcrophula, different morbid conditions, exiſting in different parts, require, according to circumſtances, various means of cure: but, upon the whole, the remedies directed may be conſidered as uſed with a view either to the tumours, to the ulcerations, or to the general ſtate of the ſyſtem.

Gentle mercurials are ſometimes of uſe as reſolvents in ſcrophulous ſwellings; but nothing has ſuch conſiderable influence as a frequent and copious uſe of cinchona. Cold bathing too, eſpecially in the ſea, together with frequent moderate exerciſe, is often of ſingular ſervice here; as is likewiſe change of air, eſpecially to a warm climate.

In the ſcrophulous inflammation of the eyes, or ophthalmia ſtrumoſa, the cinchona has alſo been given with extraordinary advantage: and we meet with an inſtance of its having cured the gutta roſacea in the face; a complaint which it is often difficult to remove, and which is extremely diſagreeable to the fair ſex.

From the various caſes related of tumefied glands it appears, that when the habit is relaxed and the circulation weak, either from conſtitution or accident, cinchona is a moſt efficacious medicine, and that it acts as a reſolvent and diſcutient. It will not, however, ſucceed in all caſes; but there are few in which a trial can be attended with much detriment. Dr Fothergill obſerves, that he has never known it avail much where the bones were affected, nor where the ſcrophulous tumor was ſo ſituated as to be accompanied with much pain, as in the joints, or under the membranous coverings of the muſcles; for when the diſeaſe attacks thoſe parts, the perioſtæum ſeldom eſcapes without ſome injury, by which the bone will of courſe be likewiſe affected. Here cinchona is of no effect: inſtead of leſſening, it rather increaſes the fever that accompanies thoſe circumſtances: and, if it do not really aggravate the complaint, it ſeems at leaſt to accelerate the progreſs of the diſeaſe.

Various are the modes in which cinchona is adminiſtered: Dr Fothergill makes uſe of a decoction, with the addition of ſome aromatic ingredients and a ſmall quantity of liquorice root, as a form in which a ſufficient quantity may be given without exciting diſguſt. But where it is eaſily retained in the ſtomach in ſubſtance, perhaps the beſt form of exhibiting it is that of powder; and in this ſtate it is often advantageouſly conjoined with powder of cicuta, an article poſſeſſing very great deobſtruent powers.

The powder, however, ſoon becomes diſagreeable to very young patients; and the extract ſeems not ſo much to be depended upon as may have been imagined. In making the extract, it is expoſed to ſo much heat, as muſt have ſome effect upon its virtues, perhaps to their detriment. In adminiſtering it, likewiſe, if great care be not taken to mix it intimately with a proper vehicle, or ſome very ſoluble ſubſtance, in weak bowels it very often purges, and thereby not only diſappoints the phyſician, but injures the patient. A ſmall quantity of the *cortex Winteranus* added gives the medicine a grateful warmth; and a little liquorice, a few raiſins, gum arabic or the like, added to the decoction before it be taken from the fire, by making the liquor viſcid enables it to ſuſpend more of the fine particles of the bark; by which proceſs the medicine is not only improved in efficacy, but at the ſame time rendered leſs diſagreeable.

In indolent ſwellings of the glands from viſcid humours, ſea water has been ſtrongly recommended by Dr Ruſſel.

Dr Fothergill alſo acquaints us, that the cicuta even by itſelf is not without a conſiderable ſhare of efficacy in removing ſcrophulous diſorders. He mentions the caſe of a gentlewoman, about 28 years of age, afflicted from her infancy with ſcrophulous complaints, ſevere ophthalmies, glandular ſwellings, &c. cured by the *extractum cicutæ* taken conſtantly for the ſpace of a year. He obſerves, however, that when given to children, even in very ſmall doſes, it is apt to produce ſpaſmodic affections; for which reaſon he rarely exhibits it to them when very young, or even to adults of very irritable habits.

Dr Fothergill gives ſeveral other inſtances of the ſucceſs of cicuta in ſcrophulous caſes, and even in one which ſeemed to be not far removed from a confirmed phthiſis; but owns that it ſeldom had ſuch good effects afterwards: yet he is of opinion, that where there are ſymptoms of tubercles forming, a ſtrumous habit, and a tendency to phthiſis, the cicuta will often be ſerviceable. It is anodyne, corrects acrimony, and promotes the formation of good matter. With regard to the quality of the medicine, he obſerves, that the extract prepared from hemlock before the plant arrives at maturity, is much inferior to that which is made when the hemlock has acquired its full vigour, and is rather on the verge of decline: juſt when the flowers fade, the rudiments of the ſeeds become obſervable, and the habit of the plant inclines to yellow; this, he thinks, is the proper time to collect the hemlock. It has then had the full benefit of the ſummer heat; and the plants that grow in expoſed places will generally be found more active than thoſe that grow in the ſhade. The leſs heat it undergoes during the preparation, the better. Therefore, if a conſiderable quantity of the dry powder of the plant gathered at a proper ſeaſon be added, leſs boiling will be neceſſary, and the medicine will be the more efficacious. But let the extract be prepared in what manner ſoever it may, provided it be made from the genuine plant, at a proper ſeaſon, and be not deſtroyed by boiling, the chief difference obſervable in uſing it is, that a larger quantity of one kind is required to produce a certain effect than of another. Twenty grains of one ſort of extract have been found equal in point of efficacy to thirty, nay near forty, of another; yet both of them made from the genuine plant, and moſt probably prepared with equal fidelity. To prevent the inconveniences ariſing from this uncertainty, it ſeems always expedient to begin with ſmall doſes, and proceed ſtep by ſtep till the extract produces certain effects, which ſeldom fail to ariſe from a full doſe. Theſe effects are different in different conſtitutions. But, for the moſt part, a giddineſs affecting the head, and motions of the eyes, as if ſomething puſhed them outwards, are firſt felt; a ſlight ſickneſs, and trembling agitation of the body; a laxative ſtool or two. One or all of theſe ſymptoms are the marks of a full doſe, let the quantity in weight be what it will. Here we muſt ſtop till none of theſe effects be felt; and in three or four days advance a few grains more. For it has been ſuppoſed by moſt of thoſe who have uſed this medicine to any good purpoſe, that the cicuta ſeldom procures any benefit, though given for a long time, unleſs in as large a doſe as the patient can bear without ſuffering any of the inconveniences above mentioned. There is however reaſon to believe, that its effects, as a diſcutient, are in no degree dependent on its narcotic powers:

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and we are inclined to think, that recourſe is often had to larger doſes than are neceſſary; or at leaſt that the ſame benefit might be derived from ſmaller ones continued for an equal length of time.

Patients commonly bear a greater quantity of the extract at night than at noon, and at noon than in the morning. Two drams may be divided into thirty pills. Adults begin with two in the morning, two at noon, and three or four at night, with directions to increaſe each doſe, by the addition of a pill to each, as they can bear it.

But, after all, the beſt form under which the cicuta can, we think, be exhibited, is that of powder from the leaves. This, either under the form of powder or made into pills, may be given at firſt to the extent of four or five grains, and the doſe gradually riſing till it amount to 15 or 20 grains twice or thrice a-day. Given to this extent, particularly when conjoined with cinchona, it has often been found of great ſervice in ſcrophulous caſes. At the ſame time it muſt be allowed, that ſuch patients, after reſiſting every mode of cure, will have in ſome inſtances a ſpontaneous recovery in the progreſs of life, probably from the ſyſtem acquiring additional vigour.

Different mineral waters, particularly the ſulphureous ones, as thoſe of Harrowgate, Moffat, and Gillsland, have been much recommended in ſcrophula, and ſometimes productive of benefit. Recourſe has ſometimes alſo been had with advantage to zinc, iron, and barytes, particularly muriate of barytes. But as well as in rachitis, no remedy has been found more efficacious in ſcrophula than cold bathing, eſpecially ſea-bathing.

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Lues Venerea, or *French Pox.*

Siphylis, *Sauv.* gen. 3086. *Lin.* 6. *Vog.* 319. *Sag.* 126.
Lues venerea, *Boerh.* 1440. *Hoffm.* III. 413. *Junck.* 96. *Aſtruc* de Lue Venerea.

Dr Aſtruc, who writes a very accurate hiſtory of the lues venerea, is fully convinced that it is a new diſeaſe, which never appeared in Europe till ſome time between the years 1494 and 1496, having been imported from America by the companions of Chriſtopher Columbus; though this opinion is not without its opponents. Dr Sanches in particular has contended with much learning and ability, that it appeared in Europe at an earlier period: But it is at leaſt certain that it was altogether unknown to the medical practitioners of Greece and Rome, and that it was a very common diſeaſe in America when the Europeans firſt viſited that country. But at whatever period it may have been introduced into Europe, or from whatever ſource it may have been obtained, there can be no doubt that, as well as ſmallpox or meaſles, ſiphylis depends on a peculiar ſpecific contagion; on a matter *ſui generis*, which is alone capable of inducing this diſeaſe.

The venereal infection, however, cannot, like the contagious miaſmata of the ſmallpox and ſome other diſeaſes, be carried through the air, and thus ſpread from place to place: for unleſs it is tranſmitted from the parents to the children, there is no other way of contracting the diſeaſe but from actual contact with the infectious matter. Thus, when a nurſe happens to labour under the diſeaſe, the infant that ſhe ſuckles will receive the infection; as, on the other hand, when the child is infected, the nurſe is liable to receive it: and there have even been inſtances known of lying-in women being infected very violently, from having employed a perſon to draw their breaſts who happened to have venereal ulcers in the throat. It may be caught by touching venereal ſores, if the cuticle be abraded or torn: and in this way accoucheurs and midwives have ſometimes been infected ſeverely. Dr Macbride ſays, the moſt inveterate pox he ever ſaw was caught by a midwife, who happened to have a whitelow on one of her fingers when ſhe delivered a woman ill of the lues venerea.

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But by far the moſt ready way of contracting this diſeaſe is by coition, the genital parts being much more bibulous than the reſt of the body. When the diſorder is communicated, the places where the morbific matter enters are generally thoſe where it firſt makes its appearance; and as coition is the moſt uſual way of contracting it, ſo the firſt ſymptoms commonly appear on or near the pudenda.

The patient's own account will, for the moſt part, help us to diſtinguiſh the diſeaſe: but there are ſometimes caſes wherein we cannot avail ourſelves of this information, and where, inſtead of confeſſing, the parties ſhall conceal all circumſtances; while, on the other hand, there are now and then people to be met with, who perſuade themſelves that ſymptoms are venereal, which in reality are owing to ſome other cauſe: and therefore it is of the utmoſt importance to inform ourſelves thoroughly of the nature of thoſe ſymptoms and appearances which may be conſidered as pathognomic ſigns of lues venerea.

In the firſt place, when we find that the local ſymptoms, ſuch as chancres, buboes, phymoſis, and the like, do not give way to the uſual methods; or when theſe complaints, after having been cured, break out again without a freſh infection; we may juſtly ſuſpect that the virus has entered the whole maſs of fluids: but if at the ſame time ulcers break out in the throat, and the face is deformed by callous tubercles, covered with a brown or yellow ſcab, we may be aſſured that the caſe is now become a confirmed lues, which will require a mercurial courſe.

When eruptions of the furfuraceous and ſuperficial kind are venereal, they are not attended with itching; and the ſcale being picked off, the ſkin appears of a reddiſh brown, or rather copper colour, underneath; whereas leprous eruptions are itchy, throw off a greater quantity of ſcales, and riſe in greater blotches, eſpecially about the joints of the knees and elbows. Venereal tubercles or puſtules are eaſily diſtinguiſhed from carbuncles of the face, by not occupying the cheeks or the noſe, nor as having a purulent apex, but are covered at top, either with a dry branny ſcurf like the ſuperficial eruptions juſt now mentioned, or elſe with a hard dry ſcab of a tawney yellow hue; they particularly break out among the hair or near to it, on the forehead or on the temples.

Venereal ulcers affecting the mouth are diſtinguiſhable from thoſe which are ſcorbutic, in the following manner: 1. Venereal ulcers firſt affect the tonſils, fauces

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ces and uvula; then the gums, but theſe very rarely: on the contrary, ſcorbutic ulcers affect the gums firſt of all; then the fauces, tonſils, and uvula. 2. Venereal ulcers frequently ſpread to the noſe; ſcorbutic ones almoſt never. 3. Venereal ulcers are callous in the edges; ſcorbutic ones are not ſo. 4. Venereal ulcers are circumſcribed, and, for the moſt part, are circular, at leaſt they are confined to certain places; ſcorbutic ones are of a more irregular form, ſpread wider, and frequently affect the whole mouth. 5. Venereal ulcers are for the moſt part hollow, and generally covered at bottom with a white or yellow ſlough; but ſcorbutic ones are more apt to grow up into looſe fungi. 6. Venereal ulcers are red in their circumference, but ſcorbutic ones are always livid. 7. Venereal ulcers frequently rot the ſubjacent bones, the ſcorbutic ones ſeldom or never. 8. And laſtly, Venereal ulcers are generally combined with other ſymptoms which are known to be venereal; ſcorbutic ones with the diſtinguiſhing ſigns of the ſcurvy, ſuch as difficult breathing, liſtleſſneſs, ſwelling of the legs, rotten gums, &c.

Another ſtrong ſign of the confirmed lues is often afforded from certain deep-ſeated nocturnal pains, particularly of the ſhins, arms, and head. As for any ſuperficial wandering pains that have no fixed ſeat, and which affect the membranes of the muſcles and ligaments of the joints, they, for the moſt part, will be found to belong to the gout or rheumatiſm, and can never be conſidered as venereal unleſs accompanied with ſome other evident ſigns; but with regard to the pains that are deeply ſeated, and always fixed to the ſame place, and which affect the middle and more ſolid part of the ulna, tibia, and bones of the cranium, and rage chiefly and with greateſt violence in the forepart of the night, ſo that the patient can get no reſt till morning approaches, theſe may ſerve to convince us that the diſeaſe has ſpread itſelf throughout the whole habit, whether they be accompanied with other ſymptoms of the lues or not. *Gummata* in the fleſhy parts, *nodes* in the perioſteum, *ganglia* upon the tendons, *tophi* upon the ligaments, *exoſtoſes* upon the bones, and *fici* at the verge of the anus, are all of them ſigns of the confirmed lues: theſe are hard indolent ſwellings; but as they ſometimes ariſe independently of any venereal infection, and perhaps may proceed from a ſcrophulous taint, unleſs they be accompanied or have been preceded by ſome of the more certain and evident ſymptoms of the lues, we muſt be cautious about pronouncing them venereal. When theſe ſwellings are not owing to the ſiphylitic virus, they are very ſeldom painful, or tend to inflame and ſuppurate, whereas thoſe that are venereal uſually do, and if they lie upon a bone generally bring on a caries.

Theſe carious ulcers are moſt commonly met with upon the ulna, tibia, and bones of the cranium; and when accompanied with nocturnal pains, we can never heſitate about declaring their genuine nature. Frequent abortions, or the excluſion of ſcabby, ulcerated, half-rotten, and dead fœtuſes, happening without any manifeſt cauſe to diſturb the fœtus before its time, or to deſtroy it in the womb, may be reckoned as a ſign that at leaſt one of the parents is infected.

Theſe then are the principal and moſt evident ſigns of the confirmed lues. There are others which are more equivocal, and which, unleſs we can fairly trace them back to ſome that are more certain, cannot be held as ſigns of the venereal diſeaſe: Such are, 1. Obſtinate inflammations of the eyes, frequently returning with great heat, itching, and ulceration of the eyelids. 2. A ſinging and hiſſing noiſe in the ears, with ulcers or caries in the bones of the meatus auditorius. 3. Obſtinate headachs. 4. Obſtinate cutaneous eruptions, of the itchy or leprous appearance, not yielding to the milder methods of treatment. 5. Swellings of the bones; and, 6. Wandering and obſtinate pains. None of theſe ſymptoms, however, can be known to be venereal, except they happen to coincide with ſome one or other of the more certain ſigns.

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It may, perhaps, be conſidered as a ſingularity in this diſeaſe, that the diagnoſis is often more difficult in the advanced than in the early periods of the affection. That is, with thoſe who have been certainly ſubjected to ſiphylis, it is often very difficult to ſay whether certain ſymptoms, remaining after the ordinary modes of cure have been employed, be ſiphylitic or not. Very frequently, as appears from the ſequel, nocturnal pains, ulcerations, and the like, remaining after a long courſe of mercury has been employed, are in no degree of a venereal nature, but are in reality to be conſidered as conſequences rather of the remedy than of the diſeaſe; and are accordingly beſt removed by nouriſhing diet, gentle exerciſe, and tonics. But as long as any ſymptoms of any kind remain, it is often impoſſible to convince ſome patients that they are cured; and it is often impoſſible for a phyſician with certainty to affirm that the diſeaſe is altogether overcome.

Upon the whole, we are firſt to diſtinguiſh and conſider the ſeveral ſymptoms apart; and then, by comparing them with each other, a clear judgement may be formed upon the general review.

Prognoſis. Being thoroughly convinced that the caſe is venereal, we are to conſider, firſt of all, whether it be of a longer or ſhorter date; for the more recent it is, it will, *cæteris paribus*, be leſs difficult to remove. But there are other circumſtances which will aſſiſt us in forming a prognoſtic as to the event. As,

1. The age of the patient. This diſorder is more dangerous to infants and old people, than to ſuch as are in the flower and vigour of life, in whom ſome part of the virus may be expelled by exerciſe, or may be ſubdued in ſome degree by the ſtrength of the conſtitution.

2. The ſex. Though women are for the moſt part weaker than men, and therefore ſhould ſeem leſs able to reſiſt the force of any diſeaſe, yet experience ſhows that this is eaſier borne by them than by men; perhaps owing to the menſtrual and other uterine diſcharges, by which a good portion of the virus may be carried off immediately from the parts where it was firſt applied; for it is obſervable, that whenever theſe diſcharges are obſtructed, or ceaſe by the ordinary courſe of nature, all the ſymptoms of this diſeaſe grow worſe.

3. The habit of body. Perſons who have acrid juices will be liable to ſuffer more from the venereal poiſon than ſuch as have their blood in a milder ſtate; hence, when people of a ſcorbutic or ſcrophulous habit contract venereal diſorders, the ſymptoms are always remarkably violent, and difficult to cure. And

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for the ſame reaſons, the confirmed lues is much more to be dreaded in a perſon already inclined to an aſthma, phthiſis, dropſy, gout, or any other chronic diſtemper, than in one of a ſound and healthy conſtitution. For as the original diſeaſe is increaſed by the acceſſion of the venereal poiſon, ſo the lues is aggravated by being joined to an old diſorder. The more numerous the ſymptoms, and the more they affect the bones, the more difficult the cure. Of all combinations the union of ſiphylis with ſcrophula is perhaps the moſt difficult to overcome: but if the acrimony ſhould ſeize on the nobler internal parts, ſuch as the brain, the lungs or the liver, then the diſeaſe becomes incurable, and the patient will either go off ſuddenly in an apoplectic fit, or ſink under a conſumption.

Cure. Viewing this diſeaſe as depending on a peculiar contagious matter introduced into the ſyſtem, and multiplied there, it is poſſible to conceive that a cure may be obtained on one of three principles; either by the evacuation of the matter from the ſyſtem, by the deſtruction of its activity, or by counteracting its influence in the ſyſtem. It is not impoſſible that articles exiſt in nature capable of removing this complaint on each of theſe grounds: but we may venture at leaſt to aſſert, that few ſuch are yet diſcovered. Notwithſtanding numbers of pretended infallible remedies for ſiphylis, mercury is perhaps the only article on which dependence is placed among European practitioners; and with regard to its mode of operation, all the three different opinions pointed out have been adopted and ſupported by different theoriſts.—But although many ingenious arguments have been employed in ſupport of each, we are, upon the whole, inclined to think it more probable that mercury operates by deſtroying the activity of the venereal virus, than that it has effect either by evacuating it, or by exciting a ſtate of action by which its influence is counteracted. Some practitioners have affirmed, that the diſeaſe may be totally extirpated without the uſe of mercury; but, excepting in ſlight caſes, it appears from the moſt accurate obſervations, that this grand ſpecific is indiſpenſable; whether it be introduced through the pores of the ſkin, in the form of ointments, plaſters, waſhes, &c.; or given by the mouth, diſguiſed in the different ſhapes of pills, troches, powders, or ſolutions.

Formerly it was held as a rule, that a ſalivation ought to be raiſed, and a great diſcharge excited. But this is now found to be unneceſſary: for as mercury probably acts by ſome ſpecific power in ſubduing and correcting the venereal virus, all that is required is to throw in a ſufficient quantity of the medicine for this purpoſe; and if it can be diverted from the ſalivary glands ſo much the better, ſince the inconveniences attending a ſpitting are ſuch as we ſhould always wiſh to avoid.

Mercury, when combined with any ſaline ſubſtance, has its activity prodigiouſly increaſed; hence the great variety of chemical preparations which have been contrived to unite it with different acids.

Corroſive ſublimate or the murias hydrargyri corroſivus is one of the moſt active of all the mercurial preparations, inſomuch as to become a poiſon even in very ſmall doſes. It therefore cannot ſafely be given in ſubſtance; but muſt be diſſolved in order to render it capable of a more minute diviſion. We may ſee, by looking into Wiſeman, that this is an old medicine, though ſeldom given by regular practitioners. How it came to be introduced into ſo remote a part of the world as Siberia, is not eaſily found out; but Dr Clerc, author of the *Hiſtoire Naturelle de l'Homme Malade*, aſſures us, that the ſublimate ſolution has been in uſe there time out of mind.

Siphylis.

It appears to have been totally forgotten in other places, until of late years, when Baron Van Swieten brought it into vogue; ſo that at one period, if we may credit Dr Locker, they uſed no other mercurial preparation at Vienna. The number of patients cured by this remedy alone in the hoſpital of St Mark, which is under the care of this gentleman, from 1754 to 1761 incluſive, being 4880.

The method of preparing the ſolution is, to diſſolve as much ſublimate in any kind of ardent ſpirit (at Vienna they uſe only corn brandy) as will give half a grain to an ounce of ſolution. The doſe to a grown perſon is one ſpoonful mixed with a pint of any light ptiſan or barley water, and this to be taken morning and evening: the patients ſhould keep principally in a warm chamber, and lie in bed to ſweat after taking the medicine; their diet ſhould be light; and they ought to drink plentifully throughout the day, of whey, ptiſan, or barley water. If the ſolution does not keep the belly open, a mild purge muſt be given from time to time; for Locker obſerves, that thoſe whom it purges two or three times a-day, get well ſooner than thoſe whom it does not purge: he alſo ſays, that it very ſeldom affects the mouth, but that it promotes the urinary and cutaneous diſcharges. This courſe is not only to be continued till all the ſymptoms diſappear, but for ſome weeks longer. The ſhorteſt time in which Locker uſed to let the patients out was ſix weeks; and they were continued on a courſe of decoction of the woods for ſome weeks after they left off the ſolution.

This method has been introduced both in Britain and Ireland, though by no means to the excluſion of others; but it appears, that the ſolution does not turn out ſo infallible a remedy, either in theſe kingdoms, or in France, as they ſay it has done in Germany. It was ſeldom if ever found to perform a radical cure, and the frequent uſe of it proved in many caſes highly prejudicial. It has therefore been ſucceeded in practice, even at Vienna, by mercury exhibited in other forms; and, among theſe, by a remedy firſt recommended by Dr Plenck, and ſince improved by Dr Saunders; conſiſting of mercury united with mucilage of gum arabic, which is ſaid to render its exhibition perfectly mild and ſafe. For particulars, we refer to Dr Saunders's treatiſe.

But a late French writer, ſuppoſed to be Dr Petit, in a ſmall book, entitled, *A parallel of the different methods of treating the venereal diſeaſe*, inſiſts, that there is neither certainty nor ſafety in any other method than the repeated frictions with mercurial ointment.

If, therefore, it is determined to have recourſe to the mercurial frictions, the patient may with advantage be prepared by going into the warm bath ſome days ſucceſſively; having been previouſly blooded if of a plethoric habit, and taking a doſe or two of ſome proper cathartic.

The patient being fitted with the neceſſary apparatus of flannels, is then to enter on the courſe.

If he be of a robuſt habit, and in the prime of life, we may begin with two drams of the *unguentum hydrargyri fortius*, (Ph. Lond.) which is to be rubbed in about the ankles by an aſſiſtant whoſe hands are covered with bladders: then having intermitted a day, we may expend two drams more of the ointment, and reſt for two days; after which, if no ſoreneſs of the mouth comes on, uſe only one dram; and at every ſubſequent friction aſcend till the ointment ſhall reach the trunk of the body; after which the rubbings are to be begun at the wriſts, and from thence gradually extended to the ſhoulders. In order to prevent the mercury from laying too much hold of the mouth, it muſt be diverted to the ſkin, by keeping the patient in a conſtant perſpiration from the warmth of the room, and by drinking plentifully of barley-water, whey, or ptiſan; but if, nevertheleſs, the mercury ſhould tend to raiſe a ſpitting, then, from time to time, we are either to give ſome gentle cathartic, or order the patient into a vapour or warm bath; and thus we are to go on, rubbing in a dram of the ointment every ſecond, third, or fourth night, according as it may be found to operate; and on the intermediate days either purging or bathing, unleſs we ſhould chooſe to let the ſalivation come on; which, however, it is much better to avoid, as we ſhall thus be able to throw in a larger quantity of mercury.

It is impoſſible to aſcertain the quantity of mercury that may be neceſſary to be rubbed in, as this will vary according to circumſtances: but we are always to continue the frictions, for a fortnight at leaſt, after all ſymptoms of the diſeaſe ſhall have totally diſappeared; and when we have done with the mercury, warm bathing, and ſudorific decoctions of the woods, are to be continued for ſome time longer.

This is a general ſketch of the methods of treatment for the confirmed lues; but for a complete hiſtory of the diſeaſe, and for ample directions in every ſituation, we refer to Aſtruc, and his abridger Dr Chapman.—We have to add, however, that a method of curing this diſeaſe by mercurial fumigation has been lately recommended in France, but it ſeems not to meet with great encouragement. One of the moſt recent propoſals for the cure of the venereal diſeaſe is that of Mr Clare, and conſiſts in rubbing a ſmall quantity of mercury under the form of the *ſubmurias hydrargyri*, or *calomel* as it is commonly called, on the inſide of the cheek; by which means it has been ſuppoſed that we will not only avoid the inconveniences of unction, but alſo the purgative effects that are often produced by this medicine when taken into the ſtomach. But after all, the introduction of mercury under the form of unction, as recommended by the lateſt and beſt writers in Britain on the venereal diſeaſe, Dr Swediaur, Mr John Hunter, and others, is ſtill very generally preferred to any mode that has yet been propoſed.

Where, after a long trial of mercury, diſtreſſing ſymptoms ſtill remain, particularly obſtinate ulcerations and ſevere pains, benefit has often been derived from the uſe of opium: but there is little reaſon to believe, as has been held by ſome, that of itſelf it affords an infallible cure of this diſeaſe; at leaſt we are inclined to think, that all the facts hitherto brought in ſupport of the cure of ſiphylis by opium are at the utmoſt very doubtful.

The ſame obſervation may perhaps be made with regard to another remedy which has of late been highly extolled in ſiphylis, viz. the nitric acid. This article ſeems to have been firſt introduced both againſt affections of the liver and venereal complaints by Dr Scott of Bombay. It has ſince been highly extolled by Dr Beddoes and other writers in Britain. And there are many well authenticated caſes on record in which it has produced a cure. But it is very rarely preferable to mercury; and it is chiefly uſeful when, from ſome peculiarity of conſtitution, mercury cannot be exhibited.

In obſtinate ulcerations, remaining probably after the venereal virus has been overcome, and reſiſting the uſe of mercury, a complete cure has in many inſtances been obtained from the uſe of the root of the mezereon, the daphne mezereum of Linnæus. This article has been chiefly employed under the form of decoction; and it now appears that it is the baſis of an article at one time highly celebrated in venereal complaints, under the title of *Liſbon diet drink*. But, upon the whole, theſe ſequelæ of this diſeaſe are perhaps more readily overcome by country air, gentle exerciſe, and nouriſhing diet, particularly a milk diet, than by the uſe of any medicine whatever. It muſt indeed be allowed, that for combating different ſequelæ, various practices accommodated to the nature of theſe will on particular occaſions be requiſite. But into the conſideration of theſe we cannot here propoſe to enter.

GENUS LXXXVI. SCORBUTUS. 351

SCURVY.

Scorbutus, *Sauv.* gen 391. *Lin.* 223. *Vog.* 318. *Sag.* 127. *Boerh.* 1148. *Hoffm.* III. 369. *Junck.* 91. *Lind* on the Scurvy. *Hulme* de Scorbuto. *Rouppe* de Morbis Navigantium.

Deſcription. The firſt indication of the ſcorbutic diatheſis is generally a change of colour in the face, from the natural and healthy look to a pale and bloated complexion, with a liſtleſſneſs, and averſion from every ſort of exerciſe; the gums ſoon after become itchy, ſwell, and are apt to bleed on the ſlighteſt touch; the breath grows offenſive; and the gums, ſwelling daily more and more, turn livid, and at length become extremely fungous and putrid, as being continually in contact with the external air; which in every caſe favours the putrefaction of ſubſtances diſpoſed to run into that ſtate, and is indeed in ſome reſpects abſolutely requiſite for the production of actual putridity.

The ſymptoms of the ſcurvy, like thoſe of every other diſeaſe, are ſomewhat different in different ſubjects, according to the various circumſtances of conſtitution; and they do not always proceed in the ſame regular courſe in every patient. But what is very remarkable in this diſeaſe, notwithſtanding the various and immenſe load of diſtreſs under which the patients labour, there is no ſickneſs at the ſtomach, the appetite keeps up, and the ſenſes remain entire almoſt to the very laſt: when lying at reſt, ſcorbutic patients make no complaints, and feel little diſtreſs or pain; but the moment they attempt to riſe or ſtir themſelves, then the breathing becomes difficult, with a kind of ſtraitneſs or catching, and great oppreſſion, and ſometimes they have been known to fall into a ſyncope. This catching of the breath upon motion, with the loſs of ſtrength, dejection of ſpirit, and rotten gums, are held as the eſſential or diſtinguiſhing ſymptoms of the diſeaſe. The ſkin is generally dry, except in the very laſt ſtage, when the patients become exceedingly ſubject to faintings, and then it grows clammy and moiſt: in ſome it has an anſerine appearance: but much oftener it is ſmooth and ſhining; and, when examined, is found to be ſpread over with ſpots not riſing above the ſurface, of a rediſh, bluiſh, livid or purple colour, with a ſort of yellow rim round them. At firſt theſe ſpots are for the moſt part ſmall, but in time they increaſe to large blotches. The legs and thighs are the places where they are principally ſeen: more rarely on the head and face. Many have a ſwelling of the legs, which is harder, and retains the impreſſion of the finger longer than the common dropſical or truly œdematous ſwellings. The ſlighteſt wounds and bruiſes, in ſcorbutic habits, degenerate into foul and untoward ulcers; and the appearance of theſe ulcers is ſo ſingular and uniform, that they are eaſily diſtinguiſhed from all others. Scorbutic ulcers afford no good digeſtion, but give out a thin and fetid ichor mixed with blood, which at length has the appearance of coagulated gore lying caked on the ſurface of the ſore, not to be ſeparated or wiped off without ſome difficulty. The fleſh underneath theſe ſloughs feels to the probe ſoft and ſpongy, and is very putrid. Neither detergents nor eſcharotics are here of any ſervice; for though ſuch ſloughs be with great pains taken away, they are found again at the next dreſſing, where the ſame ſanguineous putrid appearance always preſents itſelf. Their edges are generally of a livid colour, and puffed up with excreſcences of proud fleſh ariſing from below the ſkin. As the violence of the diſeaſe increaſes, the ulcers ſhoot out a ſoft bloody fungus, which often riſes in a night's time to a monſtrous ſize; and although deſtroyed by cauteries, actual or potential, or cut away with the knife, is found at next dreſſing as large as ever. It is a conſiderable time, however, before theſe ulcers, bad as they are, come to affect the bones with rottenneſs. Theſe appearances will always ſerve to aſſure us that an ulcer is ſcorbutic; and ſhould put us on our guard with reſpect to the giving mercurials, which are very generally pernicious in theſe caſes.

Scorbutic people, as the diſeaſe advances, are ſeldom free from pains; though they have not the ſame ſeat in all, and often in the ſame perſon ſhift their place. Some complain of univerſal pain in all their bones; but moſt violent in the limbs, and eſpecially the joints: the moſt frequent ſeat of their pain, however, is ſome part of the breaſt. The pains of this diſeaſe ſeem to ariſe from the diſtraction of the ſenſible fibres by the extravaſated blood being forced into the interſtices of the perioſteum and of the tendinous and ligamentous parts; whoſe texture being ſo firm, the fibres are liable to higher degrees of tenſion, and conſequently of pain.

The ſtates of the bowels are various: in ſome there is an obſtinate coſtiveneſs; in others a tendency to a flux, with extremely fetid ſtools: the urine is alſo rank and fetid, generally high coloured; and, when it has ſtood for ſome hours, throws up an oily ſcum on the ſurface. The pulſe is variable; but moſt commonly ſlower and more feeble than in the time of perfect health. A ſtiffneſs in the tendons, and weakneſs in the joints of the knees, appear early in the diſeaſe: but as it grows more inveterate, the patients generally loſe the uſe of their limbs altogether; having a contraction of the flexor tendons in the ham, with a ſwelling and pain in the joint of the knee. Some have their legs monſtrouſly ſwelled, and covered over with livid ſpots or ecchymoſes; others have had tumours there; ſome, though without ſwelling, have the calves of the legs and the fleſh of the thighs quite indurated. As perſons far gone in the ſcurvy are apt to faint, and even expire, on being moved and brought out into the freſh air, the utmoſt care and circumſpection are requiſite when it is neceſſary to ſtir or remove them.

Scorbutic patients are at all times, but more eſpecially as the diſeaſe advances, extremely ſubject to profuſe bleedings from different parts of the body; as from the noſe, gums, inteſtines, lungs, &c. and likewiſe from their ulcers, which generally bleed plentifully if the fungus be cut away. It is not eaſy to conceive a more diſmal and diverſified ſcene of miſery than what is beheld in the third and laſt ſtage of this diſtemper; it being then that the anomalous and more extraordinary ſymptoms appear, ſuch as the burſting out of old wounds, and the diſſolution of old fractures that have been long united.

Cauſes. The term *ſcurvy* has been indiſcriminately applied, even by phyſicians, to almoſt all the different kinds of cutaneous foulneſs; owing to ſome writers of the laſt century, who comprehended ſuch a variety of ſymptoms under this denomination, that there are few chronic diſtempers which may not be ſo called, according to their ſcheme: but the diſeaſe here meant is the true putrid ſcurvy, ſo often fatal to ſeamen, that with many it has got the name of ſea-ſcurvy, though it be a diſeaſe frequently occurring on ſhore, as was experienced by the Britiſh garriſons of Boſton, Minorca, and many other places. Indeed no diſeaſe is perhaps more frequent or more deſtructive to people pent up in garriſons without ſufficient ſupplies of ſound animal food and freſh vegetables. It is ſometimes known to be endemic in certain countries, where the nature of the ſoil, the general ſtate of the atmoſphere, and the common courſe of diet, all combine in producing that ſingular ſpecies of corruption in the maſs of blood which conſtitutes the ſcorbutic diatheſis; for the appearances, on diſſecting ſcorbutic ſubjects, ſufficiently ſhow that the ſcurvy may, with great propriety, be termed a diſeaſe of the blood.

Dr Lind has, in a poſtſcript to the third edition of his treatiſe on the ſcurvy, given the reſult of his obſervations drawn from the diſſection of a conſiderable number of victims to this fatal malady; from which it appears that the true ſcorbutic ſtate, in an advanced ſtage of the diſtemper, conſiſts in numerous effuſions of blood into the cellular interſtices of moſt parts of the body, ſuperficial as well as internal; particularly the gums and the legs; the texture of the former being almoſt entirely cellular, and the generally dependent ſtate of the latter rendering theſe parts, of all others in the whole body, the moſt apt to receive and retain the ſtagnant blood, when its craſis comes to be deſtroyed; and when it loſes that glutinous quality which, during health, hinders it from eſcaping through the pores in the coats of the blood-veſſels or through exhalant extremities.

A dropſical indiſpoſition, eſpecially in the legs and breaſt, was frequently, but not always, obſerved in the ſubjects that were opened, and the pericardium was ſometimes found diſtended with water: the water thus collected was often ſo ſharp as to ſhrivel the hands of the diſſector; and in ſome inſtances, where the ſkin happened to be broken, it irritated and feſtered the wound.

The fleſhy fibres were found ſo extremely lax and tender, and the bellies of the muſcles in the legs and thighs ſo ſtuffed with the effuſed ſtagnating blood, that it was always difficult, and ſometimes impoſſible, to raiſe or ſeparate one muſcle from another. He ſays that the quantity of this effuſed blood was amazing; in ſome bodies it ſeemed that almoſt a fourth part of the whole maſs had eſcaped from the veſſels; and it often lay in large concretions on the perioſteum, and in ſome few inſtances under this membrane immediately on the bone. Notwithſtanding this diſſolved and depraved ſtate of the external fleſhy parts, the brain always appeared perfectly ſound, and the viſcera of the abdomen, as well as thoſe in the thorax, were in general found quite uncorrupted. There were ſpots indeed, from extravaſated blood, obſerved on the meſentery, inteſtines, ſtomach, and omentum; but theſe ſpots were firm, and free from any mortified taint; and, more than once, an effuſion of blood, as large as a hand's breadth, has been ſeen on the ſurface of the ſtomach; and what was remarkable, that very ſubject was not known while living to have made any complaint of ſickneſs, pain, or other diſorder, in either ſtomach or bowels.

Theſe circumſtances and appearances, with many others that are not here enumerated, all prove to a demonſtration a putreſcent, or at leaſt a highly depraved ſtate of the blood: and yet Dr Lind takes no ſmall pains to combat the idea of the ſcurvy's proceeding from animal putrefaction; a notion which, according to him, "may, and hath miſled phyſicians to propoſe and adminiſter remedies for it altogether ineffectual."

He alſo, in the preface to his third edition, talks of the miſchief done by an attachment to deluſive theories. He ſays, "it is not probable that a remedy for the ſcurvy will ever be diſcovered from a preconceived hypotheſis, or by ſpeculative men in the cloſet, who have never ſeen the diſeaſe, or who have ſeen at moſt only a few caſes of it;" and adds, "that though a few partial facts and obſervations may, for a little, flatter with hopes of greater ſucceſs, yet more enlarged experience muſt ever evince the fallacy of all poſitive aſſertions in the healing art."

Sir John Pringle, however, is of a very different opinion. He "is perſuaded, after long reflection, and the opportunities he has had of converſing with thoſe who to much ſagacity had joined no ſmall experience in nautical practice, that upon an examination of the ſeveral articles which have either been of old approved, or have of late been introduced into the navy, it will appear, that though theſe means may vary in form and in mode of operating, yet they all ſome way contribute towards preventing putrefaction; whether of the air in the cloſer parts of a ſhip, of the meats, of the water, of the clothes and bedding, or of the body itſelf."

What Dr Lind has above advanced is the more remarkable, as, in the two former editions of his book, he embraced the hypotheſis of animal putrefaction being the cauſe of the ſcurvy; and if theſe effuſions of blood, from a deſtruction of its craſis and the diſſolved ſtate of the muſcular fibres, together with the rotten condition of the mouth and gums, do not betray putreſcency, it is hard to ſay what does, or what other name we ſhall beſtow on this peculiar ſpecies of depravation which conſtitutes the ſcurvy.

The blood, no doubt, derives its healthy properties, and maintains them, from the due ſupplies of wholeſome food; while the inſoluble, ſuperfluous, effete, and acrid parts, are carried off by the ſeveral diſcharges of ſtool, urine, and perſpiration.

Our ſenſes of taſte and ſmell are ſufficient to inform us when our food is in a ſtate of ſoundneſs and ſweetneſs, and conſequently wholeſome; but it is from chemiſtry that we muſt learn the principles on which theſe qualities chiefly depend.

Experiments of various kinds have proved, that the ſoundneſs of animal and vegetable ſubſtances depends very much, if not entirely, on the preſence of their aërial principle. Rottenneſs is never obſerved to take place without an emiſſion of fixed air from the putrefying ſubſtance: and even when putrefaction has made a conſiderable progreſs, if aërial acid can be transferred, in ſufficient quantity, from ſome other ſubſtance in a ſtate of efferveſcence or fermentation, into the putrid body, the offenſive ſmell of this will be deſtroyed. If it be a bit of rotten fleſh with which the experiment is made, the firmneſs of its fibres will be found in ſome meaſure reſtored.

The experiments of Dr Hales, as well as many others made ſince his time, ſhow that an aërial principle is greatly connected with, and remarkably abundant in, the gelatinous parts of animal bodies, and in the mucilage or farina of vegetables. But theſe are the parts of our food which are moſt particularly nutritive; and Dr Cullen, whoſe opinion on this as on every other medical ſubject muſt be allowed of the greateſt weight, affirms, in his Lectures on the Materia Medica, that the ſubſtances on which we feed are nutritious only in proportion to the quantities of oil and ſugar which they reſpectively contain. This oil and ſugar are blended together in the gelatinous part of our animal food, and in the mucilaginous and farinaceous part of eſculent vegetables; and, while thus intimately combined, are not perceivable by our taſte, though very capable of being developed and rendered diſtinct by the power of the digeſtive organs; for in conſequence of the changes produced during digeſtion, the oily and the ſaccharine matter become manifeſt to our ſenſes, as we may ſee and taſte in the milk of animals, which is chiefly chyle a little advanced in its progreſs toward ſanguification; the oil is obſerved to ſeparate ſpontaneouſly, and from which a quantity of actual ſugar may be obtained by a very ſimple proceſs.

Thus much being premiſed, we can now readily comprehend how the blood may come to loſe thoſe qualities of ſmoothneſs, mildneſs, and tenacity which are natural to it. For if, in the firſt place, the fluids, and organs ſubſervient to digeſtion, ſhould be ſo far diſtempered or debilitated that the nutritious parts of the food cannot be properly developed, the blood muſt be defrauded of its due ſupplies; which will alſo be the caſe if the aliment ſhould not originally contain enough of oily and ſaccharine matter, or ſhould be ſo circumſtanced, from being dried or ſalted, as to hinder the ready extrication of the nutritious parts; or, laſtly, if the natural diſcharges ſhould be interrupted or ſuſpended, ſo that the ſuperfluous, acrid, and effete fluids are retained in the general maſs; in all theſe inſtances the blood muſt of neceſſity run into proportionate degrees of depravation.

And hence we may underſtand how it may poſſibly happen, that when perſons are greatly weakened by ſome preceding diſorder, and at the ſame time debarred the uſe of proper bodily exerciſe, the ſcorbutic diatheſis ſhould take place, even though they enjoy the advantages of pure air and wholeſome diet. But theſe are ſolitary caſes, and very rarely ſeen; for whenever the ſcurvy ſeizes numbers, and can be conſidered as an epidemic diſeaſe, it will be found to depend on a combination of the major part, or perhaps all, of the following circumſtances:

1. A moiſt atmoſphere, and more eſpecially if cold be joined to this moiſture. 2. Too long ceſſation from bodily exerciſe, whether it be from conſtraint, or a lazy ſlothful diſpoſition. 3. Dejection of mind. 4. Neglect of cleanlineſs, and want of ſufficient clothing. 5. Want of wholeſome drink, either of pure water or fermented liquors. And, 6. Above all, the being obliged to live continually on ſalted meats, perhaps not well cured, without a due proportion of the vegetables ſufficient to correct the pernicious tendency of the ſalt, by ſupplying the bland oil and ſaccharine matter requiſite for the purpoſes of nutrition.

Theſe general principles reſpecting the cauſes and nature of ſcurvy, ſeem to afford a better explanation of the phenomena of the diſeaſe than any conjectures reſpecting it that have hitherto been propoſed. It muſt, however, be allowed, that Dr Lind is by no means the only writer who is diſpoſed to conſider this diſeaſe as not referable to the condition of the circulating fluids. In a late ingenious treatiſe on this ſubject by Sir F. Milman, he ſtrenuouſly contends, that the primary morbid affection in this complaint is a debilitated ſtate of the ſolids ariſing principally from want of aliment. But his arguments on this ſubject, as well as thoſe of Dr Lind, are very ably anſwered by a ſtill later writer on this ſubject, Dr Trotter, who has drawn his obſervations reſpecting it from very extenſive experience, and who conſiders it as clearly eſtabliſhed, by incontrovertible facts, that the proximate cauſe of ſcurvy depends on ſome peculiar ſtate of the blood.—That this diſeaſe does not depend on a debilitated ſtate of the ſolids, is demonſtratively proved from numerous caſes where every poſſible degree of debility occurs in the ſolids without the ſlighteſt appearance of ſcurvy. Dr Trotter, in the ſecond edition of his Obſervations on the Scurvy, from the reſult of farther obſervation and later diſcoveries in chemiſtry, has attempted, with much ingenuity, to prove that the morbid condition of the blood, which takes place in ſcurvy, ariſes from the abſtraction of vital air, or, as it is now generally called, *oxygene*; and this opinion, though ſtill, perhaps, in ſome particulars requiring farther confirmation, is, it muſt be allowed, ſupported by many plauſible arguments.

Prevention and Cure. The ſcurvy may be prevented, by obviating and correcting thoſe circumſtances in reſpect of the non-naturals which were mentioned as contributing to the diſeaſe, and laid down as cauſes. It is therefore a duty highly incumbent on officers commanding at ſea, or in garriſons, to uſe every poſſible precaution; and, in the firſt place, to correct the coldneſs and moiſture of the atmoſphere by ſufficient fires: in the next, to ſee that their men be lodged in dry, clean, and well ventilated births or apartments: thirdly, to promote cheerfulneſs, and enjoin frequent exerciſe, which alone is of infinite uſe in preventing the ſcurvy: fourthly, to take care that the clothing be proper, and cleanlineſs of perſon ſtrictly obſerved: fifthly, to ſupply them with wholeſome drink, either pure water or ſound fermented liquors; and if ſpirits be allowed, to have them properly diluted with water and ſweetened with melaſſes or coarſe ſugar: and laſtly, to order the ſalted meats to be ſparingly uſed, or ſometimes entirely abſtained from; and in their place, let the people live on different compoſitions of the dried vegetables; freſh meat and recent vegetables being introduced as often as they can poſſibly be procured.

A cloſe attention to theſe matters will, in general, prevent the ſcurvy from making its appearance at all, and will always hinder it from ſpreading its influence far. But when theſe precautions have been neglected, or the circumſtances ſuch that they cannot be put in practice, and the diſeaſe has actually taken place, our whole endeavour muſt be to reſtore the blood to its original ſtate of ſoundneſs: and happily, ſuch is the nature of this diſeaſe, that if a ſufficiency of new matter, of the truly mild nutritious ſort, and particularly ſuch as abounds with vital air, ſuch as recent vegetables, or different acid fruits, can be thrown into the circulation while the fleſhy fibres retain any tolerable degree of firmneſs, the patient will recover; and that in a ſurpriſingly ſhort ſpace of time, provided a pure air, comfortable lodgings, ſufficient clothing, cleanlineſs, and exerciſe, lend their neceſſary aid.

This being the caſe, the plan of treatment is to be conducted almoſt entirely in the dietetic way; as the change in the maſs of blood, which it is neceſſary to produce, muſt be brought about by things that can be received into the ſtomach by pints or pounds, and not by thoſe which are adminiſtered in drops or grains, drams or ounces. For here, as there is no diſorder of the nervous ſyſtem, we have no need of thoſe active drugs which are indiſpenſably neceſſary in febrile or nervous diſeaſes; the ſcorbutic diatheſis being quite oppoſite to that which tends to produce a fever or any ſpecies of ſpaſmodic diſorders; nay, Dr Lind ſays, he has repeatedly found, that even the infection of an hoſpital fever is long reſiſted by a ſcorbutic habit.

It will now naturally occur to the reader, what thoſe alimentary ſubſtances muſt be which bid the faireſt to reſtore the blood to its healthy ſtate; and he needs ſcarcely to be told, that they are of thoſe kinds which the ſtomach can bear with pleaſure though taken in large quantities, which abound in jelly or mucilage, and which allow thoſe nutritious parts to be eaſily developed; for though the viſcera in ſcorbutic patients may be all perfectly ſound, yet we cannot expect that either the digeſtive fluids or organs ſhould poſſeſs the ſame degrees of power, which enable them, during health, to convert the crude dry farinacea, and the hard ſalted fleſh of animals, into nouriſhment. We muſt therefore ſearch for the *antiſcorbutic virtue* in the tender ſweet fleſh of herbivorous animals; in new milk; and in the mucilaginous acid juices of recent vegetables, whether they be fruits, leaves, or roots.

The ſour juices of lemons, oranges, and limes, have been generally held as antiſcorbutics in an eminent degree, and their power aſcribed to their acid; from an idea that acids of all kinds are the only correctors of putrefaction. But the general current of practical obſervations ſhows, and our experiments confirm it, that the virtue of theſe juices depends on their *aerial principle;* accordingly, while perfectly recent and in the mucilaginous ſtate, and eſpecially if mixed with wine and ſugar, the juices of any one of theſe fruits will be found a moſt grateful and powerful antiſcorbutic.

Dr Lind obſerving, "that the lemon juice, when given by itſelf undiluted, was apt, eſpecially if overdoſed, to have too violent an operation, by occaſioning pain and ſickneſs at the ſtomach, and ſometimes a vomiting; found it neceſſary to add to it wine and ſugar. A pint of Madeira wine, and two ounces of ſugar, were put to four ounces and a half of juice, and this quantity was found ſufficient for weak patients to uſe in 24 hours: ſuch as were very weak ſipped a little of this frequently according as their ſtrength would permit; others who were ſtronger took about two ounces of it every two hours; and when the patients grew ſtill ſtronger, they were allowed eight ounces of lemon juice in 24 hours."

While this very pleaſant mixture, which is both a cordial and an antiſeptic, may be had, it would be needleſs to think of preſcribing any other; but when the freſh juice cannot be procured, we muſt have recourſe to ſuch other things as may be obtained. But the various modes of combining and adminiſtering theſe, ſo as to render them perfectly agreeable to the ſtomach, muſt always be regulated by circumſtances, and therefore it will be in vain to lay down particular directions; ſince all that we have to do is, to fix on ſuch fruits and other freſh vegetables as can be moſt conveniently had and taken, and contrive to give them in thoſe forms, either alone or boiled up with fleſh meat into ſoups, which will allow the patients to conſume the greateſt quantities.

The firſt promiſing alteration from ſuch a courſe is uſually a gentle diarrhœa; and if, in a few days, the ſkin becomes ſoft and moiſt, it is an infallible ſign of recovery; eſpecially if the patient gain ſtrength, and can bear being ſtirred or carried into the open air without fainting.

But if the belly ſhould not be looſened by the uſe of the freſh vegetables, nor the ſkin become ſoft and moiſt, then they muſt be aſſiſted by ſtewed prunes, or a decoction of tamarinds with ſupertartrite of potaſh, in order to abate the coſtiveneſs; and by drinking a light decoction of the woods, and warm bathing, in order to relax the pores of the ſkin; for nothing contributes more to the recovery of ſcorbutic patients than moderate ſweating.

With regard to particular ſymptoms, antiſeptic mouth waters compoſed of a decoction of cinchona and infuſion of roſes, with a ſolution of myrrh, muſt be uſed occaſionally, in order to cleanſe the mouth, and give firmneſs to the ſpongy gums. Swelled and indurated limbs, and ſtiffened joints, muſt be bathed with warm vinegar, and relaxed by the ſteam of warm water, repeatedly conveyed to them, and confined to the parts by means of cloſe blankets: ulcers on the legs muſt never be treated with unctuous applications nor ſharp eſcharotics; but the dreſſing ſhould conſiſt of lint or ſoft rags, dipt in a ſtrong decoction of cinchona.

This diſeaſe at no time requires, or indeed bears, large evacuations, either by bleeding or purging; and as has been already mentioned, the belly muſt only be kept open by the freſh vegetables or the mildeſt laxatives. But we are always to be careful that ſcorbutic perſons, after a long abſtinence from greens and fruits, be not permitted to eat voraciouſly at firſt, leſt they fall into a fatal dyſentery.

All, however, that has now been laid down as neceſſary towards the cure, ſuppoſes the patients to be in ſituations where they can be plentifully furniſhed with all the requiſites; but unhappily theſe things are not to be procured at ſea, and often deficient in garriſons: in order therefore, that a remedy for the ſcurvy might never be wanting, Dr Macbride, in the year 1762, firſt conceived the notion, that the *infuſion of malt*, commonly called *wort*, might be ſubſtituted for the common antiſcorbutics; and it was accordingly tried.

More than three years elapſed before any account arrived of the experiments having been made: at length, ten hiſtories of caſes were received, wherein the wort had been tried, with very remarkable ſucceſs; and this being judged a matter of great importance to the ſeafaring part of mankind, theſe were immediately communicated to the public in a pamphlet, under the title of *An hiſtorical account of a new method of treating the ſcurvy at ſea.*

This was in 1767; but after that time a conſiderable number of letters and medical journals, ſufficient to make up a ſmall volume, were tranſmitted to Dr Macbride, particularly by the ſurgeons of his Majeſty's ſhips who had been employed of late years for making diſcoveries in the ſouthern hemiſphere. Certain it is, that in many inſtances it has ſucceeded beyond expectation. In others it has fallen ſhort: but whether this was owing to the untoward ſituation of the patients, or inattention on the part of the perſons who were charged with the adminiſtration of the wort, not preparing it properly, or not giving it in ſufficient quantity, or to its own want of power, muſt be collected from the caſes and journals themſelves.

During Captain Cook's third voyage, the moſt remarkable, in reſpect of the healthineſs of the crew, that ever was performed, the wort is acknowledged to have been of ſingular uſe.

In a letter which this very celebrated and ſucceſsful circumnavigator wrote to Sir John Pringle, he gives an account of the methods purſued for preſerving the health of his people; and which were productive of ſuch happy effects, that he performed "a voyage of three years and 18 days, through all the climates from 52° north to 71° ſouth, with the loſs of one man only by diſeaſe, and who died of a complicated and lingering illneſs, without any mixture of ſcurvy. Two others were unfortunately drowned, and one killed by a fall; ſo that out of the whole number 118 with which he ſet out from England, he loſt only four."

He ſays, that much was owing to the extraordinary attention of the admiralty, in cauſing ſuch articles to be put on board as either by experience or conjecture were judged to tend moſt to preſerve the health of ſeamen: and with reſpect to the wort, he expreſſes himſelf as follows:

"We had on board a large quantity of *malt*, of which was made *ſweet wort*, and given (not only to thoſe men who had manifeſt ſymptoms of the ſcurvy, but to ſuch alſo as were, from circumſtances, judged to be moſt liable to that diſorder) from one or two to three pints in the day to each man, or in ſuch proportion as the ſurgeon thought neceſſary, which ſometimes amounted to three quarts in the 24 hours: this is without doubt one of the beſt ſea antiſcorbutic medicines yet found out; and if given in time, will, with proper attention to other things, I am perſuaded, prevent the ſcurvy from making any great progreſs for a conſiderable time: but I am not altogether of opinion that it will cure it, in an advanced ſtate, at ſea."

On this laſt point, however, the captain and his ſurgeon differ; for this gentleman poſitively aſſerts, and his journal (in Dr Macbride's poſſeſſion) confirms it, that the infuſion of malt did effect a cure in a confirmed caſe, and at ſea.

The malt being thoroughly dried, and packed up in ſmall caſks, is carried to ſea, where it will keep ſound, in every variety of climate, for at leaſt two years: when wanted for uſe, it is to be ground in a hand mill, and the infuſion prepared from day to day, by pouring three meaſures of boiling water on one of the ground malt; the mixture being well maſhed, is left to infuſe for 10 or 12 hours, and the clear infuſion then ſtrained off. The patients are to drink it in ſuch quantities as may be deemed neceſſary, from one to three quarts in the courſe of the 24 hours: a panada is alſo to be made of it, by adding biſcuit, and currants or raiſins; and this palatable meſs is uſed by way of ſolid food. This courſe of diet, like that of the recent vegetables, generally keeps the bowels ſufficiently open; but in caſes where coſtiveneſs nevertheleſs prevails, gentle laxatives muſt be interpoſed from time to time, together with diaphoretics, and the topical aſſiſtants, fomentations and gargles, as in the common way of management.

Captain Cook was alſo provided with a large ſtock of *ſour krout*; (cabbage leaves cut ſmall, fermented and ſtopped in the ſecond ſtage of fermentation, and afterwards preſerved by a due quantity of ſalt.) A pound of this was ſerved to each man, twice a-week, while they were at ſea. Sour krout, ſince the trial made of it on board Captain Cook's ſhips, has been extenſively uſed by direction of the Britiſh government in many other ſituations, where ſcorbutus has prevailed; and it has been found to be highly ſerviceable both in preventing and in curing the diſeaſe. It was particularly found, during the late American war, to be highly beneficial to the Britiſh troops beſieged in Boſton, who were at that time entirely fed on ſalt proviſions ſent from England, and among whom true ſcorbutus was very fatal till the ſour krout arrived. The ſcurvy at one period broke out among them with very alarming appearances; but by the ſeaſonable arrival of a quantity of ſour krout, it was effectually overcome. Care, however, muſt be beſtowed, that this article be properly prepared and properly kept. When due attention is paid to theſe particulars, it may be preſerved in good condition for many months; and is conſidered both by ſailors and ſoldiers as a very acceptable addition to their ſalt proviſions. But when ſerved out to them in a putrid ſtate, it is not only highly diſagreeable to the taſte, but probably alſo pernicious in its effects.

Among other means of preventing ſcurvy, Captain Cook had alſo a liberal ſupply of *portable ſoup*; of which the men had generally an ounce, three days in the week, boiled up with their peaſe; and ſometimes it was ſerved to them oftener; and when they could get freſh greens, it was boiled up with them, and made ſuch an agreeable meſs, that it was the means of making the people eat a greater quantity of greens than they would otherwiſe have done. And what was ſtill of further advantage, they were furniſhed with ſugar in lieu of butter or oil, which is ſeldom of the ſweeteſt ſort; ſo that the crew were undoubtedly great gainers by the exchange.

In addition to all theſe advantages of being ſo well provided with every neceſſary, either in the way of diet or medicine, Captain Cook was remarkably attentive to all the circumſtances reſpecting cleanlineſs, exerciſe, ſufficient clothing, proviſion of pure water, and purification of the air in the cloſer parts of the ſhip.

From the effect of theſe different means, as employed by Captain Cook, there can be little doubt that they will with due attention be ſufficient for the prevention and cure of the diſeaſe, at leaſt in moſt ſituations: but beſides theſe, there are alſo ſome other articles which may be employed with great advantage.

Newly brewed ſpruce beer made from a decoction of the tops of the ſpruce fir and melaſſes, is an excellent antiſcorbutic; it acts in the ſame way that the wort does, and will be found of equal efficacy, and therefore may be ſubſtituted. Where the tops of the ſpruce fir are not to be had, this beer may be prepared from the eſſence of ſpruce as it has been called, an article which keeps eaſily for a great length of time. But in ſituations where neither the one nor the other can be had, a moſt ſalutary meſs may be prepared from oatmeal, by infuſing it in water, in a wooden veſſel, till it ferments, and begins to turn ſouriſh; which generally happens, in moderately warm weather, in the ſpace of two days.—The liquor is then ſtrained off from the grounds, and boiled down to the conſiſtence of a jelly, which is to be eaten with wine and ſugar, or with butter and ſugar.

Nothing is more commonly talked of than a *land ſcurvy*, as a diſtinct ſpecies of diſeaſe from that which has been now deſcribed; but no writer has yet given a deſcription ſo clear as to enable us to diſtinguiſh it from the various kinds of cutaneous foulneſs and eruption, which indeed are vulgarly termed *ſcorbutic*, but which are akin to the itch or leproſy, and for the moſt part require mercurials. Theſe, however, are very different diſeaſes from the true ſcorbutus, which, it is well known, may prevail in certain ſituations on land as well as at ſea, and is in no degree to be attributed to ſea air.

352 Genus LXXXVII. ELEPHANTIASIS.

Elephantiaſis, *Sauv.* gen. 302. *Vog.* 321. *Sag.* gen. 128.
Elephantia Arabum, *Vog.* 322.

The beſt account of this diſeaſe is that by Dr Heberden, publiſhed in the firſt volume of the Medical Tranſactions. According to him, frequently the firſt ſymptom is a ſudden eruption of tubercles, or bumps of different ſizes, of a red colour, more or leſs intenſe (attended with great heat and itching), on the body, legs, arms, and face; ſometimes in the face and neck alone, at other times occupying the limbs only; the patient is feveriſh; the fever ceaſing, the tubercles remain indolent, and in ſome degree ſcirrhous, of a livid or copper colour, but ſometimes of the natural colour of the ſkin, or at leaſt very little altered; and after ſome months they not unfrequently ulcerate, diſcharging a fetid ichorous humour in ſmall quantity, but never laudable pus.

The features of the face ſwell and enlarge greatly; the part above the eyebrows ſeems inflated; the hair of the eyebrows falls off, as does the hair of the beard; but Dr Heberden has never ſeen any one whoſe hair has not remained on his head. The *alæ naſi* are ſwelled and ſcabrous; the noſtrils patulous, and ſometimes affected with ulcers, which, corroding the cartilage and *ſeptum naſi*, occaſion the noſe to fall. The lips are tumid; the voice is hoarſe; which ſymptom has been obſerved when no ulcers have appeared in the throat, although ſometimes both the throat and gums are ulcerated. The ears, particularly the lobes, are thickened, and occupied by tubercles. The nails grow ſcabrous and rugoſe, appearing ſomething like the rough bark of a tree; and the diſtemper advancing, corrodes the parts gradually with a dry ſordid ſcab or gangrenous ulcer; ſo that the fingers and toes rot and ſeparate joint after joint. In ſome patients the legs ſeem rather poſts than legs, being no longer of the natural ſhape, but ſwelled to an enormous ſize, and indurated, not yielding to the preſſure of the fingers; and the ſuperficies is covered with very thin ſcales, of a dull whitiſh colour, ſeemingly much finer, but not ſo white as thoſe obſerved in the *lepra Græcorum*. The whole limb is overſpread with tubercles, interſperſed with deep fiſſures; ſometimes the limb is covered with a thick moiſt ſcabby cruſt, and not unfrequently the tubercles ulcerate. In others the legs are emaciated, and ſometimes ulcerated; at other times affected with tubercles without ulceration. The muſcular fleſh between the thumb and forefinger is generally extenuated.

The whole ſkin, particularly that of the face, has a remarkably ſhining appearance, as if it was varniſhed or finely poliſhed. The ſenſation in the parts affected is very obtuſe, or totally aboliſhed; ſo that pinching, or puncturing the part, gives little or no uneaſineſs; and in ſome patients, the motion of the fingers and toes is quite deſtroyed. The breath is very offenſive; the pulſe in general weak and ſlow.

The diſeaſe often attacks the patient in a different manner from that above deſcribed, beginning almoſt inſenſibly; a few indolent tubercles appearing on various parts of the body or limbs, generally on the legs or arms, ſometimes on the face, neck, or breaſt, and ſometimes in the lobes of the ears, increaſing by very ſlow degrees, without any diſorder, previous or concomitant, in reſpect of pain or uneaſineſs.

To diſtinguiſh the diſtemper from its manner of attacking the patient, Dr Heberden ſtyles the firſt by *fluxion* and the other by *congeſtion*. That by fluxion is often the attendant of a crapula, or ſurfeit from groſs foods; whereby, perhaps, the latent ſeeds of the diſorder yet dormant in the maſs of blood are excited; and probably from frequent obſervations of this kind (the laſt meal being always blamed), it is, that, according to the received opinion, either fiſh, (the tunny, mackarel, and ſhell-fiſh, in particular), melons, cucumbers, young garden-beans, or mulberries, eaten at the ſame meal, with butter, cheeſe, or any preparation of milk, are ſuppoſed to produce the diſtemper, and are accordingly religiouſly avoided.

Violent commotions of the mind, as anger, fear, and grief, have more than once been obſerved to have given riſe to the diſorder; and more frequently, in the female ſex, a ſudden ſuppreſſion of an accuſtomed evacuation, by bathing the legs and feet in cold water at an improper ſeaſon.

The diſorder by fluxion is what is the ofteneſt endeavoured to be remedied by timely application; that by congeſtion, not being ſo conſpicuous, is generally either neglected or attempted to be concealed, until perhaps it be too late to be cured, at leaſt unleſs the patients would ſubmit to a longer courſe of medicine and ſtricter regimen of diet than they are commonly inclined to do.

Several incipient diſorders by fluxion have been known to yield to an antiphlogiſtic method, as bleeding, refrigerant ſalts in the ſaline draughts, and a ſolution of cryſtals of tartar in water, for common drink, (by this means endeavouring to precipitate part of the peccant matter, perhaps too groſs to paſs the pores by the kidneys); and when once the fever is overcome, cinchona, combined with ſaſſafras, is the remedy principally to be relied on. The only topical medicine preſcribed by Dr Heberden, was an attenuating embrocation of brandy and alkaline ſpirit. By the ſame method ſome confirmed caſes have been palliated. But, excepting in one patient, Dr Heberden never ſaw or heard of a confirmed elephantiaſis radically cured. He adds, however, that he never met with another patient poſſeſſed of prudence and perſeverance enough to proſecute the cure as he ought.

Impetigines. 353

GENUS LXXXVIII. LEPRA.

The LEPROSY.

Lepra, *Sauv.* gen. 303. *Lin.* 262. *Sag.* 129.
Lepra *Græcorum*, *Vog.* 320.

This diſtemper is but little known to phyſicians in the weſtern parts of Europe. Wallis tells us, that it firſt begins with red pimples, or puſtules, breaking out in various parts of the body. Sometimes they appear ſingle; ſometimes a great number ariſe together, eſpecially on the arms and legs; as the diſeaſe increaſes, freſh pimples appear, which, joining the former, make a ſort of cluſters; all which enlarge their borders, and ſpread in an orbicular form. The ſuperficies of theſe puſtules are rough, whitiſh, and ſcaly; when they are ſcratched the ſcales fall off, upon which a thin ichor oozes out, which ſoon dries and hardens into a ſcaly cruſt. Theſe cluſters of puſtules are at firſt ſmall and few; perhaps only three or four in an arm or leg, and of the ſize of a ſilver penny. But if the diſeaſe be ſuffered to go on, they become more numerous, and the cluſters increaſe to the ſize of a crown-piece, but not exactly round. Afterwards the affection increaſes to ſuch a degree, that the whole body is covered with a leprous ſcurf. The cure of this diſtemper is very much the ſame with that of the ELEPHANTIASIS. Here, however, recourſe is frequently had to antimonial and mercurial medicines, continued for a conſiderable length of time. In conjunction with theſe, warm bathing, particularly the vapour bath, has often been employed with advantage.

Although what can ſtrictly be called lepra is now, at leaſt, a very rare diſeaſe in this country, yet to this general head may be referred a variety of cutaneous affections which are here very common, and which in many inſtances prove very obſtinate. Theſe appear under a variety of different forms; ſometimes under that of red puſtules; ſometimes of white ſcurfs; ſometimes of ulcerations; and not unfrequently a tranſition takes place from one form to another, ſo that they cannot be divided into different genera from the external appearance. Theſe affections will often yield to the remedies already mentioned; but where antimonials and mercurials either fail, or from different circumſtances are conſidered as unadviſeable, a cure may ſometimes be effected by others. In particular caſes, purging mineral waters, the decoction of cinchona, the infuſion of the œnanthe crocata, and various others, have been employed with ſucceſs. Different external applications alſo have ſometimes been employed with advantage. An article uſed in this way, known under the name of Gowland's lotion, with the compoſition of which we are unacquainted, has been much celebrated, and has been ſaid to be employed with great ſucceſs, particularly againſt eruptions on the face and noſe.

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GENUS LXXXIX. FRAMBOESIA.

The YAWS.

Frambœſia, *Sauv.* gen. 125. *Sag.* 125.

Deſcription. The deſcription which is given of this diſtemper by the anonymous author of a paper in the 6th volume of the Edinburgh Medical Eſſays, (art. 76.) differs, in ſome circumſtances, from one that Sauvages received from M. Virgile, an eminent ſurgeon of Montpelier, who practiſed twelve years in the iſland of St Domingo; and therefore he diſtinguiſhes the *frambœſia* into two ſpecies, *Guineenſis* and *Americana*.

Frambœſia.

The *frambœſia Guineenſis* is ſaid by the firſt-mentioned writer to be ſo common on the coaſt of Guinea and other parts of Africa, that it ſeldom fails to attack each individual of both ſexes, one time or other, in the courſe of their lives; but moſt commonly during childhood or youth. "It makes its appearance in little ſpots on the cuticle, level with the ſkin, at firſt no larger than a pin's head, which increaſe daily, and become protuberant like pimples: ſoon after the cuticle frets off, and then, inſtead of finding pus or ichor, in this ſmall tumor, only white ſloughs or ſordes appear, under which is a ſmall red fungus, growing out of the cutis, increaſing gradually to very different magnitudes, ſome leſs than the ſmalleſt wood ſtrawberry, ſome as big as a raſpberry, and others exceeding in ſize even the largeſt mulberries; which berries they very much reſemble, being knobbed as theſe are." Theſe protuberances, which give the name to the diſeaſe, appear on all parts of the body: but the greateſt numbers, and the largeſt ſized, are generally found in the groins, and about the pudenda or anus, in the armpits, and on the face: when the yaws are very large, they are few in number; and when remarkably numerous, they are leſs in ſize. The patients, in all other reſpects, enjoy good health, do not loſe their appetite, and ſeem to have little other uneaſineſs than what the ſores occaſion.

M. Virgile deſcribes the ſpecies of yaws that is common among the negroes of St Domingo, and which Sauvages has termed *frambœſia Americana*, as beginning from an ulcer that breaks out indiſcriminately in different parts of the body, though moſt commonly on the legs; at firſt ſuperficial, and not different from a common ulcer in any other circumſtance ſaving its not healing by the uſual applications; ſooner or later, numerous fungous excreſcences break out on the ſurface of the body, as before deſcribed, like little berries, moiſt, with a reddiſh mucus. Beſides theſe, the ſoles of the feet and palms of the hands become raw, the ſkin fretting off, ſo as to leave the muſcles bare; theſe excoriations are ſometimes moiſt with ichor and ſometimes dry, but always painful, and conſequently very diſtreſſing. They are mentioned alſo by the author of the article in the Medical Eſſays; and both he and M. Virgile obſerve, that there is always one excreſcence, or yaw, of an uncommon ſize, which is longer in falling off than the others, and which is conſidered as the *maſter-yaw*, and ſo termed. An ingenious inaugural diſſertation on the ſubject of the yaws was lately publiſhed at Edinburgh by Dr Jonathan Anderſon Ludford, now phyſician in Jamaica. The author of that diſſertation conſiders Dr Cullen as improperly referring frambœſia to the claſs of cachexiæ. He thinks that this diſeaſe ought rather to be referred to the exanthemata; for, like the ſmallpox, he tells us, it has its acceſſion, height, and decline. It begins with ſome degree of fever, either more or leſs violent; it may be propagated by inoculation; and it attacks the ſame individual only once in the courſe of a lifetime, thoſe who recover from the diſeaſe being never afterwards affected with it. Theſe particulars reſpecting frambœſia are reſted not merely on the authority of Dr Ludford, but are ſupported alſo by the teſtimony of Dr William Wright, a phyſician of diſtinguiſhed eminence, who, while he reſided in Jamaica, had, in the courſe of extenſive practice, many oppoitunities of obſerving this diſeaſe, and to whom Dr Ludford acknowledges great obligations for having communicated to him many important facts reſpecting it.

Dr Ludford conſiders the yaws as being in every inſtance the conſequence of contagion, and as depending on a matter *ſui generis*. He ſuppoſes no peculiar prediſpoſition from diet, colour, or other circumſtances, as being in any degree neceſſary. He views the diſeaſe as chiefly ariſing from contact with the matter, in conſequence of ſleeping in the ſame bed, waſhing in the ſame veſſel with the infected, or the like. In ſhort, the yaws may be communicated by any kind of contact; nay, it is even believed that flies often convey the infection, when, after having gorged themſelves with the virulent matter by ſucking the ulcers of thoſe who are diſeaſed, they make punctures in the ſkin of ſuch as are ſound, and thus inoculate them; in conſequence of which the diſorder will ſoon appear.

Prognoſis. The yaws are not dangerous, if the cure be ſkilfully managed at a proper time; but if the patient has been prematurely ſalivated, or has taken any quantity of mercury, and if his ſkin has been ſuddenly cleared, the cure will be very difficult, if not impracticable.

Cure. In attempting the cure of this diſeaſe, the four following indications are chiefly to be held in view:

1. To ſupport the ſtrength of the patient.
2. To promote excretion by the ſkin.
3. To correct the vitiated fluids.
4. To remove and counteract the injuries done either to the conſtitution in general, or to particular parts, by the diſeaſe.

With the firſt of theſe intentions, a liberal diet, conſiſting of a conſiderable quantity of animal food, with a conſiderable proportion of wine, and gentle exerciſe, are to be employed: but the cure is principally to be effected by mercurial ſalivation, after the virulent matter has been completely thrown out to the ſurface of the body by ſudorifics. The following are the particular directions given on this head by the author of the article in the Medical Eſſays. The yaws being an infectious diſeaſe, as ſoon as they begin to appear on a negro, he muſt be removed to a houſe by himſelf; or, if it is not certain whether the eruption be the yaws or not, ſhut him up ſeven days, and look on him again, as the Jews were commanded to do with their lepers, and in that time you may in moſt caſes be certain.

As ſoon as you are convinced that it is the yaws, give a bolus of flowers of ſulphur, with camphor and theriaca. Repeat this bolus every night for a fortnight or three weeks, or till the yaws come to the height; that is, when they neither increaſe in ſize or number: then throw your patient into a gentle ſalivation with calomel given in ſmall doſes, without farther preparation; five grains repeated once, twice, or thrice a-day, is ſufficient, as the patient can bear it. If he ſpits a quart in 24 hours, it is enough. Generally, when the ſalivation is at this height, all the yaws are covered with dry ſcaly cruſts or ſcabs; which, if numerous, look terribly. Theſe fall off daily in ſmall white ſcales; and in ten or twelve days leave the ſkin ſmooth and clean. Then the calomel may be omitted, and the ſalivation permitted to go off ſpontaneouſly. A dram of corroſive ſublimate diſſolved in an ounce of rum or brandy, and the ſolution daubed on the yaws, will, it is ſaid, in general clear the ſkin in two days time.

After the ſalivation, ſweat the patient twice or thrice in a frame or chair with ſpirits of wine; and give an alterative electuary of æthiops and gum guaiac. He may likewiſe uſe the decoction of guaiacum and ſaſſafras fermented with melaſſes, for his conſtant drink while the electuary is taking, and a week or a fortnight after the electuary is finiſhed.

The maſter-yaw muſt be conſumed an eighth or a tenth part of an inch below the ſkin, with *Mercur. corroſ. rub. et alum. uſt. part. æqual.* and digeſted with *Ung. baſil. flav.* ℥j. and *mercur. corroſ. rub.* ʒj. and cicatrized with lint preſſed out of ſpirits of wine, and with the ſulphate of copper.

After the yaws are cured, ſome patients are afflicted with carbuncles in their feet; which ſometimes render them incapable of walking, unleſs with pain. The method of cure is, by bathing and paring to deſtroy the cuticle, and then proceed as in the maſter-yaw. The gentle eſcharotics are to be preferred; and all imaginable care is to be taken to avoid the tendons and perioſteum.

To children under ſix or ſeven years old, at the proper time of ſalivating, when the yaws are come to their full growth, give a grain or two of calomel in white ſugar, once a-day, once in two days, or once in three days, ſo as only to keep their mouths a little ſore till the yaws dry, and, falling off in white ſcales, leave the ſkin clean. This ſucceeds always, but requires a longer time than in adults.

In St Domingo they are ſalivated by unction; but it does not appear that ſucceſs always followed this practice. It is alſo uſual in that iſland to give the ſolution of corroſive ſublimate along with a decoction of ſarſaparilla. Twelve ounces of this root, and 12 pounds of the coarſeſt ſugar, macerated for 15 days in 12 quarts of water, is mentioned as a ſpecific, and ſaid to be the preſcription of an Engliſh phyſician; the doſe is four ounces every ſixth hour.

GENUS XC. TRICHOMA.

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The *PLICA POLONICA*, or *Plaited Hair*.

Trichoma, *Sauv.* gen. 311. *Sag.* 137.
Plica, *Lin.* 313.
Plica ſive Rhopaloſis, *Vog.* 323.

This diſorder is only met with in Poland and Lithuania, and conſiſts of ſeveral blood-veſſels running from the head into the ends of the hairs; which cleave together, and hang from the head in broad flat pieces, generally about an ell in length, but ſometimes they are five or ſix yards long; one patient has more or leſs of theſe, up to 20, and ſometimes 30. They are painful to the wearer, and odious to every ſpectator. At the approach of winter an eruptive fever happens to many in theſe countries: the eruptions principally infeſt the head, and when at the height an ichorous humour flows from them. In this ſtate they are too tender to admit of being touched, and the matter running down the hairs mats them together; the ſkin by degrees, breaking, the ramifications of the capillary veſſels following the courſe of the hair, or prolonged out of the ſkin, are increaſed to a vaſt length.

No method of relief is yet known; for if the diſcharge be checked, or the veſſels cut off, the conſequence is an increaſe of more miſerable ſymptoms, and in the end death. Sennertus ſays, when all the morbid matter is thrown out of the body the plicæ fall off ſpontaneouſly. He further obſerves, that the only ſafe practice in this caſe is, to ſollicit the peccant matter to the hairs, to which it naturally tends; and that this is beſt anſwered by lotions of bear's-breech. Some ſay that a decoction of the herb club-moſs, and its ſeeds, with which the head is to be waſhed, is a ſpecific.

356 GENUS XCI. ICTERUS.

The *JAUNDICE*.

Icterus, *Lin.* 224. *Vog.* 306. *Boerh.* 918. *Junck.* 90.
Aurigo, *Sauv.* gen. 306. *Sag.* 132.
Cachexia icterica, *Hoffm.* III. 301.

Deſcription. The jaundice firſt ſhows itſelf by a liſtleſſneſs and want of appetite, the patient becomes dull, oppreſſed, and generally coſtive. Theſe ſymptoms have continued but a very ſhort time, when a yellow colour begins to diffuſe itſelf over the *tunica albuginea*, or white part of the eye, and the nails of the fingers; the urine becomes high coloured, with a yellowiſh ſediment capable of giving a yellow tinct to linen; the ſtools are whitiſh or gray. In ſome there is a moſt violent pain in the epigaſtric region, which is conſiderably increaſed after meals. Sometimes the patient has a continual propenſity to ſleep; but in others there is too great watchfulneſs; and ſometimes the pain is ſo great, that though the patient be ſleepy he cannot compoſe himſelf to reſt. The pains come by fits; and moſt women who have had the jaundice and born children, agree, that they are more violent than labour-pains. As the diſeaſe increaſes, the yellow colour becomes more and more deep; an itching is felt all over the ſkin; and even the internal membranes of the viſcera, the bones, and the brain itſelf, become tinged, as hath been ſhown from diſſections, where the bones have been found tinged ſometimes for years after the jaundice has been cured

In like manner, all the ſecretions are affected with the yellow colour of the bile, which in this diſeaſe is diffuſed throughout the whole maſs of fluids. The ſaliva becomes yellowiſh and bitter; the urine exceſſively high coloured, in ſuch a manner as to appear almoſt black; nay, the blood itſelf is ſometimes ſaid to appear of a yellow colour when drawn from a vein; yet Dr Heberden ſays, that he never ſaw the milk altered in its colour, even in caſes of very deep jaundice. In proceſs of time the blood begins to acquire a tendency to diſſolution and putrefaction; which is known by the patient's colour changing from a deep yellow to a black or dark yellow. Hæmorrhages enſue from various parts of the body, and the patients frequently die of an apoplexy; though in ſome the diſeaſe degenerates into an incurable dropſy; and there have not been wanting inſtances of ſome who have died of the dropſy after the jaundice itſelf had been totally removed.

Cauſes. As the jaundice conſiſts in a diffuſion of the bile throughout the whole ſyſtem, it thence follows, that whatever may favour the diffuſion is alſo to be reckoned among the cauſes of jaundice. Many diſputes have ariſen concerning the manner in which the bile is introduced into the blood; but it is now generally agreed that it is taken up by the lymphatics of the gall-bladder and biliary ducts. Hence, a jaundice may ariſe from any thing obſtructing the paſſage of the bile into the duodenum, or from any thing which alters the ſtate of the lymphatics in ſuch a manner as to make them capable of abſorbing the bile in its natural ſtate. Hence the jaundice may ariſe from ſcirrhi of the liver or other viſcera preſſing upon the biliary ducts, and obſtructing the paſſage of the bile; from flatus diſtending the duodenum, and ſhutting up the entrance of the ductus communis choledochus into it; from the ſame orifice being plugged up by viſcid bile, or other ſordes; but by far the moſt frequent cauſe of jaundice is the formation of calculi, or more properly biliary concretions: for although they were long conſidered as being of a calcareous nature, yet more accurate experiments have now demonſtrated, that they conſiſt principally of a ſebaceous matter; accordingly, while they are ſo light as to ſwim in water, they are alſo highly inflammable. Theſe are found of almoſt all ſizes, from that of a ſmall pea to that of a walnut, or bigger: they are of different colours; and ſometimes appear as if formed in the inward part by cryſtallization, but of lamellæ on the outer part; though ſometimes the outward part is covered with rough and ſhining cryſtals, while the inward part is lamellated. Theſe enter into the biliary ducts, and obſtruct them, cauſing a jaundice, with violent pain for ſome time; and which can be cured by no means till the concretion is either paſſed entirely through the ductus communis or returned into the gall-bladder. Sometimes, in the opinion of many celebrated phyſicians, the jaundice is occaſioned by ſpaſmodic conſtrictions of the biliary ducts; but this is denied by others, and it is not yet aſcertained whether theſe ducts are capable of being affected by ſpaſm or not, as the exiſtence of muſcular fibres in them has not with certainty been diſcovered. It cannot, however, be denied, that violent fits of paſſion have often produced jaundice, ſometimes temporary, but frequently permanent. This has been by ſome deemed a ſufficient proof of the ſpaſmodic contraction of the ducts; but their opponents ſuppoſed, that the agitation occaſioned by the paſſion might puſh forward ſome biliary concretion into a narrow part of the duct, by which means a jaundice would certainly be produced, till the concretion was either driven backward or forward into the duodenum altogether. But even ſuppoſing the ducts themſelves to be incapable of ſpaſm, yet there can be no doubt that by a ſpaſm of the inteſtines biliary concretions may be retained in the ducts;

and indeed it is principally where the duct entering obliquely into the inteſtine forms as it were a ſpecies of valve that theſe concretions are retained.

In a very relaxed ſtate of the body there is alſo an abſorption of the bile, as in the yellow fever; and indeed in all putrid diſorders there is a kind of yellowiſh tinct over the ſkin, though much leſs than in the true jaundice. The reaſon of this is, that in theſe diſorders there is uſually an increaſed ſecretion of bile, commonly of a thinner conſiſtence than in a healthy ſtate, while the orifices of the lymphatics are probably enlarged, and thus ready to abſorb a fluid ſomewhat thicker than what they ought to take up in a healthy ſtate; but theſe diſorders are of ſhort duration in compariſon with the real jaundice, which ſometimes laſts for many years. Theſe affections, however, cannot with propriety in any caſe be conſidered as real inſtances of jaundice; for, to conſtitute that diſeaſe bile muſt not only be preſent in the blood, but wanting in the alimentary canal.

It is obſervable, that women are more ſubject to jaundice than men, which probably ariſes from their more ſedentary life; for this, together with ſome of the depreſſing paſſions of the mind, is found to promote the acceſſion of the diſeaſe, if not abſolutely to produce it. Pregnant women alſo are frequently attacked by the jaundice, which goes off after their delivery.

Prognoſis. As jaundice may ariſe from many different cauſes, ſome of which cannot be diſcovered during the patient's life, the prognoſis muſt on this account be very uncertain. The only caſes which admit of a cure are thoſe depending upon biliary concretions, or obſtructions of the biliary ducts by viſcid bile; for the concretions are ſeldom of ſuch a ſize that the ducts will not let them paſs through, though frequently not without extreme pain. Indeed this pain, though ſo violent, and almoſt intolerable to the ſick perſon, affords the beſt prognoſis; as the phyſician may readily aſſure his patient that there is great hope of his being relieved from it. The coming on of a gentle diarrhœa, attended with bilious ſtools, together with the ceſſation of pain, are ſigns of the diſeaſe being cured. We are not, however, always to conclude, becauſe the diſeaſe is not attended with acute pain, that it is therefore incurable; for frequently the paſſage of a concretion through the biliary ducts is accompanied only with a ſenſation of ſlight uneaſineſs.

Cure. The great object to be aimed at in the cure of jaundice is unqueſtionably the removal of the cauſe which obſtructs the paſſage of bile into the inteſtines: But before this can be accompliſhed, practices are often neceſſary for alleviating urgent ſymptoms; which may be done ſometimes by ſupplying the want of bile in the alimentary canal, ſometimes by affording an exit for bilious matter from the general maſs of blood, but moſt frequently by obviating the effects of diſtention and obſtruction to the circulation in the ſyſtem of the liver.

The meaſures to be employed for the removal of the obſtruction muſt depend very much on the nature of the obſtructing cauſe.

When the jaundice ariſes from indurated ſwellings or ſcirrhi of the viſcera, it is abſolutely incurable; nevertheleſs, as theſe cannot always be diſcovered, the phyſician ought to proceed in every caſe of jaundice as if it aroſe from calculi. The indications here are, 1. To diſſolve the concretions; and, 2. To prevent their formation a ſecond time. But unhappily the medical art has not yet afforded a ſolvent for biliary concretions. They cannot even be diſſolved when tried out of the body either by acids or alkalies, or any thing but a mixture of oil of turpentine and ſpirit of wine; and theſe ſubſtances are by far too irritating to be given in ſufficient quantity to affect a concretion in the biliary ducts. Boerhaave obſerves, that diſeaſes of the liver are much more difficult to cure than thoſe in any other part of the body; becauſe of the difficulty there is in getting at the part affected, and the tedious and round-about paſſage the blood has to it. The juice of common graſs has indeed been recommended as a ſpecific in the jaundice, but on no good foundation. Gliſſon obſerves, that black cattle are ſubject to biliary concretions when fed with hay or dried ſtraw in winter, but are cured by the ſucculent graſs in the ſpring; and Van Swieten tells a ſtrange ſtory of a man who cured himſelf of the jaundice by living almoſt entirely on graſs, of which he devoured ſuch quantities, that the farmers were wont to drive him out of their fields; but other practitioners have by no means found this in any degree effectual. The only method of cure now attempted in the jaundice is to expel the concretion into the inteſtines; for which vomits and exerciſe are the principal medicines. The former are juſtly reckoned the moſt efficacious medicines, as they powerfully ſhake all the abdominal and thoracic viſcera; and thus tend to diſlodge any obſtructing matter that may be contained in them. But if there be a tendency to inflammation, vomits muſt not be exhibited till bleeding has been premiſed. We muſt alſo proceed with caution if the pain be very ſharp; for in all caſes where the diſeaſe is attended with violent pain, it will be neceſſary to allay it by opiates before the exhibition of an emetic. There is alſo danger, that, by a continued uſe of vomits, a concretion which is too large to paſs, may be ſo impacted in the ducts, that it cannot even be returned into the gall-bladder, which would otherwiſe have happened. In all caſes, therefore, if no relief follows the exhibition of the ſecond or third emetic, it will be prudent to forbear their farther uſe for ſome time.

Of all kinds of exerciſe, that of riding on horſeback is moſt to be depended upon in this diſeaſe. It operates in the ſame manner with vomits, namely, by the concuſſion it gives to the viſcera; and therefore the cautions neceſſary to be obſerved in the uſe of vomits are alſo neceſſary to be obſerved in the uſe of riding. Cathartics alſo may be of ſervice, by cleanſing the *primæ viæ*, and ſoliciting a diſcharge of the bile into the inteſtines; but they muſt not be of too draſtic a nature, elſe they may produce incurable obſtructions, by bringing forward concretions that are too large to paſs. Anodynes and the warm bath are ſerviceable by their relaxing quality; and there can be no doubt, that, from acting as powerful antiſpaſmodics, they often give an opportunity for the diſcharge of concretions by very ſlight cauſes, when they would otherwiſe be firmly retained. Soap has been ſuppoſed to do ſervice as a ſolvent; but this is now found to be a miſtake, and it acts in no other way than as a relaxant or as a gentle purgative.

But when all means of relief fail, as in caſes of ſcirrhus, we can then only attempt to palliate the ſymptoms, and preſerve the patient's life as long as poſſible. This is beſt accompliſhed by diuretics; for thus a great quantity of bilious matter is evacuated, and the ſyſtem is freed from the bad conſequences which enſue on its ſtagnation in the habit. But even this is by no means equal to the common evacuation by ſtool; nor can all the attempts to ſupply the want of bile in the inteſtines by bitters and other ſtomachics reſtore the patient to his wonted appetite and vigour. If the pain be very violent, we muſt on all occaſions have recourſe to opiates; or if the blood has acquired a tendency to diſſolution, it muſt be counteracted by proper antiſeptics.

If the diſeaſe goes off, its return muſt be prevented by a courſe of tonic medicines, particularly the cinchona and antiſeptics: but we can by no means be certain that the jaundice will not return, and that at any interval; for there may be a number of concretions in the gall-bladder, and though one has paſſed, another may very quickly follow, and produce a new fit of jaundice; and thus ſome people have continued to be affected with the diſtemper, at ſhort intervals, during life.

In the Eaſt Indies, mercury has been lately recommended as exceedingly efficacious in diſorders of the liver, eſpecially thoſe which follow intermitting and remitting fevers. Dr Monro, in his Obſervations on the means of preſerving the health of ſoldiers, acquaints us, that he has ſeen ſome icteric caſes which, he thought, received benefit from taking a few grains of the ſubmurias hydrargyri at night, and a purge next morning; and this repeated two or three times a-week.

Infants are ſubject to a temporary jaundice, commonly called the *gum*, ſoon after birth; the cauſe of which is not well underſtood. It differs remarkably from the common jaundice; as, in the latter, the diſeaſe is firſt diſcoverable in the white of the eyes; but though the ſkin of infants in the gum is all over yellow, their eyes always remain clear. The diſorder goes off ſpontaneouſly, or by the uſe of a gentle purgative or two.

357 Class IV. LOCALES.

Vitia, *Sauv.* Claſs I. *Lin.* Claſs XI. *Vog.* Claſs X. *Sag.* Claſs. I.
Plagæ, *Sag.* Claſs II.
Morbi organici Auctorum.

358 Order I. DYSÆSTHESIÆ.

Dyſæſtheſiæ, *Sauv.* Claſs VI. Ord. I. *Sag.* Claſs IX. Ord. I.

359 Genus XCII. CALIGO.

The *Cataract.*

Caligo, *Sauv.* gen. 153. *Vog.* 288. *Sag.* gen. 259.
Cataracta, *Lin.* 109.

A *cataract* is an obſtruction of the pupil, by the interpoſition of ſome opaque ſubſtance which either diminiſhes or totally extinguiſhes the ſight. It is generally an opacity in the cryſtalline humour. In a recent or beginning *cataract*, the ſame medicines are to be uſed as in the *gutta ſerena*; and they will ſometimes ſucceed. But when this does not happen, and the cataract becomes firm, it muſt be couched, or rather extracted; for which operation, ſee Surgery.—Dr Buchan ſays he has reſolved a recent cataract by giving the patient ſome purges with calomel, keeping a poultice of freſh hemlock conſtantly upon the eye, and a perpetual bliſter on the neck.

There is, however, but little reaſon to ſuppoſe that theſe practices will frequently ſucceed. A reſolution can only be effected here by an abſorption of the opaque matter; and where this is poſſible, there is perhaps a better chance of its being effected by the agency of the electric fluid than by any other means. For this purpoſe electricity is chiefly applied under the form of the *electric aura*, as it has been called; but even this is very rarely ſucceſsful.

Genus XCIII. AMAUROSIS. 360

The *Gutta Serena.*

Amauroſis, *Sauv.* gen. 155. *Lin.* 110. *Vog.* 238. *Sag.* 261.
Amblyopia, *Lin.* 108. *Vog.* 236.

A *gutta ſerena* is an abolition of the ſight without any apparent cauſe or fault in the eyes. In every caſe it depends on an affection of ſome part of the optic nerve. But the affections which may produce this diſeaſe are of different kinds. When it is owing to a decay or waſting of the optic nerve, it does not admit of a cure; but when it proceeds from a compreſſion of the nerves by redundant humours, theſe may be in ſome meaſure drained off, and the patient relieved. For this purpoſe, the body muſt be kept open with the laxative mercurial pills. If the patient be young, and of a ſanguine habit, he may be bled. Cupping with ſcarifications on the back part of the head will likewiſe be of uſe. A running at the noſe may be promoted by volatile ſalts, ſtimulating powders, &c. But the moſt likely means of relieving the patient, are iſſues or bliſters kept open for a long time on the back part of the head, behind the ears, or on the neck; which have been known to reſtore ſight even after it had been for a conſiderable time loſt.—Should theſe fail, recourſe muſt be had to a mercurial ſalivation; or, what will perhaps anſwer the purpoſe better, 12 grains of the corroſive ſublimate mercury may be diſſolved in an Engliſh pint and a half of brandy, and a table ſpoonful of it taken twice a-day, drinking half a pint of the decoction of ſarſaparilla after it.—Of late electricity has been much celebrated as efficacious, when no other thing could do ſervice; and here it has in ſome degree the ſame chance of ſucceſs as in other caſes of inſenſibility, depending on an affection of the nerves, in ſome of which it has certainly in particular caſes been of uſe.

In the amauroſis, Dr Porterfield obſerves, that it is of the utmoſt conſequence to know of how long ſtanding the diſeaſe has been; which is not always eaſily done if one eye only be affected. This is a very eſſen-

Dyſæſthe-ſiæ.

tial point; becauſe an amauroſis of long ſtanding is altogether incurable. Mr Boyle mentions the caſe of a man who had a cataract for ſeveral years without knowing it himſelf, though others did. He diſcovered it at laſt by happening to rub his ſound eye, and was ſurpriſed to find himſelf in the dark. When a perſon therefore has a gutta ſerena only in one of the eyes, he may think that the eye has but lately loſt the power of ſight; though this perhaps has been the caſe for ſeveral years. On the other hand, he may imagine that a recent diſeaſe of this kind is really of long ſtanding. But by inquiring at what time he firſt became ſubject to miſtakes in all actions that require the diſtance to be exactly diſtinguiſhed, as in pouring liquor into a glaſs, ſnuffing a candle, or threading a needle, we may diſcover the age of the diſeaſe, and thence be aſſiſted to form a more juſt prognoſtic with reſpect to its cure. Dr Porterfield gives an inſtance of his conjecturing in this manner concerning the caſe of a young lady who had diſcovered a loſs of ſight in one of her eyes only the day before. The diſeaſe was thought to be of long ſtanding; but as the doctor found that ſhe had only been ſubject to miſtakes of the kind above mentioned for about a month, he drew a favourable prognoſtic, and the diſeaſe was cured.

361 Genus XCIV. DYSOPIA.

Depraved Vision.

Amblyopia, *Sauv.* gen. 154. *Sag.* 258.

There are ſeveral ſpecies referred to this genus by Dr Cullen, viz.

1. *Dyſopia* TENEBRARUM; 2. *Dyſopia* LUMINIS.—The former of theſe is properly the *nyctalopia*, or night-blindneſs, of ancient authors. But amongſt both the Greek and Latin writers, there is a direct oppoſition in the uſe of this word *nyctalopia*; ſome ſaying it ſignifies "thoſe who *cannot* ſee by night," and others expreſs by it "thoſe who cannot ſee during the day, but during the *night*."—The difference in the account of this diſorder, as to its appearing in the night or in the day, is reconciled by conſidering it as of the intermitting kind: the difference then will conſiſt in the different times of its approach; ſo it may be called *periodical blindneſs*. Intermittents appearing in a variety of modes, and the ſucceſs of cinchona in ſome inſtances of this ſort of blindneſs, both favour the opinion of its being an intermittent diſeaſe of the eyes; and this view has accordingly been taken of it by ſome late writers, particularly in ſome papers in the London Medical Obſervations, and Medical Tranſactions.

3. *Dyſopia* PROXIMORUM (*Preſbytia*), or the defect of thoſe who *ſee only at too great diſtance*. 4. *Dyſopia* DISSITORUM (*Myopia*), or the defect of thoſe who are *ſhortſighted*.—Theſe are diſorders which depend on the original ſtructure or figure of the eye, therefore admit of no cure. The inconveniences ariſing from them may, however, be in ſome meaſure remedied by the help of proper glaſſes. The former requires the aid of a convex, and the latter of a concave glaſs.

5. *Dyſopia* LATERALIS; a defect by which objects cannot be viewed diſtinctly but in an oblique poſition.—Thus, in viewing an object placed on the left, they turn their face and eyes to the right, and *vice verſa*.—This diſorder may proceed from various cauſes both natural and accidental, ſome of which admit of no remedy. If it be occaſioned by a partial adheſion of the eyelids, the hand of the ſurgeon is required: if by a tranſverſe poſition of the pupil, ſome mechanical contrivance is neceſſary. If it be owing to an *albugo* covering part of the pupil, or to a film rendering a portion of the cornea opaque, the remedies for theſe affections are to be here applied.

Genus XCV. PSEUDOBLEPSIS. 362

Imaginary Vision of Objects which do not exiſt.

Suffuſio, *Sauv.* gen. 217. *Sag.* 329.
Phantaſma, *Lin.* 73. *Sag.* 289.

This very often takes place when the body is diſeaſed, and then the patient is ſaid to be delirious. Sometimes, however, in theſe caſes, it does not amount to delirium; but the perſon imagines he ſees gnats or other inſects flying before his eyes; or ſometimes, that every thing he looks at has black ſpots in it, which laſt is a very dangerous ſign. Sometimes alſo ſparks of fire appear before the eyes; which appearances are not to be diſregarded, as they frequently precede apoplexy or epilepſy. Sometimes, however, people have been affected in this manner during life without feeling any other inconvenience. Such a diſorder can rarely if ever be cured.

Genus XCVI. DYSECŒA. 363

Deafneſs, or *Difficulty of Hearing.*

Genus XCVII. PARACUSIS. 364

Paracuſis.

Depravation of HEARING.

Paracuſis, *Sauv.* gen. 159. *Sag.* 265.
Syrigmus, *Sauv.* gen. 219. *Sag.* 231.

The functions of the ear may be injured by wounds, ulcers, or any thing that hurts its fabric. The hearing may likewiſe be hurt by exceſſive noiſe; violent colds in the head; fevers; hard wax, or other ſubſtances ſticking in the cavity of the ear; too great a degree of moiſture or dryneſs of the ear. Deafneſs is very often the effect of old age, and is incident to moſt people in the decline of life. Sometimes it is owing to an original fault in the ſtructure or formation of the ear itſelf. When this is the caſe it admits of no cure; and the unhappy perſon not only continues deaf, but generally likewiſe dumb, for life.

When deafneſs is the effect of wounds or ulcers of the ears, or of old age, it is not eaſily removed. When it proceeds from cold applied to the head, the patient muſt be careful to keep his head warm, eſpecially in the night; he ſhould likewiſe take ſome gentle purges, and keep his feet warm, and bathe them frequently in lukewarm water at bedtime. When deafneſs is the effect of a fever, it generally goes off after the patient recovers. If it proceed from dry wax ſticking in the ears, it may be ſoftened by dropping oil into them; afterwards they muſt be ſyringed with warm milk and water.

If deafneſs proceeds from dryneſs of the ears, which may be known by looking into them, half an ounce of the oil of ſweet almonds, and the ſame quantity of camphorated ſpirit of wine, or tincture of aſafœtida, may be mixed together, and a few drops of it put into the ear every night at bedtime, ſtopping them afterwards with a little wool or cotton. Some, inſtead of oil, put a ſmall ſlice of the fat of bacon into each ear, which is ſaid to anſwer the purpoſe very well.—When the ears abound with moiſture, it may be drained off by an iſſue or ſeton, which ſhould be made as near the affected parts as poſſible.

Some, for the cure of deafneſs, recommend the gall of an eel mixed with ſpirit of wine, to be dropped into the ear; others, equal parts of Hungary water and ſpirit of lavender. Etmuller extols amber and muſk; and Brookes ſays, he has often known hardneſs of hearing cured by putting a grain or two of muſk into the ear with cotton wool. Where, however, an application with conſiderable ſtimulant power is neceſſary, camphorated oil, with the addition of a few drops of volatile alkaline ſpirit, may be conſidered as one of the beſt. It is proper, however, to begin with a ſmall quantity of the alkali, increaſing it as the ear is found to bear it. In ſome inſtances, where deafneſs depends on a ſtate of inſenſibility in the nerves, electricity, particularly under the form either of ſparks or of the electric aura, has been employed with great ſucceſs. Great benefit has alſo in ſome caſes been derived from galvaniſm. But theſe and other applications muſt be varied according to the cauſe of the diſorder.

Though ſuch applications may ſometimes be of ſervice, yet they much oftener fail, and frequently they do hurt. Neither the eyes nor ears ought to be tampered with; they are tender organs, and require a very delicate touch. For this reaſon, what we would chiefly recommend in deafneſs, is to keep the head warm. From whatever cauſe this diſorder proceeds, this is always proper; and more benefit has often been derived from it alone, in the moſt obſtinate caſes of deafneſs, than from any medicines whatever.

GENUS XCVIII. ANOSMIA. 365

Defect of SMELLING.

Anoſmia, *Sauv.* gen. 156. *Lin.* 113. *Vog.* 248. *Sag.* 262.

Cauſes. Morbid affections in the ſenſe of ſmelling, may be conſidered with reſpect to their cauſes, as ariſing from one of two ſources; either from ſome organic affection of the parts here principally concerned, or from a mere atonic ſtate of the parts without any obvious affection. The ſenſe of ſmelling may be diminiſhed or deſtroyed by various diſeaſes of the parts; as, the moiſture, dryneſs, inflammation or ſuppuration of that membrane which lines the inſide of the noſe commonly called the *olfactory membrane*; the compreſſion of the nerves which ſupply this membrane, or ſome fault in the brain itſelf at their origin. A defect, or too great a degree of ſolidity, of the ſmall ſpongy bones of the upper jaw, the caverns of the forehead, &c. may likewiſe impair the ſenſe of ſmelling. It may alſo be injured by a collection of fetid matter in thoſe caverns, which keeps conſtantly exhaling from them. Few things are more hurtful to the ſenſe of ſmelling than taking great quantities of ſnuff.

Cure. When the noſe abounds with moiſture, after gentle evacuations, ſuch things as tend to take off irritation and coagulate the thin ſharp ſerum may be applied; as the oil of aniſe mixed with fine flour, camphire diſſolved in oil of almonds, &c. The vapours of amber, frankincenſe, gum maſtic, and benzoin, may likewiſe be received into the noſe and mouth. For moiſtening the mucus when it is too dry, ſome recommend ſnuff made of the leaves of marjoram, mixed with oil of amber, and aniſeed; or a ſternutatory of calcined ſulphate of zinc, 12 grains of which may be mixed with two ounces of marjoram water and filtrated. The ſteam or vapour of vinegar thrown upon hot iron received up the noſtrils is likewiſe of uſe for ſoftening the mucus, opening obſtructions, &c.

If there be an ulcer in the noiſe, it ought to be dreſſed with ſome emollient ointment, to which, if the pain be very great, a little laudanum may be added. If it be a venereal ulcer, it is not to be cured without mercury. In that caſe, the ſolution of the corroſive ſublimate in brandy may be taken, as directed in the gutta ſerena. The ulcer ought likewiſe to be waſhed with it; and the fumes of cinnabar may be received up the noſtrils.

If there be reaſon to ſuſpect that the nerves which ſupply the organs of ſmelling are inert or want ſtimulating, volatile ſalts, ſtrong ſnuffs, and other things which occaſion ſneezing, may be applied to the noſe. The forehead may likewiſe by anointed with balſam of Peru, to which may be added a little of the oil of amber.

GENUS XCIX. AGEUSTIA. 266

Defect of TASTING.

Ageuſtia, *Sauv.* gen. 157. *Sag.* 265.
Ageuſtia, *Lin.* 114.
Apogeuſis, *Vog.* 449.

Cauſe. This diſeaſe alſo may ariſe either from an organic affection, or an atonic ſtate of the parts. The taſte may be diminiſhed by cruſts, filth, mucus, aphthæ, pellicles, warts, &c. covering the tongue; it may be depraved by a fault of the ſaliva, which, being diſcharged into the mouth, gives the ſame ſenſation as if the food which the perſon takes had really a bad taſte; or it may be entirely deſtroyed by injuries done to the nerves of the tongue and palate. Few things prove more hurtful either to the ſenſe of taſting or ſmelling than obſtinate colds; eſpecially thoſe which affect the head.

Cure. When the taſte is diminiſhed by filth, mucus, &c. the tongue ought to be ſcraped, and frequently waſhed with a mixture of water, vinegar, and honey, or ſome other detergent. When the ſaliva is vitiated, which ſeldom happens unleſs in fevers or other diſeaſes, the curing of the diſorder is the cure of this ſymptom. To relieve it, however, in the mean time, the following practices may be of uſe: if there be a bitter taſte, it may be taken away by vomits, purges, and other things which evacuate bile: what is called a *nidorous taſte*, ariſing from putrid humours, is corrected by the juice of citrons, oranges, and other acids: a ſalt taſte is cured by plentiful dilution with watery liquors: an acid taſte is deſtroyed by abſorbents and alkaline ſalts, as powder of oyſter-ſhells, ſalt of wormwood, &c.

When the ſenſibility of the nerves which ſupply the organs of taſte is diminiſhed, the chewing of horſe-radiſh, and or other ſtimulating ſubſtances, will help to recover it.

367 GENUS C. ANÆSTHESIA.

Defect of the Senſe of FEELING.

Sauv. gen. 161. *Lin.* 218. *Vog.* 267.

Cauſes, &c. This ſenſe may be hurt by any thing that obſtructs the nervous influence, or prevents its being regularly conveyed to the organs of touching, as preſſure, extreme cold, &c. It may likewiſe be hurt by too great a degree of ſenſibility, when the nerve is not ſufficiently covered by the cuticle or ſcarf-ſkin, or where there is too great a tenſion of it, or it is too delicate. Whatever diſorders the functions of the brain and nerves, hurts the ſenſe of touching. Hence it appears to proceed from the ſame general cauſes as palſy and apoplexy, and requires nearly the ſame method of treatment.

In a *ſtupor*, or defect of touching, which ariſes from an obſtruction of the cutaneous nerves, the patient muſt firſt be purged; afterwards ſuch medicines as excite the action of the nerves, or ſtimulate the ſyſtem, may be uſed. For this purpoſe, the ſpirit of hartſhorn, either by itſelf or combined with eſſential oils, horſe-radiſh, &c. may be taken inwardly; the diſordered parts, at the ſame time, may be frequently rubbed with freſh nettles or ſpirit of ſal ammoniac. Bliſters and ſinapiſms applied to the parts will likewiſe be of uſe; and alſo warm bathing, eſpecially in the natural hot baths.

368 ORDER II. DYSOREXIÆ.

SECT. I. *APPETITUS ERRONEI.*

Moroſitates, *Sauv.* Claſs VIII. Order II. *Sag.* Claſs XIII. Order II.
Pathetici, *Lin.* Claſs V. Order II.
Hyperæſtheſes, *Vog.* Claſs VII.

369 GENUS CI. BULIMIA.

INSATIABLE HUNGER, or *Canine Appetite.*

Bulimia, *Sauv.* gen. 223. *Lin.* 79. *Sag.* gen. 335.
Bulimus, *Vog.* 296.
Addephagia, *Vog.* 297.
Cynorexia, *Vog.* 298.

This diſeaſe is commonly owing to ſome fault in the ſtomach, by which the aliments are thrown out too ſoon; and unleſs the perſon be indulged in his deſire for eating, he frequently falls into fainting fits. Sometimes it is attended with ſuch a ſtate of the ſtomach, that the aliment is rejected by vomit almoſt immediately after being ſwallowed; after which the appetite for food returns as violent as ever. But there are many circumſtances which ſeem to render it probable that it more frequently ariſes from a morbid condition of the ſecreted fluid poured into the ſtomach, by means of which the aliment is diſſolved. When the activity of this fluid is morbidly increaſed, it will both produce too ſudden a ſolution of the ſolid aliment, and likewiſe operate as a powerful and peculiar ſtimulus to the ſtomach, giving an uneaſy ſenſation, ſimilar to that which takes place in natural hunger. Such things are proper for the cure as may enable the ſtomach to perform its office: chalybeates and other tonics will generally be proper. In ſome, brandy drunk in a morning has been uſeful; and frequent ſmoking tobacco has relieved others. Oil, fat meat, pork, opiates, and in ſhort every thing which in a ſound perſon would be moſt apt to pall the appetite, may alſo be uſed as temporary expedients, but cannot be expected to perform a cure. In ſome, the pylorus has been found too large; in which caſe the diſeaſe muſt have been incurable.

GENUS CII. POLYDIPSIA. 370

EXCESSIVE THIRST.

Polydipſia, *Sauv.* gen. 224. *Lin.* 80. *Vog.* 275. *Sag.* 336.

This is almoſt always ſymptomatic; and occurs in fever, dropſy, fluxes, &c. The cure is very generally obtained only by the removal of the primary diſeaſe; and it is beſt palliated by the gradual introduction of diluents: But when theſe are contraindicated, it may often be ſucceſsfully obviated by ſuch articles taken into the mouth as have effect in augmenting the flow of ſaliva.

GENUS CIII. PICA.

LONGING, or *Falſe Appetite.* 371

Pica, *Sauv.* gen. 222. *Sag.* 334.
Citta, *Lin.* 78.
Allotriophagia, *Vog.* 299.
Malacia, *Vog.* 300.

The pica is alſo very generally ſymptomatic of other diſeaſes, as of worms, chloroſis, pregnancy, &c.; and is therefore chiefly to be combated by the removal of the primary affection. It may, however, be obſerved, that peculiar longings occurring in certain diſeaſes, as for example in fevers, often point out a natural cure. The indulgence of ſuch appetites to a moderate degree is ſeldom productive of any inconvenience, and often followed by the beſt conſequences. —Hence there are ſome practitioners who think that ſuch craving ſhould very generally be indulged; particularly when the patient can aſſign no reaſon whatever for ſuch particular longings, but is merely prompted by an uncommon and inexplicable deſire.

GENUS CIV. SATYRIASIS. 372

Satyriaſis, *Sauv.* gen. 228. *Lin.* 81. *Sag.* 340.

Satyriaſis is a violent deſire of venery in men, even ſo that reaſon is depraved by it. The pulſe is quick, and the breathing ſhort; the patient is ſleepleſs, thirſty, and loathes his food; the urine is evacuated with difficulty, and a fever ſoon comes on. Theſe ſymptoms, however, are probably not ſo much the conſequence of ſatyriaſis, as merely concomitant effects reſulting from the ſame cauſe. And indeed this affection is moſt frequently the concomitant of a certain modification of inſanity. The nature and cauſe of this affection are in moſt inſtances very little aſcertained; but as far as we are acquainted with the treatment, it agrees very much with the affection next to be mentioned, which, of the two, is the moſt common occurrence.

373 Genus CV. NYMPHOMANIA.

Furor Uterinus.

Nymphomania, *Sauv.* 229. *Sag.* 341.
Satyriaſis, *Lin.* 81.

The *furor uterinus* is in moſt inſtances either a ſpecies of madneſs or a high degree of hyſterics. Its immediate cauſe is a preternatural irritability of the uterus and pudenda of women (to whom the diſorder is proper), or an unuſual acrimony of the fluids in theſe parts.—Its preſence is known by the wanton behaviour of the patient: ſhe ſpeaks and acts with unreſtrained obſcenity; and as the diſorder increaſes, ſhe ſcolds, cries, and laughs, by turns. While reaſon is retained, ſhe is ſilent, and ſeems melancholy, but her eyes diſcover an unuſual wantonneſs. The ſymptoms are better and worſe until the greateſt degree of the diſorder approaches, and then by every word and action her condition is too manifeſt.—In the beginning a cure may be hoped for; but if it continue, it degenerates into a mania.—In order to the cure, blood-letting is commonly recommended in proportion to the patient's ſtrength. Camphor in doſes of 15 or 20 grains, with nitre, and ſmall doſes of the tincture of opium, ſhould be repeated at proper intervals. Some venture to give ceruſa acetata in doſes from three to five grains. Beſides bleeding, cooling purges ſhould alſo be repeated in proportion to the violence of ſymptoms, &c. What is uſeful in maniacal and hypochondriac diſorders, is alſo uſeful here, regard being had to ſanguine or phlegmatic habits, &c. When the delirium is at the height, give opiates to compoſe; and uſe the ſame method as in a phrenitis or a mania. Injections of barley-water, with a ſmall quantity of hemlock-juice, according to Riverius, may be frequently thrown up into the uterus: this is called *ſpecific*; but matrimony, if poſſible, ſhould be preferred. For although this cannot be repreſented as a cure for the diſeaſe when in an advanced ſtate, yet there is reaſon to believe that it has not unfrequently prevented it where it would otherwiſe have taken place.

374 Genus CVI. NOSTALGIA.

Vehement Desire *of* revisiting *one's* Country.

Noſtalgia, *Sauv.* gen 226. *Lin.* 83. *Sag.* 338.

This is to be reckoned a ſpecies of melancholy; and unleſs it be indulged, it very commonly proves not only incurable but even fatal. Although it cannot be conſidered as altogether peculiar to any nation, yet it is obſerved to be much more frequent with ſome than with others; and it has particularly been remarked among Swiſs ſoldiers in the ſervice of foreign ſtates.

Sect. II. *APPETITUS DEFICIENTES.*

Anepithymiæ, *Sauv.* Claſs VI. Ord. II. *Sag.* IX. Ord. II.
Privativi, *Lin.* Claſs VI. Order III.
Adynamiæ, *Vog.* Claſs VI.

Genus CVII. ANOREXIA. 375

Want of Appetite.

Anorexia, *Sauv.* gen. 162. *Lin.* 116. *Vog.* 279. *Sag.* 268.

The anorexia is ſymptomatic of many diſeaſes, but ſeldom appears as a primary affection; and it is very generally overcome only by the removal of the affection on which it depends.

Genus CVIII. ADIPSIA. 376

Want of Thirst.

Adipſia, *Sauv.* gen. 163. *Lin.* 117. *Vog.* 281. *Sag.* 269.

This by Dr Cullen is reckoned to be always ſymptomatic of ſome diſtemper affecting the *ſenſorium commune.*

Genus CIX. ANAPHRODISIA. 377

Impotence to Venery.

Anaphrodiſia, *Sauv.* gen. 164. *Sag.* 270.
Atecnia, *Lin.* 119.
Ageneſia, *Vog.* 283.

For this, ſee the article Impotence in the alphabetical order.

Order III. DYSCINESIÆ. 378

Genus CX. APHONIA. 379

Loſs of Voice.

Aphonia, *Sauv.* gen. 166. *Lin.* 115. *Vog.* 253. *Sag.* 272.

The loſs of voice may proceed from various cauſes. If one of the recurrent nerves, which are formed by the *par vagum* and the *nervus acceſſorius*, and reach the larynx, be cut, the perſon is capable of only as it were a half-pronunciation; but if both be cut, the ſpeech and voice are both loſt. The loſs of ſpeech happening in hyſteric patients is alſo called *aphonia*; but more properly that loſs of ſpeech is thus named which depends on ſome fault of the tongue.

Since the motion of any part is deſtroyed, or leſſened at leaſt, by the interception of the nervous fluid in its paſſage thither, and ſince the nerves deſtined for the motion of the tongue ariſe principally from the fifth pair, it appears that the ſeat of this diſorder is in the fifth pair of nerves, and that the immediate cauſe is

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is a diminution or total deſtruction of the nervous power in them. Hence a palſy of the tongue, which is either antecedent or ſubſequent to hemiplectic or apoplectic diſorders, demand our utmoſt attention.

If an aphonia appears alone, it generally beſpeaks an approaching hemiplegia or apoplexy; but if it ſucceed theſe diſorders, and is complicated with a weak memory and a ſluggiſhneſs of the mental powers, it threatens their return. That aphony uſually terminates the beſt which proceeds from a ſtagnation of ſerous humours compreſſing the branches of the fifth pair of nerves, which run to the tongue; but it is no leſs afflictive to the patient, and is very obſtinate of cure.

Other cauſes of this diſorder are, the ſtriking in of eruptions on the ſkin, a congeſtion of blood in the fauces and tongue, obſtructed periodical evacuations in plethoric habits, ſpaſmodic affections, worms, a crumb of bread falling into the larynx, fear, too free an uſe of ſpirituous liquors; alſo whatever deſtroys the ligaments which go from the arytænoid to the thyroid cartilages, will deſtroy the voice.

The *prognoſtics* vary according to the cauſe. That ſpecies which is owing immediately to ſpaſms, ſoon gives way on the removal of them. If a palſy of the tongue be the cauſe, it is very apt to return, though relieved, but often continues incurable.

In order to the *cure*, we muſt endeavour firſt to remove whatever obſtructs the influx of the nervous fluid into the tongue, and ſecondly to ſtrengthen the weak parts. Theſe general intentions, in all caſes, being regarded, the particular cauſes muſt be removed by remedies accommodated to each.

If worms be the cauſe, antiſpaſmodics may give preſent relief; but the cure depends on the deſtruction or expulſion of the animals themſelves. In caſe of a congeſtion of blood about the head, bleeding and nitrous medicines are to be uſed.—That ſpecies of aphony which remains after the ſhock of an hemiplegia or apoplexy, requires bliſters to be applied to the nape of the neck; if ſpaſmodic conſtrictions about the fauces and and tongue be the cauſe, external paregorics are of the greateſt ſervice, anodyne antiſpaſmodics may be laid under the tongue, and the feet bathed in warm water; carminative clyſters alſo are uſeful.—When a palſy of the tongue produces this complaint, evacuations, according to the patient's habit, muſt be made, and warm nervous medicines muſt be externally applied, and internally adminiſtered; bliſters alſo ſhould be placed between the ſhoulders.—In caſe of repelled cuticular eruptions, ſudorifics ſhould be given, and the patient's drink ſhould be warm. The ſpiritus ammoniæ ſuccinatus, or vinum antimonii, may be employed either in combination with other articles, or by themſelves, and given at proper diſtances of time, in the patient's drink, or on a bit of ſugar.—Sometimes the ſerum flows ſo rapidly to the fauces and adjacent parts, in a ſalivation, as to deprive the patient of all power to ſpeak; in this caſe diaphoretics and laxatives, with a forbearance of all mercurials, are the ſpeedieſt remedies.

380 GENUS CXI. MUTITAS.

DUMBNESS.

Mutitas, *Sauv.* gen. 165. *Vog.* 257. *Sag.* 271.

Mutitas.

Dumb people are generally born deaf; in which caſe the diſtemper is incurable by medicine: though even ſuch people may be taught not only to read and write, but alſo to ſpeak and to underſtand what others ſay to them. For ſome obſervations on the method in which this has been accompliſhed, we may refer the reader to the article DUMBNESS, in the alphabetical order. But in theſe caſes, admitting of cure in the manner above alluded to, the dumbneſs proceeds principally, if not ſolely, from the deafneſs. For when it proceeds from a defect of any of the organs neceſſary for ſpeech, the tongue for inſtance, it is always incurable; but if it ariſe from a palſy, the medicines applicable in that caſe will ſometimes reſtore the ſpeech.

GENUS CXII. PARAPHONIA. 381

Change in the Sound of the VOICE.

Paraphonia, *Sauv.* gen. 168.
Cacophonia, *Sag.* 274.
Raucedo, *Lin.* 146.
Raucitas, *Vog.* 252.
Aſaphia, &c. *Vog.* 250, 251, 254, 255, 256.

The voice may be changed from various cauſes. In males it becomes much more hard about the time of puberty; but this can by no means be reckoned a diſeaſe. In others it proceeds from a catarrh, or what we call a *cold;* it ariſes alſo from affections of the noſe and palate, as polypi, ulcers, &c. in which caſe the cure belongs properly to SURGERY. In ſome it ariſes from a laxity of the *velum pendulum palati* and glottis which makes a kind of ſnoring noiſe during inſpiration. The cure of this laſt caſe is to be attempted by tonics and ſuch other medicines as are of ſervice in diſeaſes attended with laxity.

GENUS CXIII. PSELLISMUS. 382

Defect in PRONUNCIATION.

Pſelliſmus, *Sauv.* gen. 167. *Lin.* 139. *Sag.* 273.
Traulotis, &c. *Vog.* 258, 259, 260, 261.

Of this diſeaſe (if ſuch it may be called), there are many different kinds. Some cannot pronounce the letter S; others labour under the ſame difficulty with R, L, M, K: &c.; while ſome who can with ſufficient eaſe pronounce all the letters, yet repeat their words, or the firſt ſyllables of them, in ſuch a ſtrange manner, that they can ſcarce be underſtood. Very frequently theſe defects ariſe entirely from habit, and may then be got the better of by thoſe who have the reſolution to attempt it; as we are told that Demoſthenes the celebrated orator got the better of a habit of ſtammering by declaiming with pebbles in his mouth. Sometimes, however, pronunciation may be impeded by a wrong conformation of the tongue or organs of ſpeech; and then it cannot by any pains whatever be totally removed.

GENUS CXIV. STRABISMUS. 383

SQUINTING.

Strabiſmus, *Sauv.* gen. 116. *Lin.* 304. *Vog.* 514. *Sag.* 222.

Deſcription. This diſeaſe ſhows itſelf by an uncommon contraction of the muſcles of the eye; whereby the axis of the pupil is drawn towards the noſe, temples, forehead, or cheeks, ſo that the perſon cannot behold an object directly.

Cauſes, Prognoſis, &c. I. This diſeaſe may proceed from cuſtom and habit; while in the eye itſelf, or in its muſcles, nothing is preternatural or defective.

Thus children by imitating thoſe that ſquint, and infants by having many agreeable objects preſented to them at once, which invite them to turn one eye to one and the other eye to another, do frequently contract a habit of moving their eyes differently, which afterwards they cannot ſo eaſily correct. Infants likewiſe get a cuſtom of ſquinting by being placed obliquely towards a candle, window, or any other agreeable object capable of attracting their ſight: for though, to ſee the object, they may at firſt turn both eyes towards it; yet, becauſe ſuch an oblique ſituation is painful and laborious, eſpecially to the moſt diſtant eye, they ſoon relax one of the eyes, and content themſelves with examining it with the eye that is next it; whence ariſes a diverſity of ſituation and a habit of moving the eyes differently.

In this caſe, which may admit of a cure if not too much confirmed, it is evident, that objects will be ſeen in the ſame place by both eyes, and therefore muſt appear ſingle as to other men; but becauſe, in the eye that ſquints, the image of the object to which the other eye is directed falls not on the moſt ſenſible and delicate part of the retina, which is naturally in the axis of the eye, it is eaſy to ſee that it muſt be but faintly perceived by this eye. Hence it is, that while they are attentive in viewing any object, if the hand be brought before the other eye, this object will be but obſcurely ſeen, till the eye change its ſituation and have its axis directed to it; which change of ſituation is indeed very eaſy for them, becauſe it depends on the muſcles of the eyes, whoſe functions are entire; but, by reaſon of the habit they have contracted of moving their eyes differently, the other eye is at the ſame time frequently turned aſide; ſo that only one at a time is directed to this object.

II. The *ſtrabiſmus* may proceed from a fault in the firſt conformation, by which the moſt delicate and ſenſible part of the retina is removed from its natural ſituation, which is directly oppoſite to the pupil, and is placed a little to a ſide of the axis of the eye; which obliges ſuch people to turn away the eye from the object they would view, that its picture may fall on this moſt ſenſible part of the organ.

When this is the caſe, the diſeaſe is altogether incurable, and the phenomena that ariſe therefrom differ in nothing from the phenomena of the former caſe, excepting only that here, 1. The object to which the eye is not directed will be beſt ſeen; which is the reverſe of what happens when this diſeaſe ariſes barely from habit and cuſtom. 2. No object will appear altogether clear and diſtinct: for all objects to which the eye is directed, by having their image painted in the retina at the axis of the eye, where it is not very ſenſible, will be but obſcurely ſeen; and objects that are placed ſo far to a ſide of the optic axis as is neceſſary for making their image fall on the moſt ſenſible and delicate part of the retina, muſt appear a little confuſed, becauſe the ſeveral pencils of rays that come therefrom fall too obliquely on the cryſtalline to be accurately collected in ſo many diſtinct points of the retina; though it muſt be acknowledged, that this confuſion will, for the moſt part, be ſo ſmall as to eſcape unobſerved.

III. This diſeaſe may proceed from an oblique poſition of the cryſtalline, where the rays that come directly to the eye from an object, and that ought to converge to the point of the retina, which is in the axis of the eye, are, by reaſon of the obliquity of the cryſtalline, made to converge to another point on that ſide of the viſual axis where the cryſtalline is moſt elevated; and therefore the object is but obſcurely ſeen, becauſe its image falls not on the retina at the axis of the eye, where it is moſt ſenſible: But the rays that fall obliquely on the eye, will after refraction, converge to this moſt ſenſible part of the retina; and, by converging there, muſt impreſs the mind with a clear idea of the object from whence they came. It is for this reaſon that the eye never moves uniformly with the other, but turns away from the object it would view, being attentive to the object to which it is not directed. When this is the caſe, it is in vain to expect any good from medicine.

The ſymptoms which naturally ariſe from it are, 1. The object to which the eye is directed will be but faintly ſeen, becauſe its image falls on the retina where it is not very ſenſible. 2. The object to which the eye is not directed, by having its image painted on the retina at the axis of the eye, will be clearly perceived. But, 3. This ſame object muſt appear ſomewhat indiſtinct, becauſe the pencils of rays that flow from it are not accurately collected in ſo many diſtinct points in the retina, by reaſon of their oblique incidence on the cryſtalline. 4. It muſt be ſeen, not in its proper place, but thence tranſlated to ſome other place ſituated in the axis of viſion. And, 5. Being thus tranſlated from its true place, where it is ſeen by the other eye that does not ſquint, it muſt neceſſarily appear double; and the diſtance between the places of its appearance will be ſtill greater, if the cryſtalline of the other eye incline to the contrary ſide.

IV. This diſeaſe may ariſe from an oblique poſition of the cornea; which, in this caſe, is generally more arched and prominent than what it is naturally.

When the eye has this conformation, no object to which it is directed can be clearly ſeen, becauſe its image falls not on the retina at the axis of the eye; and therefore the eye turns aſide from the object it would view, that its image may fall on the moſt ſenſible part of the retina.

When the ſtrabiſmus proceeds from this cauſe, the prognoſtic and the phænomena that attend it will be much the ſame as in the caſe immediately preceding; from which nevertheleſs it may be diſtinguiſhed by the obliquity of the cornea, which is manifeſt to the ſenſes and if the cornea be alſo more arched and prominent than what it is naturally, which is commonly the caſe, the eye will alſo be ſhort-ſighted.

V. This want of uniformity in the motions of our eyes, may ariſe from a defect, or any great weakneſs or imperfection, in the ſight of both or either of the eyes; and this, according to Dr Porterfield, is the moſt common cauſe of this diſeaſe. The prognoſtic in this caſe is the ſame with that of the diſeaſe from which it proceeds.

VI. Another cauſe from which the ſtrabiſmus may proceed, lies in the muſcles that move the eye. When any of thoſe muſcles are too ſhort or too long, too tenſe or too lax, or are ſeized with a ſpaſm or paralyſis, their equilibrium will be deſtroyed, and the eye will be turned towards or from that ſide where the muſcles are faulty.

In this caſe, the diſeaſe frequently yields to medicine, and therefore admits of favourable prognoſtic; excepting only when, by a fault in the firſt conformation, any of the muſcles are longer or ſhorter than their antagoniſt; in which caſe, if ever it ſhould happen, no medicine can be of any uſe.

As to what concerns the optical phænomena, they are the ſame here as in caſe firſt: only when the diſeaſe commences not till, by cuſtom and habit, the uniform motion of the eyes has been rendered neceſſary, all objects do for ſome time appear double; but in time they appear ſingle.

Laſtly, This want of uniformity in the motions of our eyes may proceed from a preternatural adheſion or attachment to the eyelids: of this we have an inſtance in Langius. And that the ſame thing may alſo be occaſioned by a tumor of any kind within the orbit, preſſing the eye aſide, and reſtraining it from following the motions of the other, is ſo evident, that inſtances need not be brought to prove it. Here alſo the caſe may admit of a favourable prognoſtic; and as for what concerns the optical phænomena, they muſt be the ſame as in the caſe immediately preceding.

The *cure*, in confirmed caſes, is to be effected by mechanical contrivances, by which the perſon may be obliged to look ſtraight upon objects, or not ſee them at all; or at leaſt that he may ſee with uneaſineſs and confuſedly when he ſquints. In the 68th volume of the Philoſophical Tranſactions we have an account of a confirmed caſe of ſquinting of a very uncommon kind. The patient was a boy of five years old, and viewed every object which was preſented to him with but one eye at a time. If the object was preſented on his right ſide, he viewed it with his left eye; and if it was preſented on his left ſide, he viewed it with his right eye. He turned the pupil of that eye which was on the ſame ſide with the object in ſuch a direction that the image of the object might fall on that part of the bottom of the eye where the optic nerve enters it. When an object was held directly before him, he turned his head a little to one ſide, and obſerved it with but one eye, viz. that moſt diſtant from the object, turning away the other in the manner above deſcribed; and when he became tired of obſerving it with that eye, he turned his head the contrary way, and obſerved it with the other eye alone, with equal facility; but never turned the axis of both eyes on it at the ſame time. He ſaw letters which were written on bits of paper, ſo as to name them with equal eaſe, and at equal diſtances, with one eye as with the other. There was no perceptible difference in the diameters of the iriſes, nor in the contractility of them after having covered his eyes from the light. Theſe obſervations were carefully made by writing ſingle letters on ſhreds of paper, and laying wagers with the child that he could not read them when they were preſented at certain diſtances and in certain directions.

As from theſe circumſtances it appeared that there was no defect in either eye, which is frequently the caſe with perſons who ſquint, and hence that the diſeaſe was ſimply a depraved habit of moving his eyes, the diſeaſe ſeemed capable of a cure. A paper gnomon was made for this purpoſe, and fixed to a cap; and when this artificial noſe was placed over his real noſe, ſo as to project an inch between his eyes, the child, rather than turn his head ſo far to look at oblique objects, immediately began to view them with that eye which was next to them. But having the misfortune to loſe his father ſoon after this method was begun to be followed, the child was neglected for ſix years, during which time the habit was confirmed in ſuch a manner as ſeemed to leave little room to hope for a cure. The ſame phyſician, however, being again called, attempted a ſecond time to remove the deformity by a ſimilar contrivance. A gnomon of thin braſs was made to ſtand over his noſe, with a half circle of the ſame metal to go round his temples: theſe were covered with black ſilk, and by means of a buckle behind his head, and a croſs-piece over the crown of his head, this gnomon was worn without any inconvenience, and projected before his noſe about two inches and an half. By the uſe of this machine he ſoon found it leſs inconvenient to view all oblique objects with the eye next to them than the eye oppoſite to them.

After this habit was weakened by a week's uſe of the gnomon, two bits of wood, about the ſize of a gooſe-quill, were blackened all but a quarter of an inch at their ſummits; theſe were frequently preſented to him to look at, one being held on one ſide the extremity of his black gnomon, and the other on the other ſide of it. As he viewed theſe, they were gradually brought forwards beyond the gnomon, and then one was concealed behind the other: by theſe means, in another week, he could bend both his eyes on the ſame object for half a minute together; and by continuing the uſe of the ſame machine, he was in a fair way of being cured when the paper was written.

Dr Darwin, who writes the hiſtory of the above caſe, adds, that all the other ſquinting people he had occaſion to attend, had one eye much leſs perfect than the other: theſe patients, ſays he, are certainly cureable by covering the beſt eye many hours in a day; as by a more frequent uſe of the weak eye, it not only acquires a habit of turning to the objects which the patient wiſhes to ſee, but gains at the ſame time a more diſtinct viſion; and the better eye at the ſame time ſeems to loſe ſomewhat in both theſe reſpects, which alſo facilitates the cure.

Genus CXV. CONTRACTURA. 384

Contractions of the Limbs.

Contractura, *Sauv.* gen. 119. *Lin.* 299. *Sag.* 225.
Obſtipitas, *Sauv.* gen. 11.

Caput obſtipum, *Vog.* 513.
Digitium, *Vog.* 221.

The contraction of various muſcles of the body is generally the conſequence of ſome other diſeaſe, as the rheumatiſm, gout, ſcurvy, or palſy, eſpecially that ſpecies of the latter which follows the *colica Pictonum*. It is exceedingly difficult of cure; though the warm medicinal waters are much recommended, and have ſometimes done great ſervice. Of late electricity has been found to perform ſurpriſing cures in this way.

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ORDER IV. APOCENOSES.

Apocenoſes, *Vog.* Claſs II. Ord. II.
Fluxus, *Sauv.* Claſs IX. *Sag.* Claſs V.
Morbi evacuatorii, *Lin.* Claſs IX.

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GENUS CXVI. PROFUSIO.

FLUX of BLOOD.

Profuſio, *Lin.* 239.
Hæmorrhagia, *Vog.* 81. *Boerh.* 218.

The diſeaſe commonly known by the name of *bloody flux*, is the putrid or contagious dyſentery, a diſeaſe which has already been treated of. But independent of the diſcharge of blood which then takes place, hæmorrhagy may take place from the alimentary canal as well as from other parts of the ſyſtem. In ſuch inſtances, however, if we except the place from which the diſcharge occurs, the phenomena are very much the ſame as in menorrhagia, hæmoptyſis, and other hæmorrhagies already treated of; while the diſeaſe is to be combated on the ſame principles and by the ſame remedies.

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GENUS CXVII. EPHIDROSIS.

Exceſſive SWEATING.

Ephidroſis, *Sauv.* gen. 258. *Sag.* gen. 194.
Sudor, *Lin.* 208.
Hydropedeſis, *Vog.* 121.

This is generally ſymptomatic; and occurs in almoſt all fevers, but eſpecially in the latter ſtages of the hectic. Sometimes it is a primary diſeaſe, ariſing merely from weakneſs; and then eaſily admits of a cure by the uſe of the cinchona, the cold bath, and other tonics.

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GENUS CXVIII. EPIPHORA.

FLUX of the LACHRYMAL HUMOUR.

Epiphora, *Sauv.* gen. 259. *Lin.* 172. *Vog.* 99. *Sag.* 195.

This by Sauvages is deſcribed as an involuntary effuſion of tears without any remarkable itching, heat, or pain. It follows long continued ophthalmias; or it may be occaſioned by immoderate ſtudy, or any thing that weakens the eyes: hence it comes on about the age of 50 years, when the eyeſight naturally becomes weak. It in general grows worſe in the winter-time, and is very hard to cure. Some authors recommend purgatives, and bliſters on the nape of the neck, in order to draw off the abundant humours; but as the diſeaſe evidently proceeds from weakneſs, it would rather ſeem proper to purſue a contrary method. Sauvages recommends to the patients to abſtain from ſtudy, wine, and ſalted meats; and alſo to avoid ſmoke or wind, and at night to foment the eyes with an infuſion of four cloves in two ounces of proof-ſpirit.—Hungary water, roſe water with ſulphate of zinc diſſolved it it, &c. have alſo been recommended.

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GENUS CXIX. PTYALISMUS.

SALIVATION.

Ptyaliſmus, *Sauv.* gen. 261. *Lin.* 176. *Vog.* 103. *Sag.* 197.

A ſalivation is often ſymptomatic, but rarely a primary diſeaſe. Dr Cullen is of opinion, that when the latter happens to be the caſe, it ariſes from laxity; and then is to be cured by aſtringents and tonics. In the Medical Tranſactions we have the following account of a ſalivation brought on by a foreign ſubſtance irritating one of the parotid glands.

In the month of April 1751, a young lady about the age of 16 years, of a delicate habit, but ſubject to no particular complaints, perceived the beginning of a diſeaſe which afterwards proved moſt obſtinate and loathſome, viz. an inceſſant ſpitting. The quantity of this diſcharge was different at different times, varying from one pint to two pints and an half in 24 hours. As to its quality, it ſeemed to be no other than the ordinary ſecretion of the ſalival glands. By ſo large and conſtant an evacuation, her ſtrength became extremely impaired, and the moſt efficacious medicines had proved uſeleſs. She had taken large quantities of cinchona, both alone and combined with preparations of iron: and afterwards the fetid gums, opium, amber, alum, and the Neville-Holt water, had in ſucceſſion been given her. In the mean time an exact regimen had been preſcribed: ſhe had been ordered to ride conſtantly; and to confine herſelf to a mucilaginous diet, ſuch as veal, calves feet, &c. Likewiſe a gentle opening medicine had now and then been interpoſed. The diſeaſe ſtill continuing unaltered, ſhe had afterwards tried the *tinctura ſaturnina*; and had, at the ſame time, been encouraged to chew cinchona, and to ſwallow the ſaliva. But all theſe attempts had been vain; and after ſhe had taken ſome or other of the medicines above mentioned until the end of September 1753, namely, above two years, it appeared to her phyſician, Sir George Baker, unreaſonable to expect relief in ſuch a caſe from any internal medicines whatever.

He now conceived a ſuſpicion, that ſome extraneous body having accidentally found its way into the *meatus auditorius*, might poſſibly be the cauſe of this extraordinary ſecretion, by keeping up a continued irritation in the parotid glands. With this view he examined her ears, and extracted from them a quantity of fetid wool. How, or when, it came thither, no account could be given.

To this ſubſtance he attributed the beginning of the ſalivation, notwithſtanding that the diſeaſe did not immediately abate on the removal of the wool; as it appeared to be no improbable ſuppoſition that the diſcharge might be continued by the force of habit, though the original cauſe no longer remained.

It ſeemed, therefore, expedient to introduce ſome other habit, in the place of the increaſed ſecretion of ſaliva; which habit might afterwards be gradually left off. With this intention, he prevailed on the patient to chew perpetually a little dry bread, and to ſwallow it with her ſpittle. In a few weeks, it became neceſſary for her to chew the bread only at certain hours in the day; and thus, after two months, ſhe became entirely free from a moſt diſguſtful and tedious diſorder.

It is worthy of obſervation, that, at firſt, the ſwallowing of ſo much ſaliva frequently occaſioned a nauſea; and that then, for a few hours, ſhe was obliged to ſpit it out as uſual; and that, during the greateſt part of the time, when ſhe chewed the bread, ſhe had a ſtool or two every day more than common.

390 GENUS CXX. ENURESIS.

An involuntary FLUX *of* URINE.

Enureſis, *Sauv.* gen. 264. *Lin.* 195. *Vog.* 113. *Sag.* 200.

This is a diſtemper which frequently affects children, otherwiſe healthy, when aſleep; and is extremely diſagreeable. Often it is merely the effect of lazineſs, and may be driven off by proper correction; but ſometimes it proceeds from an atony or weakneſs of the ſphincter of the bladder. Many ridiculous cures have been preſcribed for it, and among the reſt field-mice dried and powdered. Tonics are frequently of uſe; but ſometimes the diſtemper proves obſtinate, in ſpite of every thing we can uſe. In the London Medical Obſervations we find bliſters much recommended in this diſeaſe, when applied to the region of the os ſacrum. A girl of 13 years of age had been ſubject to an enureſis for four years. She could retain her water but a very little while in the day-time, but it flowed continually in the night. She had taken Peruvian bark and elixir of vitriol in conſiderable quantities; alſo valerian and the volatile julep, without effect. She was ſeverely threatened, as the phyſician ſuſpected it might ariſe from a bad habit; but this producing no effect, a bliſter was applied to the os ſacrum, which in 24 hours totally removed the diſeaſe. A man aged 32, having been ſeized with an incontinence of urine and palſy of the lower extremities in conſequence of taking a quack medicine, was cured of the incontinence of urine in 24 hours by one bliſter, and of the palſy itſelf by another. A woman of 50 having been ſeized with an enureſis and paralytic affection of the right thigh and leg in conſequence of a ſprain, was cured of both by a ſingle bliſter. Several other caſes are mentioned, by which the power of bliſters in removing this diſtemper ſeems to exceed that of every other medicine whatever.

391 GENUS CXXI. GONORRHOEA.

Gonorrhœa, *Sauv.* gen. 208. *Lin.* 200. *Vog.* 118. *Sag.* 204.

The gonorrhœa is a flux of viſcid matter of various colours, from the urethra in men and the vagina in women. It commonly proceeds from coition with a perſon infected with the venereal diſeaſe, and is one of the moſt common forms under which that diſeaſe ſhows itſelf.

Deſcription. The firſt ſymptoms of the diſeaſe in men are commonly a ſenſation at the end of the penis not unlike a flea-bite, together with a fulneſs of the lips of the urethra, and ſome degree of tenſion in the penis, the urinary canal feeling as if tightened, and the urine flowing in a ſmall and unequal ſtream: a little whitiſh mucus is to be ſeen about the orifice of the urethra, and oozing from it when ſlightly preſſed, eſpecially if the preſſure be made on the ſpot where the ſoreneſs is moſt felt. The diſcharge ſoon increaſes in quantity, and varies in its colour according to the degree of inflammation. The patient feels a ſenſation of heat and pain in evacuating his urine, particularly at certain ſpots of the urethra, and above all towards its orifice; and the involuntary erections to which he is ſubjected from the ſtimulus, particularly when warm in bed, occaſion a diſtortion or curvature of the penis, attended with exquiſite pain. When the inflammation is violent, the glans appears tumid and tranſparent, the tenſion extends through the whole of the penis, the perinæum is affected with ſwelling and redneſs, and even the loins, buttocks, and anus, ſympathize and afford a very uneaſy ſenſation. Sometimes the prepuce inflames about the end of the penis, and cannot be drawn back, occaſioning what is called a *phymoſis;* at other times, as in the *paraphymoſis*, it remains in an inflamed ſtate below the glans, ſo that it cannot be drawn forwards; and, if the ſtricture and inflammation be violent, may terminate in gangrene. Now and then, eſpecially when there is a phymoſis, we may perceive a hard chord extending along the back of the penis. This is an inflamed lymphatic, and may be conſidered as a prelude to a bubo. When, however, a bubo does appear, almoſt univerſally ſome ulceration is previouſly to be diſcovered about the præputium, or glans penis; which gives ground to preſume that ſome other contagious matter beſides that of gonorrhœa may have been applied to the urethra. For it is certain that matter capable of communicating the contagion of gonorrhœa to a female, is often copiouſly applied to the whole glans penis of a male for ſeveral days together, without giving either ulceration or bubo.

In mild caſes, the ſeat of the diſeaſe is in the urethra, not far from its orifice; but it frequently happens that the virus inſinuates itſelf much higher up, ſo as to affect Cowper's glands, the proſtate, and parts very near to the neck of the bladder.

In the generality of caſes, the inflammation goes on increaſing for ſeveral days, commonly for a week or a fortnight; after which the ſymptoms begin to abate; and the running, when left to itſelf, gradually leſſens in quantity, and becomes whiter and thicker, till at length it totally ſtops. The colour of the mucus, however, is by no means a certain guide in theſe caſes: for in many patients it is of a yellowiſh, and ſometimes of a greeniſh hue to the very laſt; but in general it becomes more conſiſtent towards the cloſe of the diſeaſe.

In women, the external parts of generation being fewer and more ſimple, the diſeaſe is leſs complicated than in men. Sometimes the vagina only is affected; and when this happens, the ſymptoms are very trifling: but in general it comes on with an itching and ſenſation of heat as in the other ſex; and is attended with inflammation of the nymphæ, inſide of the *labia*, *clitoris*, *carunculæ myrtiformes*, the orifice and ſometimes the whole of the *meatus urinarius*. Very often the deep-ſeated glands of the vagina are affected, and it is ſometimes difficult to diſtinguiſh the diſcharge of a gonorrhœa from that of the fluor albus.

Cauſes, &c. Many ingenious arguments have of late been advanced to prove, that the gonorrhœa and the lues venerea are different affections, originating from two diſtinct ſpecies of virus; and this controverſy ſtill, perhaps, remains to be decided by future facts. Certain it is, that in 19 of 20 caſes of gonorrhœa, no ſymptom whatever of ſiphylis appears; and that the diſeaſe readily admits of cure without having recourſe to thoſe remedies which are univerſally requiſite for combating the contagion of ſiphylis. It is by no means wonderful, that in ſome caſes both contagious, ſuppoſing them different, ſhould be communicated at the ſame time. Nay, caſes are by no means rare, where the contagion of itch, though eſſentially different from both, has been communicated with either. But as undeniable proof that the contagion in both caſes is preciſely the ſame, it has been alleged by ſome, that the matter of a chancre introduced into the urethra will generate a gonorrhœa, and that the diſcharge from a gonorrhœa will produce chancre, bubo, and every other ſymptom of ſiphylis. On the other hand, however, it is contended, that when experiments of this nature are conducted with the greateſt accuracy, the matter of ſiphylis uniformly produces ſiphylis, and that of gonorrhœa, gonorrhœa only. Without pretending to decide on which of theſe experiments the greateſt dependence is to be put, we may only obſerve, that while an almoſt inconceivably ſmall portion of ſiphylitic matter applied to the glans penis, from connection with an infected female, infallibly produces ſiphylis if it be not ſpeedily removed, the matter of gonorrhœa, in every inſtance of that diſeaſe, is applied to the whole ſurface of the glans penis for many days together without producing almoſt any bad effect whatever. From this, therefore, there is ground for inferring, either that it is not capable of being abſorbed, or that if abſorbed it is innocent.

But while there have been diſputes with regard to the peculiar nature of the matter in gonorrhœa, there have alſo been controverſies with reſpect to the ſource from whence it is derived. While ſome ſuppoſe it to be principally purulent matter ariſing from ulcerations, others aſſert that no ſuch ulceration is ever produced in the urethra by gonorrhœa. They contend that the increaſed ſecretion in theſe caſes is exactly ſimilar to what happens in the catarrh. But the compariſon will by no means hold good in every particular: in the latter the whole membrane of the noſe is equally irritated; whereas in the gonorrhœa, only particular parts of the urethra ſeem to be affected. The diſeaſe, in the generality of caſes, ſeldom extends more than an inch and a half along that canal, and in many is confined (at leaſt in the beginning) to a ſmall ſpot about an inch from the extremity of the glans. The diſcharge is produced from that part of the urethra where the pain is felt; and the patient, when he voids his urine, feels no ſmarting till it reaches the inflamed ſpot: but as the diſorder increaſes, the inflammation affects a greater number of points, juſt in the ſame manner as chancres affect different parts of the glans. It might be ſuppoſed that diſſection would at once clear up this matter, and put an end to the diſpute; but this is far from being the caſe. Dr Simmons has ſeen ſeveral urethras opened in perſons who had a gonorrhœa at the time of their death: in three of them the ſurface of the urethra, as in the caſes related by Morgagni, appeared for ſome way down of a ſlight red colour, and in all of them was covered with mucus; but without any appearance of ulceration, except in two diſſections at Paris, in which moſt of the gentlemen preſent were convinced that they ſaw evident marks of it: but Dr Simmons ſays that the appearances were to him not ſufficiently ſatisfactory to enable him to decide with certainty on the ſubject. On the other hand, when we conſider that the diſcharge in a gonorrhœa is ſometimes tinged with blood, and that when this happens a little blood-veſſel is no doubt ruptured, we can have no reaſon to doubt that an ulceration may, and ſometimes does, happen in theſe caſes; eſpecially as we often obſerve an excoriation near the orifice of the urethra. It is certain, that wherever there is conſiderable inflammation, there will be danger of ulceration. Beſides, from a neglected or badly-treated gonorrhœa, we often ſee fiſtulas *in perineo*, and other ulcers of the urethra, penetrating through its ſubſtance, and affording a paſſage to the urine. And there can be no doubt that ſlight ulcerations of this canal often occur, and are afterwards perfectly obliterated, in a ſimilar manner to what happens in the papillæ of the tongue, the tonſils, &c. Such an obliteration will the more readily take place in a part like the urethra, defended with mucus, and not expoſed to the air, which is known to have no little effect in hardening a cicatrix.

But whether ulcers take place or not, whether the virus of gonorrhœa be preciſely of the ſame kind with that which gives ſiphylis, or of a different kind, there is reaſon from the phenomena of the diſeaſe to conclude, that the matter firſt acts by mixing with the mucus at the extremity of the urethra; and that from thence it is propagated upwards, particularly where the excretories of mucus are moſt numerous; and that on the parts to which it is applied, it operates as a peculiar irritating cauſe. The conſequences of this irritation will be inflammation and an increaſed ſecretion of mucus; and ſo far the complaint will be local. In ninety-nine caſes of an hundred a local affection of this kind conſtitutes the whole of the diſeaſe; and of this inflammation, ulcerations within the urethra, ſtrictures, and other local affections, may be the conſequence. But whether a diſeaſe of the habit ever takes place, unleſs when the contagion of ſiphylis is communicated with that of gonorrhœa, ſtill remains to be determined by future obſervations and experiments.

Nothing can be more variable than the period at which the diſeaſe makes its appearance after infection. Perhaps, at a medium, we may place it between the 4th and 14th day; but in ſome caſes it happens within

24 hours; and in others, not before the end of five or even ſix weeks: neither of theſe extremes, however, are common.

From what has been ſaid of the manner in which the contagious matter in gonorrhœa acts, and of the influence it exerts on thoſe parts with which it comes in contact, it follows, that the prevention of gonorrhœa muſt depend on the removal of the contagious matter, as ſoon as that can be done; and where this is either altogether neglected or not properly accompliſhed, that the cure muſt depend on counteracting the inflammation which this contagious matter excites, and the conſequences which reſult from it.

The firſt of theſe intentions may be moſt certainly and moſt eaſily accompliſhed by careful lotion of all the parts to which the contagious matter has any chance of being applied. Theſe parts, at leaſt on the firſt application of the matter, are readily acceſſible: for even in men there is no reaſon to believe that it at firſt penetrates to any extent in the urethra. This waſhing of the parts ſhould be performed as ſoon as poſſible; becauſe then the matter is both moſt acceſſible and leaſt involved with mucus: but although waſhing cannot be accompliſhed at an early period, it ſhould not be neglected afterwards; for from the diſeaſe uniformly commencing, even when it does not appear till a conſiderable time after the application of the contagious matter, with a peculiar ſenſe of titillation at the external parts, particularly in men at the extremity of the urethra, there is reaſon to believe that the contagious matter attached to the mucus may remain latent there for a very conſiderable time. For the purpoſe of waſhing, with a view to the prevention of this diſeaſe, recourſe may be had to almoſt any watery fluid, provided it be not ſo ſtimulant as to produce bad effects from injuring the parts. Pure water, properly applied, is perhaps one of the beſt lotions; but there can be no doubt that its power in removing the contagious matter may be ſomewhat increaſed by ſuch additions as render it a more powerful ſolvent of mucus. With this intention, one of the moſt powerful additions is the vegetable alkali, either in its mild or cauſtic ſtate. In the latter ſtate it is the moſt active, but in the former it is moſt ſafe; and the *carbonas potaſſæ* of the Edinburgh pharmacopœia, to the extent of half a dram, diſſolved in ſix or eight ounces of water, is one of the beſt lotions that can be employed. The purpoſe of removing the contagion may often alſo be effectually anſwered from waſhing with water impregnated with ſoap; for there the alkali, though in a cauſtic ſtate, is prevented from exerting any diſagreeable effects, in conſequence of its being combined with oily matters.

With the view of preventing gonorrhœa, ſome have adviſed, that the alkali either in its mild or cauſtic ſtate, properly diluted with water, ſhould be injected into the urethra: and there can be no doubt, that by this means the contagious matter, when it has entered the urethra, may be removed. A removal may alſo be effected by the injection of a weak ſolution of corroſive ſublimate, which ſeems to act not by diſſolving the mucus but by producing an augmented ſecretion. But at a very early period of the diſeaſe, injections are probably unneceſſary; and if it has made any conſiderable progreſs, they are dangerous: for from the augmented ſenſibility of the part, even very gentle ones are apt to excite a high degree of inflammation.

There are practitioners who, ſuppoſing that the body poſſeſſes powers to expel the virus, and that the diſeaſe has a certain period to run through its ſeveral ſtages of progreſs, acmè, and decline, are for leaving the cure to nature; or at leaſt content themſelves with aſſiſting her by an antiphlogiſtic regimen, gentle evacuations, and the like.

That in many caſes the diſorder admits of a natural cure, there can be no doubt; the increaſed ſecretion of mucus carrying off the virus faſter than it is formed, till at length the infection is wholly removed: But it is equally certain, that in every caſe, by the application of ſuitable remedies to the inflamed part, we may ſhorten the duration of the complaint, and abridge the ſufferings of the patient, with the ſame certainty and ſafety as we are enabled to remove the effects of an ophthalmia or any other local inflammation, by proper topical applications. General remedies, ſuch as occaſional blood-letting, a cooling diet, the liberal uſe of diluting liquors, and mild purges, are by all allowed to be uſeful, and even neceſſary. Aſtruc was of opinion that in theſe caſes blood-letting ought to be repeated five or ſix times; and there are ſtill many practitioners who depend much on repeated evacuations of this ſort for a removal of the inflammation. But there is, perhaps, not one caſe in ten in which it is at all requiſite; and this ſmall number of caſes will conſiſt only of the ſtrong and plethoric: in ſuch, when the chordee is frequent and painful, and the pulſe hard and full, the loſs of from eight to twelve ounces of blood will be beneficial, but it will be ſeldom neceſſary to repeat the operation. The inflammation in theſe caſes is kept up by the local ſtimulus of the virus and the urine; and all that we can expect from veneſection is to moderate the pain and the frequency of erection. In perſons of a delicate habit, and of an irritable fibre, the evacuation will do no good; but if repeated will certainly be liable to do harm, by increaſing irritability, and of courſe rendering the patient more ſuſceptible of ſtimulus.

The utility, and even the neceſſity, of a cooling regimen, are ſufficiently obvious; wine and ſpirituous liquors, ſpiceries, a fiſh diet, much animal-food, and ſalted and high-ſeaſoned diſhes of every ſort, will conſtantly add to the complaint. The patient ſhould eat meat only once a-day, and that ſparingly. He ſhould abſtain from hot ſuppers. Milk, mild vegetables, and fruit, ſhould conſtitute the principal part of his diet while the inflammatory ſymptoms continue. Every thing that tends to excite the venereal imagination ſhould be ſtudiouſly avoided; for whatever promotes erections of the penis will increaſe the inflammation, and of courſe add fuel to the diſeaſe. For the ſame reaſons much walking or riding on horſeback will be hurtful, from the irritation kept up in the perinæum by ſuch means. Violent exerciſe of any kind, or any thing that is liable to increaſe the heat and the momentum of the blood, will of courſe be improper.

The drinking freely of mild, cooling, mucilaginous liquors, ſuch as linſeed-tea, orgeat, whey, milk and water, almond emulſion, and the like, will be extremely uſeful, by diluting the urine, and preventing its ſalts from ſtimulating the urethra. When the heat and pain in making water are very conſiderable, mucilaginous ſubſtances are found to have the beſt effect, particularly the gum tragacanth. It is a common practice to give equal quantities of this gum or gum-arabic and nitre, and to diſſolve nitre in the patient's drink, with a view to leſſen the inflammation. But in theſe caſes nitre is always improper: it is known to be a powerful diuretic, its chief action being upon the urinary paſſages; ſo that the ſtimulus it occaſions will only ſerve to increaſe the evil it is intended to alleviate. Supertartrite of potaſs, on account of its diuretic quality, will be equally improper. Our view here is not to promote a preternatural flow of urine; for the virus, being inſoluble in water, cannot eaſily be waſhed away by ſuch means; but our object ought to be, to render the urine that is ſecreted as mild and as little ſtimulating as poſſible.

Mild purges, which conſtitute another material part of the general remedies, are no doubt extremely uſeful when exhibited with prudence; but it is well known that the abuſe of purgative medicines in this diſeaſe has been productive of numerous evils. Formerly it was a pretty general practice to give a large doſe of calomel at bed-time, three or four times a-week; and to work it off the next morning with a ſtrong doſe of the *pilulæ cocciæ*, or ſome other draſtic purge. This method was perſevered in for ſeveral weeks: in conſequence of which the patient often found himſelf troubled with an obſtinate gleet, and perhaps his conſtitution materially injured; the effect of ſuch a method being (eſpecially in irritable habits) to weaken the ſtomach and bowels, and lay the foundation of hypochondrial complaints. Violent purging likewiſe often occaſions ſtrangury, and other troubleſome ſymptoms.

The cathartics employed in theſe caſes ſhould be gentle; ſuch as Rochelle ſalt, manna, tartariſed alkali, and the like. They ſhould be given only in a doſe ſufficient to procure two or three ſtools, and be repeated only every two or three days. The daily uſe of the purgative electuaries that are ſtill given by ſome practitioners, ſerves only to keep up a continual irritation on the bladder, and of courſe to prolong the inflammation.

The topical remedies that are uſed conſiſt chiefly of different ſorts of injections, the ingredients of which are extremely various; but their modes of operation may in general be referred to their mucilaginous and ſedative, or to their detergent, ſtimulating, and aſtringent qualities. In the hands of ſkilful practitioners, great advantages may doubtleſs be derived from the uſe of theſe remedies; but, on the other hand, the improper and unſeaſonable adminiſtration of them may prove a ſource of irreparable miſchief to the patient.

We know that mucilaginous and oily injections will tend to allay the local inflammation; and that a ſedative injection, ſuch as a ſolution of opium, will leſſen the irritability of the parts, and of courſe produce a ſimilar effect; the utility of ſuch applications is therefore ſufficiently obvious.

A detergent injection, or one that will act upon the mucus of the urethra, increaſe the diſcharge of it, waſh it away, and with it the venereal virus that is blended with it, can only be uſed as a prophylactic before the ſymptoms of infection have made their appearance. But great circumſpection is neceſſary in the uſe of this kind of injection. If it be too weak, it can be of no efficacy; and if it be too ſtrong, it may prove dangerous to the patient. A ſuppreſſion of urine has been brought on by the improper uſe of an injection of this kind. When the ſymptoms of inflammation have once made their appearance, the ſtimulus of ſuch an injection muſt be extremely hazardous. Excoriation of the urethra has but too often been produced by remedies of this ſort in the hands of adventurous and unſkilful practitioners.

While the inflammation of the urethra continues, every thing that ſtimulates it muſt be hurtful. If the injection excites a painful ſenſation in the urethra, as is but too often the caſe, it will be liable to produce ſwelled teſticles, difficulty in making water, excoriation, and other effects of increaſed inflammation: if, by its aſtringency, the running be checked before the virus that excited the diſcharge be properly ſubdued, the patient will be expoſed to freſh dangers; and perhaps to a variety of local complaints, ſuch as obſtructions in the urethra, and abſceſſes *in perinæo*, which are well known to be ſometimes owing to applications of this ſort improperly managed.

When the inflammation has ſubſided, gently ſtimulating and aſtringent injections may be uſed with ſafety, and with conſiderable advantage: for as the inflammation is at firſt excited by the ſtimulus of the venereal virus, ſo when the former begins to leſſen, we may be aſſured that the activity of the latter has abated in proportion; and, in general, when the inflammatory ſymptoms are entirely removed, it will be found, that the mucus is no longer of an infectious nature, but is merely the effect of an increaſed ſecretion and of relaxation. Mild aſtringents will therefore ſerve to brace and ſtrengthen the veſſels ſecreting mucus, and in this way will leſſen the diſcharge, and greatly promote the cure. It is certain, that in the greater number of caſes, a gonorrhœa, which if treated by internal remedies alone, would continue for five or ſix weeks, or longer, may, when judiciouſly treated with injections, be cured in a fortnight, and very often in leſs time. The great aim, therefore, of the practitioner ought to be at firſt to make uſe of ſuch injections only as will tend to lubricate the ſurface of the urethra, and to counteract and deſtroy the ſtimulus of the virus: as the inflammation abates, he may add ſome gently aſtringent preparation to a mucilaginous and ſedative injection; taking care that its aſtringency be ſuited to the ſtate of the diſeaſe, and to the irritability of the patient. Amongſt a great variety of ſubſtances, mercury in different forms is one of thoſe that is the moſt frequently employed in injections. All theſe mercurial injections have more or leſs of aſtringency; and, according to Dr Simmons, it is ſolely to this property that we are to aſcribe their effects; for the idea of their correcting the venereal virus was originally introduced, and has, he thinks, been continued, upon miſtaken principles.

Calomel, mixed with the mucus diſcharged in a gonorrhœa, has no more power in deſtroying the infectious properties of that mucus than ceruſſe or any other preparation would have. A diluted ſolution of ſublimate injected into the urethra, will, like a ſolution of verdigriſe, or blue vitriol, or any other ſtyptic, conſtringe the mouths of the lacunæ; but this is all that it will do, for it will never leſſen the infectious nature of the virus. The ſame thing may be obſerved of crude mercury extinguiſhed by means of mucilage, or of mercurial ointment, blended with the yolk of an egg, and which, when thrown up into the urethra, will act nearly in the ſame manner as balſam of copaiva, or any other ſtimulating injection. The ſtimulus of mercury, however, has often been found of conſiderable efficacy; and in women, when the vagina only was affected, after waſhing the parts well, the cure has been accompliſhed by rubbing them repeatedly with mercurial ointment.

As the gonorrhœa is only a local affection, it may be inferred, that the internal uſe of mercury is unneceſſary towards the cure. Very often indeed this complaint may be removed without having recourſe to mercurials. Sometimes patients have been met with whoſe general health has been greatly impaired by a long continued uſe of mercury in ſuch caſes, while the original diſeaſe, the gonorrhœa, was rendered much worſe by it. In ſome it has degenerated into a gleet, that was cured with extreme difficulty; in others it has brought on a variety of diſtreſſing ſymptoms. In caſes of gonorrhœas, therefore, whenever mercury is adminiſtered, it ought to be, not with a view to expedite the cure, but merely to obviate the dangers of ſyphilis. When the infection is apparently ſlight, and the inflammation and the ſymptoms trifling, we may proceed without the aſſiſtance of mercury, eſpecially if the patient be of a weak, relaxed, and irritable habit, likely to be injured by mercurial medicines. On the other hand, when the diſcharge is violent, the inflammation conſiderable, or the ſeat of the diſeaſe high up in the urethra, it is perhaps the moſt prudent plan to give mercurials in ſmall doſes, and in ſuch forms as ſeem the beſt adapted to the conſtitution of the patient.

The *pilulæ hydrargyri*, as prepared according to the receipts inſerted in the laſt edition either of the London or Edinburgh Pharmacopœias, in both of which the mercury is rendered active merely by triture, may perhaps be conſidered as one of the mildeſt and moſt efficacious forms under which mercury can be exhibited by the mouth. Its efficacy will depend on its not irritating the bowels, and thus paſſing off by ſtool; care muſt likewiſe be taken to prevent its affecting the mouth. Of the chemical preparations of mercury, the mildeſt and leaſt irritating is calomel. It may be given from gr. iſs. to gr. iii. at bed-time, occaſionally interpoſing a mild purgative to prevent it from ſalivating; but in general the mercurial pill juſt mentioned is to be preferred.

When there is no chancre nor bubo, no appearance in ſhort of ſyphilitic infection, it would be improper to adminiſter corroſive ſublimate, the mercurius calcinatus, or any other of the more acrid preparations of mercury.

After a gonorrhœa proceeding from venereal cauſes has been removed, another kind of running without pain, called the *gonorrhœa mucoſa*, or *gleet*, ſometimes remains. Sometimes it ariſes from a conſtriction and excoriation of the urethra, and frequently it is the effect of an enlargement and diſeaſed ſtate of the proſtate. In each of theſe caſes, as the gleet is the effect of irritation, the cure will depend on the removal of the local diſeaſe that occaſions it. But there is another ſpecies of gleet that ſeems to depend chiefly on relaxation. It is in general free from infection, and is moſt common in thoſe who have had long and frequent gonorrhœas. It is likewiſe often the effect of a debilitated habit, from ſevere purging, or a long continued uſe of mercurials. A diſcharge of this kind is more frequent in women than in men; or, at leaſt, the fluor albus, after a gonorrhœa, will often be miſtaken for a gleet.

When there is no reaſon to ſuſpect remaining contagion, aſtringent injections will be of the greateſt ſervice. It will be neceſſary, at the ſame time, to attend to the health of the patient, by employing cinchona, chalybeate waters, cold bathing, and ſuch other remedies as will tend to ſtrengthen the ſyſtem: and indeed by the uſe of theſe, particularly by the cinchona, ſuch runnings are often ſucceſsfully combated in thoſe who from apprehenſion of dangerous conſequences cannot be prevailed upon to employ injections. When there is no tendency to inflammation, the balſam of copaiva may be preſcribed with advantage in large doſes. Dr Simmons ſays he once ſaw a complaint of this ſort removed by applying a bliſter to the perinæum, after it had reſiſted a variety of other remedies. In the Medical Obſervations alſo we have an account of a gleet and incontinence of urine removed at once by a bliſter to the os ſacrum. In general, however, the other methods above mentioned will be ſufficient to remove it, though ſometimes it will continue for a long time in ſpite of all our endeavours to check it.—Other kinds of gonorrhœa, in which the ſemen itſelf is ejected, eſpecially during ſleep, may be cured by tonics and a mild cooling regimen.

ORDER V. EPISCHESES. 392

GENUS CXXII. OBSTIPATIO. 393

COSTIVENESS.

Obſtipatio, *Lin.* 166. *Vog.* 128. *Sag.* 221.

Coſtiveneſs is ſometimes occaſioned by debility in dyſpeptic perſons, ſometimes it is the effect of rigidity, and ſometimes it is ſymptomatic of the colic. It may proceed from an affection of the liver; drinking rough red wines, or other aſtringent liquors; too much exerciſe, eſpecially on horſeback: it may likewiſe proceed from a long uſe of cold inſipid food, which does not ſufficiently ſtimulate the inteſtines. Sometimes it is owing to the bile not deſcending to the inteſtines, as in the jaundice; and at other times it proceeds from diſeaſes of the inteſtines themſelves, as a palſy, ſpaſms, tumors, &c.

Exceſſive coſtiveneſs is apt to occaſion pains of the head, vomiting, colics, and other complaints of the bowels. It is peculiarly hurtful to hypochondriac and hyſteric perſons, as it generates wind and other diſtreſſing ſymptoms.

Perſons who are generally coſtive ſhould live upon a moiſtening and laxative diet; as roaſted or boiled apples, pears, ſtewed prunes, raiſins, gruels with currants, butter, honey, ſugar, and ſuch like. Broths with ſpinage, leeks, and other ſoft pot-herbs, are likewiſe proper. Rye-bread, or that which is made of a mixture of wheat and rye together, ought to be eaten. No perſon troubled with coſtiveneſs ſhould eat white bread alone, eſpecially that which is made of fine flour: The beſt bread for keeping the belly ſoluble is what in ſome parts of England they call *meſlin*. It is made of a mixture of wheat and rye, and is very agreeable to thoſe who are accuſtomed to it.

Coſtiveneſs is increaſed by keeping the body too warm, and by every thing that promotes the perſpiration; as wearing flannel, lying too long in bed, &c. Intenſe thought, and a ſedentary life, are likewiſe hurtful. All the ſecretions and excretions are promoted by moderate exerciſe without doors, and by a gay, cheerful, ſprightly temper of mind.

The drink ſhould be of an opening quality. All ardent ſpirits, auſtere and aſtringent wines, as port, claret, &c. ought to be avoided. Malt liquor that is fine and of a moderate ſtrength is very proper. Butter-milk, whey, and other watery liquors, are likewiſe proper, and may be drank in turns, as the patient's inclination directs.

Thoſe who are troubled with coſtiveneſs ought, if poſſible, to remedy it by diet, as the conſtant uſe of medicines for that purpoſe is attended with many inconveniences, and often with bad conſequences. In time the cuſtom becomes neceſſary, and generally ends in a total relaxation of the bowels, indigeſtion, loſs of appetite, waſting of the ſtrength, and death.

The learned Dr Arbuthnot adviſes thoſe who are troubled with coſtiveneſs to uſe animal oils, as freſh-butter, cream, marrow, fat broths, &c. He likewiſe recommends the expreſſed oils of mild vegetables, as olives, almonds, piſtaches, and the fruits themſelves; all oily and mild fruits, as figs; decoctions of mealy vegetables; theſe lubricate the inteſtines; ſome ſaponaceous ſubſtances which ſtimulate gently, as honey, hydromel, or boiled honey and water, unrefined ſugar, &c. are uſeful.

The doctor obſerves, that ſuch lenitive ſubſtances are proper for perſons of dry atrabilarian conſtitutions, who are ſubject to aſtriction of the belly and the piles, and will operate when ſtronger medicinal ſubſtances are ſometimes ineffectual; but that ſuch lenitive diet hurts thoſe whoſe bowels are weak and lax. He likewiſe obſerves, that all watery ſubſtances are lenitive; and that even common water, whey, ſour milk, and butter-milk, have that effect:—That new milk, eſpecially aſſes milk, ſtimulates ſtill more when it ſours on the ſtomach; and that whey, turned ſour, will purge ſtrongly:—That moſt part of fruits are likewiſe laxative; and that ſome of them, as grapes, will throw ſuch as take them immoderately, into a cholera morbus, or incurable diarrhœa.

When the body cannot be kept open without medicine, gentle doſes of rhubarb may be taken twice or thrice a-week. This is not near ſo injurious to the ſtomach as aloes, jalap, or the other draſtic purgatives ſo much in uſe. Infuſions of ſenna and manna may likewiſe be taken, or half an ounce of tartariſed alkali diſſolved in water gruel. About the ſize of a nutmeg of lenitive electuary taken twice or thrice a-day, generally anſwers the purpoſe very well.

394 GENUS CXXIII. ISCHURIA.

SUPPRESSION of *Urine*.

Iſchuria, *Sauv.* gen. 293. *Lin.* 167. *Vog.* 129. *Sag.* 212. *Home's* Clinical Experiments, ſect. xv.

This diſeaſe is diſtinguiſhed into various ſpecies, according as the ſeat of it is in the kidneys, the ureters, the bladder, or the urethra; and hence theſe ſpecies are named *renalis*, *ureterica*, *veſicalis*, and *urethralis*.

395 1. *Iſchuria renalis*, or a ſuppreſſion of urine from an affection of the kidneys, happens but rarely; however, Dr Home in his Clinical Experiments deſcribes ſuch a caſe. In the end of December 1774, a man of a full habit, aged 35, was ſeized with ſhivering, coldneſs, and ſevere cough. Three days after, his urine appeared high-coloured, was paſſed with pain, and in ſmall quantity. About the 8th of January 1775, he was attacked with violent pains in the ſmall of his back, over the whole abdomen, and in the ankles, with pain in the region of the liver when preſſed. A general ſwelling was afterwards obſerved all over the body, but chiefly in the ankles and abdomen, which laſt was tenſe and hard. Theſe were attended with vomiting, bad appetite, and conſiderable thirſt. When he entered the clinical ward (January 21ſt), the cough, ſickneſs, and vomiting, had gone off, but the ſuppreſſion of urine remained. The little which he made was paſſed with his ſtools, ſo that Dr Home ſaw it but once; and then it was pale, and had a white powder at bottom. The pains and ſwellings, which retained the impreſſion of the finger, continued; he had a headach, and a very ſlow pulſe, beating only 48 ſtrokes in a minute. He had taken a great many diuretic medicines before his admiſſion. The day after his reception, he was ſeized with a ſpontaneous diarrhœa, which continued during the remainder of his life. Cryſtals of tartar were exhibited in doſes of half an ounce each morning; at bed-time he took 20 drops of tincture of opium with a ſcruple of nitre, and continued this courſe for eight days without any increaſe of urine. The ſtronger and heating diuretics were then tried, as an infuſion of juniper berries and pills of garlic; but they were attended with no ſenſible advantage. Whenever the pulſe became ſo ſtrong that he could bear bleeding, eight ounces of blood were taken away, which was ſizy. This was thrice repeated; he appeared eaſier after each bleeding, his pulſe bore it well, and the ſwellings and other ſymptoms abated. The heating diuretics, in this ſtate, were given up; and a mixture of vinegar and nitre was ſubſtituted in their place, in each doſe of which, taken every two hours, there was a ſcruple of nitre. Fomentations were applied to the region of the kidneys, and camphorated oil was afterwards rubbed on the part. He was ordered the ſemicupium, which from a deficiency of water in the hoſpital at that time he got only once; and which then ſeemed to have a good effect, as he paſſed a gill of urine when he was in it. Notwithſtanding this, however, the diſeaſe continually gained ground; he became comatoſe, delirious, and died ten days after his admiſſion. On diſſection, the kidneys were found of an irregular form; ſome watery veſicles appeared on their ſurface, containing black gritty particles like fine ſand; and the lower part of the right kidney was conſiderably inflamed. The pylorus, part of the duodenum, and a conſiderable part of the ſmall inteſtines, were much inflamed. In the abdomen were found about five pounds of fluid, and in the cavities of the thorax about half a pound.

The lungs were a little inflamed, and full of ſmall tubercles on their ſurface and in their ſubſtance: the heart was large, and a polypus in each ventricle. About ſix ounces of fluid were found in the pericardium: in the brain nothing preternatural appeared, except about an ounce of water in each ventricle.

Dr Home ſeems to have been at a loſs for the remote cauſe of this ſuppreſſion of urine, which manifeſtly had its immediate origin from the kidneys having loſt the power of performing their functions. He thinks the inflammation which appeared in the right kidney was ſcarce ſufficient to have occaſioned the diſtemper, as the other would have ſupplied its place: for which reaſon alſo he thinks that the iſchuria was owing to a general affection of the ſyſtem; and that it was of an arthritic nature, the patient having been troubled with complaints of that kind for a long time before.

396 2. The *iſchuria ureterica* is alſo a rare diſeaſe, unleſs the obſtruction proceeds from a ſtone or clot of blood ſtopping up the paſſage. Gravel or ſtones, indeed, are very frequently formed in the kidneys; and, by falling into the ureters, occaſion an iſchuria, with violent pain, and ſymptoms more or leſs urgent in proportion to the ſize and ſhape of the ſtones. Sometimes it is attended with coldneſs of the extremities, nauſea, vomiting, and ſpaſtic conſtriction of the præcordia, a difficulty of making water, conſtipation of the belly, difficulty of breathing, ſtupor of the thigh, retraction of the teſticle, inquietude, loſs of ſtrength, ſyncope, and convulſion fits. When the violent pain has continued for ſeveral days and nights without intermiſſion, and has brought the patient exceeding low, and the ſuppreſſion of urine is complete, with coldneſs of the extremities and convulſions of the tendons, death is at hand. Nor is it a good ſign when the ſtone continues long in the ureter; for then the appetite decays, a nauſea and retching to vomit ſupervene, and the patient is conſumed with a hectic heat. Sometimes the pain is attended with an inflammation of the ſtomach and inteſtines; and ſometimes the diſeaſe ends in a dropſy of the breaſt, or lethargy, which ſoon carry off the patient.

The indications of cure are, to exclude the ſtone as eaſily as poſſible, and prevent the breeding of others. If the patient be of a ſanguineous temperament, Sydenham recommends to take away ten ounces of blood from the affected ſide; and then to give the patient a gallon of poſſet-drink in which two ounces of marſhmallow roots have been boiled, injecting at the ſame time an emollient glyſter. After the poſſet drink has been vomited up, and the clyſter returned, give a pretty large doſe of an opiate. But if the patient be old or weak, or ſubject to nervous affections, bleeding may be omitted, eſpecially if his urine at the beginning of the fit be coffee-coloured, and mixed with gravel; but as to other things, the cure is the ſame.—Huxham highly recommends an emollient bath prepared of a decoction of marſh-mallow root, lintſeed, fœnugreek ſeed, and flowers of chamomile, to which may be added a few white poppy ſeeds. By the uſe of this bath he ſays he has ſeen the moſt cruel fit of the gravel ſuddenly ended, when neither copious bleeding nor opiates had the leaſt effect. Mild diuretics are alſo of ſervice. Hoffman recommends dulcified ſpirit of nitre as proper to relax the ſpaſtic ſtricture. It is to be taken with ſuitable diſtilled waters and ſyrup of poppies; or in broth, with a few ſpoonfuls of oil of ſweet almonds. Turpentine glyſters are alſo accounted very ſerviceable; and may be prepared with ten ounces of a decoction of chamomile, with half an ounce of turpentine diſſolved in the yolk of an egg, and about as much honey. The *ſal diureticus*, or *acetis potaſſæ*, is much eſteemed by ſome, when taken along with an opiate. But when the ſtone is too big to paſs, Arbuthnot recommends a cool and diluent diet to hinder the further growth of it. Whey, infuſion of lintſeed, decoction of marſhmallows, and gently reſolving diuretics, are alſo proper. To put a ſtop to the vomiting, the compound tincture of benzoin, formerly named *balſamum traumaticum*, has ſometimes been uſed with ſucceſs, when almoſt every other means have failed.

3. The *iſchuria veſicalis* may ariſe from a ſtone in 397 the bladder; and this indeed is the moſt common cauſe of it: but there are certain caſes, in which, though the uſual quantity of urine, or perhaps more, be paſſed, the patient dies from the retention of a ſtill greater quantity in the bladder. Of this Dr Home gives the following inſtances. A man of 58 years of age, of a ſtrong ſpare habit, and never ſubject to the gravel, had, during the winter of 1777, a cough with expectoration, which went off in the beginning of 1778. About the 17th of February 1778 he felt ſome difficulty in paſſing his urine, and much pain about the region of the bladder. He continued in this way for ten days, after which he became eaſier on application of ſome medicines. The abdomen then ſwelled, and he had pains in his loins and thighs. On the 3d of March he was admitted into the clinical ward: his abdomen was then ſwelled and tenſe; and an evident fluctuation was felt, which ſome that touched him thought was ſonorous and produced by wind. A tumor was diſcovered between the navel and ſpine of the os ilium on the left ſide, which gave him much pain, eſpecially when preſſed. This tumor became more eaſily felt after the ſwelling of the abdomen decreaſed, ſeemed round, and very near as large as the head of a child. It appeared very much on the left ſide, even when the patient lay on the right, and it then became dependent. He paſſed urine frequently, and rather more than in health, as it was computed at four pints a-day. It was always clear, and of a light colour. His body had a ſtrong diſagreeable ſmell; his ſkin was dry, belly bound, and his appetite entirely gone, ſo that he had hardly taken any food for 12 days. His legs ſwelled ſlightly for ſome days in the evening. His pulſe was generally regular, ſometimes ſlower than natural, and ſometimes a little quicker; being once felt at 64, and another time at 92. He was often ſeized, eſpecially after eating or drinking, with hiccough; which increaſed and laſted till his death. On the 20th day of his diſeaſe, after ſome doſes of ſquills, the general ſwelling of his abdomen fell, became much ſofter, and more diſtinctly diſcovered the ſwelling of the left ſide. The next day a vomiting came on; he became delirious, and died the day following. The body being opened, it appeared that the tumor which was ſo diſtinctly felt on the left ſide of the abdomen, was owing to a diſtenſion of the bladder with urine. Its fundus reached to about the diviſion of the aorta into the

Epiſcheſis.

the iliacs; it entirely filled the pelvis, and contained between five and ſix pounds of urine of a pale colour. On examining the external ſurface, its neck, and the beginning of the urethra, were found to be ſurrounded with a ſcirrhoſity, which impeded the evacuation of the urine. The bladder itſelf was much thickened, but not more in one part than another. The ureters entered naturally; but were much thickened in their upper half near the kidney. The kidneys were ſomewhat enlarged; particularly the left, which had ſeveral watery veſicles on its external ſurface. Theſe organs were not in their uſual ſituation; but lay cloſe on each ſide of the ſpine, and very near the aorta; ſo that the renal veſſels were very ſhort. What was very ſingular, the lower end of each aroſe over the ſpine, and they were united together by their membranes, the aorta paſſing beneath the union. The bladder had preſſed conſiderably on this part; and the peritoneum covering them was conſiderably thicker than natural. The lungs adhered every where to the pleura, and in ſome places very firmly: they were of a looſe texture and black colour; and the veins of the lower extremities were turgid with blood. It does not appear that this patient got any medicines farther than a few dried ſquills, which diminiſhed the ſwellings and brought off much wind. He alſo got a mixture of muſk, and afterwards of opium, for his hiccough; but without ſucceſs. His diſeaſe was miſtaken for an aſcites; and the catheter was not tried: but in another caſe the uſe of this inſtrument was apparently of more ſervice than any internal medicines. This laſt patient was about 90 years of age, and laboured under ſymptoms very ſimilar to thoſe already mentioned. When admitted into the clinical ward, he had the hypogaſtric region ſwelled, and difficulty of paſſing his water; but without pain, vomiting, or hiccough. He had loſt all appetite; was thirſty, and coſtive. His pulſe was 110, and weak. In the evening about three Engliſh pints of pale clear urine were drawn off by means of the catheter: the next day all the ſymptoms were gone off or abated. After this he continued to paſs ſome urine, ſometimes voluntarily, ſometimes involuntarily and inſenſibly; but ſo much always remained behind, that his bladder was conſtantly full, unleſs when the urine was drawn off, which was done twice every day. The urine was ſometimes pale, ſometimes of a deep red colour; and once there was ſome blood mixed with it, which perhaps might have been occaſioned by the catheter. About the ſixth day the urine was very putrid, with much purulent like matter at the bottom, and was paſſed with more pain. About the 11th, the putrid ſmell went off. The next day all the urine paſſed inſenſibly except what was drawn off; and an hiccough, though not very ſevere, had come on. In this way he continued without fever, though frequently troubled with the hiccough, eſpecially during thoſe nights in which the urine had not been drawn off. A month after admiſſion, the bladder, with the aſſiſtance of the catheter, was almoſt entirely, though inſenſibly evacuated, and the hiccough had left him; he had no other complaint but that of voiding his urine inſenſibly, the natural effect of a ſcirrhous bladder, and which was probably incurable. With this patient the hot bath and mercurials were tried, in order to ſoften the ſcirrhoſity of the bladder, but without effect.

Iſchuria.

398 4. The *iſchuria urethralis* ariſes from ſome tumor obſtructing the paſſage of the urethra, and thus hindering the flow of urine. It is no uncommon diſtemper, and often follows a gonorrhœa. Dr Home gives us an example of this alſo.—The patient was a man of 60 years of age, who had laboured under a gonorrhœa ſix months before, and which was ſtopped by ſome medicines in two or three days. He felt, ſoon afterwards, a difficulty in paſſing his urine, which gradually increaſed. About 10 days before his admiſſion into the clinical ward, it was attended with pains in the glans, and *ardor urinæ;* he had paſſed only about eight ounces the day before his admiſſion, and that with very great difficulty; and the hypogaſtric region was ſwelled and pained. On introducing the catheter, three pounds of urine were drawn off, by which the pain and ſwelling were removed. The inſtrument required force to make it paſs the neck of the bladder, and blood followed the operation; and the finger, introduced into the anus, felt a hard tumor about its neck. He was treated with mercurial pills and ointment, by which the ſwelling about the neck of the bladder ſoon began to decreaſe; but at the ſame time a ſwelling of the right teſticle appeared. He was vomited with four grains of turbith-mineral, the *ſubſulphas hydrargyri flavus* of the preſent pharmacopœia, which operated gently; and here Dr Home obſerves, that though theſe vomits are little uſed, from a miſtaken notion of their ſeverity, he never ſaw them operate with more violence than other vomits, or than he could have wiſhed. The ſwelling diminiſhed in conſequence of the emetic and ſome external applications; and the cure was completed by bleeding and a decoction of mezereon root.

GENUS CXXIV. DYSURIA. 399

DIFFICULTY of DISCHARGING URINE.

Dyſuria, *Sauv.* gen. 265. *Lin.* 57. *Vog.* 164. *Sag.* 213.
Stranguria *auctorum.*

A difficulty of making water may ariſe from many different cauſes; as from ſome acrid matter in the blood, cantharides, for inſtance: and hence a ſtrangury very often ſucceeds the application of bliſters. In many caſes it ariſes from a compreſſion of ſome of the neighbouring parts; of the uterus, for inſtance, in a ſtate of pregnancy. Or it may ariſe from a ſpaſmodic affection of the bladder, or rather its ſphincter; or from an inflammation of theſe parts, or others near them. Hence the diſeaſe is diſtinguiſhed into ſo many ſpecies, the cure of which is to be attempted by remedies indicated by their different cauſes.

But the moſt common, as well as the moſt dangerous ſpecies is that ariſing from a calculous concretion, or

STONE in the BLADDER. 400

Dyſuria calculoſa, *Sauv.* ſp. 12.

The ſigns of a ſtone in the bladder are, pain, eſpecially about the ſphincter; and bloody urine, in conſequence of riding or being jolted in a carriage; a ſenſe of weight in the *perinæum;* an itchineſs of the *glans penis;* ſlimy ſediment in the urine; and frequent ſtoppages in making water; a *teneſmus* alſo comes on while the urine is diſcharged: but the moſt certain ſign is, when the ſtone is felt by the finger introduced into the anus, or by ſounding.

Cauſes, &c. It is not eaſy to ſay what the particular cauſes are which occaſion the apparently earthy particles of the fluids to run together, and form thoſe calculous concretions which are found in different parts of the body, and eſpecially in the organs for ſecreting and diſcharging the urine.

The gout and ſtone are generally ſuppoſed to have ſome affinity, becauſe gouty people are for the moſt part afflicted with the gravel. But perhaps this is in part owing to their long confinement, and to lying on the back, which people who labour under the gout are often obliged to ſubmit to; ſince the want of exerciſe, and this poſture, will naturally favour the ſtagnation of groſs matters in the kidneys: beſides, there are many inſtances of people ſeverely afflicted with the ſtone for the greateſt part of a long life, who have never had the leaſt attack of the gout.

There is, however, good reaſon for believing, that ſome farther connection takes place between the two diſeaſes; and when treating of the gout we have already given ſome account of the opinion of an ingenious anonymous author, who has endeavoured to prove, that both the one and the other depend on a peculiar acid, the concreting, lithic, or uric acid, which is always preſent in blood; and which may be precipitated from thence by various cauſes, ſuch as the introduction of other acids, or the like. When thus precipitated, he ſuppoſes it to produce the whole phenomena of both diſeaſes. The objections we formerly ſtated to his theory of gout, do not equally militate againſt that of calculus; and it is at leaſt certain, from the beſt chemical analyſis, that what are commonly called *urinary calculi*, and have been conſidered as entirely an earthy matter, conſiſt principally of acid in a ſolid ſtate united only with a ſmall proportion of earth or mucus. We may, therefore, whether this hypotheſis be altogether well founded or not, juſtly view lithiaſis as depending, in a great meaſure, on the ſeparation of an acid from the blood.

Whatever may be the particular cauſe of the diſpoſition to *lithiaſis*, the kidneys appear to be the moſt likely places for particles to concrete or run together, becauſe of the great quantity of blood which paſſes through the renal arteries, and which comes immediately from the heart, fraught with various newly-received matters, that have not undergone much of the action of the veſſels, and therefore cannot as yet be ſuppoſed to be thoroughly aſſimilated.

Anatomiſts who have carefully examined the kidneys in the human ſubject, particularly M. Bertin, inform us, that there are two ſets of *tubuli uriniferi;* the one continued directly from the extremities of the renal artery, and the other ſpringing from that veſicular texture which is conſpicuous in the kidneys.

It is in this veſicular part of the kidney that we preſume the particles of the concreting matter firſt ſtagnate and coaleſce: for it is hardly to be ſuppoſed, that ſuch ſolid matters could be allowed to ſtop in the extremities of the renal arteries, ſince the blood, and the urine ſeparated from it, muſt flow through theſe veſſels with great degrees of force and velocity; but in the intermediate veſiculæ the particles may lie, and there attracting each other, ſoon come to acquire ſenſible degrees of magnitude, and thus become ſand or gravel. As long as this ſand or gravel formed in the veſicular part of the kidney lies quiet, there will be no pain or uneaſineſs, until the concretions become large enough to preſs either on the adjoining *tubuli*, or on the blood-veſſels; then a ſenſe of weight, and a kind of obtuſe pain in the loins, will be felt. But when the ſmall pieces of concreting matter ſhall be diſlodged and waſhed off by the force of the circulating fluids, or looſened by ſome ſpaſmodic action of the moving fibres in theſe parts, they will in their paſſage create pain, raiſe different degrees of inflammation, or perhaps lacerate ſome blood-veſſels, and cauſe bloody urine. When theſe little concretions happen to be detained in the pelvis of the kidney, or any other place where a flow of urine continually paſſes, they ſoon increaſe in ſize, and become calculi, from the conſtant acceſſion of particles, which are attracted by the original bit of ſand, which thus becomes the nucleus of a ſtone.

It is an opinion which Hippocrates firſt advanced, and which has been almoſt univerſally adopted by his followers, and has remained till lately uncontroverted, that the ſtone and gravel are generated by the uſe of hard water. From the quality, which the waters of certain ſprings poſſeſs, of depoſiting a large earthy ſediment, either in the aquæducts through which they are conveyed, or in the veſſels in which they are boiled or preſerved, it was conjectured, that in paſſing through the kidneys, and eſpecially whilſt retained in the bladder, they would let fall their groſſer particles, which by the continued appoſition of freſh matter, connected by the animal gluten, and compacted by the muſcular action of that organ, would in time form a calculus ſufficiently large to produce a train of the moſt excruciating ſymptoms. And this reaſoning *à priori* has been ſuppoſed to be confirmed by facts and experience; for not to mention the authority of Hippocrates, Dr Liſter has obſerved, that the inhabitants of Paris are peculiarly ſubject to the ſtone in the bladder. Nicholas de Blegny has related the hiſtory of one who was diſſected at Paris, in whom the pylorus, a great part of the duodenum, and the ſtomach itſelf, were found incruſtated with a ſtony matter, to the thickneſs of a finger's breadth. And it is well known, that the water of the river Seine, with which that city is ſupplied, is ſo impregnated with calcareous matter, as to incruſtate, and in a ſhort time to choak up, the pipes through which it runs. But on the other hand it is objected, that the human calculus is of animal origin, and by chemical analyſis appears to bear very little analogy to the ſtony concretions of water: and though it be allowed, that more perſons are cut for the ſtone in the hoſpitals at Paris than in moſt other places; yet upon inquiry it is found, that many of thoſe patients come from different provinces, and from towns and villages far diſtant from the Seine.

Dr Percival conjectures, that though this diſeaſe may chiefly depend upon a peculiar diſpoſition to concrete in the animal fluids, which in many inſtances is hereditary, and in no inſtance can with certainty be imputed to any particular cauſe; yet hard water is at leaſt negatively favourable to this diatheſis, by having no tendency to diminiſh it. The urine of the moſt healthy perſon is generally loaded with an apparently terreous matter, capable in favourable circumſtances of forming a calculus; as is evident from the thick cruſt which it depoſits on the ſides of the veſſels in which it is contained. And it ſeems as if nature intended by this excretion to diſcharge all the ſuperfluous ſalts of the blood, together with thoſe earthy particles, which are either derived from our aliment, and fine enough to paſs through the lacteals, though inſuperable by the powers of circulation, or which ariſe from the abraſion of the ſolids, or from the diſſolution of the red globular part of our fluids. Now water, whether uſed as nature preſents us with it, or mixed with wine, or taken under the form of beer or ale, is the great diluter, vehicle, and menſtruum, both of our food, and of the ſaline, earthy, and excrementitious parts of the animal juices. And it is more or leſs adapted to the performance of theſe offices, in proportion to its degree of purity. For it muſt appear evident to the moſt ordinary underſtanding, that a menſtruum already loaded, and perhaps ſaturated with different contents, cannot act ſo powerfully as one which is free from all ſenſible impregnation. Nor is this reaſoning founded upon theory alone; for it is obſerved, that Malvern water, which iſſues from a ſpring in Worceſterſhire remarkable for its uncommon purity, has the property of diſſolving the little ſabulous ſtones which are often voided in nephritic complaints. And the ſolution too, which is a proof of its being complete, is perfectly colourleſs. Hence this water is drunk with great advantage in diſorders of the urinary paſſages. And during the uſe of it, the patient's urine is generally limpid, and ſeldom depoſits any ſandy ſediment. Yet notwithſtanding this appearance of tranſparency, it is certainly at ſuch times loaded with impurities, which are ſo diluted and diſſolved as not to be viſible. For it is attended with a ſtrong and fetid ſmell, exactly reſembling that of aſparagus. Hoffman mentions a pure, light, ſimple water in the principality of Henneberg, in Germany, which is remarkable for its efficacy in the ſtone and gravel; and a water of ſimilar virtues was diſcovered not many years ago in the Black foreſt, near Oſterod, which upon examination did not afford a ſingle grain of mineral matter. Indeed it is worthy of obſervation, that moſt of the ſprings which were formerly held in great eſteem, and were called *holy wells*, are very pure, and yield little or no ſediment.

Dr Percival informs us that a gentleman of Mancheſter, who had been long ſubject to nephritic complaints, and often voided ſmall ſtones, was adviſed to refrain from his own pump-water, which is uncommonly hard, and to drink conſtantly the ſoft water of a neighbouring ſpring; and that this change alone, without the uſe of any medicine, has rendered the returns of his diſorder much leſs frequent and painful. A lady alſo, much affected with the gravel, was induced by the peruſal of the firſt edition of Dr Percival's Eſſay, to try the effect of ſoft water; and by the conſtant uſe of it remained two years entirely free from her diſorder.

In nephritic caſes, diſtilled water would be an excellent ſubſtitute for Malvern water, as the following experiment evinces.

Two fragments of the ſame calculus, nearly of equal weight, were immerſed, the one in three ounces of diſtilled water, the other in three ounces of hard pump-water. The phials were hung up cloſe together in a kitchen-chimney, at a convenient diſtance from the fire. After 14 days maceration, the calculi were taken out, and carefully dried by a very gentle heat. The former, viz. that which had been immerſed in diſtilled water, was diminiſhed in its weight a grain and a half; the latter had loſt only half a grain.

It is the paſſage of theſe calculi from the kidneys down into the bladder, which occaſions the pain, vomiting, and other ſymptoms, that conſtitute what is uſually termed a *fit of the gravel* or *ſtone*.

When an inflammation is actually raiſed, the diſeaſe is known by the name of *nephritis*, and has been already treated of.

As ſoon as the ſtone paſſes through the ureter, and falls into the bladder, the pain and other nephritic ſymptoms ceaſe; and every thing will remain quiet, either till the ſtone be carried into the urethra, or until it has remained long enough in the bladder to acquire weight ſufficient to create new diſtreſs.

If a ſtone happen to be ſmooth and of a roundiſh form, it may lie in the bladder and acquire conſiderable bulk before it can be perceived by the patient; but when it is angular, or has a rugged ſurface, even though it may be ſmall in ſize, yet it ſeldom fails to raiſe pain, and occaſion bloody urine, or the diſcharge of a ſlimy fluid, with teneſmus, and difficulty in making water.

There have been various attempts made to diſſolve the ſtone; and there are certainly ſome articles which have this effect when applied to them out of the body; but the almoſt total impoſſibility of getting theſe conveyed to the kidneys, renders it extremely doubtful whether a ſolvent ever will be diſcovered. Of all the articles employed for this purpoſe, no one perhaps has had greater reputation than fixed alkaline ſalt in its cauſtic ſtate, particularly under the form of the *lixivium cauſticum*, or *aqua potaſſæ*, as it is now called: but this being of a very acrid nature, it requires to be well ſheathed by means of ſome gelatinous or mucilaginous vehicle. Veal-broth is as convenient as any for this purpoſe; and accordingly it is uſed by thoſe who make a ſecret of the cauſtic alkali as a ſolvent of calculus.

Mr Blackrie, who has taken much pains in this inquiry, has proved very ſatisfactorily, that Chittrick's noſtrum is no other than ſoap-lees given in veal-broth, which the patients ſend every day to the doctor, who returns it mixed up with the medicine, in a cloſe veſſel ſecured by a lock.

It is not every caſe, however, that either requires or will bear a courſe of the cauſtic alkali. Some calculi are of that ſoft and friable nature, that they will diſſolve even in common water; and there are caſes wherein it appears that the conſtant uſe of ſome very ſimple decoction or infuſion of an inſignificant vegetable, has brought away large quantities of earthy matter, in flakes which apparently have been united together in layers to form a ſtone. Dr Macbride aſſures us, that a decoction of raw coffee, only 30 berries in a quart of water, boiled till it acquired a deep greeniſh colour, taken morning and evening to the quantity of eight or ten ounces, with ten drops of ſweet ſpirit of nitre, had the powerful effect of bringing away, in the courſe of about two months, as much earthy matter in flakes as filled a large tea cup. The patient was far advanced in years; and, before he began this decoction, had been reduced to great extremities by the continuance of pain and other diſtreſſing ſymptoms: he was purged occaſionally with *oleum ricini.*

Very lately the alkali in a mild ſtate, and in a different form, has been much uſed by many calculous patients, and with great advantage, under the form of what is called *alkaline aërated water*, the aqua ſupercarbonatis potaſſæ of the preſent edition of the Edinburgh Pharmacopœia. For the introduction of this medicine, or at leaſt for its extenſive uſe, we are chiefly indebted to that ingenious phyſician Dr William Falconer of Bath. He has lately publiſhed an account of the *Aqua Mephitica Alkalina*, or ſolution of fixed alkaline ſalt, ſaturated with fixable air, in calculous diſorders; which contains a number of caſes ſtrongly ſupporting the benefit to be derived from it. But whether the good effects obtained in theſe inſtances are to be explained from its operating as a ſolvent of calculus, ſeems to be extremely doubtful. There are indeed caſes in Dr Falconer's treatiſe, of patients in whom, after uſing it for a conſiderable time, no ſtone could be detected by ſounding, although it had been diſcovered in that way before they began the employment of it. But in many inſtances, the relief has been ſo ſudden, that it may be concluded, that, notwithſtanding the eaſe obtained, the calculus ſtill remained. In ſuch caſes, it probably removed from the urine that quality by which it gives to the calculus freſh accretions, producing that roughneſs of its ſurface by which it is chiefly capable of acting as a ſtimulus. For the diſtreſſing ſymptoms reſulting from ſtone are chiefly to be attributed to the inflammatory and ſpaſmodic affections which it induces; and when its ſurface is leaſt capable of operating as a ſtimulus, theſe of courſe will be leaſt conſiderable. It is therefore not improbable, that this remedy produces relief, by preventing freſh additions being made to the calculus.

An infuſion of the ſeeds of *daucus ſylveſtris* ſweetened with honey, is another ſimple and much celebrated remedy; it has been found to give conſiderable eaſe in caſes where the ſtomach could not bear any thing of an acrid nature. The leaves of the *uva urſi* were ſtrongly recommended by the late celebrated De Haen; and this, whatever its way of operating may be, ſeems to have been productive of good effects in ſome inſtances. There is no reaſon to believe that it has any influence in diſſolving calculus; and indeed it ſeems to be chiefly uſeful in theſe inſtances where ulcerations take place in the urinary paſſages.

In the Edinburgh Medical Commentaries, vol. iii. we have an account of a method uſed by the inhabitants of Arabia Petræa for curing the ſtone, to which they are very much ſubject, and which the author (an Engliſh gentleman of experience and candour) affirms he has ſeen frequently performed with ſucceſs. By means of a catheter, they inject into the bladder a weak ley of alkali with the purified fat of a ſheep's tail, and a proper quantity of opium, all put together. Their catheters are made of gold; and in performing the operation they introduce them quite into the bladder; ſo that the compoſition is ſafely conveyed to the ſtone without hurting any other part. But when a ſtone is ſituated in the kidney, they have no method of cure.

If this method of curing by injection could be ſafely practiſed, it would no doubt have the advantage over that of taking alkalies by the mouth, where the medicine is not only much weakened, but the conſtitution of the patient runs the riſk of being greatly injured. But from ſome experiments mentioned in the ſecond volume of the Medical Tranſactions, and ſtill more from the chemical analyſis of urinary concretions, lately publiſhed by Fourcroy and other modern chemiſts, it appears that the human calculi are very different from one another in their natures. Some, for inſtance, will eaſily yield to an alkaline menſtruum, and very little to an acid; while others are found to reſiſt the alkali, and yield to the acid; and ſome are of ſuch a compact nature, that they yield neither to acids nor alkalies. An attention, however, to the fragments, ſcales, or films, which the ſtone may caſt off, and alſo to the contents and ſediment of the urine, may lead to the diſcovery of what ſolvent is proper, or whether the ſtone can be diſſolved by any. To uſe either alkalies or acids improperly may be hurtful; though there may be ſuch kinds of calculi as demand the alternate uſe of acids and alkalies; nay, there may be found calculi of oppoſite kinds in the ſame ſubject.

In ſuch caſes as will not allow us to think of diſſolving the ſtony concretions, and where the only object is to palliate and procure eaſe from time to time, little more can be done than to keep the bowels open occaſionally by ſome gentle cathartic, and waſh off as much of the looſe gravelly matter and ſlime as can be removed by ſuch mild diuretic infuſions and decoctions as ſhall be found to paſs freely and ſit well on the ſtomach. Perſons afflicted with the ſtone ſhould be careful in reſpect of their diet, and ſtudiouſly avoid all heavy and flatulent food, as well as high ſauces that are apt to turn rancid. For the ſame reaſon, butter and acids are to be ſhunned; for theſe often create heart-burning, and every thing that offends the ſtomach raiſes the nephritic pain; ſuch is the ſympathy that obtains between the digeſtive and the uropoietic organs.

There have been ſurgeons bold enough to entertain an idea of cutting even into the kidney, in order to extract a ſtone: this, however, except in caſes where an abſceſs has been formed, and nature points out the way, is both very uncertain and very hazardous. But cutting into the bladder for the ſame purpoſe, is an ancient and well known operation, and often crowned with ſucceſs. A deſcription, however, of this operation belongs to the article SURGERY, to which we refer; and here ſhall only make this remark, that a ſurgeon ſhould never begin his operation, until he and his aſſiſtants are perfectly ſatisfied, from actually feeling the ſtone, that there is one in the bladder; becauſe it has ſometimes happened, that when the inciſion has been made, no ſtone could be found: and the patient having died in conſequence of the operation, and the body being opened, it has appeared that the ſymptoms which occaſioned the belief of a ſtone in the bladder aroſe from ſome other cauſe.

When a dyſuria proceeds from any acrimonious matter thrown into the blood, it may be readily cured by bleeding, emollient clyſters, cooling and diluting drinks with gum arabic or gum tragacanth, linſeed tea, or the warm bath. When it ariſes from inflammations of the bladder or parts adjoining to it, we are to regard it only as a ſymptomatic affection; and the remedies uſed to remove the primary diſeaſe will alſo remove the dyſuria. Sometimes it may ariſe from an ulcer of the bladder; in which caſe it is generally incurable; a mild nutritious diet will, however, protract the patient's life; and even render that life tolerable, by alleviating ſymptoms.

401 Genus CXXV. DYSPERMATISMUS.

Difficult Emission *of* Semen.

Dyſpermatiſmus, *Sauv.* gen. 260.
Sterilitas, *Lin.* 171. *Sag.* 211.
Ageneſia, *Vog.* 283.

This impediment proceeds generally from obſtructions in the urethra, either by tumors in itſelf, or in the cavernous bodies of the penis; in which caſe the treatment is the ſame as in the iſchuria urethralis; ſometimes it is owing to a kind of epileptic fit which ſeizes the man in the venereal act; and ſometimes the ſemen, when ejected from the proper receptacles, is again abſorbed, or flows into the bladder, and is expelled along with the urine. The laſt caſe it is very difficult, or even impoſſible, to cure; as proceeding from ſcirrhi, or other indiſſoluble tumors of the verumontanum, or the neighbouring parts. It is alſo, in general, incurable. In ſome it proceeds merely from too violent an erection; in which caſe emollient and relaxing medicines will be of ſervice; and we have an example of a cure performed by means of theſe in the firſt volume of the Edinburgh Medical Eſſays.

402 Genus CXXVI. AMENORRHOEA.

Suppression *of the* Menses.

Amenorrhœa, *Vog.* 130.
Dyſmenorrhœa, *Lin.* 168. *Sag.* 218.

This obſtruction, with many other ſymptoms, as dyſpepſia, yellowiſh or greeniſh colour of the ſkin, unuſual appetites, &c. conſtitutes the *chloroſis* already treated of, a diſeaſe which ſeldom or never appears without a ſuppreſſion of the menſes. In Dr Hume's Clinical Experiments we find the virtues of ſeveral emmenagogues ſet forth in the following manner. Chalybeates ſeldom or never ſucceeded: they were always found more uſeful in diminiſhing the evacuation when too violent, than in reſtoring it when deficient. The tincture of black hellebore proved ſucceſsful only in one of nine or ten caſes, though given to the length of four tea-ſpoonfuls a-day, which is double the quantity recommended by Dr Mead. Compreſſion of the crural artery, recommended by Dr Hamilton in the Phyſical and Literary Eſſays, vol. ii. proved ſucceſsful only in one of ſix caſes. From the effects produced by this compreſſion, it has the ſtrongeſt appearance of loading the uterus with blood; from the ſenſations of the patient it produces the ſame effects as the approach of the menſes, and has every appearance in its favour; yet does not ſucceed. Dr Hume ſuppoſes that the uterus is moſt frequently in too plethoric and inflammatory a ſtate; in which caſe, this remedy will do more hurt than in a ſtate of inanition; however, he owns, that in the caſe in which it did ſucceed, the patient was plethoric and inflammatory. Veneſection is recommended as an excellent remedy; the doctor gives three inſtances of its ſucceſs, and ſays he could give many more. It acts by removing the plethoric ſtate of the uterus, relaxing the fibres, and giving the veſſels full play; ſo that their action overcomes all reſiſtance, and the evacuation takes place. It is of no great moment from whence the blood is taken: the ſaphænic vein has been ſuppoſed to empty the uterus moſt; but it is difficult to get the proper quantity from it, and the quantity of the diſcharge cannot be ſo well meaſured. The powder of ſavine is a moſt powerful remedy; and proved ſucceſsful in three caſes out of four in which it was tried. It was given to the quantity of half a dram twice a-day. It is a ſtrong topical ſtimulus, and ſeems improper in plethoric habits. Madder-root, according to Dr Hume, is a very powerful medicine in this diſeaſe; and proved ſucceſsful in 14 out of 19 caſes in which it was tried, being ſometimes exhibited in the quantity of two ſcruples, or a dram, four times a-day. It has ſcarcely any ſenſible effects; never quickens the pulſe, or excites inflammatory ſymptoms: on the contrary, the heat, thirſt, and other complaints abate; and ſometimes theſe ſymptoms are removed, though the diſeaſe be not cured; but when it ſucceeds, the menſes appear from the third to the 12th day.

We have now conſidered all thoſe diſeaſes enumerated in Dr Cullen's Noſology, the cure of which is to be attempted chiefly by internal medicines. The other genera either require particular manual operations, or a very conſiderable uſe of external applications; and therefore more properly fall under the article Surgery. To this, therefore, we ſhall refer the genera which fall under the three laſt orders of the claſs of locales, viz. the *tumores*, *ectopiæ*, and *dialyſes*; and we ſhall add, by way of Appendix, a few obſervations on ſome important affections to which Dr Cullen has not given a place in his ſyſtem, or which practitioners in general are not agreed in referring to any one particular genus which he has mentioned.

APPENDIX.

403 ANGINA PECTORIS.

DR HEBERDEN was the firſt who deſcribed this diſeaſe, though it is an extremely dangerous, and, by his account, not very rare affection. It ſeizes thoſe who are ſubject to it when they are walking, and particularly when they walk ſoon after eating, with a moſt diſagreeable and painful ſenſation in the breaſt, which ſeems to threaten immediate deſtruction: but the moment they ſtand ſtill, all the uneaſineſs vaniſhes. In all other reſpects the patients at the beginning of this diſorder are well, and have no ſhortneſs of breath; from which the *angina pectoris* is totally different. After it has continued ſome months, the fits will not ceaſe inſtantaneouſly on ſtanding ſtill; and it will come on not only when the patients are walking, but when they are lying down, and oblige them to riſe up out of bed every night for many months together. In one or two very inveterate caſes, it has been brought on by the motion of a horſe or carriage, and even by ſwallowing, coughing, going to ſtool, ſpeaking, or by any diſturbance of mind. The perſons affected were all men, almoſt all of whom were above 50 years of age, and moſt of them with a ſhort neck and inclining to be fat. Something like it, however, was obſerved in one woman, who was paralytic; and one or two young men complained of it in a ſlight degree. Other practitioners have obſerved it in very young perſons.

When a fit of this ſort comes on by walking, its duration is very ſhort, as it goes off almoſt immediately upon ſtopping. If it comes on in the night, it will laſt an hour or two. Dr Heberden met with one in whom it once continued for ſeveral days; during all which time the patient ſeemed to be in imminent danger of death. Moſt of thoſe attacked with the diſtemper died ſuddenly: though this rule was not without exceptions; and Dr Heberden obſerved one who ſunk under a lingering illneſs of a different nature.

The *os ſterni* is uſually pointed to as the ſeat of this malady. It ſeems as if it was under the lower part of that bone, and at other times under the middle or upper part, but always inclining more to the left ſide; and in many caſes there is joined with it a pain about the middle of the left arm, which appears to be ſeated in the biceps muſcle.

The appearance of Dr Heberden's paper in the Medical Tranſactions very ſoon raiſed the attention of the faculty, and produced other obſervations from phyſicians of eminence; particularly Dr Fothergill, Dr Wall of Worceſter, Dr Haygarth of Cheſter, and Dr Percival of Mancheſter. It alſo induced an unknown ſufferer under the diſeaſe to write Dr Heberden a very ſenſible letter, deſcribing his feelings in the moſt natural manner; which, unfortunately, in three weeks after the date of this anonymous epiſtle, terminated in a ſudden death, as the writer himſelf had apprehended.

The youngeſt ſubject that Dr Fothergill ever ſaw afflicted with this diſorder was about 30 years of age; and this perſon was cured. The method that ſucceeded with him was a courſe of pills, compoſed of the maſs of gum pill, ſoap, and native cinnabar; with a light chalybeate bitter: this was continued for ſome months, after which he went to Bath ſeveral ſucceſſive ſeaſons, and acquired his uſual health: he was ordered to be very ſparing in his diet; to keep the bowels open; and to uſe moderate exerciſe on horſeback, but not to take long or fatiguing walks.

The only ſymptom in this patient that is mentioned, was a ſtricture about the cheſt, which came on if he was walking up hill or a little faſter than ordinary, or if he was riding at a very briſk trot; for moderate exerciſe of any kind did not affect him: and this uneaſy ſenſation always obliged him to ſtop, as he felt himſelf threatened with immediate death if he had been obliged to go forward.

It is the ſharp conſtrictive pain acroſs the cheſt, which (according to Dr Fothergill's obſervation) particularly marks this ſingular diſeaſe; and which is apt to ſupervene upon a certain degree of muſcular motion, or whatever agitates the nervous ſyſtem.

In ſuch caſes as fell under the inſpection of Dr Fothergill, he very ſeldom met with one that was not attended with an irregular and intermitting pulſe; not only during the exacerbations, but often when the patient was free from pain and at reſt: but Dr Heberden obſerves, that the pulſe is, at leaſt ſometimes, not diſturbed; and mentions his having once had an opportunity of being convinced of this circumſtance, by feeling the pulſe during the paroxyſm.

But no doubt theſe varieties, as well as many other little circumſtances, will occur in this diſeaſe, as they do in every other, on account of the diverſity of the human frame; and if thoſe which in general are found to predominate and give the diſtinguiſhing character be preſent, they will always authoriſe us in giving the name to the diſeaſe: thus, when we find the conſtrictory pain acroſs the cheſt, accompanied with a ſenſe of ſtrangling or ſuffocation; and ſtill more, if this pain ſhould ſtrike acroſs the breaſt into one or both arms; we ſhould not heſitate to pronounce the caſe an *angina pectoris*.

As to the nature of this diſeaſe, it appears to be purely ſpaſmodic: and this opinion will readily preſent itſelf to any one who conſiders the ſudden manner of its coming on and going off; the long intervals of perfect eaſe; the relief afforded by wine, and ſpirituous cordials; the influence which paſſionate affections of the mind have over it; the eaſe which comes from varying the poſture of the head and ſhoulders, or from remaining quite motionleſs; the number of years for which it will continue, without otherwiſe diſordering health; its bearing ſo well the motion of a horſe or carriage, which circumſtance often diſtinguiſhes ſpaſmodic pains from thoſe which ariſe from ulcers; and, laſtly, its coming on for the moſt part after a full meal, and in certain patients at night, juſt after the firſt ſleep, at which time the incubus, convulſive aſthma, and other diſeaſes, juſtly attributed to the diſordered functions of the nerves, are peculiarly apt to return or to be aggravated.

From all theſe circumſtances taken together, there can be little doubt that this affection is of a ſpaſmodic nature: but though it ſhould be admitted, that the whole diſtreſs in theſe caſes ariſe from ſpaſm, it may not be ſo eaſy to aſcertain the particular muſcles which are thus affected.

The violent ſenſe of ſtrangling or choaking, which ſhows the circulation through the lungs to be interrupted during the height of the paroxyſm; and the peculiar conſtrictive pain under the ſternum, always inclining (according to Dr Heberden's obſervation) to the left-ſide; together with that moſt diſtreſſing and alarming ſenſation, which, if it were to increaſe or continue, threatens an immediate extinction of life; might authoriſe us to conclude that the heart itſelf is the muſcle affected: the only objection to this idea is, that the pulſe is not always interrupted during the paroxyſm. The appearances in two of the diſſections, favour the opinion that the ſpaſm affects the heart; as in one ſubject the left ventricle was found as empty of blood as if it had been waſhed; and in another, the ſubſtance of the heart appeared whitiſh, not unlike a ligament; as it ſhould ſeem, in both caſes, from the force of the ſpaſm ſqueezing the blood out from the veſſels and cavities.

If this hypotheſis be allowed, we muſt conclude that the ſpaſm can only take place in an inferior degree, as long as the patient continues to ſurvive the paroxyſm; ſince an affection of this ſort, and in this part, of any conſiderable duration or violence, muſt inevitably prove fatal: and accordingly, as far as could be traced, the perſons who have been known to labour under this diſeaſe have in general died ſuddenly.

The diſſections alſo ſhow, that whatever may be the true ſeat of the ſpaſm, it is not neceſſary for the bringing of it on, that the heart, or its immediate appendages, ſhould be in a morbid ſtate; for in three out of the ſix that have as yet been made public, theſe parts were found in a ſound ſtate.

On opening the body of the poor gentleman who wrote the letter to Dr Heberden, "upon the moſt careful examination, no manifeſt cauſe of his death could be diſcovered; the heart, in particular, with its veſſels and valves, were all found in a natural condition."

In the caſe communicated by Dr Percival to the publiſhers of the Edinburgh Medical Commentaries, "the heart and aorta deſcendens were found in a ſound ſtate." And in Dr Haygarth's patient, "on opening the thorax, the lungs, pericardium, and heart, appeared perfectly ſound." Not to mention Dr Fothergill's patient (R. M.), in whoſe body the only morbid appearance about the heart was a ſmall white ſpot near the apex. Thus the cauſe, whatever its nature might have been, was at too great a diſtance, or of too ſubtile a nature, to come under the inſpection of the anatomiſt. But there was a circumſtance in two of the ſubjects that is worthy of remembrance; and which ſhows that the craſis of the blood, while they were living, muſt have been greatly injured, namely, its not coagulating, but remaining of a cream-like conſiſtence, without any ſeparation into ſerum and craſſamentum.

From all that we have ſeen hitherto publiſhed, it does not appear that any conſiderable advances have been made towards the actual cure of this anomalous ſpaſm.

The very judicious and attentive Dr Heberden (to whom the public are highly indebted for firſt making the diſorder known) confeſſes, that bleedings, vomits, and other evacuations, have not appeared to do any good: wine and cordials taken at bed-time, will ſometimes prevent or weaken the fits; but nothing does this ſo effectually as opiates: in ſhort, the medicines uſually called *nervous* or *cordial*, ſuch as relieve and quiet convulſive motions, and invigorate the languiſhing principle of life, are what he recommends.

Dr Wall mentions one patient, out of the 12 or 13 that he had ſeen, who applied to him early in the diſeaſe, and was relieved conſiderably by the uſe of antimonial medicines joined with the fetid gums: he was ſtill living at the time the doctor wrote his paper, (November 1772), and going about with tolerable eaſe. Two were carried off by other diſorders; all the reſt died ſuddenly.

Dr Fothergill's directions are chiefly calculated with the view to prevent the diſorder from gaining ground, and to alleviate preſent diſtreſs. Accordingly he enjoins ſuch a kind of diet as may be moſt likely to prevent irritability: in particular, not to eat voraciouſly: to be very abſtemious in reſpect to every thing heating; ſpices, ſpirits, wines, and all fermented liquors: to guard moſt ſcrupulouſly againſt paſſion, or any vehement emotions; and to make uſe of all the uſual means of eſtabliſhing and preſerving general health: to mitigate exceſſes of irritability by anodynes; or pains, if they quicken the circulation: to diſperſe flatulencies when they diſtend the ſtomach, by moderate doſes of carminatives; amongſt which, perhaps, ſimple peppermint water may be reckoned one of the ſafeſt. But ſince obeſity is juſtly conſidered as a principal prediſpoſing cauſe, he inſiſts ſtrongly on the neceſſity of preventing an increaſe of fat, by a vegetable diet, and uſing every other practicable method of augmenting the thinner ſecretions.

Theſe were the only means recommended by the practitioners mentioned above for oppoſing this formidable diſeaſe: but Dr Smyth of Ireland has, we are told, diſcovered that it may be certainly cured by iſſues, of which Dr Macbride gives the following inſtance.

" *A. B.* a tall well-made man; rather large than otherwiſe; of healthy parents, except that there had been a little gout in the family; temperate; being very attentive to the buſineſs of his trade (that of a watchmaker), led a life uncommonly ſedentary; had, from his boyhood upwards, been remarkably ſubject to alarming inflammations of his throat, which ſeized him, at leaſt, once in the courſe of the year; in all other reſpects well.

" In 1767, (then 48 years of age), he was taken, without any evident cauſe, with a ſudden and very diſpiriting throbbing under the ſternum. It ſoon afterwards increaſed, and returned upon him every third or fourth week, accompanied with great anxiety, very laborious breathing, choaking, a ſenſation of fulneſs and diſtenſion in the head, a bloated and fluſhed countenance, turgid and watery eyes, and a very irregular and unequal pulſe. The paroxyſm invaded, almoſt conſtantly, while he was ſitting after dinner; now and then he was ſeized with it in the morning, when walking a little faſter than uſual: and was then obliged to ſtop, and reſt on any object at hand. Once or twice it came on in bed; but did not oblige him to ſit up, as it was then attended with no great difficulty in breathing. In the afternoon fits, his greateſt eaſe was from a ſupine poſture; in which he uſed to continue motionleſs for ſome hours, until, quite ſpent and worn out with anguiſh, he dropt into a ſlumber. In the intervals between theſe attacks, which at length grew ſo frequent as to return every fourth or fifth day, he was, to appearance, in perfect health.

"Thus matters continued for more than two years; and various antiſpaſmodics were ineffectually tried for his relief. In 1769, there ſupervened a very ſharp conſtrictory pain at the upper part of the ſternum, ſtretching equally on each ſide, attended with the former ſymptoms of anxiety, dyſpnœa, choaking, &c. and with an excruciating cramp, as he called it, that could be covered with a crown-piece, in each of his arms, between the elbow and the wriſt, exactly at the inſertion of the pronator teres; the reſt of the limb was quite free. The fits were ſometimes brought on, and always exaſperated, by any agitation of mind or body. He once attempted to ride on horſeback during the paroxyſm; but the experiment was near proving fatal to him. The difference of ſeaſon or weather made no impreſſion upon him. Still, in the intervals, his health was perfectly good; except that his eyes, which before his illneſs were remarkably ſtrong and clear, were now grown extremely tender: and that his ſight was much impaired. He had no flatulency of ſtomach, and his bowels were regular.

"In this ſituation, February 22. 1770, he applied to me for aſſiſtance. I had ſeen, I believe, eight or ten of theſe frightful caſes before. Two of the patients dropt dead ſuddenly. They were men between 40 and 50 years of age, and of a make ſomewhat fleſhy. The fate of the others I was not informed of; or, at leaſt cannot now recollect.

"Having found the total inefficacy of bliſters and the whole claſs of nervous medicines in the treatment of this anomalous ſpaſm, I thought it right to attempt the correcting or draining off of the irritating fluid in the caſe now before us. To this purpoſe, I ordered a mixture of lime-water with a little of the compound juniper-water, and an alterative proportion of Huxham's antimonial wine: I put the patient on a plain, light, perſpirable diet; and reſtrained him from all viſcid, flatulent, and acrimonious articles. By purſuing this courſe, he was ſoon apparently mended; but after he had perſiſted regularly in it for at leaſt two months, he kept for ſome time at a ſtand. I then ordered a large iſſue to be opened on each of his thighs. Only one was made. However, as ſoon as it began to diſcharge, his amendment manifeſtly increaſed. The frequency and ſeverity of the fits abated conſiderably: and he continued improving gradually, until, at the end of 18 months he was reſtored to perfect health: which he has enjoyed, without the leaſt interruption, till now, except when he has been tempted (perhaps once in a twelvemonth) to tranſgreſs rules, by making a large meal on ſalted meat, or indulging himſelf in ale or rum-punch, each of which never failed to diſorder him from the beginning of his illneſs: and even on theſe occaſions, he has felt no more than the ſlighteſt motion of his former ſufferings; inſomuch that he would deſpiſe the attack, if it did not appear to be of the ſame ſtock with his old complaint. No other cauſe has had the leaſt ill effect on him.

"Though rum was conſtantly hurtful, yet punch made with a maceration of black currants in our vulgar corn-ſpirit, is a liquor that agrees remarkably well with him.

"He never took any medicine after the iſſue began to diſcharge; and I have directed that it ſhall be kept open as long as he lives. The inflammations of his throat have diſappeared for five years paſt; he has recovered the ſtrength and clearneſs of his ſight; and his health ſeems now to be entirely re-eſtabliſhed."

Dr Macbride, in a letter to Dr Duncan, publiſhed in the Edinburgh Medical Commentaries, gives the following additional obſervations on this diſeaſe.

"Within theſe few weeks I have, at the deſire of Dr Smyth, viſited, three or four times, a very ingenious man who keeps an academy in this city, of about 34 years of age, who applied to the doctor for his advice in January laſt.

"I ſhall give you his ſymptoms as I had them from his own mouth, which appear to me to mark his caſe to be an angina pectoris, and as deplorable as any that I have read of. It was ſtrongly diſtinguiſhed by the exquiſite conſtrictory pain of the ſternum, extending to each of his arms as far as the inſertion of the deltoid muſcle, extreme anxiety, laborious breathing, ſtrangling, and violent palpitation of the heart, with a moſt irregular pulſe. The paroxyſms were ſo frequent, that he ſcarcely ever eſcaped a day, for ſix or ſeven years, without one. They were uſually excited by any agitation of mind or body, though ſlight. He had clear intervals of health between the fits. The diſtemper ſeems hereditary in him, as he ſays his father was affected in the ſame manner ſome years previous to his death. He has a ſtrong gouty taint, which never ſhowed itſelf in his limbs; and he has led a life of uncommon ſedentarineſs, from intenſe application to mathematical ſtudies, attention of mind, and paſſion, even from his boyiſh years. Theſe circumſtances may, perhaps, account for his having been taken with this diſeaſe at ſo early an age as 17.

"A large iſſue was immediately opened in each of his thighs. In a month afterwards he began to mend, and has gone on improving gradually. He can now run up ſtairs briſkly, as I ſaw him do no later than yeſterday, without hurt; can bear agitation of mind; and has no complaint, excepting a ſlight oppreſſion of the breaſt, under the ſternum, which he feels ſometimes in a morning, immediately after dreſſing himſelf, and which he thinks is brought on by the motion uſed in putting on his clothes; though for a complete week preceding the day on which I ſaw him laſt, he told me that he had been entirely free from all uneaſineſs, and was exulting that he had not had ſuch an interval of eaſe for theſe laſt ſeven years.

"Doctor Smyth alſo ſhowed me, in his *adverſaria*, the caſe of a gentleman who had been under his care in 1760, which he had forgotten when my book went to the preſs, and which he was reminded of the other day by a viſit from his patient. It was a genuine angina pectoris, brought on by a very ſedentary life, and great vexation of mind, clearly marked by the exquiſite pain under the ſternum, that extended acutely to the upper extremities, particularly along the left arm, together with the other ſymptoms of dyſpnœa, anxiety, palpitation of the heart, &c. recited in the caſe above. The diſorder went off in 1762, by large ſpontaneous diſcharges from the piles, but returned upon him ſeverely in 1765. Iſſues in his thighs were then recommended to him, but not made. But, whether it was by the perſuaſion of ſome friend, or of his own accord, he went into a courſe of James's powder, in ſmall alterative doſes, combined with a little caſtor and aſafœtida. This he perſiſted in for about ſix weeks; in the meanwhile, he had large acrimonious gleetings from the ſcrotum and a plentiful diſcharge of ichor from the anus.—From this time he began to find his complaints grow leſs and leſs diſtreſſing, and he has now been totally free from them for ſix years paſt."

404 The PUERPERAL, or CHILDBED FEVER.

This ſpecies of fever, as its name imports, is peculiar to women in childbed; and is uſually the moſt fatal of all the diſorders to which the ſex is liable. But, notwithſtanding the prevalence of it in all ages, its real nature has remained, to the preſent time, a ſubject of much diſpute and uncertainty. The critical period of its invaſion, when febrile commotions are apt to be excited by various accidents, and the equivocal ſymptoms which accompany it, have even afforded room for queſtioning whether it be a primary or a ſecondary diſeaſe. Some writers have conſidered it as proceeding entirely from an inflammation of the uterus; others have imagined it to be the conſequence of an obſtruction to the ſecretion of the milk; while the greater number has been inclined, for reaſons equally if not more plauſible, to impute it to a ſuppreſſion of the lochia. If we examine this fever attentively, however, according to its natural courſe, and independently of all the accidental concomitant ſymptoms with which it is not eſſentially connected, we may ſafely pronounce it to be a primary diſeaſe of a particular nature, and perhaps not the neceſſary conſequence of any of the cauſes above-mentioned.

This fever is moſt generally incident to women within 48 hours after delivery, though it may ſupervene on the fourth or fifth day, and ſometimes conſiderably later. It is preceded, like other fevers, by a rigor, which is commonly violent; and, when happening during the time of labour, may be confounded with the pains of parturiency. In its earlier ſtage it is attended with the ſigns of inflammation. A great pain is felt in the back, hips, and the region of the uterus; which, in the part laſt mentioned, is accompanied with the ſenſe of heat and throbbing. A ſudden change in the quality or quantity of the lochia now alſo takes place; the patient is frequently troubled with a teneſmus; and the urine, which is very high-coloured, is diſcharged in ſmall quantity and with pain. At the firſt attack of the fever, the woman is generally ſeized with a vomiting of porraceous matter, as in the *cholera morbus*, to which diſeaſe it then bears a ſtrong reſemblance.—But inſtead of this ſymptom, there is ſometimes only a nauſea, or loathing at the ſtomach, with a diſagreeable taſte in the mouth. The belly ſwells to a conſiderable bulk, and becomes ſuſceptible of painful ſenſations from the ſlighteſt impreſſion. The tongue is generally dry, though ſometimes moiſt, and covered with a thick browniſh fur. When the fever has continued a few days, the ſymptoms of inflammation uſually ſubſide, and the diſeaſe acquires a more putrid form. At this period, if not at the very beginning of the diſorder, a bilious or putrid diarrhœa, of a dangerous and obſtinate nature, ſupervenes, and accompanies it through all its future progreſs; each motion to ſtool being preceded by a temporary increaſe, and followed by an alleviation of pain. The patient uſually nauſeates all kind of food and drink, except what is cold and acidulated. A brown or blackiſh ſordes, the conſequence of putrid exhalations, adheres to the edges of the teeth; a troubleſome hiccough is at length produced, which greatly exaſperates the pains of the abdomen; petechiæ or vibices alſo appear, with ſometimes a miliary eruption, but which produces no mitigation of the diſeaſe. Through the whole courſe of the fever, the patient is affected with great anxiety and dejection of ſpirits.

Such in general is the courſe of the puerperal fever; the ſymptoms of which, however, may be often varied, according to the conſtitution of the patient, the degree of the diſeaſe, and its earlier or later invaſion. When the woman is naturally weak, or her ſtrength has been greatly reduced by immoderate evacuations after delivery; when the diſeaſe is violent, and immediately follows that period; its progreſs and termination are proportionably rapid and fatal. In ſuch unfortunate circumſtances, many have been known to expire within 24 hours from the firſt attack of the diſeaſe; nay, there are ſome inſtances where the rigor has concluded the ſcene. The cataſtrophe, however, is moſt generally ſuſpended for ſome days; and the number of theſe is variable, though the 11th from the commencement of the fever may juſtly be fixed as the period which is uſually deciſive. In whatever ſtage of the diſeaſe an unfavourable termination may happen, it would ſeem as if the commencement of the patient's recovery were not marked by any critical revolution of the fever, as depending on an alteration of the humours; but that the cure is gradually effected, either by a ſpontaneous vomiting, or a long continued diſcharge by ſtool of that porraceous matter, the exiſtence of which in the ſtomach is uſually evinced at the firſt attack of the diſeaſe. The moſt unfavourable prognoſtic, therefore, ariſes from ſuch a weakneſs of the patient as renders her unable to ſupport ſo tedious an evacuation as that by which the fever is overcome. When the lochia return to their former ſtate, when the ſwelling and tenderneſs of the abdomen abate, and there is a moiſture on the ſkin, we have reaſon to hope for a happy termination of the diſeaſe.

Though the puerperal fever may generally be aſcertained from the deſcription which has been given, and chiefly by that remarkable tenderneſs of the abdomen which particularly diſtinguiſhes it: yet, as ſome of its ſymptoms may be confounded with thoſe ariſing from other diſeaſes, and which require a different method

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of cure, it will be proper to mention here the circumſtances by which it may be known with greater certainty.

The pains of the abdomen, attending the childbed fever, may be diſtinguiſhed from thoſe called *after-pains*, by their uninterrupted continuance through the courſe of the diſeaſe, though ſometimes they ſuffer exacerbations; whereas, in the latter, they often totally intermit. They are alſo diſtinguiſhable by the abſence of fever with concomitant ſymptoms in the one, and their evident exiſtence in the other.

Many circumſtances evince a diſſimilarity between the puerperal and miliary fevers, notwithſtanding the ſymptoms of anxiety and oppreſſion are common to both; inſomuch that the nature of the approaching diſeaſe may be aſcertained at the very commencement of its attack. In the puerperal fever the rigor is more violent, of longer duration, and not interrupted, as it is in the other. The pulſe is fuller and ſtronger; the ſkin is more hot; and the tongue, whether moiſt or dry, though generally the latter, is not of a white, but browniſh appearance; and the urine is alſo higher coloured. Eruptions, which are critical in miliary fevers, procure no mitigation of the puerperal fever, and cordials generally increaſe it.

When the original attack of the puerperal fever happens to coincide with the febrile commotion which is excited in childbed women by the milk, the nature of it may at firſt be miſapprehended; but the concomitant ſymptoms, and greater violence of the diſeaſe, muſt in a ſhort time diſſipate ſuch an error.

From all the moſt accurate accounts of this diſeaſe, and from the period at which it generally commences, there ſeems reaſon to conclude, that it owes its riſe more immediately to accidents after delivery. For it is allowed that it may follow a labour under the beſt and moſt favourable circumſtances, though endeavours to dilate the os internum are ſuppoſed frequently to produce it. The more immediate cauſes generally aſſigned by authors are a ſtoppage of perſpiration, the too free uſe of ſpices, and the neglect of procuring ſtools after delivery; ſudden frights, too haſty a ſeparation of the placenta, and binding the abdomen too tight. The putrid appearance, however, which this diſeaſe ſo ſoon aſſumes, affords ground to ſuſpect that the prediſpoſing cauſe of it is a vitiated ſtate of the humours; for it is generally obſerved to be moſt prevalent in an unhealthy ſeaſon, and among women of a weakly and ſcorbutic conſtitution. But from its prevalence in ſome particular hoſpitals, while others in the ſame city are entirely free from it, there can be little doubt that it is often communicated by contagion from one female to another. This opinion is corroborated alſo by many other circumſtances; particularly by the means by which it has been removed from hoſpitals. It would ſeem, however, that this contagion does not act on the female ſyſtem without a certain prediſpoſition, and that this prediſpoſition is induced by thoſe changes to which the female habit is ſubjected in conſequence of delivery.

Within theſe few years this fever has been treated of by ſeveral writers, moſt of whom have differed from each other in their ſentiments of the nature of the diſeaſe. The firſt in the order of publication is Dr Denman, who ſeems to be of opinion, that it may derive its origin either from a redundancy or too great acrimony of the bile, the ſecretion of which appears to be much interrupted in the time of geſtation. In Dr Manning's treatiſe on this fever, he mentions its being highly probable that ſuch a cauſe contributes greatly to produce the diſeaſe, eſpecially where the putrid tendency of the humours is increaſed by unwholeſome air and diet.

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It has likewiſe been the fate of the puerperal fever, that no diſeaſe has more divided the ſentiments of phyſicians in regard to the method of cure. The apparent indications and contra-indications of bleeding, and other remedies, ariſing from the complication of inflammatory and putrid ſymptoms; the equivocal appearance of the vomiting and purging, as whether they be critical or ſymptomatical; and the different cauſes whence ſymptoms ſimilar to each other may ariſe in pregnant women; all theſe circumſtances concur to involve the ſubject in great obſcurity and indeciſion. If we carefully attend to the ſeveral characteriſtics of the diſeaſe, however, ſo as to be able to diſtinguiſh it from every other puerperal complaint, and obſerve at the ſame time the uſual manner of its declenſion, our judgement may be guided in the method of cure by the ſalutary efforts of nature. But, in order to obtain a clearer view of the genuine indications, it will be proper to conſider them under the ſeveral lights in which they have been generally agitated by authors.

One of the moſt eſſential points to be aſcertained in the cure of the childbed fever, reſpects the propriety of bleeding. A free uſe of the lancet has been generally regarded as the moſt ſucceſsful expedient in practice; and there are ſome inſtances of critical hæmorrhagies which would ſeem to confirm its utility. But Dr Denman thinks we may ſafely affirm from experience, that for one who will be benefited by large bleeding, a much greater number will be injured, and that even almoſt irretrievably. Nor can this ſeem ſurpriſing, when we conſider the ſituation of childbed women. In moſt, the evacuations conſequent upon delivery are ſufficient to diminiſh any undue ſuperabundance of the fluids; and if, as frequently happens, the diſeaſe be produced by too haſty a ſeparation of the placenta, the conſequence of which is generally a very copious diſcharge of blood, we can never ſuppoſe that nature will be aſſiſted in overcoming the febrile commotion, by the farther evacuation of the vital fluid, through the defect of which ſhe is now rendered unequal even to the ordinary ſupport of the animal œconomy. We may appeal to every practical phyſician, how much he has known the pulſe to ſink, and what a train of nervous ſymptoms he has obſerved to ſucceed an exceſs of the diſcharge above mentioned. Beſides, it is an axiom in phyſic, that a remedy which cures any diſorder, will always prove ſufficient to prevent it; and therefore, if bleeding were the proper cure in the childbed fever, the diſeaſe ought to have been prevented by a large evacuation of blood, when that happened previous to its attack. Experience, however, in this, as in all other diſeaſes, is the only unerring guide we can follow; and whoever regulates his practice by fact and obſervation, will be convinced that bleeding, eſpecially in a larger quantity, is, in general, very far from being attended with ſucceſs. Bleeding is ſeldom proper, except in women of plethoric conſtitutions, and in whom the ſigns of inflammation riſe high. Nor even in ſuch patients ought it to be repeated without great caution, and the exiſtence of ſtrong indications. Bleeding, when uſed in proper circumſtances, may unqueſtionably palliate the fever; but that it often ſhortens the duration of it, appears to be a matter of much doubt. On this account the practice becomes ſtill more ſuſpicious and exceptionable, when we conſider that by veneſection improperly uſed the patient's ſtrength may be ſo far reduced as not to ſupport the tedious looſeneſs by which the diſeaſe is generally carried off. Though bleeding, however, ought in general to be uſed with great caution, there are certainly many caſes in which it is both neceſſary and advantageous.

The genuine nature and effects of the looſeneſs in this diſeaſe, is another controverted point of the higheſt importance, and which merits the moſt attentive inquiry. Phyſicians, obſerving that women who die of the puerperal fever are generally moleſted with that evacuation, have been induced to conſider this ſymptom as of the moſt dangerous and fatal tendency; and what, therefore, we ſhould endeavour by every means to reſtrain. In this opinion, however, they would ſeem to have been governed by too partial an obſervation of facts. For experience certainly authoriſes the aſſertion, that more women appear to have recovered of the childbed fever, through the intervention of a diarrhœa, than have been deſtroyed by that cauſe. If it alſo be conſidered, that purging is uſually almoſt the only ſenſible evacuation in the more advanced ſtate of the diſeaſe, and is that which accompanies it to its lateſt period, we ſhall have the ſtrongeſt reaſon to think that it is critical rather than ſymptomatical, and ought therefore to be moderately ſupported, inſtead of being unwarily reſtrained. Nay, the advantage which is found to attend vomiting as well as purging, in the earlier ſtage of the diſeaſe, would ſeem to evince that the matter diſcharged by theſe evacuations is what chiefly foments the diſeaſe. Emetics and purgatives, therefore, in the opinion of Dr Manning, are the only medicines on which any rational dependence is to be placed in this fever; at leaſt, they are certainly ſuch as are found the moſt ſucceſsful. It is an eſtabliſhed rule in practice, to preſcribe a vomit at the beginning of every fever attended with any nauſea or loathing of the ſtomach, and where there is not any reaſon to apprehend an inflammation of that organ. Nor does the ſtate of childbed women afford the ſmalleſt ground for prohibiting our recourſe to the ſame expedient in anſwering a ſimilar indication.

It is ſo ſeldom a phyſician is called during the rigor preceding the puerperal fever, that he has few opportunities of trying the effects of remedies in that early ſtate of the diſeaſe. When ſuch occur, however, we ſhould endeavour as much as poſſible to abate and ſhorten that period, as the ſucceeding fever is generally found to bear a proportion to the violence and duration of it. For this purpoſe, warm diluting drinks ſhould be plentifully uſed, with a ſmall quantity of volatile ſpirits or brandy. When Dr Manning apprehended ſuch an accident, he ſometimes ordered the nurſe to give immediately a diſh or two of warm ſack-whey; taking care that it was not too ſtrong, which is a caution that ought always to be remembered: for though a free uſe of the more cordial and ſpirituous kinds of liquors might perhaps ſoon abate the rigor, there is danger to be feared from their influence on the approaching fever, eſpecially in women of a ſtrong and healthy conſtitution. In all caſes, warm applications to the extremities, ſuch as heated bricks, towels, or toaſted grains in a linen bag, may be uſed with perfect ſafety, and ſome advantage.

When the hot fit is advanced, the firſt thing Dr Manning orders is ſome emollient injection, as chicken-water, or water and milk, which ought to be frequently repeated through the courſe of the diſeaſe. Theſe prove beneficial, not only by promoting the diſcharge from the inteſtines, which ſeems in fact to be the ſolution of the diſeaſe; but alſo by acting as a kindly fomentation to the uterus and adjacent parts. With this intention they are particularly ſerviceable when the lochia are ſuppreſſed. Great care, however, is requiſite in adminiſtering them, on account of the tenderneſs and inflammatory diſpoſition, which at that time render the parts in the pelvis extremely ſuſceptible of pain.

The next ſtep in the method of cure ought to be to promote the diſcharge of the morbid matter both by the ſtomach and inteſtines. This intention may be anſwered by a remedy preſcribed by Dr Denman—Two grains of tartrite of antimony rubbed up with a ſcruple of the powder of lapilli cancrorum.

Of a powder thus prepared, Dr Denman gives from two to ſix grains, and repeats it as circumſtances require. If the firſt doſe do not procure any ſenſible operation, he repeats it in an increaſed quantity at the end of two hours, and proceeds in that manner; not expecting any benefit but from its ſenſible evacuation.

Should the diſeaſe be abated, but not removed, (which ſometimes happens), by the effect of the firſt doſe, the ſame medicine muſt be repeated, but in a leſs quantity, till all danger be over. But if any alarming ſymptoms remain, he does not heſitate one moment to repeat the powder, in the ſame quantity as firſt given; though this be ſeldom neceſſary, if the firſt doſe operates properly.

It is to be obſerved, ſays Dr Denman, that as the certainty of cure depends upon the proper repetition of the medicine, the method of giving it at ſtated hours does not appear eligible. If the firſt doſe produce any conſiderable effect by vomiting, procuring ſtools, or plentifully ſweating, a repetition of the medicine in a leſs quantity will ſeldom fail to anſwer our expectations; but great judgement is required in adapting the quantity firſt given to the ſtrength of the patient and other circumſtances. We are not to expect that a diſeaſe which from the firſt formation carries ſo evident marks of danger, ſhould inſtantly ceaſe, even though a great part of the cauſe be removed.

Frequent doſes of the ſaline draughts ought alſo to be given, which not only promote the evacuation by the inteſtines, but likewiſe increaſe the ſalutary diſcharges of urine and perſpiration. Theſe medicines are particularly ſerviceable in ſubduing the remains of the fever, after its violence has been broken by the more efficacious remedies above mentioned; but when they are uſed even in the decline of the diſeaſe, gentle laxatives of rhubarb and magneſia, as adviſed by Dr

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Denman, ought to be frequently interpoſed, ſince, as he juſtly obſerves, without ſtools we can do little ſervice.

Although the diſcharge by the inteſtines appears to have the moſt ſalutary effect in this diſeaſe; yet when the ſtomach has not been properly unloaded of offenſive matter, though a great nauſea and ſickneſs had indicated the expediency of ſuch an evacuation at the beginning of the fever, the continuance of the looſeneſs is ſometimes ſo long protracted as in the end to prove fatal. In this alarming ſtate of the diſeaſe, when the ſtools are very frequent and involuntary, and all appearances threaten danger, Dr Denman ſays, that a clyſter of chicken-water injected every one, two, or three hours, or as often as poſſible without fatiguing the patient too much, with a cordial diaphoretic draught taken every ſix hours, has produced better effects than could be expected.

While theſe medicines are employed, we ſhould endeavour to mitigate the pains of the belly by relaxing applications. During the courſe of the diſeaſe, the patient ought to drink freely of diluting liquors, and abſtain from every thing of a heating quality, unleſs great faintneſs ſhould indicate the uſe of a ſmall quantity of ſome cordial medicine.

Such is the practice recommended in this diſeaſe by Dr Denman. We ſhall now take a curſory view of the ſentiments of ſucceeding writers on this ſubject.

According to Dr Hulme, the proximate cauſe of the puerperal fever is an inflammation of the inteſtines and omentum; for the confirmation of which opinion he appeals to diſſections. He ſuppoſes the chief prediſponent cauſe of the diſeaſe to be the preſſure of the gravid uterus againſt the parts above mentioned. The omentum, ſays he, in the latter ſtage of pregnancy, muſt either be flat, which is its natural ſituation, or be rumpled or carried up by the gravid uterus in folds or doublings. When the latter is the caſe, which he obſerves is probably not ſeldom, the danger of a ſtrangulated circulation will be greater.

Mr White, who has alſo written on this diſeaſe, judiciouſly remarks, that were Dr Hulme's hypotheſis well founded, the diſorder ought rather to take place before delivery, and be immediately removed at that period: That it would likewiſe moſt generally happen to women at their firſt labour, when the abdominal muſcles are leſs yielding, and the pains more violent; the contrary of which is moſt frequently experienced to be the caſe.

It alſo deſerves to be remarked, that, upon Dr Hulme's ſuppoſition, we cannot account for the diſeaſe being more common and fatal in large towns and in hoſpitals, than in the country and private practice, while other inflammatory diſorders are more endemic among thoſe who live in the latter than the former ſituation. Even admitting the friction of the inteſtines and omentum againſt the uterus to be as violent as Dr Hulme ſuppoſes, is it not highly improbable, that any inflammation could be occaſioned by the preſſure of ſuch ſoft ſubſtances upon each other? Or, were this effect really produced, ought not the puerperal fever to be more common and fatal after the moſt laborious deliveries? But this obſervation is not ſupported by experience.

Dr Hulme, in favour of his own hypotheſis, alleges that it gives a ſatisfactory anſwer to the queſtion, "Why all lying-in women have been, and ever will be, ſubject to this diſeaſe?" In this propoſition, however, the doctor ſuppoſes ſuch an univerſality of the diſeaſe as is not confirmed by obſervation. It is affirmed upon undoubted authority, that in many parts of Britain the puerperal fever is hardly known; whereas, were it really produced by the cauſes he aſſigns, it would be equally general and unavoidable.

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But how peculiar ſoever this author's ſentiments are in reſpect of the proximate cauſe of this diſeaſe, they have not led him to any method of cure different from the eſtabliſhed practice. On this ſubject Dr Hulme divides his obſervations into two parts, comprehending under the former the more ſimple method of treatment, and under the latter the more complex. He ſets out with remarking, that the patient being generally coſtive at the beginning of the diſeaſe, an emollient opening clyſter will often give immediate relief; but if this ſhould not prove effectual, recourſe muſt be had to cathartics. Thoſe which he found anſwer his purpoſe beſt, were the *ſal catharticus amarus*, the *oleum ricini*, emetic tartar, and antimonial wine. When the bowels have been ſufficiently cleared and the pain abates, he adviſes encouraging a gentle diaphoreſis by medicines which neither bind the body nor are heating; ſuch as ſmall doſes of ipecacuan, emetic tartar, and antimonial wine, combined with an opiate in a moderate doſe, and given once or twice in the courſe of 24 hours; adminiſtering the ſaline draughts in the intermediate ſpaces. If, preceding or during this courſe, a ſickneſs at ſtomach or vomiting attend, he adviſes aſſiſting the efforts of nature, by drinking, plentifully of chamomile tea, warm water, or any other diluting liquor. He concludes with recommending a cooling regimen, reſt of body, and tranquillity of mind; prohibiting all kinds of bandage upon the abdomen, and enjoining particular attention to the ſtate of the bowels, which ought to be kept gently open for ſome time, even after the diſorder ſeems to be gone off, till the patient be quite out of danger.

So much for the ſimple treatment: we now proceed to the ſecond part, where he deſcribes the method of practice when the diſeaſe is in its more irregular and complicated ſtate.

When a diarrhœa accompanies the diſeaſe, he obſerves that it ought by no means to be checked, but ſupported, by ordering the patient to drink plentifully of mild aperient liquors. If the pain of the hypogaſtric region be attended with ſtitches in the ſides or over the pit of the ſtomach, and a pulſe that reſiſts the finger pretty ſtrongly, he remarks that bleeding would then be highly neceſſary: declaring, however, his opinion, that, in the puerperal fever, bleeding is to be conſidered only as a ſecondary means of relief, though the firſt in point of time; that it ought to be adviſed with great caution; and that the greateſt dependence is always to be placed upon evacuations by ſtool.

Mr White imputes the puerperal fever to a putreſcent diſpoſition of the humours, contracted during pregnancy, and fomented by the hot regimen commonly uſed by women in childbed. In conformity to this opinion, the chief means which he recommends for preventing the diſeaſe is a cool regimen and free circula-

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tion of air, which he evinces to be of the greateſt importance. In reſpect of bleeding, he informs us, that, upon the ſtricteſt inquiry, he cannot find that thoſe who have bled the moſt copiouſly have had the greateſt ſucceſs, either in private or hoſpital practice. He even ſeems to queſtion the propriety of this evacuation in any caſe; but approves of emetics, cathartics, and clyſters, for cleanſing the *primæ viæ*, and likewiſe of ſuch medicines and diet as will correct the putrid humours: adding, that an upright poſture and free ventilation are at all times uſeful, and abſolutely neceſſary, both for the the prevention and cure of the diſeaſe.

Another writer who treats of the childbed fever is Dr Leake, who has publiſhed the reſult of his obſervations on this diſeaſe from April 1768 to the autumn of the year 1770; but chiefly from December 1769 to May 1770, during which period the childbed fever prevailed much about London.

Dr Leake tells us that this fever generally commenced the evening of the ſecond or morning of the third day after delivery, with a rigor or ſhivering fit. Sometimes it invaded ſoon after delivery, and at other times, though rarely, it has ſeized ſo late as the fifth or ſixth day. Now and then it ſeemed to be occaſioned by catching cold, or by errors in diet; but oftener by anxiety of mind. Sometimes the thirſt was great; though the tongue had, in general, a better appearance at the beginning than is common in other fevers. It was ſeldom ever black or very foul: but, as the diſeaſe advanced, became white and dry, with an increaſe of thirſt; and at laſt was of a browniſh colour towards the root, where it was ſlightly covered with an inſpiſſated mucus. The loſs of ſtrength was ſo great and ſudden, that few of the patients could turn in bed without aſſiſtance, even ſo early as the firſt or ſecond day after the attack. The lochia, from firſt to laſt, were not obſtructed, nor deficient in quantity; neither did the quality of this diſcharge ſeem to be in the leaſt altered from its natural ſtate; a preſumption, ſays the author, that the uterus was not at all affected. Of this he was convinced by making a conſiderable preſſure above the pubes with the hand, which did not occaſion pain; but when the ſame degree of preſſure was applied higher, between the ſtomach and umbilical region, it became almoſt intolerable. A perfect criſis ſeldom if ever happened in this fever, which he imputes to the great oppreſſion of the vital powers, whereby they were rendered unable to produce ſuch an event. When the diſeaſe proved mortal, the patient generally died on the 10th or 11th day from the firſt attack. In thoſe who died of the fever, the omentum was found ſuppurated; an inflammation of which part, or of the inteſtines, Dr Leake concludes to be the proximate cauſe of the diſeaſe.

In conſequence of this idea of the cauſe of the diſeaſe, Dr Leake affirms that veneſection is the only remedy which can give the patient a chance for life. But, though it be the principal reſource to be depended upon at the beginning of the fever, he obſerves that it will ſeldom prove of ſervice after the ſecond or third day; and, if directed yet later, will only weaken and exhauſt the patient; when, matter having begun to form in the omentum, the progreſs of the diſeaſe can no longer be prevented by that evacuation. At this period the blood begins to be tainted by the abſorption of the purulent fluid; and the fever, from being inflammatory, is changed into a putrid nature.

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After bleeding in ſuch a quantity as the ſymptoms require, he adviſes that the corrupted bile be evacuated and corrected as ſoon as poſſible; that the diarrhœa, when exceſſive, be reſtrained by emollient anodyne clyſters and gentle ſudorifics, or even by opiates and mild aſtringents, when the patient's ſtrength begins to ſink under the diſcharge; and, laſtly, that where the ſigns of the putrefaction or intermiſſion take place, antiſeptics and the cinchona may be adminiſtered.

The great uniformity of the ſymptoms in all Dr Leake's patients might authoriſe an opinion, that the fever which he deſcribes was in a great meaſure a diſeaſe *ſui generis*, and depended much upon the conſtitution of the air preceding and during the period in which the fever prevailed.

Dr Kirkland has alſo made judicious obſervations on this ſubject. He rejects the opinion that the puerperal fever is a diſeaſe *ſui generis*, and ariſes always from the ſame cauſe. The particular ſituation of childbed women, he acknowledges, occaſions a ſimilarity in the appearance of all the febrile ſymptoms: but he affirms that the ſame kind of fever may be produced by various cauſes; for inſtance, by an inflammation of the uterus or abdomen, by putrid blood or other matter, and putrid miaſms. The ſymptoms, he obſerves, will vary according to the time of ſeizure. If the fever happen in three or four days after delivery, all the ſymptoms uſual to the ſituation of the patient will make their appearance; but if it do not invade till the milk has been ſecreted, and the lochial diſcharge be nearly finiſhed, the ſymptoms, if the breaſts are properly drawn, will, for the moſt part, be thoſe only which are common to that kind of diſorder by which the fever has been produced.

With reſpect to the cure of puerperal fevers, Dr Kirkland adviſes the antiphlogiſtic method when they ariſe from inflammation; but when this method fails of ſucceſs, and a diarrhœa ſupervenes, the diſeaſe has changed its nature, having become more or leſs putrid, and requires a very different treatment.

His obſervations relative to the management of the diarrhœa merit attention. No one, ſays he, would purge and bleed to cure the colliquative fever ariſing from the abſorption of matter in large wounds; and yet the only difference is, that in the puerperal fever the matter abſorbed from the uterus, &c. acts with more violence, becauſe the blood is commonly thinner and the habit in a more irritable ſtate. We ſee, continues he, that abſorbed matter purges as effectually as if any purging medicine had been given by the mouth; and may we not therefore do harm by additional purging, when there has been a large evacuation, eſpecially as purges in this caſe are incapable of entirely removing the *fomes morbi*?

He conſiders cinchona as the principal remedy, as ſoon as the pulſe ſinks, the heat is leſſened, and the ſtomach will bear it. If this increaſe the diarrhœa beyond moderation, he joins with it ſmall doſes of laudanum; but if the diarrhœa ſhould entirely ſtop without the fever going off, in place of laudanum he adviſes a proper quantity of rhubarb. Should the diarrhœa, notwithſtanding the uſe of the medicines propoſed, be-

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come ſo violent as to endanger the patient, he agrees with Mr White in recommending the columbo root, which is a warm cordial, and removes the irritability of the ſtomach and inteſtines more powerfully than any other bitter he knows.

Of this diſeaſe alſo, as it appeared in Derbyſhire and ſome of the adjacent provinces, an account has been publiſhed by Dr Butter. Concerning the cauſes and nature of the diſeaſe, he obſerves, that pregnancy ſeems to add much to the natural ſenſibility of the female conſtitution; becauſe at this period women are often ſubject to a train of nervous ſymptoms, which never moleſt them at other times. During geſtation likewiſe, the appetite is for the moſt part keen, while the digeſtion appears to be impaired; and this weakneſs is increaſed not only by improper food, of which the woman is frequently deſirous, but alſo by the inactivity attending her ſituation. To theſe circumſtances, it is added, that the inteſtinal paſſage being interrupted by the uterine preſſure, coſtiveneſs generally prevails. From the ſeveral obſervations here enumerated, Dr Butter concludes, that the proximate cauſe of the puerperal fever is a ſpaſmodic affection of the firſt paſſages, with a morbid accumulation in their cavity; and upon this ſuppoſition he endeavours to account for the various ſymptoms of the diſeaſe.

In treating of the method of cure, he lays down two indications; the former of which is to promote two, three, or four ſtools daily, in a manner ſuited to the ſtrength of the patient, till ſuch time as they reſume a natural appearance. The ſecond indication is to relieve all uneaſy ſymptoms, ſuch as heat, thirſt, headach, &c.

With reſpect to the opinion entertained by Dr Butter of the cauſe of the puerperal fever, it nearly coincides with that of Mr White. But however plauſible it may appear, we are not entirely ſatisfied that a diſeaſe attended with ſo peculiar ſymptoms as the puerperal fever can depend principally upon an irritability, which is not reſtricted either to the pregnant or puerperal ſtate.

The late Dr Thomas Young profeſſor of midwifery in the univerſity of Edinburgh, although he publiſhed nothing on the ſubject of the puerperal fever, wrote a very ingenious diſſertation reſpecting it, which was read in the Philoſophical Society of Edinburgh. In that diſſertation, after giving a very accurate account of the ſymptoms of the diſeaſe, which coincides very nearly with the account given by others, he endeavours to ſhow, that the *puerperal fever*, ſtrictly ſo called, is in every inſtance the conſequence of contagion; but he contends, that the contagious matter of this diſeaſe is capable only of producing its effect, in conſequence of a peculiar prediſpoſition given by delivery and its conſequences. In ſupport of this doctrine, he remarks, that for many years the diſeaſe was altogether unknown in the lying-in ward of the Royal Infirmary at Edinburgh; but that after it was once accidentally introduced into the hoſpital, almoſt every woman was in a ſhort time after delivery attacked with it; although prior to her delivery, ſhe may have lain, even for weeks together, not only in the ſame ward with the infected, but even in the very next bed. He remarks, that it was only eradicated from the hoſpital in conſequence of the wards being entirely emptied, thoroughly ventilated, and new painted. After theſe proceſſes, puerperal females in the hoſpital remained as free from this diſeaſe as formerly. The puerperal fever, according to Dr Young, has very generally a ſtrong tendency to the typhoid type; although he allows, that in the beginning it is not unfrequently attended with inflammatory ſymptoms, and even with topical inflammation, particularly in the inteſtinal canal. On this idea, he conſiders the puerperal fever as admitting of the ſame variety of treatment with other affections depending on contagion, in which ſometimes an inflammatory, ſometimes a putreſcent tendency, prevails; ſuch, for example, as ſmallpox or eryſipelas. But from the prevailing putreſcent tendency in this affection, he conſiders the free acceſs of cool air, with the liberal uſe of antiſeptics, as being very generally requiſite.

It deſerves to be remarked, that though the ſeveral writers who treat of this ſubject have conducted their method of cure conformably to their particular idea of the cauſe of the diſeaſe, reſpecting which their ſentiments are very different, they ſeem to have been equally ſucceſsful in the treatment of their patients. Indeed the ſeveral writers differ leſs from each other in their method of cure than might be expected, where ſo great an oppoſition of theoretical ſentiment prevails. For after endeavouring to eſtabliſh indications correſpondent to their particular ſyſtems, thoſe who contend for the expediency of promoting the inteſtinal diſcharge, diſſuade not from having recourſe to phlebotomy when the diſeaſe is attended with inflammatory ſymptoms; while, on the other hand, the moſt ſtrenuous advocates for bleeding admit the utility of the former evacuation. It appears, therefore, that a due regulation of the alvine diſcharge is neceſſary through the whole courſe of the fever, but veneſection only ſometimes.

Worms.

WORMS.

Thoſe infeſting the human body are chiefly of three kinds: the *aſcarides*, or ſmall round and ſhort white worms; the *teres*, or round and long worm; and the *tænia*, or tape worm. 405

The *aſcarides* have uſually their ſeat in the rectum.— 406
The *teretes* or *lumbrici* are about a ſpan long, round and ſmooth: they are ſeated for the moſt part in the upper ſmall inteſtines; but ſometimes they are lodged alſo in the ſtomach, and in any part of the inteſtines, even to the rectum.—The tape-worms are from two to forty 407
feet long, according to the teſtimony of Platerus; they generally poſſeſs the whole tract of the inteſtines, but eſpecially the ileum: they very much reſemble a tape in their appearance, whence the name of *tape worm*: but another ſpecies of this genus, from the reſemblance of each joint to a gourd ſeed, has the name of the *gourd-worm*.

In the Medical Tranſactions, vol. 1ſt. Dr Heberden gives a very accurate account of the ſymptoms produced by the *aſcarides*, from an eminent phyſician who was troubled with them all his life. They brought on an uneaſineſs in the rectum, and an almoſt intolerable itching in the anus; which ſenſations moſt uſually came on in the evening, and prevented ſleep for ſeveral hours. They were attended with heat, ſometimes ſo conſiderable as to produce a ſwelling in the rectum both internally and externally; and if theſe ſymptoms were not ſoon relieved, a teneſmus was brought on, with a mucous dejection. Sometimes there was a griping pain in the lower part of the abdomen, a little above the *os pubis*. If this pain was very ſevere, a bloody mucus followed, in which there were often found aſcarides alive. They were alſo ſometimes ſuſpected of occaſioning diſturbed ſleep, and ſome degree of headach.

On this caſe Dr Heberden obſerves, that the general health of the patient did not ſeem to have ſuffered from the long continuance of the diſeaſe, nor the immediate inconveniences of the diſorder itſelf to have increaſed. "It is (ſays he) perhaps univerſally true, that this kind of worms, though as difficult to be cured as any, yet is the leaſt dangerous of all. They have been known to accompany a perſon through the whole of a long life, without any reaſon to ſuſpect that they had haſtened its end. As in this caſe there was no remarkable ſickneſs, indigeſtion, giddineſs, pain of the ſtomach, nor itching of the noſe, poſſibly theſe ſymptoms, where they have happened to be joined with the aſcarides, did not properly belong to them, but aroſe from ſome other cauſes. There is indeed no one ſign of theſe worms, but what in ſome patients will be wanting."

The above mentioned patient uſed purging and irritating clyſters with very little ſucceſs. One dram and an half of tobacco was infuſed in ſix ounces of boiling water; and the ſtrained liquor being given as a clyſter, occaſioned a violent pain in the lower part of the abdomen, with faintneſs and a cold ſweat: this injection, though retained only one minute, acted as a ſmart purge, but did little or no good. Lime-water was alſo uſed as a clyſter; which brought on a coſtiveneſs, but had no good effect. Six grains of ſalt of ſteel were diſſolved in ſix ounces of water, and injected. This clyſter in a few minutes occaſioned an aching in the rectum, griped a little without purging, and excited a teneſmus. Some few aſcarides were brought off with it; but all of them were alive. The uneaſy ſenſation in the rectum did not abate till ſome warm milk was thrown up. Whenever the teneſmus or mucous ſtools were thought worth the taking notice of, warm milk and oil generally gave immediate relief. If purging was neceſſary, the lenient purges, ſuch as manna with oil, were, in this particular caſe, made uſe of: rhubarb was found too ſtimulating.—But, in general, the moſt uſeful purge, and which therefore was moſt uſually taken, was cinnabar and rhubarb, of each half a drachm: this powder ſeldom failed to bring away a mucus as tranſparent as the white of an egg, and in this many aſcarides were moving about. The cinnabar frequently adhered to this mucus, which did not come off in large quantities, when a purge was taken without cinnabar. Calomel did no more than any other purge which operates briſkly would have done; that is, it brought away aſcarides, with a great deal of mucus. Oil given as a clyſter ſometimes brought off theſe animalcules: the oil ſwam on the ſurface of the mucus, and the aſcarides were alive and moving in the mucus itſelf, which probably hindered the oil from coming in contact with them and killing them.

Dr Heberden alſo obſerves, that mucus or ſlime is the proper neſt of the aſcarides, in which they live, and is perhaps the food by which they are nouriſhed; and it is this mucus which preſerves them unhurt, though ſurrounded with many other liquors, the immediate touch of which would be fatal. It is hard to ſatisfy ourſelves by what inſtinct they find it out in the human body, and by what means they get at it; but it is obſervable in many other parts of nature, as well as here, that where there is a fit ſoil for the hatching and growth of animals and vegetables, nature has taken ſufficient care that their ſeeds ſhould find the way thither. Worms are ſaid to have been found in the inteſtines of ſtill-born infants. Purges, by leſſening this ſlime, never fail to relieve the patient: and it is not unlikely, that the worms which are not forced away by this quickened motion of the inteſtines, may, for want of a proper quantity of it, languiſh, and at laſt die; for if the aſcarides are taken out of their mucus, and expoſed to the open air, they become motionleſs, and apparently die in a very ſhort time. Dr Heberden ſuppoſes that the kind of purge made uſe of is of ſome conſequence in the cure of all other worms as well as aſcarides; the animals being always defended by the mucus from the immediate action of medicines; and that therefore thoſe purges are the beſt which act briſkly, and of which a repetition can be moſt eaſily borne. Purging waters are of this ſort, and jalap eſpecially for children; two or more grains of which, mixed with ſugar, are moſt eaſily taken, and may be repeated daily.

From Dr Heberden's obſervations, we may eaſily ſee why it is ſo difficult to deſtroy theſe animals; and why anthelmintics, greatly celebrated for ſome kinds, are yet ſo far from being ſpecifics in the diſeaſe. As the worms which reſide in the cavities of the human body are never expoſed to the air, by which all living creatures are invigorated, it is evident, that in themſelves they muſt be the moſt tender and eaſily deſtructible creatures imaginable, and much leſs will be requiſite to kill them than any of our common inſects. The moſt pernicious ſubſtances to any of the common inſects are oil, cauſtic fixed alkali, lime, and lime-water. The oil operates upon them by ſhutting up the pores of their bodies; the lime-water, lime, and cauſtic alkali, by diſſolving their very ſubſtance. In the caſe of inteſtinal worms, however, the oil can have very little effect upon them, as they are defended from it by the moiſture and mucus of the inteſtines; the like happens with lime-water: and therefore it is neceſſary that the medicine ſhould be of ſuch a nature as to deſtroy both mucus and inſects together; for which purpoſe the cauſtic fixed alkali is at once ſafe and efficacious; nor is it probable that any caſe of worms whatever could reſiſt the proper uſe of this medicine. A very large doſe of any ſalt indeed will alſo deſtroy the mucus and deſtroy the worms; but it is apt to inflame and excoriate the ſtomach and inteſtines, and thus to produce worſe diſtempers than that which it was intended to cure. Dr Heberden gives the following remarkable caſe of a patient cured of worms by enormous doſes of common ſalt, after trying many other remedies in vain. In February 1757, the patient was ſeized with uncommon pains in his ſtomach, attended with nauſea, vomiting, and conſtipation of bowels, and an almoſt total loſs of ſleep and appetite:

He ſoon became much emaciated, and could neither ſtand nor walk upright; his belly grew ſmall and hard, and cloſely retracted, inſomuch that the ſternum covered the navel, and the latter could ſcarce be diſcovered or felt by the finger: his urine was always milky, and ſoon depoſited a thick white ſediment; his excrements were very hard and lumpy, reſembling thoſe of ſheep, only of a brown colour; nor had he ever a ſtool without ſome medicine or other to procure it. In this ſituation he continued four years; during which time he had been in an infirmary, attended by eminent phyſicians, but was diſmiſſed as incurable. At laſt he was adviſed by a neighbour to drink ſalt and water, as he ſaid he knew one cured by it who had for many years been afflicted with the ſame kind of pains in the belly and ſtomach. As his diſtemper was now almoſt inſupportable, he willingly tried the experiment. Two pounds of common ſalt were diſſolved in as little water as poſſible, all which he drank in leſs than an hour. Soon afterwards he found himſelf greatly oppreſſed at the ſtomach, grew extremely ſick, and vomited violently; on the fourth ſtraining he brought up about half a pint of ſmall worms, part aſcarides, and the reſt reſembling thoſe worms which are called the *botts*, and frequently met with in the ſtomach of horſes, but much ſmaller, and about the ſize of a grain of wheat. The ſalt ſoon began to operate downwards, and he had five or ſix very copious fetid ſtools, tinged with blood; and in them diſcharged near an equal quantity of the ſame kind of worms he had vomited. Being greatly fatigued with the violence of the operations, he fell into a calm ſleep, which laſted two hours, during which he ſweated profuſely, and awoke much refreſhed. Inſtead of his uſual pains, he now only complained of a rawneſs and ſoreneſs of his gullet, ſtomach, and bowels, with an almoſt unquenchable thirſt; to allay which, he drank large quantities of cold water, whey, butter-milk, or whatever he could get. The urine he now paſſed was ſmall in quantity, and rendered with very great difficulty, being highly ſaturated with the ſalt, from whence aroſe a moſt troubleſome dyſuria and ſtrangury. However, theſe ſymptoms gradually abated by a free uſe of the liquors above-mentioned; and on the third morning he was ſo well recovered, that he took two pounds more of ſalt, diſſolved in the like quantity of water., The effects were nearly ſimilar to the former; only that moſt of the worms were now burſt, and came away with a conſiderable quantity of ſlime and mucus. The drought, ſtrangury, &c. returned with their former violence, but ſoon yielded to the old treatment. He ſweated very copiouſly for three days, ſlept eaſily, and by that time could extend his body freely: on the fifth day he left his bed, and, though very weak, could walk upright; his ſtrength and appetite ſoon returned, and he became robuſt and well.

The anthelmintic medicines which have been recommended by one perſon or other, are in a manner innumerable; but the principal are,

1. *Quickſilver.* This is very efficacious againſt all kinds of worms, either taken in the form of calomel or corroſive ſublimate. Even the crude metal boiled in water, and the water drunk, has been recommended as an almoſt certain cure. But this, it is evident, can receive no impregnation from the mercury. If, therefore, it have any effect, it muſt be from ſome foreign and accidental impregnation. In moſt inſtances there can be no objection to mercury, but only that it is not endowed with any attenuating quality whereby the mucus in which theſe inſects reſides can be diſſolved. It therefore fails in many caſes, though it will moſt certainly deſtroy worms where it can get at them.

2. *Powder of tin.* This was for ſome time celebrated as a ſpecific, and indeed we may reaſonably expect good effects from it; as by its weight and grittineſs it rubs off the mucus and worms it contains from the coats of the inteſtinal canal, in which caſe they are eaſily evacuated by purgatives. In order to produce any conſiderable effects, it muſt be given in a large doſe.

3. *Geoffræa inermis*, or *cabbage bark.* This remedy is uſed by the inhabitants of Jamaica. The firſt account of it which appeared in this country was publiſhed in the Phyſical and Literary Eſſays, vol. ii. by Mr Daguid ſurgeon in that iſland. He acquaints us, that the inhabitants of Jamaica, young and old, white and black, are much infeſted with worms, eſpecially the long round ſort; the reaſon of which, he thinks, is the quantity of ſweet viſcid vegetables which they eat. On diſſecting a child of ſeven months old, who died of vomiting and convulſions, twelve large worms were found; one of them filled the *appendix vermiformis*, and three of them were entwiſted in ſuch a manner as to block up the *valvula Tulpii*, ſo that nothing could paſs from the ſmall to the great guts.—The cabbage bark, however, he tells us, is a ſafe and effectual remedy, and the moſt powerful vermifuge yet known; and that it frequently brings away as many worms by ſtool as would fill a large hat. He owns that it has ſometimes violent effects; but this he aſcribes to the negroes who make the decoction (in which form the bark is uſed) too ſtrong, and not to the remedy itſelf.

Mr Anderſon, ſurgeon in Edinburgh, has alſo given an account of this bark and its operation, in a letter to Dr Duncan, publiſhed in the Edinburgh Medical Commentaries, volume iv. p. 84. From this account it appears, that there are two different kinds of cabbage bark; the one much paler than the other: the pale kind operates much more violently than the other. It often occaſions looſe ſtools, great nauſea, and ſuch like ſymptoms, attended with great uneaſineſs in the belly: in one or two inſtances it was ſuſpected of inducing ſyncope. The darker coloured kind reſembles the caſſia lignea, though it is of a much coarſer texture. This kind, Mr Anderſon thinks, may be exhibited in any caſe where an anthelmintic is neceſſary; the dangerous ſymptoms might have followed either from the uſe of the firſt kind, or from an over-doſe of the ſecond. The uſual method of preparing the medicine is by boiling two ounces and a half of the bark in two quarts of water to a pint and a half. Of this a tea-ſpoonful may be given at firſt in the morning, gradually increaſing the quantity till we come to four or five table-ſpoonfuls in a day. When exhibited in this manner, Mr Anderſon informs us, that he never ſaw it produce any violent ſymptoms, and has experienced the beſt effects from it as an anthelmintic. After the uſe of this decoction for eight or nine mornings ſucceſſively, a doſe of jalap with calomel muſt be given, which ſeldom fails to bring away the worms, ſome dead, ſome alive. If at any time the decoction produce more than one or two looſe ſtools, a few drops of liquid laudanum may be given; and, in general, Mr Anderſon gave 15 or 20 drops of the ſpirit of lavender with each doſe.

In a letter from Dr Ruſh, profeſſor of chemiſtry at Philadelphia, to Dr Duncan of Edinburgh, the following account is given of another preparation of this medicine. "It has long (ſays he) been a complaint among phyſicians, that we have no *vermifuge* medicine which can be depended upon. Even calomel fails in many caſes where there are the moſt pathognomonic ſigns of worms in the bowels. But this complaint, it is hoped, is now at an end. The phyſicians of Jamaica have lately found, that the *cabbage-bark*, as it is called in the Weſt Indies, made into a ſyrup with brown ſugar, is an infallible antidote to them. I have uſed above 30 pounds of it, and have never found it fail in one inſtance. The ſyrup is pleaſant; it ſometimes pukes, and always purges, the firſt or ſecond time it is given."

The moſt accurate botanical deſcription of the geoffrœa inermis, or the tree furniſhing the worm bark, as it has often been called, is that which was publiſhed ſome years ago in the Philoſophical Tranſactions by Dr Wright, formerly phyſician at Jamaica, now of Edinburgh, who alſo highly extolls this remedy as an anthelmintic.

Notwithſtanding theſe encomiums, however, the cabbage bark has not come into general uſe in Britain. But diſeaſes from the *teretes*, or *lumbrici* as they are often called, the ſpecies of worm againſt which this bark is employed, much leſs frequently occur in Britain than in ſome other countries. When they do occur, in almoſt every inſtance they readily yield to more gentle and ſafe anthelmintics; and the worms may not only be expelled by calomel, but by the vegetable bitters; as the powder of the artemiſia ſantonica, or the like.

4. *Couhage*, or *cow itch*. This is the *Dolichos urens* or *pruriens* of Linnæus; and the principles on which it acts have been already explained under the article DOLICHOS. It is ſomewhat ſimilar to the powder of tin, but bids fair for being more efficacious. It might at firſt appear to occur as objections to this medicine, that by the hairs of it entangling themſelves with one another, calculi might be formed in the inteſtines, or obſtructions equally bad; or if the ſharp points and hooks with which it abounds were to adhere to the nervous coats of the inteſtines themſelves, they might occaſion a fatal irritation, which could not be removed by any means whatever. But from the experience of thoſe who have employed it extenſively in practice, it would appear, that theſe objections are entirely theoretical: and that it may be employed with perfect ſafety. The ſpiculæ, gently ſcraped off from a ſingle pod, and mixed with ſyrup or melaſſes, are taken for a doſe in the morning faſting. This doſe is repeated in this manner for two or three days without any ſenſible operation; but even a very ſlight purgative taken afterwards has been found to diſcharge an almoſt incredible quantity of worms. And according to Dr Bancroft, who has given a very particular account of its uſe in his Natural Hiſtory of Guiana, it is one of the ſafeſt and moſt certain anthelmintics yet diſcovered; but, as well as the bark of the *Geoffræa*, it has hitherto been very little uſed in Britain, probably from its not being neceſſary.

5. *Indian pink*. This plant, which is the *Spigelia marilandica* of Linnæus, is alſo an American plant, and was firſt recommended in the Edinburgh Phyſical and Literary Eſſays by Dr Garden of Charleſtown in South Carolina. He is of opinion that a vomit ought always to precede the uſe of it; and informs us, that half a dram of it purges as briſkly as the ſame quantity of rhubarb. At other times he has known it produce no effect on the belly though given in very large quantity: In ſuch caſes it becomes neceſſary to add a grain or two of ſweet mercury, or ſome grains of rhubarb; but then it is leſs efficacious than when it proves purgative without addition. The uſe of it, however, in ſmall doſes, is by no means ſafe; as it frequently produces giddineſs, dimneſs of ſight, convulſions, &c. The addition of a purgative, indeed, prevents theſe effects; but at the ſame time, as already obſerved, it diminiſhes the virtue of the medicine. The doctor therefore recommends large doſes, as from them he never knew any other effect than the medicine's proving emetic or violently cathartic. The doſe is from 12 to 60 or 70 grains of the root in ſubſtance, or two, three, or four drams of the infuſion, twice a day. This medicine has alſo had its day, and is now very far from being conſidered as a ſpecific.

The long round worms ſeem to be the moſt dangerous which infeſt the human body, as they often pierce through the ſtomach and inteſtines, and thus bring on a miſerable death. The common ſymptoms of them are nauſea, vomiting, looſeneſs, fainting, ſlender intermitting pulſe, itching of the noſe, and epileptic fits. By the conſumption of the chyle they produce hunger, paleneſs, weakneſs, coſtiveneſs, tumor of the abdomen, eructations, and rumbling of the inteſtines; but it is from the perforation of the inteſtines that the diſeaſe proves ſo frequently fatal. A child may be known to have worms from his cold temperament, paleneſs of the countenance, livid eyelids, hollow eyes, itching of the noſe, voracity, ſtartings, and grinding of the teeth, in ſleep; and more eſpecially by a very fetid breath. Very frequently, however, they are voided by the mouth and anus, in which caſe there is no room for doubt. In the Medical Commentaries, vol. ii. we have an account of the inteſtines being perforated by a worm, and yet the patient recovered. The patient was a woman troubled with an inflammation in the lower part of the abdomen. The pain was ſo violent, that for ſix days ſhe ſlept none at all; the tumor then broke, diſcharged upwards of a pound of thin watery ſanies, immediately after which the excrements followed. The next day ſhe was extremely low; her pulſe could ſcarcely be felt; the extremities were cold; and there was a conſiderable diſcharge from the wound, which had already begun to mortify. She got a decoction of cinchona with wine, which alleviated the ſymptoms; but in removing the mortified parts a worm was found among them nine inches long, and as thick as an eagle's quill. By proper applications, the diſcharge of excrements ceaſed, and ſhe recovered perfect health. She was ſenſible of no accident giving riſe to the inflammation; ſo that in all probability it aroſe entirely from the worm itſelf.

The *tænia*, or *tape worm* as it is called, is one of thoſe moſt difficult to be removed from the human body. It is of two kinds, *tænia ſolium* and *tænia lata;* for a deſcription of which ſee the article TÆNIA.— The reaſon of its being ſo difficult to cure is, that though portions of it are apt to break off and be diſcharged, it is endowed with a power of reproduction, ſo that the patient is little or nothing better. The ſymptoms occaſioned by it are not different from thoſe above deſcribed. A ſpecific againſt the *tænia lata* has been lately ſo much celebrated in France, that the king thought proper to purchaſe it from the proprietor (Madame Nouffer), and the account of it has been tranſlated into Engliſh by Dr Simmons. The patients are required to obſerve no particular regimen till the day before they take the ſpecific. That day they are to take nothing after dinner till about 7 o'clock; after which, they are to take the following ſoup: "Take a pint and an half of water, two or three ounces of good freſh butter, and two ounces of bread cut into thin ſlices; add to this ſalt enough to ſeaſon it, and then boil it to the conſiſtence of panada." About a quarter of an hour after this, they take a biſcuit and a glaſs of white wine, either pure or mixed with water; or even water alone, if they have not been accuſtomed to wine. If the patient has not been to ſtool that day, (which, however, is not uſual with patients in this way), the following clyſter is to be injected. "Take a ſmall quantity of the leaves of mallows, and boil them in a ſufficient quantity of water, mixing with it a little ſalt, and when ſtrained off add two ounces of olive oil." Next morning, about eight or nine hours after the ſupper above mentioned, the ſpecific is to be taken. This is no other than two or three drams of the root of male fern, *polypodium filix mas* of Linnæus, gathered in autumn, and reduced to fine powder. It is to be taken in any diſtilled water, or in common water. This medicine is apt to occaſion a nauſea: to avoid which, Madame Nouffer allows her patients to chew any thing that is agreeable, but forbids any thing to be ſwallowed; or they may ſmell to vinegar, to check the ſickneſs: but if, notwithſtanding this, the ſpecific be thrown up, a freſh doſe muſt be ſwallowed as ſoon as the ſickneſs is gone off, and then they muſt try to ſleep. About two hours after this the following bolus is to be taken. "Take of the panacea of mercury 14 times ſublimed, and ſelect reſin of ſcammony, each ten grains: of freſh and good gamboge ſix or ſeven grains: reduce each of theſe ſubſtances ſeparately into powder, and then mix them with ſome conſerve into a bolus" This compoſition is to be ſwallowed at two different times, waſhing it down with one or two diſhes of weak green-tea, after which the patient muſt walk about his chamber. When the bolus begins to operate, he is to take a diſh of the ſame tea occaſionally, until the worm be expelled; then, and not before, Madame Nouffer gives him broth or ſoup, and he is directed to dine as is uſual after taking phyſic. After dinner he may either lie down or walk out, taking care to conduct himſelf diſcreetly, to eat but little ſupper, and to avoid every thing that is not of eaſy digeſtion.

The cure then is complete; but it is not always effected with the ſame quickneſs in every ſubject. He who has not kept down the whole bolus, or who is not ſufficiently purged by it, ought to take, four hours after it, from two to eight drams of Epſom ſalt diſſolved in boiling water. The doſe of this ſalt may be varied according to the temperament and other circumſtances of the patient.

If the worm ſhould not come away in a bundle, but in the form of a thread (which particularly happens when the worm is involved in much tenacious mucus), the patient muſt continue to ſit upon the cloſe ſtool without attempting to draw it away, drinking at the ſame time warm weak tea: ſometimes this alone is not ſufficient, and the patient is obliged to take another doſe of purging ſalt, but without varying his poſition till the worm be wholly expelled.

It is unuſual for patients who have kept down both the ſpecific and purging doſe, not to diſcharge the worm before dinner-time. This, however, ſometimes happens when the dead worm remains in large bundles in the inteſtines, ſo that the fæces becoming more limpid towards the end of the purging, paſs by it without drawing it with them. The patient may in this caſe eat his dinner; and it has been obſerved, that the food, joined to the uſe of a clyſter, has brought about the expulſion of the worm.

Sometimes the worm is brought away by the action of the ſpecific alone, before the patient has taken the purging bolus: when this happens, Madame Nouffer gives only two thirds of it, or ſubſtitutes the ſalt in its ſtead.

Patients muſt not be alarmed by any ſenſation of heat or uneaſineſs they may feel during the action of the remedy, either before or after a copious evacuation, or juſt as they are about to void the worm. Theſe ſenſations are tranſitory, and go off ſpontaneouſly, or by the aſſiſtance of the vapour of vinegar drawn in at the noſe.

They who have vomited both the ſpecific and bolus, or who have kept down only a part of them, ſometimes do not void the worm that day. Madame Nouffer therefore directs them to take again that night the ſoup, the wine and biſcuit; and if circumſtances require it, the clyſter. If the worm do not come away during the night, ſhe gives them early the next morning another doſe of the ſpecific, and, two hours afterwards, ſix drams or an ounce of purging ſalt, repeating the whole proceſs of the preceding day; excepting the bolus, which ſhe ſuppreſſes.

She obſerves, that very hot weather diminiſhes in ſome degree the action of her remedy; ſhe therefore prefers the month of September for adminiſtering it; but as ſhe has not been always able to chooſe the ſeaſon, and has been ſometimes obliged to undertake the cure of patients in the hotteſt days of ſummer, ſhe then gave her ſpecific very early in the morning; and with this precaution ſhe ſaw no difference in its effects.

On the day appointed for the trial of this medicine before the commiſſioners nominated by the king of France, it was exhibited to five different perſons; but only one of them was certainly known to have the *tænia lata* by having diſcharged parts of it before. That perſon was cured; the ſecond voided a portion of the *tænia ſolium;* the third ſome *aſcarides*, with a part of the *tænia ſolium;* the fourth and fifth voided no worms;

but the laſt conſidered much of the viſcid ſlime he voided to be worms in a diſſolved ſtate.

This trial was thought ſufficient to aſcertain the efficacy of the medicine, and further trials were made by thoſe to whom the ſecret was communicated. The firſt voided two tænia, after much vomiting and 18 or 20 ſtools; the ſecond had no vomiting, but was as violently purged, and diſcharged two worms; the third had 20 copious ſtools during the night, and diſcharged the worm in the morning; and the fifth was affected in much the ſame manner. Some others who were not relieved, were ſuppoſed not to have a tænia.

This ſpecific, however, is not to be conſidered as a new diſcovery; the efficacy of fern in caſes of tænia having been known long ago. Theophraſtus preſcribes its root, in doſes of four drams, given in water ſweetened with honey, as uſeful in expelling flat worms.—Dioſcorides orders it in the ſame doſe, and adds, that its effects are more certain when it is mixed with four oboli (40 grains) of ſcammony or black hellebore; he particularly requires that garlic ſhould be taken before hand. Pliny, Galen, Oribaſius, and Aëtius, aſcribe this ſame virtue to fern; and are followed in this by Avicenna, and the other Arabian phyſicians. Dorſtenius, Valerius Cordus, Dodonæus, Mathiolus, Dalechampius, who commented on Dioſcorides, or copied him in many things, all mention the fern-root as a ſpecific againſt the tænia. Sennertus, and Burnet after him, recommended in ſimilar caſes an infuſion of this plant, or a dram of its powder, for young perſons, and three drams for adults. Simon Paulus, quoted by Ray and Geoffroy, conſiders it as the moſt efficacious of all poiſons againſt the flat worm, and as being the baſis of all the ſecret remedies extolled by empirics in that diſeaſe. Andry prefers diſtilled fern-water to the root in powder, or he employs it only in the form of an opiate, or mixed with other ſubſtances.

Theſe are not the only authors who have mentioned the tænia; many others have deſcribed this worm, the ſymptoms it excites, and the treatment proper to expel it. Almoſt all of them mention the fern root, but at the ſame time they point out other remedies as poſſeſſing equal efficacy. Amongſt theſe we find the bark of the root of the mulberry-tree, the juice of the *auricula murus*, the roots of *chamæleon niger*, ginger, zedoary; decoctions of mugwort, ſouthernwood, wormwood, penny-royal, origanum, hyſſop, and in general all bitter and aromatic plants, &c. Some of them direct the ſpecific to be ſimply mixed and taken in wine or honey and water; others join to it the uſé of ſome purgative remedy, which they ſay adds to its efficacy. Oribaſius, Sylvius, &c. diſtinguiſh the ſpecific that kills the worm, from the purgative that evacuates it, and direct them to be given at different times. Sennertus gives a very ſatisfactory reaſon for adopting this method. If we give, ſays he, the purgative medicine and the ſpecific at the ſame time, the latter will be haſtily carried off before it can have exerted its powers on the worm: whereas, if we give the ſpecific firſt, and thus weaken the worm, it will collect itſelf into a bundle, and, being brought away by means of the purge, the patient will be cured. The cure will be more ſpeedy if the *primæ viæ* have been previouſly lubricated. Theſe precautions are all of them eſſential to the ſucceſs of the remedy, nor are they neglected by Madame Nouffer in her method of treatment. The panada and injection ſhe preſcribes the night before, to lubricate the inteſtines, and prepare the *primæ viæ*. The fern root, taken in the morning, kills and detaches the worm; of this the patients are ſenſible by the ceſſation of the pain in the ſtomach, and by the weight that is felt in the lower belly. The purgative bolus adminiſtered two hours after this, procures a complete evacuation; it is compoſed of ſubſtances that are at once purgative and vermifuge, and which, even when adminiſtered alone, by different phyſicians, ſometimes ſucceeded in expelling the worm. If this purgative appear to be too ſtrong, the reader is deſired to recollect, that it produced no ill effects in either of the caſes that came under the obſervation of the phyſicians appointed to make the trials; and that in one of thoſe caſes, by diminiſhing the doſe, they evidently retarded the evacuations.—Regard however, they obſerve, is to be had both to the age and the temperament of the patient, and the treatment ſhould always be directed by a prudent and experienced phyſician, who may know how to vary the proportions of the doſe as circumſtances may require. If the purgative be not of ſufficient ſtrength, the worm, after being detached by the ſpecific, remains too long a time in the inteſtines, and becoming ſoon corrupted, is brought away only in detached portions: on the other hand, if the purgative be too ſtrong, it occaſions too much irritation, and evacuations that cannot fail to be inconvenient.

Madame Nouffer's long experience has taught her to diſtinguiſh all theſe circumſtances with ſingular adroitneſs.

This method of cure is, as we have ſeen, copied in a great meaſure from the ancients: it may be poſſible to produce the ſame effects by varying the remedies; but the manner of applying them is by no means indifferent: we ſhall be always more certain of ſucceſs, if the inteſtines be previouſly evacuated, and if the ſpecific be given ſome time before the purgative bolus. It is to this method that Madame Nouffer's conſtant ſucceſs is attributed.

Her remedy has likewiſe ſome power over the *tænia folium*; but as the rings of this worm ſeparate from each other more eaſily than thoſe of the *tænia lata*, it is almoſt impoſſible for it to be expelled entire. It will be neceſſary therefore to repeat the treatment ſeveral times, till the patient ceaſe to void any portions of worms. It muſt likewiſe be repeated, if, after the expulſion of one *tænia folium*, another ſhould be generated in the inteſtinal canal. This laſt caſe is ſo rare, that it has been ſuppoſed that no perſon can have more than one of theſe worms; and for this reaſon it has been named *ſolitary worm*, which, being once removed, could never be renewed or replaced by a ſecond: but experience has proved, that this notion is an ill-founded prejudice; and we know that ſometimes theſe worms ſucceed each other, and that ſometimes ſeveral of them exiſt together. Two living tæniæ have frequently been expelled from the ſame patient. Dr De Haen relates an inſtance of a woman who voided 18 tæniæ at once. In theſe caſes the ſymptoms are uſually more alarming; and the appetite becomes exceſſive, becauſe theſe worms derive all their nouriſhment from the chyle. If too auſtere and ill-judged a regimen deprives them of this, they may be expected to attack even the membranes of the inteſtines themſelves. This evil is to be avoided by eating frequently.

Such are the precautions indicated in this diſeaſe. The ordinary vermifuge remedies commonly procured only a palliative cure, perhaps becauſe they were too often improperly adminiſtered. But the efficacy of the preſent remedy, in the opinion of the French phyſicians, ſeems to be ſufficiently confirmed by experience. To the above account, however, it ſeems proper to ſubjoin the following obſervations by Dr Simmons.

" A Swiſs phyſician, of the name of *Herrenſchwand*, more than 20 years ago, acquired no little celebrity by diſtributing a compoſition of which he ſtyled himſelf the *inventor*, and which was probably of the ſame nature as Madame Nouffer's. Several very eminent men, as Tronchin, Hovius, Bonnet, Cramer, and others, have written concerning the effects of this remedy. It ſeems that Dr Herrenſchwand uſed to give a powder by way of preparation, the night before he adminiſtered his ſpecific. Nothing could be ſaid with certainty concerning the compoſition either of one or the other. The treatment was ſaid ſometimes to produce moſt violent effects, and to leave the patients in a valetudinary ſtate. Dr De Haen was diſſuaded by his friends from uſing it, becauſe it diſordered the patients too much. It will be readily conceived, now that we are acquainted with Madame Nouffer's method, that theſe effects were occaſioned wholly by the purgative bolus. It is not ſtrange, that reſin of ſcammony or jalap, combined with *mercurius dulcis* and gamboge, all of them in ſtrong doſes, ſhould in many ſubjects occaſion the greateſt diſorders. It ſeems likely, however, that much of the ſucceſs of the remedy depends on the uſe of a draſtic purge. Some of the ancients who were acquainted with the virtues of the fern root, obſerved that its efficacy was increaſed by ſcammony. Reſinous purges, eſpecially when combined with mercury, have often been given with ſucceſs in caſes of *tænia*. Dr De Haen ſaw a worm of this ſort five ells long expelled by the reſin of jalap alone. Dr Gaubius knew a woman who had taken a variety of anthelmintic remedies without any effect, though ſhe had voided a portion of *tænia* an ell and a half long previous to the uſe of theſe medicines: but at length, after taking a purge of ſingular ſtrength, ſhe voided the worm entire. Many other inſtances of the ſame kind are to be met with in authors. Other remedies have occaſionally been given with ſucceſs. In Sweden, it has been a practice to drink ſeveral gallons of cold water, and then to take ſome draſtic purge. Boerhaave ſays, that he himſelf ſaw a *tænia* meaſuring 300 ells expelled from a Ruſſian by means of the ſulphate of iron.

From ſome late accounts, there is reaſon to believe that Dr Herrenſchwand's remedy for *tænia* does not ſo exactly agree with that of Madame Nouffer as Dr Simmons ſeems to imagine. According to the account given us by a gentleman who had his information from Dr Herrenſchwand himſelf, it conſiſts entirely of gamboge and fixed vegetable alkali.

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Of many poiſons we have already treated, but there are ſome of which nothing has hitherto been ſaid. Among the moſt fatal of theſe are the bites and ſtings of ſerpents, ſcorpions, &c. According to Dr Mead, the ſymptoms which follow the bite of a viper are, an acute pain in the place wounded, with a ſwelling, at firſt red, but afterwards livid, which by degrees ſpreads farther to the neighbouring parts; with great faintneſs, and a quick, low, and ſometimes interrupted pulſe; great ſickneſs at ſtomach, with bilious convulſive vomitings, cold ſweats, and ſometimes pains about the navel. Frequently a ſanious liquor runs from the ſmall wound, and little puſtules are raiſed about it: the colour of the whole ſkin in leſs than an hour is changed yellow, as if the patient had the jaundice. Theſe ſymptoms are very frequently followed by death, eſpecially if the climate be hot, and the animal of a large ſize. This is not, however, the caſe with all kinds of ſerpents. Some, we are aſſured, kill by a fatal ſleep; others are ſaid to produce an univerſal hæmorrhage and diſſolution of the blood; and others an unquenchable thirſt. But of all the ſpecies of ſerpents hitherto known, there is none whoſe bite is more expeditiouſly fatal than that of the rattleſnake. Dr Mead tells us, that the bite of a large ſerpent of this kind killed a dog in a quarter of a minute; and to the human ſpecies they are almoſt equally fatal. Of this ſerpent it is ſaid, that the bite makes the perſon's ſkin become ſpotted all over like the ſkin of the ſerpent; and that it has ſuch a motion as if there were innumerable living ſerpents below it. But this is probably nothing more than a diſſolution of the blood, by which the ſkin becomes ſpotted as in petechial fevers, at the ſame time that the muſcles may be convulſed as in the diſtemper called *hieranoſos*, which was formerly thought to be the effect of evil ſpirits: but it is even not improbable that obſervers have been ſomewhat aided by fancy and ſuperſtition when they thought that they detected ſuch appearances.

It has juſtly appeared ſurpriſing to philoſophers, how ſuch an inconſiderable quantity of matter as the poiſon emitted by a viper at the time of biting ſhould produce ſuch violent effects. But all inquiries into this matter muſt neceſſarily be uncertain; neither can they contribute any thing towards the cure. It is certain that the poiſon produces a gangrenous diſpoſition of the part itſelf, and likewiſe ſeemingly of the reſt of the body; and that the original quantity of poiſon continues ſome time before it exerts all its power on the patient, as it is known that removing part of the poiſonous matter by ſuction will alleviate the ſymptoms. The indications of cure then are three: 1. To remove the poiſonous matter from the body: Or, 2. If this cannot be done, to change its deſtructive nature by ſome powerful and penetrating application to the wound: And, 3. To counteract the effects of that portion already received into the ſyſtem.

The poiſonous matter can only be removed from the body by ſucking the wound either by the mouth, or by means of a cupping glaſs; but the former is probably the more efficacious, as the ſaliva will in ſome meaſure dilute and perhaps obtund the poiſon. Dr Mead directs the perſon who ſucks the wound to hold warm oil in his mouth, to prevent inflammation of the lips and tongue: but as bites of this kind are moſt likely to happen in the fields, and at a diſtance from houſes, the want of oil ought by no means to retard the operation, as the delay of a few minutes might prove of the moſt fatal conſequence; and it appears from Dr Mead's experiments, that the taking the poiſon of a viper into the mouth undiluted, is attended with no worſe conſequences than that of raiſing a ſlight inflammation. A quick exciſion of the part might alſo be of very great ſervice.

The only way of anſwering the ſecond indication is, by deſtroying the poiſoned part by a red-hot iron, or the application of alkaline ſalts, which have the power of immediately altering the texture of all animal ſubſtances to which they are applied, provided they are not covered by the ſkin; and as long as the poiſon is not totally abſorbed into the ſyſtem, theſe muſt certainly be of uſe.

To anſwer the third indication, Dr Mead recommends a vomit of ipecacuanha, encouraged in the working with oil and warm water. The good effects of this, he ſays, are owing to the ſhake which it gives to the nerves, whereby the irregular ſpaſms into which their whole ſyſtem might be drawn are prevented. After this the patient muſt go to bed, and a ſweat muſt be procured by cordial medicines; by which the remaining effects of the poiſon will be carried off.

It has been confidently aſſerted by many, that the American Indians are poſſeſſed of ſome ſpecific remedy by which they can eaſily cure the bite of a rattleſnake. But Mr Cateſby, who muſt have had many opportunities of knowing this, poſitively denies that they have any ſuch medicine. They make applications indeed, and ſometimes the patient recovers; but theſe recoveries he aſcribes to the ſtrength of nature overcoming the poiſon, more than to the remedies made uſe of. He ſays, they are very acute in their prognoſtics whether a perſon that is bit will die or not; and when they happen to receive a bite in certain parts of the body, when the teeth of the animal enter a large vein, for inſtance, they quietly reſign themſelves to their fate, without attempting any thing for their own relief. Indeed, ſo violent and quick is the operation of this poiſon, that unleſs the antidote be inſtantly applied, the perſon will die before he can get to a houſe. It would ſeem therefore eligible for thoſe who are in danger of ſuch bites, to carry along with them ſome ſtrong alkaline ley, or dry alkaline ſalt, or both, which could be inſtantly clapt on the wound, and by its diſſolving power would deſtroy both the poiſon and the infected parts. Strong cordials alſo, ſuch as ardent ſpirits, volatile alkali, &c. might poſſibly excite the languid powers of nature, and enable her to expel the enemy, which would otherwiſe prove too powerful. This ſeems to be ſomewhat confirmed from the account we have in the Philoſophical Tranſactions of a gentleman bit by a rattleſnake, who was more relieved by a poultice of vinegar and vine-aſhes put to his wound than any thing elſe. The vine aſhes being of an alkaline nature, muſt have ſaturated the vinegar, ſo that no part of the cure could be attributed to it: on the other hand, the aſhes themſelves could not have been ſaturated by the ſmall quantity of acid neceſſary to form them into a poultice; of conſequence they muſt have operated by their alkaline quality.—Soap ley, therefore, or very ſtrong ſalt of tartar, may reaſonably be thought to be the beſt external application, not only for the bites of vipers, but of every venomous creature; and in fact we find *dry ſalt* univerſally recommended both in the bites of ſerpents and of mad dogs. Dr Mead recommends the fat of vipers immediately rubbed into the wound; but owns that it is not ſafe to truſt to this remedy alone.

Some years ago the volatile alkali was ſtrongly recommended by M. Sage of the French academy, as a powerful remedy againſt the bite of the viper: and, by a letter from a gentleman in Bengal to Dr Wright, it would appear that this article, under the form of the *eau de luce*, which is very little if any thing different from the *ſpiritus ammoniæ ſuccinatus* of the London Pharmacopœia, has been employed with very great ſucceſs againſt this affection in the Eaſt Indies: but from the trials made with it by the abbé Fontana, publiſhed in his Treatiſe on the Poiſon of the Viper, it would appear that it by no means anſwered his expectation; and the efficacy of this, as well as of the ſnake pills mentioned under the article HYDROPHOBIA, ſtill requires to be confirmed by further experience.

MELÆNE. 409

This is a diſtemper not very common, but it has been obſerved by the ancient phyſicians, and is deſcribed by Hippocrates under the name of *morbus niger*. It ſhows itſelf by a vomiting and purging of black tar-like matter, which Hippocrates, Boerhaave, and Van Swieten, ſuppoſed to be occaſioned by atra bilis. But Dr Home, in his Clinical Experiments, endeavours to ſhew that it is owing to an effuſion of blood from the meſeraic veſſels, which, by its ſtagnation and corruption, aſſumes that ſtrange appearance. The diſeaſe, he ſays, frequently follows hæmorrhage; and thoſe of a ſcorbutic habit are moſt ſubject to it. It is an acute diſeaſe, and terminates ſoon; yet it is not attended with any great degree of fever. In one of Dr Home's patients the criſis happened on the eighth day by diarrhœa; in another, on the 14th, by ſweat and urine; and a third had no evident critical evacuation.

As to the cure, Dr Home obſerves, that bleeding is always neceſſary where the pulſe can bear it; nor are we to be deterred from it by a little weakneſs of the pulſe, more than in the enteritis. Emetics are hurtful, but purgatives are uſeful. But the moſt powerful medicine for checking this hæmorrhage is the ſulphuric acid: and, that this might be given in greater quantity, he mixed it with mucilage of gum arabic; by which means he was enabled to give double the quantity he could otherwiſe have done. The cold bath was tried in one inſtance, but he could not determine whether it was of any ſervice or not. The cure was completed by exerciſe and cinchona.

Of the DISEASES *of* CHILDREN. 410

Dr Buchan obſerves, that from the annual regiſters of the dead, it appears that about one half of the children born in Great Britain die under twelve years of age; and this very great mortality he attributes in a great meaſure to wrong management. The particulars of this wrong management enumerated by him are,

1. Mothers not ſuckling their own children. This, he owns, it is ſometimes impoſſible for them to do;

but where it can be done, he affirms that it ought never to be omitted. This, he ſays, would prevent the unnatural cuſtom of mothers leaving their own children to ſuckle thoſe of others; on which he paſſes a moſt ſevere cenſure, and indeed ſcarce any cenſure can be ſevere enough upon ſuch inhumanity. Dr Buchan informs us, "He is ſure he ſpeaks within bounds, when he ſays not one in a hundred of theſe children live who are thus abandoned by their mothers." For this reaſon he adds, that no mother ſhould be allowed to ſuckle another's child till her own be fit to be weaned. A regulation of this kind would ſave many lives among the poorer ſort, and would do no harm to the rich; as moſt women who make good nurſes are able to ſuckle two children in ſucceſſion upon the ſame milk.

2. Another ſource of the diſeaſes of children is the unhealthineſs of parents: and our author inſiſts that no perſon who labours under an incurable malady ought to marry.

3. The manner of clothing children tends to produce diſeaſes. All that is neceſſary here, he ſays, is to wrap the child in a ſoft looſe covering; and the ſoftneſs of every part of the infant's body ſufficiently ſhows the injury which muſt neceſſarily enſue by purſuing a contrary method.

4. A new born infant, inſtead of being treated with ſyrups, oils, &c. ought to be allowed to ſuck the mother's milk almoſt as ſoon as it comes into the world. He condemns the practice of giving wines and ſpirituous liquors along with the food ſoon after birth; and ſays, that if the mother or nurſe has a ſufficient quantity of milk, the child will need little or no other food before the third or fourth month. But to this it may reaſonably be objected, not only that the nurſing would thus be very ſevere on the mother; but if the child be left thus long without other food, it will not eaſily reliſh that food for ſome time, and its ſtomach is apt to be eaſily hurt by a ſlight change of diet after it has been long accuſtomed to one thing. The human ſpecies are unqueſtionably fitted by nature for a mixed aliment, both from the vegetable and animal kingdom. And the analogy of other animals belonging to the claſs of mammalia for whom milk is equally provided at the earlieſt periods of life, would lead us to the concluſion, that mixed aliment is well fitted for the human ſpecies even in the earlieſt periods of infancy. The lamb is no ſooner dropt than, by natural inſtinct, it crops the graſs as well as it ſucks its mother. And the ſtomach in the human ſpecies, immediately after birth, can digeſt other food as well as milk. Neither can it be ſhown, that the ſtrongeſt and moſt healthy infants are thoſe which get no other food but the mother's milk during the firſt months of their life. In fact, children are evidently of a weak and lax habit of body, ſo that many of their diſeaſes muſt ariſe from that cauſe; all directions which indiſcriminately adviſe an antiphlogiſtic regimen for infants as ſoon as they come into the world, muſt of neceſſity be wrong. Many inſtances in fact might be brought to ſhow, that by the prepoſterous method of ſtarving infants, and at the ſame time treating them with vomits and purges, they are often hurried out of the world. Animal food indeed, particularly under the form of broths, is exceſſively agreeable to children, and they ought to be indulged with it in moderation. This will prove a much better remedy for thoſe acidities with which children are often troubled, than magneſia alba, crabs eyes, or other abſorbents, which have the moſt pernicious effects on the ſtomachs of theſe tender creatures, and pall the appetite to a ſurpriſing degree. The natural appetites of children are indeed the beſt rule by which we can judge of what is proper or improper for them. They muſt no doubt be regulated as to the quantity; but we may be aſſured that what a child is very fond of will not hurt it, if taken in moderation. When children are ſick, they refuſe every thing but the breaſt; and if their diſtemper be very ſevere, they will refuſe it alſo, and in this caſe they ought not to be preſſed to take food of any kind; but when the ſickneſs goes off, their appetite alſo returns, and they will require the uſual quantity of food.

According to Dr Armſtrong, *inward fits*, as they are called, are in general the firſt complaint that appears in children; and as far as he has obſerved, moſt, if not all infants, during the firſt months, are more or leſs liable to them. The ſymptoms are theſe: The child appears as if it was aſleep, only the eyelids are not quite cloſed; and if you obſerve them narrowly, you will ſee the eyes frequently twinkle, with the white of them turned up. There is a kind of tremulous motion in the muſcles of the face and lips, which produces ſomething like a ſimper or a ſmile, and ſometimes almoſt the appearance of a laugh. As the diſorder increaſes, the infant's breath ſeems now and then to ſtop for a little; the noſe becomes pinched; there is a pale circle about the eyes and mouth, which ſometimes changes to livid, and comes and goes by turns; the child ſtarts, eſpecially if you attempt to ſtir it though ever ſo gently, or if you make any noiſe near it. Thus diſturbed, it ſighs, or breaks wind, which gives relief for a little, but preſently it relapſes into the dozing. Sometimes it ſtruggles hard before it can break wind, and ſeems as if falling into convulſions; but a violent burſt of wind from the ſtomach, or vomiting, or a loud fit of crying, ſets all to rights again. As the child increaſes in ſtrength, theſe fits are the more apt to go off ſpontaneouſly and by degrees; but in caſe they do not, and if there is nothing done to remove them, they either degenerate into an almoſt conſtant drowſineſs, (which is ſucceeded by a fever and the thruſh), or elſe they terminate in vomitings, ſour, curdled, or green ſtools, the watery gripes, and convulſions. The thruſh indeed very often terminates in theſe laſt ſymptoms. As theſe complaints naturally run into one another, or ſucceed one another, they may be conſidered, in a manner, as only different ſtages of the ſame diſeaſe, and which derive their origin from the ſame cauſe. Thus, the inward fits may be looked upon as the firſt ſtage of the diſorder; the fever, and thruſh (when it happens), as the ſecond; the vomitings, ſour, curdled, green or watery ſtools, as the third; and convulſions, as the laſt.

As to the cauſe of theſe complaints, he obſerves, that in infants the glandular ſecretions, which are all more or leſs glutinous, are much more copious than in adults. During the time of ſucking, the glands of the mouth and fauces being ſqueezed by the contraction of the muſcles, pour forth their contents plentifully; which afterwards mixing with the mucus of the gullet and ſtomach, render the milk of a ſlimy conſiſtence, by which means it is not ſo readily abſorbed into the lacteals; and as in moſt infants there is too great an acidity in the ſtomach, the milk is thereby curdled, which adds to the load; hence ſickneſs and ſpaſms, which, being communicated by ſympathy to the nerves of the gullet and fauces, produce the convulſive motions above deſcribed, which go commonly by the name of *inward fits*. The air, likewiſe, which is drawn in during ſuction, mixing with the milk, &c. in the ſtomach, perhaps contributes towards increaſing the ſpaſms above mentioned. Dr Armſtrong is the more induced to attribute theſe fits to the cauſes now aſſigned, that they always appear immediately after ſucking or feeding; eſpecially if the child has been long at the breaſt, or fed heartily, and has been laid down to ſleep without having firſt broken wind. Another reaſon is, that nothing relieves them ſo ſoon as belching or vomiting; and the milk or food they throw up is generally either curdled, or mixed with a large quantity of heavy phlegm. If they be not relieved by belching or vomiting, the fits ſometimes continue a good while, and gradually abate, according as the contents of the ſtomach are puſhed into the inteſtines; and as ſoon as the former is pretty well emptied, the child is waked by hunger, cries, and wants the breaſt; he ſucks, and the ſame proceſs is repeated.—Thus, ſome children for the firſt weeks are kept almoſt always in a doſe, or ſeemingly ſo; eſpecially if the nurſes, either through lazineſs or want of ſkill, do not take care to rouſe them when they perceive that it is not a right ſleep, and keep them awake at proper intervals. This dozing is reckoned a bad ſign amongſt experienced nurſes; who look upon it as a forerunner of the thruſh, as indeed it often is; and therefore, when it happens, we ought to be upon our guard to uſe the neceſſary precautions for preventing that diſorder.

For theſe diſorders, the only remedy recommended by Dr Armſtrong is antimonial wine, given in a few drops, according to the age of the infant. By this means the ſuperabundant mucus will no doubt be evacuated; but at the ſame time we muſt remember, that this evacuation can only *palliate*, and not cure the diſeaſe. This can only be effected by tonics; and, when from inward fits and other ſymptoms it appears that the tone of the ſtomach is very weak, a decoction of cinchona, made into a ſyrup, will readily be taken by infants, and may be ſafely exhibited from the very day they come into the world, or as ſoon as their bowels are emptied of the meconium by the mother's milk or any other means.

Dr Clarke obſerves, that *fractures* of the *limbs*, and *compreſſions* of the *brain*, often happen in difficult labours; and that the latter are often followed by convulſions ſoon after delivery. In theſe caſes, he ſays, it will be adviſable to let the navel-ſtring bleed two or three ſpoonfuls before it be tied. Thus the oppreſſion of the brain will be relieved, and the diſagreeable conſequences juſt mentioned will be prevented. But if this has been neglected, and fits have actually come on, we muſt endeavour to make a revulſion by all the means in our power; as by opening the jugular vein, procuring an immediate diſcharge of the urine and meconium, and applying ſmall bliſters to the back, legs, or behind the ears. The ſemicupium, too, would ſeem to be uſeful in this caſe, by driving the oppreſſive load of fluids from the head and upper parts.

It ſometimes happens after a tedious labour, that the child is ſo faint and weak as to diſcover little or no ſigns of life. In ſuch a caſe, after the uſual cleanſing, the body ſhould be immediately wrapped in warm flannel, and briſkly toſſed about in the nurſe's arms, in order, if poſſible, to excite the languid circulation. If this fail, the breaſt and temples may be rubbed with brandy or other ſpirits; or the child may be provoked to cry, by whipping, or other ſtimulating methods, as the application of onion, or ſalt and ſpirit of hartſhorn, to the mouth and noſtrils. But after all theſe expedients have been tried in vain, and the recovery of the child abſolutely deſpaired of, it has ſometimes been happily revived by introducing a ſhort catheter or blowpipe into the mouth, and gently blowing into the lungs at different intervals. Such children, however, are apt to remain weak for a conſiderable time, ſo that it is often no eaſy matter to rear them; and therefore particular care and tenderneſs will be required in their management, that nothing may be omitted which can contribute either to their preſervation or the improvement of their ſtrength and vigour.

All the diſorders which ariſe from a *retention* of the *meconium*, ſuch as the *red gum*, may eaſily be removed by the uſe of gentle laxatives; but the great ſource of mortality among children is the *breeding* of their *teeth*. The uſual ſymptoms produced by this are fretting; reſtleſſneſs; frequent and ſudden ſtartings, eſpecially in ſleep; coſtiveneſs; and ſometimes a violent diarrhœa, fever, or convulſions. In general, thoſe children breed their teeth with the greateſt eaſe, who have a moderate laxity of the bowels, or a plentiful flow of ſaliva during that time.

In mild caſes, we need only, when neceſſary, endeavour to promote the means by which nature is obſerved to carry on the buſineſs of dentition in the eaſieſt manner. For this purpoſe, if a coſtiveneſs be threatened, it muſt be prevented, and the body kept always gently open; the gums ſhould be relaxed by rubbing them frequently with ſweet oils, or other ſoftening remedies of that kind, which will greatly diminiſh the tenſion and pain. At the ſame time, as children about this period are generally diſpoſed to chew whatever they get into their hands, they ought never to be without ſomething that will yield a little to the preſſure of their gums, as a cruſt of bread, a wax candle, a bit of liquorice root, or ſuch like; for the repeated muſcular action, occaſioned by the conſtant biting and gnawing at ſuch a ſubſtance, will increaſe the diſcharge from the ſalivary glands, while the gums will be ſo forcibly preſſed againſt the advancing teeth, as to make them break out much ſooner, and with leſs uneaſineſs, than would otherwiſe happen. Some likewiſe recommend a ſlice of the rind of freſh bacon, as a proper maſticatory for the child, in order to bring moiſture into its mouth, and facilitate the eruption of the teeth by exerciſing the gums. If theſe means, however, prove ineffectual, and bad ſymptoms begin to appear, the patient will often be relieved immediately by cutting the inflamed gum down to the tooth, where a ſmall white point ſhows the latter to be coming forward. When the pulſe is quick, the ſkin hot and dry, and the child of a ſufficient age and ſtrength, emptying the veſſels by bleeding,

ing, eſpecially at the jugular, will frequently be neceſſary here, as well as in all other inflammatory caſes; and the belly ſhould be opened from time to time by emollient, oily, or mucilaginous clyſters. But, on the contrary, if the child be low, ſunk, and much weakened, repeated doſes of the ſpirit of hartſhorn, and the like reviving medicines, ought to be preſcribed. Bliſters applied to the back, or behind the ears, will often be proper in both caſes. A prudent adminiſtration of opiates, when their uſe is not forbid by coſtiveneſs or otherwiſe, is ſometimes of great ſervice in difficult teething, as, by mitigating pain, they have a tendency to prevent its bad effects, ſuch as a fever, convulſions, or other violent ſymptoms; and often they are abſolutely neceſſary, along with the teſtaceous powders, for checking an immoderate diarrhœa.

When cathartics are neceſſary, if the child ſeems too tender and weak to bear their immediate operation, they ſhould be given to the nurſe; in which caſe they will communicate ſo much of their active powers to the milk as will be ſufficient to purge the infant. This at leaſt certainly holds with regard to ſome cathartics; ſuch, for example, as the infuſion of ſenna, particularly if a very weak infuſion be employed, and not uſed to ſuch an extent as to operate as a purgative to the nurſe.

As moſt young children, if in health, naturally ſleep much, and pretty ſoundly, we may always be apt to ſuſpect that ſomething is amiſs when they begin to be ſubject to *watching* and *frights*; ſymptoms which ſeldom or never occur but either in conſequence of ſome preſent diſorder not perceived, or as the certain forerunners of an approaching indiſpoſition. We ſhould immediately, therefore, endeavour to find out the cauſe of watchfulneſs, that we may uſe every poſſible means to remove or prevent it; otherwiſe the want of natural reſt, which is ſo very prejudicial to perſons of all ages, will ſoon reduce the infant to a low and emaciated ſtate, which may be followed by a hectic fever, diarrhœa, and all the other conſequences of weakneſs. Theſe ſymptoms, being always the effects of irritation and pain, may proceed, in very young infants, from crudities or other affections of the *primæ viæ* producing flatulencies or gripes; about the ſixth or ſeventh month, they may be owing to that uneaſineſs which commonly accompanies the breeding of the teeth; and after a child is weaned, and begins to uſe a different kind of food, worms become frequently an additional cauſe of watchings and diſturbed ſleep. Hence, to give the neceſſary relief on theſe occaſions, the original complaint muſt firſt be aſcertained from the child's age and other concomitant circumſtances, and afterwards treated according to the nature of the caſe. Women and nurſes are too apt to have recourſe to opiates in the watchings of children, eſpecially when their own reſt happens to be much diſturbed by their continual noiſe and clamour. But this practice is often prejudicial, and never ought to have place when the belly is in the leaſt obſtructed.

There is no complaint more frequent among children than that of worms, the general ſymptoms of which have been already enumerated; but it muſt be obſerved, that all the ſymptoms commonly attributed to worms, may be produced by a foulneſs of the bowels. Hence practitioners ought never to reſt ſatisfied with adminiſtering to their patients ſuch medicines as are poſſeſſed only of an anthelmintic quality, but to join them with thoſe which are particularly adapted for cleanſing the *primæ viæ*; as it is uncertain whether a foulneſs of the bowels may not be the cauſe of all the complaints. This practice is ſtill the more adviſable, on account of viſcid humours in the inteſtines affording lodgement to the ova of worms; which, without the convenience of ſuch a receptacle, would be more ſpeedily diſcharged from the body.

The difficulty of curing what is called a *worm fever*, ariſes, according to Dr Muſgrave, from its being frequently attributed to worms, when the cauſe of the diſorder is of a quite different nature. He does not mean to deny that worms do ſometimes abound in the human body, nor that the irritation cauſed by them does ſometimes produce a fever; but he apprehends theſe caſes to be much more uncommon than is generally imagined, and that great miſchief is done by treating ſome of the diſorders of children as worm caſes, which really are not ſo. Dr Hunter is of the ſame opinion on this point. He has, we are told, diſſected great numbers of children who have been ſuppoſed to die of worm fevers, and whoſe complaints were of courſe treated as proceeding from worms, in whom, however, there appeared, upon diſſection, to be not only no worms, but evident proofs of the diſorder's having been of a very different nature.

The *ſpurious worm fever*, as Dr Muſgrave terms it, has, in all the inſtances he has ſeen of it, ariſen evidently from the children having been indulged with too great quantities of fruit. Every ſort of fruit eaten in exceſs will probably produce it; but an immoderate uſe of cherries ſeems to be the moſt common cauſe of it. The approach of this diſorder has a different appearance, according as it ariſes from a habit of eating fruit in rather too large quantities, or from an exceſſive quantity eaten at one time. In the former caſe, the patient gradually grows weak and languid: his colour becomes pale and livid; his belly ſwells and grows hard; his appetite and digeſtion are deſtroyed; his nights grow reſtleſs, or at leaſt his ſleep is much diſturbed with ſtartings, and then the fever ſoon follows, in the progreſs of which, the patient grows comatoſe, and at times convulſed; in which ſtate, when it takes place to a high degree, he often dies. The pulſe at the wriſt, though quick, is never ſtrong or hard; the carotids, however, beat with great violence, and elevate the ſkin ſo as to be diſtinctly ſeen at a diſtance. The heat is at times conſiderable, eſpecially in the trunk; though at other times, when the brain is much oppreſſed, it is little more than natural. It is ſometimes accompanied by a violent pain of the epigaſtric region, though more commonly the pain is ſlight, and terminates in a coma; ſome degree of pain, however, ſeems to be inſeparable from it, ſo as clearly to diſtinguiſh this diſorder from other comatoſe affections.

When a large quantity of fruit has been eaten at once, the attack of the diſorder is inſtantaneous, and its progreſs rapid; the patient often paſſing, in the ſpace of a few hours, from apparently perfect health, to a ſtupid, comatoſe, and almoſt dying ſtate. The ſymptoms of the fever, when formed, are in both caſes nearly the ſame; except that, in this latter ſort, a little purulent matter is ſometimes diſcharged, both by vomit and ſtool, from the very firſt day. The ſtools, in both caſes, exhibit ſometimes a kind of curd reſembling curdled milk, at other times a floating ſubſtance is obſerved in them; and ſometimes a number of little threads and pellicles, and now and then a ſingle worm.

Strong purgatives, or purges frequently repeated, in this diſorder, are greatly condemned by Dr Armſtrong, as they in general not only aggravate the ſymptoms already preſent, but are ſometimes the origin of convulſions. Bloodletting is not to be thought of in any ſtage of the diſorder.

Although frequent purging, however, be not recommended, yet a ſingle vomit and purge are adviſed in the beginning of the diſorder, with a view to evacuate ſuch indigeſted matter and mucus as happens to remain in the ſtomach and bowels. Theſe having operated properly, there is ſeldom occaſion for repeating them; and it is ſufficient, if the body be coſtive, to throw up, every ſecond or third day, a clyſter, compoſed of ſome grains of aloes, diſſolved in five or ſix ounces of infuſion of chamomile.

The principal part of the cure, however, depends upon external applications to the bowels and ſtomach; and as the cauſe of the diſorder is of a cold nature, the applications muſt be warm, cordial, and invigorating; and their action muſt be promoted by conſtant actual heat.

When any nervous ſymptoms come on, or remain after the diſorder is abated, they are eaſily removed by giving a pill with a grain or two of aſafœtida once or twice a day.

The diagnoſtics of worms are very uncertain; but, even in real worm caſes, the treatment above recommended would, it is imagined, be much more efficacious than the practice commonly had recourſe to. As worms either find the conſtitution weakly, or very ſoon make it ſo, the frequent repetition of purges, particularly mercurials, cannot but have a pernicious effect. Bear's foot is ſtill more exceptionable, being in truth to be ranked rather among poiſons than medicines. Worm ſeed and bitters are too offenſive to the palate and ſtomach to be long perſiſted in, though ſometimes very uſeful. The powder of coralline creates diſguſt by its quantity; and the infuſion of pink root is well known to occaſion now and then vertiginous complaints and fits.

Fomenting the belly night and morning with a ſtrong decoction of rue and wormwood, is much recommended. It is a perfectly ſafe remedy, and, by invigorating the bowels, may thereby have ſome influence in rendering them capable of expelling ſuch worms as they happen to contain. After the fomentation, it is adviſed to anoint the belly with a liniment, compoſed of one part of eſſential oil of rue, and two parts of a decoction of rue in ſweet oil. It is, however, a matter of great doubt whether theſe external applications, in conſequence of the articles with which they are impregnated, exert any influence on the worms themſelves.

The diet of children diſpoſed to worms ſhould be warm and nouriſhing, conſiſting in part at leaſt of animal food, which is not the worſe for being a little ſeaſoned. Their drink may be any kind of beer that is well hopped, with now and then a ſmall draught of porter or negus. A total abſtinence from butter is not ſo neceſſary, perhaps, as is generally imagined. Poor cheeſe muſt by all means be avoided; but ſuch as is rich and pungent, in a moderate quantity, is particularly ſerviceable. In the ſpurious worm fever, the patient ſhould be ſupported occaſionally by ſmall quantities of broth; and, at the cloſe of it, when the appetite returns, the firſt food given ſhould be of the kinds above recommended.

The diet here recommended will, perhaps, be thought extraordinary, as the general idea is at preſent, that in the management of children, nothing is ſo much to be avoided as repletion and rich food. It is no doubt an error to feed children too well, or to indulge them with wine and rich ſauces; but it is equally an error to confine them to too ſtrict or too poor a diet, which weakens their digeſtion, and renders them much more ſubject to diſorders of every kind, but particularly to diſorders of the bowels. In regard to the ſpurious worm fever, if it be true that acid fruits too plentifully eaten are the general cauſe of it, it follows as a conſequence, that a warm nutritious diet, moderately uſed, will moſt effectually counteract the miſchief, and ſooneſt reſtore the natural powers of the ſtomach. Beſides, if the diſorder does not readily yield to the methods here directed, as there are many examples of its terminating by an inflammation and ſuppuration of the navel, it is highly adviſeable to keep this probability in view, and, by a moderate allowance of animal food, to ſupport thoſe powers of nature, from which only ſuch a happy criſis is to be expected.

Beſides theſe, many other diſeaſes might here be mentioned, which, if not peculiar to infants, are at leaſt peculiarly modified by the infant ſtate. But into details reſpecting theſe we cannot propoſe to enter. It is ſufficient to ſay, that due regard being paid to age and conſtitution, the cure is to be conducted on the ſame general principles as in the adult ſtate.

MEDICAL JURISPRUDENCE. 411

During the progreſs of ſcience in Europe this ſubject has not been altogether neglected. But we may ſafely venture to aſſert, that even from many enlightened governments it has hitherto claimed much leſs attention than its importance merits. At the Britiſh univerſities this has been two much the caſe. It is indeed true, that for near 20 years a few lectures on this ſubject have been delivered at the univerſity of Edinburgh, by the profeſſor of the inſtitutions of medicine. But he could by no means conſider the ſubject on that extenſive ſcale which its importance merited. And he had often expreſſed his regret, that, as in ſeveral of the foreign univerſities, a profeſſorſhip had not been inſtituted for the expreſs purpoſe of giving a courſe of lectures on medical juriſprudence. That defect, however, in medical education at Edinburgh is now ſupplied. When that able and upright ſtateſman Lord Grenville, to whom every thing that regarded the laws of his country was an object of peculiar attention, was at the head of his majeſty's councils, a regius profeſſorſhip of juridical and political medicine was eſtabliſhed in the univerſity of Edinburgh by a royal warrant.

And there is every reaſon to hope, that this appointment will be attended with many effects highly beneficial to the nation.

A ſhort view of the extent and importance of this ſubject will, we preſume, not be unacceptable to the intelligent reader.

Whatever aid the ſcience of medicine can contribute towards the good of the ſtate, and the execution of its laws, has been by the Germans denominated State Medicine; a new, but not improper, appellation, for that branch of knowledge which many writers have termed Medical Juriſprudence.

It comprehends both medical police and juridical medicine. The former conſiſts of the medical precepts which may be of uſe to the legiſlature or to the magiſtracy. The latter is the aggregate of all the information, afforded by the different branches of medicine, which is neceſſary for elucidating doubtful queſtions in courts of law.

Although there are ſome traces of juridical medicine in the Juſtinian code; ſuch as determining the real period of birth, with a view to prevent the impoſition of ſpurious children: it properly originated with the code of laws enacted by the emperor Charles V. under the name of *Conſtitutio criminalis Carolina;* in which it is ordained, that the opinions of phyſicians ſhould be taken, with regard to the danger of wounds, child-murder, murder, poiſoning, procured abortion, concealed pregnancy, &c. Theſe directions, and the impoſſibility which was found of determinating many queſtions by ſimply legal means, induced ſome legiſlators to enjoin, that all tribunals and judges ſhould procure from ſworn phyſicians, appointed to this office, their opinions concerning all the ſubjects to be mentioned hereafter.

Since that time, it has been treated ſyſtematically by many learned men; ſuch as Fortunatus Fidelis, Zacchias, Alberti, Hebenſtreit, Haller, Ludwig, Plenck; and laſtly, in the moſt maſterly manner, by Metzger. Numberleſs diſſertations have been written on all its parts; and among thoſe who contributed to its advancement, we may reckon Ambroſe Parry, Bohn, Butener, Morgagni, Camper, and Gruner. Collections of caſes, illuſtrating its principles, have been made by Amman, Daniel, Bucholz, Pyl, Scherf and Metzger. Theſe are only a few of the principal writers, who have attended to this ſcience: to enumerate more would be unneceſſary.

From its very nature, it is evident how neceſſary a knowledge of this ſcience muſt be to every medical practitioner, who is liable to be called upon to illuſtrate any queſtion comprehended under it before a court of juſtice. On his anſwers, the fate of the accuſed perſon muſt often depend; both judge and jury regulating their deciſion by his opinion. On the other hand, while he is delivering his ſentiments, his own reputation is before the bar of the public. The acuteneſs of the gentlemen of the law is univerſally acknowledged; the verſatility of their genius, and the quickneſs of their apprehenſion, are rendered almoſt inconceivable, by conſtant exerciſe. It is their duty to make every poſſible exertion for the intereſt of their client, and they ſeldom leave unnoticed any inaccurate or contradictory evidence. How cautious muſt, then, a medical practitioner be, when examined before ſuch men, when it is their duty to expoſe his errors, and magnify his uncertainties, till his evidence ſeem contradictory and abſurd? How often muſt he expoſe himſelf to ſuch ſevere criticiſm, if he be not maſter of the ſubject on which he is giving evidence, and have not arranged his thoughts on it according to juſt principles? On the other hand, he may deſerve and gain much credit, by ſo public a diſplay of judgement and profeſſional knowledge.

Some acquaintance with this part of medical ſcience muſt be uſeful at leaſt, and ſometimes neceſſary, to judges and lawyers. They will thus be enabled to eſtimate how much they may depend on the opinion of any phyſician, and will know how to direct their queſtions, ſo as to arrive at the truth, and avoid being miſled by his partiality or favourite opinions. To the lawyer who conducts the defence of an accuſed perſon, in a criminal caſe, it is almoſt indiſpenſable; without it, he cannot do juſtice to the cauſe of his client.

Before criminal courts, the queſtions which occur moſt generally are, reſpecting

1. The cauſe of death, as aſcertained from the examination of the body.
2. The ſufficiency of the ſuppoſed cauſe to have produced death.
3. Probable event of wounds, contuſions, &c.
4. The importance of the part injured.
5. Suppoſed child murder; whether ſtill-born or not.
6. Whether death accidental or intended.
7. Abortion; its having occurred,
8. Spontaneouſly, from habit; accidentally, from external violence or paſſions of the mind; or intentionally, from the introduction of a ſharp inſtrument, uſe of certain drugs, &c.
9. Rape; its being attempted or conſummated; recent or previous defloration.
10. The reſponſibility of the accuſed for his actions.

Before civil courts the queſtions generally regard,

1. The ſtate of mind; madneſs, melancholy, idiotiſm.
2. Pregnancy; concealed, pretended.
3. Parturition; concealed, pretended, retarded, premature.
4. The firſt-born of twins.
5. Diſeaſes; concealed, pretended, imputed.
6. Age and duration of life.

Before conſiſtorial courts, the ſubjects inveſtigated are,

1. Impotence; general, relative, curable, incurable.
2. Sterility; curable, relatively incurable, abſolutely incurable.
3. Uncertainty of ſex; hermaphrodites.
4. Diſeaſes preventing cohabitation; venereal diſeaſe, leproſy, &c.

MEDICAL POLICE. 412

Of incomparably greater conſequence, and more widely extended influence, is the ſecond diviſion of this ſubject. It regards not merely the welfare of individuals, but the proſperity and ſecurity of nations. It is perhaps the moſt important branch of general police; for its influence is not confined to thoſe whom accidental circumſtances bring within its ſphere, but extends over the whole population of the ſtate.

Many of its principles have been long acknowledged, and conſidered as neceſſary conſequences of medical and political truths; and ſome few of them have acquired the authority of laws. But it was reſerved for the philanthropic Frank, to collect the whole into one vaſt and beneficent ſyſtem, and to ſeparate it from juridical medicine; in the old ſyſtems of which, it was neglected, or mentioned only in a few ſhort paragraphs. His enlarged mind perceived at once, and fully vindicated its importance. The very name of Medical Police, is now ſufficient to attract the attention of legiſlators and of magiſtrates, and to make them deſirous of becoming acquainted with its principles, and anxious to ſee them carried into execution. In fact, its influence is already viſible in the countries where it is cultivated. If the principles of medical police were ſeparated from the profeſſional part of medicine, and communicated in a form generally intelligible, in what country have we reaſon to expect more beneficial effects from its influence than this? Where is the ſpirit of patriotiſm and benevolence ſo prevalent? What nation is more generous in its public inſtitutions? Where does the individual ſacrifice a part of his wealth ſo willingly for the benefit of the community? It ſeems only neceſſary to prove that an undertaking will be of advantage to the ſtate, to have it carried into inſtant execution. But, can medical knowledge be more uſefully employed than in pointing out the means of preſerving or improving health; of ſupplying healthy nouriſhment to the poor, eſpecially in times of ſcarcity; of oppoſing the introduction of contagious diſeaſes, and of checking their progreſs; of ſecuring to the indigent the advantages intended by their benefactors; of rearing the orphan to be the ſupport of the nation which has adopted him; and of diminiſhing the horrors of confinement to the poor maniac and the criminal? Theſe good effects are not to be promoted ſo much by rigid laws, as by recommendation and example. Nor can it be reaſonably objected to a ſyſtem of medical police, that it is a pleaſing dream, which flatters the imagination, but the execution of which is in reality impracticable. As well might we entirely throw aſide the rules of humanity, becauſe no one is able to obſerve them all; or live without laws, becauſe no exiſting code is unexceptionable.

Medical police may be defined,—The application of the principles deduced from the different branches of medical knowledge, for the promotion, preſervation and reſtoration of general health.

The effects to be expected from it are the general welfare of the ſtate, and increaſe of healthy population; and are to be attained by means of public inſtitutions, expreſs laws, and popular inſtruction. Inſtructing the people, and convincing them of the propriety of certain precautions and attentions, in regard to their own and the general ſtate of health, are neceſſary to ſecure the good effects of our public inſtitutions and regulations; to obtain reſpect and obedience in many things, to which no expreſs law can be adapted; and, to induce them to forego what may be prejudicial to the ſafety of the community, and of themſelves.

Public medical inſtitutions and laws, muſt be adapted to the country for which they are intended. Many local circumſtances, national character, habits of life, prevalent cuſtoms and profeſſions, ſituation, climate, &c. make conſiderable varieties neceſſary. And many inſtitutions, many a law which would be highly beneficial to the public health, in ſome circumſtances, would be uſeleſs, impracticable, and even hurtful, in others. Theſe cauſes and their effects, muſt, therefore, be particularly attended to.

The principal authors who have written on this ſubject, are Alberti, Heiſter, Plaz, Frank, Huſſty, Metzger, and Hebenſtreit; to whom we may add Howard and Rumford.

The ſubjects which it comprehends, cannot be claſſed very regularly or ſyſtematically. Its views will be different, according to occaſional and temporary cauſes; and its interference may ſometimes be advantageouſly extended beyond what may ſeem the ſtrict limits of a branch of the medical profeſſion.

MEDICAL POLICE RELATES TO

THE SITUATION OF PLACES OF ABODE. Conſtruction of houſes.

AIR. Means of counteracting its impurity—Its various impregnations.

WATER. Its neceſſity and purity.

FOOD. Its various kinds—Comparative quantities of nouriſhment afforded by them—Cheaper kinds, which may be ſafely ſubſtituted in times of ſcarcity—Bread—Animal food—Butcher meat—Fiſh—Vegetables—Veſſels—Cookery; Healthy; Œconomical.

DRINK. Beer—Ale—Porter—Cyder—Spirituous liquors—Wine—Warm drinks—Adulterations of theſe liquors—Hurtful additions—Veſſels.

FIRE and LIGHT.

CLOTHING.

CLEANLINESS.

PROFESSIONS. Manufacturers—Mechanics—Soldiers Sailors—Men of letters.

HEALTHY PROPAGATION.

PREGNANT and PUERPERAL WOMEN.

NEW-BORN INFANTS. Regiſters of birth.

PHYSICAL EDUCATION.

PREVENTION of ACCIDENTS. From poiſon—Hurtful Effluvia—Maniacs—Rabid animals.

RESTORATION of the APPARENTLY DEAD. Humane Societies—Care of the dying—Danger of too early—too late burial—Places of interment—manner of conducting it—bills of mortality.

CONTAGIOUS and EPIDEMIC DISEASES. Plague—Putrid fever—Dyſentery—Smallpox—Inoculation—Extirpation of them—Leproſy—Itch and pox—Precautions to be taken, to prevent their introduction, to diminiſh their violence, to deſtroy their cauſe, and to counteract their effects.

MANAGEMENT of PUBLIC INSTITUTIONS, in which many people are collected under the care of the public.

Hoſpitals for the Indigent:
1. Lying in Hoſpitals.
2 Foundling ditto.
3 Orphan ditto.
4. Hoſpitals for Education.

5. Aged.
6. Blind.
7. Maimed.

Military Hoſpitals:
Priſoners of War.
Lazarettoes.
Work-houſes.
Priſons.

Hoſpitals for the Sick.
Maniacs.
Convaleſcents.
Incurables.

Obſervations on the MEANS *of preſerving* HEALTH.

Having now treated of all the moſt important diſeaſes to which the human body is ſubjected, we ſhall conclude the article MEDICINE, with a few obſervations on the means of preſerving health, both for the general management of valetudinarians, and of thoſe alſo who wiſh to obtain long life and good health by avoiding the cauſes of thoſe diſeaſes which the human ſpecies often bring upon themſelves. On this ſubject much has been written at almoſt every period of medicine. And we may refer thoſe readers who wiſh for a full and extenſive view of this intereſting ſubject to a very elaborate work lately publiſhed by Sir John Sinclair Bart. entitled the Code of Health and Longevity. Here we cannot propoſe to give even an abridged view of this extenſive inquiry; but muſt content ourſelves with offering only a very few general obſervations.

I. RULES *for the Management of* VALETUDINARIANS.

413 THAT part of the medical ſyſtem which lays down rules for the preſervation of health, and prevention of diſeaſes, termed *Hygieina*, is not to be ſtrictly underſtood as if it reſpected only thoſe people who enjoy perfect health, and who are under no apprehenſions of diſeaſe, for ſuch ſeldom either deſire or attend to medical advice; but is rather conſidered as relating to valetudinarians, or ſuch as, though not actually ſick, may yet have ſufficient reaſon to fear that they will ſoon become ſo: hence it is that the rules muſt be applied to correct morbific diſpoſitions, and to obviate various particulars which were ſhown to be the remote or poſſible cauſes of diſeaſes.

From the way in which the ſeveral temperaments are commonly mentioned by ſyſtematic writers, it ſhould ſeem as if they meant that every particular conſtitution might be referred to one or other of the four; but this is far from being the caſe, ſince by much the greater number of people have temperaments ſo indiſtinctly marked, that it is hard to ſay to which of the temperaments they belong.

When we actually meet with particular perſons who have evidently either,

1. Too much ſtrength and rigidity of fibre, and too much ſenſibility;

2. Too little ſtrength, and yet too much ſenſibility;

3. Too much ſtrength, and but little ſenſibility; or,

4. But little ſenſibility joined to weakneſs;

we ſhould look on ſuch perſons as more or leſs in the valetudinary ſtate, who require that theſe morbific diſpoſitions be particularly watched, leſt they fall into thoſe diſeaſes which are connected with the different temperaments.

People of the firſt mentioned temperament being liable to ſuffer from continued fevers, eſpecially of the inflammatory ſpecies, their ſcheme of preſerving health ſhould conſiſt in temperate living, with reſpect both to diet and exerciſe; they ſhould ſtudiouſly avoid immoderate drinking, and be remarkably cautious leſt any of the natural diſcharges be checked. People of this habit bear evacuations well, eſpecially bleeding: they ought not, however, to loſe blood but when they really require to have the quantity leſſened; becauſe too much of this evacuation would be apt to reduce the conſtitution to the ſecond-mentioned temperament, in which ſtrength is deficient, but ſenſibility redundant.

Perſons of the ſecond temperament are remarkably prone to ſuffer from painful and ſpaſmodic diſeaſes, and are eaſily ruffled; and thoſe of the ſofter ſex who have this delicacy of habit, are very much diſpoſed to hyſterical complaints. The ſcheme here ſhould be, to ſtrengthen the ſolids by moderate exerciſe, cold bathing, cinchona, and chalybeate waters; particular attention ſhould conſtantly be had to the ſtate of the digeſtive organs, to prevent them from being overloaded with any ſpecies of ſaburra which might engender flatus, or irritate the ſenſible membranes of the ſtomach and inteſtines, from whence the diſorder would ſoon be communicated to the whole nervous ſyſtem. Perſons of this conſtitution ſhould never take any of the draſtic purges, or ſtrong emetics; neither ſhould they loſe blood but in caſes of urgent neceſſity. But a principal ſhare of management, in theſe extremely irritable conſtitutions, conſiſts in avoiding all ſudden changes of every ſort, eſpecially thoſe with reſpect to diet and clothing, and in keeping the mind as much as poſſible in a ſtate of tranquillity: hence the great advantages which people of this frame derive from the uſe of medicinal waters drank on the ſpot, on account of that freedom from care and ſerious buſineſs of every kind, which generally obtains in all the places planned for the reception of valetudinarians.

The third-mentioned temperament, where there is an exceſs of ſtrength and but little ſenſibility, does not ſeem remarkably prone to any diſtreſſing or dangerous ſpecies of diſeaſe; and therefore it can hardly be ſuppoſed that perſons ſo circumſtanced will either of themſelves think of any particular ſcheme of management, or have recourſe to the faculty for their inſtructions: ſuch conſtitutions, however, we may obſerve, bear all kinds of evacuations well, and ſometimes require them to prevent an over-fulneſs, which might end in an oppreſſion of the brain or ſome other organ of importance.

But the fourth temperament, where we have weakneſs joined to want of ſenſibility, is exceedingly apt to fall into tedious and dangerous diſeaſes, ariſing from a defect of abſorbent power in the proper ſets of veſſels, and from languor of the circulation in general: whence corpulency, dropſy, jaundice, and different degrees of ſcorbutic affection. In order to prevent theſe, or any other ſpecies of accumulation and depravation of the animal fluids, the people of this conſtitution ſhould uſe a generous courſe of diet, with briſk exerciſe, Means of preſerving Health.

exerciſe, and be careful that none of the ſecretions be interrupted, nor any of the natural diſcharges ſuppreſſed. Theſe conſtitutions bear purging well, and often require it; as alſo the uſe of emetics, which are frequently found neceſſary to ſupply the place of exerciſe, by agitating the abdominal viſcera, and are of ſervice to prevent the ſtagnation of bile, or the accumulation of mucous humours, which hinder digeſtion, and clog the firſt paſſages. The free uſe of muſtard, horſe radiſh, and the like ſort of ſtimulating dietetics, is ſerviceable in theſe torpid habits.

When the general maſs of fluids is increaſed beyond what is conducive to the perfection of health, there ariſes what the writers term a *plethora*, which may prove the ſource of different diſeaſes; and therefore, when this overfulneſs begins to produce languor and oppreſſion, care ſhould be taken in time to reduce the body to a proper ſtandard, by abridging the food and increaſing the natural diſcharges, uſing more exerciſe, and indulging leſs in ſleep.

But in oppoſite circumſtances, where the fluids have been exhauſted, we are to attempt the prevention of further waſte by the uſe of ſtrengthening ſtomachics, nouriſhing diet, and indulgence from fatigue of body or mind.

Vitiated fluids are to be conſidered as tainted either with the different kinds of general acrimony, or as betraying ſigns of ſome of the ſpecies of morbific matter which give riſe to particular diſeaſes, ſuch as calculus, ſcurvy, &c.

During the ſtate of infancy, we may ſometimes obſerve a remarkable acidity, which not only ſhows itſelf in the firſt paſſages, but alſo ſeems to contaminate the general maſs of fluids. As it takes its riſe, however, from weak bowels, our views, when we mean to prevent the ill conſequences, muſt be chiefly directed to ſtrengthen the digeſtive organs, as on their ſoundneſs the preparation of good chyle depends; and hence ſmall doſes of rhubarb and chalybeates (either the natural chalybeate waters mixed with milk, or the *murias ammoniæ et ferri* in doſes of a few grains, according to the age of the child), are to be adminiſtered; and the diet is to be ſo regulated as not to add to this acid tendency: briſk exerciſe is likewiſe to be enjoined, with frictions on the ſtomach, belly, and lower extremities.

Where the fluids tend to the putreſcent ſtate, which ſhows itſelf by fetid breath, ſpongineſs and bleeding of the gums, a bloated look and livid caſt, the diet then ſhould be chiefly of freſh vegetables and ripe fruits, with wine in moderation, due exerciſe, and ſtrengthening bitters.

Where acrimony ſhows itſelf by itching eruptions, uncommon thirſt, and fluſhing heats, nothing will anſwer better than ſuch ſulphureous waters as the Harrowgate and Moffat, at the ſame time uſing a courſe of diet that ſhall be neither acrid nor heating.

So far with reſpect to thoſe kinds of morbific matter which do not invariably produce a particular ſpecies of diſeaſe: but there are others of a ſpecific nature, ſome of which are generated in the body ſpontaneouſly, and ſeem to ariſe from errors in diet, or other circumſtances of ill management with reſpect to the animal economy; and hence it is ſometimes poſſible, to a certain degree if not altogether, to prevent the ill conſequences. Thus, there are inſtances where returns of the gout have been prevented by adhering ſtrictly to a milk diet.

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The rheumatiſm has alſo been ſometimes warded off by wearing a flannel ſhirt, or by uſing the cold bath without interruption.

Calculus may be retarded in its progreſs, and prevented from creating much diſtreſs, by the internal uſe of ſoap and lime-water, by ſoap lees taken in milk or in veal-broth, or by the uſe of aërated alkaline water, which may perhaps be conſidered as being both more ſafe and more efficacious, and at the ſame time more pleaſant, than any of the other practices.

The ſcurvy may be prevented by warm clothing and perſeverance in briſk exerciſe, by drinking wine or cyder, and eating freely of ſuch vegetable ſubſtances as can be had in thoſe ſituations where this diſeaſe is moſt apt to ſhow itſelf.

In conſtitutions where there is an hereditary diſpoſition to the ſcrophula, if early precautions be taken to ſtrengthen the ſolids by cold bathing, a nouriſhing courſe of diet, and moderate uſe of wine, the conſtitution which gives riſe to the diſeaſe will probably be prevented from producing any very bad effects.

The other kinds of morbific matter, which are of the ſpecific nature, are received into the body by infection or contagion.

The infection of a putrid fever or dyſentery is beſt prevented by immediately taking an emetic on the firſt attack of the ſickneſs or ſhivering; and if that do not completely anſwer, let a large bliſter be applied between the ſhoulders: by this method the nurſes and other attendants on the ſick in the naval hoſpitals have often been preſerved. As to other infectious morbific matter, we muſt refer to what has already been ſaid when treating of hydrophobia, poiſons, gonorrhœa, &c.

The ill effects which may ariſe from the different ſpecies of ſaburra, are to be obviated, in general, by the prudent adminiſtration of emetics, and carefully abſtaining from ſuch kinds of food as are known to cauſe the accumulation of noxious matters in the firſt paſſages.

Crude vegetables, milk, butter, and other oily ſubſtances, are to be avoided by perſons troubled with a ſourneſs in the ſtomach; briſk exerciſe, eſpecially riding, is to be uſed, and they are to refrain from fermented liquors: the common drink ſhould be pure water; or water with a very little of ſome ardent ſpirit, ſuch as rum or brandy. Seltzer and Pyrmont waters are to be drunk medicinally; and aromatic bitters, infuſions, or tinctures, acidulated with ſulphuric acid, will be found ſerviceable, in order to ſtrengthen the fibres of the ſtomach, and promote the expulſion of its contents, thereby preventing the too haſty fermentation of the alimentary mixture. In order to procure immediate relief, magneſia alba, or *creta præparata*, will ſeldom fail; the magneſia, as well as the chalk, may be made into lozenges, with a little ſugar and mucilage; and in that form may be carried about and taken occaſionally by people afflicted with the acid ſaburra.

In conſtitutions where there is an exuberance or ſtagnation of bile, and a troubleſome bitterneſs in the mouth, it is neceſſary to keep the bowels always free, by taking occaſionally ſmall doſes of pure aloes, *oleum*

ricini,

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ricini, ſupertartrite of potaſs, ſome of the common purging ſalts, or the natural purging waters.

When there is a tendency to the empyreumatic and rancid ſaburra, people ſhould carefully avoid all the various kinds of thoſe oily and high-ſeaſoned articles of diet generally termed *made-diſhes*, and eat ſparingly of plain meat, without rich ſauces or much gravy; and in theſe caſes the moſt proper drink is pure water.

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THERE can be no doubt, that, in general, temperance is the true foundation of health; and yet the ancient phyſicians, as we may ſee in the rules laid down by Celſus, did not ſcruple to recommend indulgence now and then, and allowed people to exceed both in eating and drinking: but it is ſafer to proceed to exceſs in drink than in meat; and if the debauch ſhould create any extraordinary or diſtreſſing degree of pain or ſickneſs, and a temporary fever ſhould enſue, there are two ways of ſhaking it off, either to lie in bed and encourage perſpiration, or to get on horſe-back and by briſk exerciſe reſtore the body to its natural ſtate. The choice of theſe two methods muſt always be determined by the peculiar circumſtances of the parties concerned, and from the experience which they may before have had which agrees beſt with them.

If a perſon ſhould commit exceſs in eating, eſpecially of high-ſeaſoned things, with rich ſauces, a draught of cold water, acidulated with ſulphuric acid, will take off the ſenſe of weight at the ſtomach, and aſſiſt digeſtion by moderating and keeping within bounds the alimentary fermentation, and thus preventing the generation of too much flatus. The luxury of ices may be here of real ſervice at the tables of the great, as producing ſimilar effects with the cold water acidulated. Perſons in theſe circumſtances ought not to lay themſelves down to ſleep, but ſhould keep up and uſe gentle exerciſe until they are ſenſible that the ſtomach is unloaded, and that they no longer feel any oppreſſive weight about the præcordia.

If a man be obliged to faſt, he ought, if poſſible, during that time, to avoid laborious work: after ſuffering ſevere hunger, people ought not at once to gorge and fill themſelves; nor is it proper, after being overfilled, to enjoin an abſolute faſt: neither is it ſafe to indulge in a ſtate of total reſt immediately after exceſſive labour, nor ſuddenly fall hard to work after having been long without motion: in a word, all changes ſhould be made by gentle degrees; for though the conſtitution of the human body be ſuch that it can bear many alterations and irregularities without much danger, yet, when the tranſitions are extremely ſudden, there is a great riſk of producing ſome degree of diſorder.

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It is alſo the advice of Celſus to vary the ſcenes of life, and not confine ourſelves to any ſettled rules: but as inaction renders the body weak and liſtleſs, and exerciſe gives vigour and ſtrength, people ſhould never long omit riding, walking, or going abroad in a carriage. Fencing, playing at tennis, dancing, or other ſimilar engagements, which afford both exerciſe and amuſement, as each ſhall be found moſt agreeable or convenient, are to be uſed in turn, according to the circumſtances and tendency to any particular ſpecies of diſeaſe. But when the weakneſs of old age ſhall have rendered the body incapable of all theſe, then dry frictions with the fleſh-bruſh will be very requiſite to preſerve health, by accelerating the flow of humours through the ſmalleſt orders of veſſels, and preventing the fluids from ſtagnating too long in the cellular interſtices of the fleſhy parts.

Sleep is the great reſtorer of ſtrength; for, during this time, the nutritious particles appear to be chiefly applied to repair the waſte, and replace thoſe that have been abraded and waſhed off by the labour and exerciſe of the day; but too much indulgence in ſleep has many inconveniencies, both with reſpect to body and mind, as it blunts the ſenſes, and encourages the fluids to ſtagnate in the cellular membrane; whence corpulency, and its neceſſary conſequences languor and weakneſs.

The proper time for ſleep is the night, when darkneſs and ſilence naturally bring it on: ſleep in the day time, from noiſe and other circumſtances, is in general not ſo ſound or refreſhing; and to ſome people is really diſtreſſful, as creating an unuſual giddineſs and languor, eſpecially in perſons addicted to literary purſuits. Cuſtom, however, frequently renders ſleep in the day neceſſary; and in thoſe conſtitutions where it is found to give real refreſhment, the propenſity to it ought to be indulged, particularly in very advanced age.

With regard to the general regimen of diet, it has always been held as a rule, that the ſofter and milder kinds of aliment are moſt proper for children and younger ſubjects: that grown perſons ſhould eat what is more ſubſtantial; and old people leſſen their quantity of ſolid food, and increaſe that of their drink both of the diluent and cordial kind.

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Medicis.

MEDICIS, Cosmo de, was born in the year 1389, and was in the prime of life, at the death of his father, Giovanni. His conduct was diſtinguiſhed for urbanity and kindneſs to the ſuperior ranks of his fellow-citizens, and by a conſtant attention to the wants of the lower claſs, whom his munificence abundantly relieved. His prudence and moderation, however, could not repreſs the ambitious deſigns of the rival families, the Florentines and Medici; for in 1433, Rinaldo de Albizi, at the head of a formidable party, carried the appointment of the magiſtracy. On returning from his country ſeat he was ſeized upon by his adverſaries, and committed to priſon. The conſpirators not agreeing as to the proper method of diſpatching their priſoner, one Peruzzi recommended poiſon, which was heard by Coſmo, who refuſed to take any other ſuſtenance than a ſmall portion of bread. In this diſmal ſituation he remained four days, ſhut up from all his kindred and friends, where he ſoon expected to be numbered with the dead. But the man employed to take him off, unexpectedly proved his friend. Malavolta, the keeper of the priſon, relented, and declared that he had no juſt reaſon to be alarmed, as he heſitated not to eat of every thing that was brought him.

His brother Lorenzo, and his couſin Averardo, raiſed a conſiderable body of men in Romagna and other diſtricts; and being joined by the commander of the republican forces, they marched to Florence to relieve him. A decree was obtained from the magiſtracy, by which he was baniſhed to Padua for ten years, his brother to Venice for five, and ſeveral of their relations ſhared a ſimilar fate. Padua was in the dominions of Venice, and he received a deputation from the ſenate before he reached it, promiſing him their protection and aſſiſtance in whatever he ſhould deſire. He rather experienced the treatment of a prince than of an exile, as they entertained the higheſt expectations from his great commercial knowledge. From this period his life may be conſidered as one continued ſcene of uninterrupted proſperity, and his family received education equal to that of the greateſt potentates. In his public and private charities he was almoſt unbounded, and perhaps poſſeſſed more wealth than any ſingle individual in Europe at that period. In his promotion of ſcience and encouragement of learned men he was truly exemplary, and from this ſource he acquired the greateſt honour and eſteem.

Medicis.

His foſtering hand protected the arts as well as the ſciences; and architecture, ſculpture, and painting, all flouriſhed under his powerful protection. The countenance he ſhewed to theſe arts was not ſuch as their profeſſors generally receive from the great; for the ſums of money which he expended on pictures, ſtatues, and public buildings, appear almoſt incredible. When he approached the period of his mortal exiſtence, his faculties were ſtill unimpaired; and 20 days before he died, he requeſted Ficino to tranſlate from the Greek the treatiſe of Xenocrates on death. He died on the 1ſt of Auguſt 1464, at the age of 75, and gave ſtrict injunctions, that his funeral ſhould be conducted with as much privacy as poſſible. By public decree he was honoured with the title of *Pater Patriæ*, an appellation which was inſcribed on his tomb, and was declared by competent judges, to be founded in real merit.

Medici, *Lorenzo de*, ſtiled, with great propriety, the Magnificent, was the grandſon of Coſmo, and about 16 years of age at his deceaſe. In 1469 his father died, and he ſucceeded to his authority as if it had conſtituted a part of his fortune. In the year 1474, Lorenzo incurred the diſpleaſure of the pope for the oppoſition he made to ſome of his encroachments on the petty princes of Italy, and for this reaſon he deprived him of the office of treaſurer of the Roman ſee, which he conferred on one Pazzi, connected with a Florentine family, the intereſt of which he thus ſecured, and intended to ſacrifice Lorenzo and Juliano to his private revenge. Their aſſaſſination was fixed for Sunday, April 26. 1478, and the cathedral was the place in which a monſter of an archbiſhop had reſolved to murder them by the inſtigation of the pope. When the people ſaw one of their favourites (Juliano) expiring, and the other (Lorenzo) covered with blood, their rage was not to be expreſſed in language. The interference of the magiſtrates was finally victorious, who had the courage and virtue to hang the archbiſhop from one of the windows, arrayed in his pontifical robes, which made Florence reſound with the acclamation—Medici, Medici! down with their enemies!

Lorenzo was delivered from that part of the cathedral to which he had fled for refuge, and was triumphantly carried home, where his wounds were attended to by men of ability. His friends in the mean time purſued the conſpirators, and ſpared none who happened to fall in their way. In a word, the generality of them were either hanged or decapitated, and very few had the good fortune to eſcape their uncommon vigilance. Much to the honour of Lorenzo, he exerted all his influence to prevent the indiſcriminate maſſacre of his cruel enemies, and reſtrain the juſt indignation of the people, begging that they would truſt the magiſtrates with the puniſhment of the guilty; and the reſpect in which he was held had the moſt aſtoniſhing effect in reſtraining the vengeance of popular indignation.

No ſooner had hoſtilities ceaſed between Pope Sextus and the Florentine republic, then Lorenzo began to develope plans for ſecuring the internal peace and tranquillity of Italy, by which the higheſt honour has been conferred on his political life. But the life of this great man was again brought into imminent danger by the intrigues of Cardinal Riario, and ſome Florentine exiles, who determined to aſſaſſinate him in the church of the Carmeli, on the feſtival of the Aſcenſion 1481; but the plot was happily diſcovered, the conſpirators were executed, and after this Lorenzo very ſeldom went abroad without being ſurrounded by a number of friends in whom he could ſecurely confide.

When we attentively examine the character of Lorenzo, it will not perhaps appear aſtoniſhing, that Italy, Chriſtendom, and even the Mahometans themſelves, conferred upon him the moſt flattering approbation. Even Prince Mirandola choſe Florence as the place of his reſidence entirely upon his account, and there ended his mortal career. To a moſt engaging perſon Lorenzo added almoſt every other accompliſhment. He was the favourite of the ladies, the envy of his own ſex, and the admiration of all. He was declared to be unrivalled in chivalry, and one of the moſt eminent orators that the world in any age has produced. According to the opinion of his contemporaries, he was even ſuperior to Julius Cæſar himſelf, except as a general, yet he would alſo have proved a moſt conſummate commander had not peace been always the darling of his ſoul. We recollect a memorable paſſage in the Rambler, which may here be appoſitely introduced. A great man condeſcending to do little things, is like the ſun in his weſtern declination; he remits his ſplendor, but retains his magnitude, and pleaſes more though he dazzles leſs. To ſuch little things did Lorenzo frequently ſubmit, often ſeeking pleaſure in his nurſery, and ſpending hours there in all the frivolous pranks of childiſh diverſion. The gravity of his life, if contraſted with its levity, muſt make him appear as a compoſition of two different perſons, incompatible, and, as it were, impoſſible to be joined the one with the other.

Such were the love and veneration of the citizens for Lorenzo, that the phyſician who attended him on his deathbed, terrified to return to Florence, left the houſe in a ſtate of diſtraction, and plunged himſelf into a well. When Ferdinand king of Naples was informed of his death, he cried out, "This man has lived long enough for his own glory, but too ſhort a time for Italy." He died on the 8th of April 1492, amidſt a number of his weeping friends, who appeared deeply conſcious of ſuch an irreparable loſs.

MEDICIS, *John de*, on account of his bravery and knowledge in military affairs, was ſurnamed the *Invincible*. He was the ſon of John, otherwiſe called *Jourdain*, de Medicis. His only ſon Coſmo I. ſtyled the *Great*, was choſen duke of Florence after the murder of Alexander de Medicis, A. D. 1537. He firſt carried arms under Laurence de Medicis againſt the duke of Urbino, afterwards under Pope Leo X. Upon the death of Leo, he entered into the ſervice of Francis I. which he quitted to follow the fortune of Francis Sforza duke of Milan. When Francis I. formed an alliance with the pope and the Venetians againſt the emperor, he returned to his ſervice. He was wounded in the knee at Governola, a ſmall town in the Mantuan territory, by a muſket ball; and being carried to Mantua, he died the 29th of November 1526, aged 28. Brantome relates, that when his leg was to be cut off, and when he was informed that he needed ſome perſon to ſupport him, "Proceed without fear (ſaid he), I need nobody!" and he held the candle himſelf during the operation. This anecdote is alſo mentioned by Varchi. John de Medicis was above the middle ſtature, ſtrong, and nervous. His ſoldiers, to expreſs their affection for him and their concern for his loſs, aſſumed a mourning dreſs and ſtandards, which gave the name of *the black band* to the Tuſcan troops whom he commanded.

MEDICIS, *Laurence*, or *Laurenein de*, was deſcended from a brother of Coſmo the Great, and affected the name of *popular*. In 1537, he killed Alexander de Medicis, whom Charles V. had made duke of Florence, and who was believed to be the natural ſon of Laurence de Medicis duke of Urbino. He was jealous of Alexander's power, and diſguiſed this jealouſy under the ſpecious pretext of love to his country. He loved men of learning, and cultivated literature. His works are, 1. *Lamenti*, Modena, 12mo. 2. *Acidoſio Commedia*, Florence 1595, 12mo. He died without iſſue.

MEDICIS, *Hypolitus de*, natural ſon of Julian de Medicis and a lady of Urbino, was early remarkable for the brilliancy of his wit and the graces of his perſon. Pope Clement VII. his couſin, made him cardinal in 1529, and ſent him as legate into Germany to the court of Charles V. When that prince went into Italy, Medicis, yielding to his warlike diſpoſition,

Medicis

appeared in the dreſs of an officer, and advanced before the emperor, followed by ſeveral reſpectable gentlemen of the court. Charles, naturally ſuſpicious, and afraid that the legate intended to do him ſome ill offices with the pope, ſent after him and cauſed him to be apprehended. But when he underſtood that it was a mere ſally of humour in the young cardinal, he ſet him at liberty in a few days. The character which Medicis obtained by the happy ſucceſs of this appointment was of eſſential ſervice to him. He was conſidered as one of the ſupports of the Holy See; and a little before Clement's death, when the corſair Barbaroſſa made a deſcent into Italy to the great terror of Rome, which was only defended by 200 of the pope's guards, Medicis was deſpatched to protect the coaſts from the fury of the barbarians. On his arrival at the place of deſtination, he was fortunate enough to find that Barbaroſſa had withdrawn himſelf at that critical moment; which allowed him to claim the honour of the retreat without expoſing his perſon or his army. When he returned to Rome, he was of great ſervice in the election of Paul III. who nevertheleſs refuſed to make him legate to Ancona, though that office had been promiſed to him in the conclave. Enraged alſo that the pope had beſtowed the principality of Florence on Alexander de Medicis, ſuppoſed to be the natural ſon of Laurence duke of Urbino, he was prompted by his ambition to believe that he might ſucceed to that dignity by the deſtruction of Alexander. He entered into a conſpiracy againſt him, and determined to carry him off by a mine; but the plot was diſcovered before he had accompliſhed his purpoſe. Octavian Zanga, one of his guards, was arreſted as his chief accomplice. Hypolitus de Medicis, apprehenſive for his own ſafety, retired to a caſtle near Tivoli. On his road to Naples, he fell ſick at Itri in the territory of Fondi, and died Auguſt 13. 1535, in his 24th year, not without ſuſpicion of being poiſoned. His houſe was an aſylum for the unfortunate, and frequently for thoſe who were guilty of the blackeſt crimes. It was open to men of all nations; and he was frequently addreſſed in twenty different languages. He had a natural ſon named *Aſdrubal de Medicis*, who was a knight of Malta. This anecdote proves that his manners were more military than eccleſiaſtic. He wore a ſword, and never put on the habit of cardinal except on occaſions of public ceremony. He was wholly devoted to the theatre, hunting, and poetry.

Medicis, *Alexander de*, firſt duke of Florence in 1530, was natural ſon of Laurence de Medicis ſurnamed the *Younger*, and nephew of Pope Clement VII. He owed his elevation to the intrigues of his uncle and to the arms of Charles V. This prince having made himſelf maſter of Florence after an obſtinate ſiege, conferred the ſovereignty of this city on Alexander, and afterwards gave him in marriage Margaret of Auſtria his natural daughter. According to the terms of capitulation granted to the Florentines, the new duke was to be only hereditary doge, and his authority was tempered by councils; which left them at leaſt a ſhadow of their ancient liberty. But Alexander, who felt himſelf ſupported by the emperor and the pope, was no ſooner in poſſeſſion of his new dignity, than he began to govern like a tyrant; being guided by no law but his own caprice, indulging the moſt brutal paſſions, and making light of diſhonouring families, and of violating even the aſylum of the cloiſters to gratify his luſt. Among the confidants of his debauchery was a relation of his own, Laurence de Medicis. This young man, who was only 22 years of age, at the inſtigation of Philip Strozzi, a zealous republican, conceived the deſign of aſſaſſinating Alexander, and thereby of delivering his country from oppreſſion. From the moment when he firſt became attached to him, he tried to gain his confidence, for no other reaſon but that he might the better have it in his power to take away his life. A conſiderable time elapſed before he found ſuch an opportunity as he deſired. At length, under pretence of procuring the duke a *tête à tête* with a lady of whom he was deeply enamoured, he brought him alone and unattended into his chamber, and put him under his bed. He went out, under pretence of introducing the object of his paſſion; and returned along with an aſſaſſin by profeſſion, to whom alone he had entruſted his deſign, only to ſtab him. This cruel ſcene happened on the night betwixt the 5th and 6th of January 1537. Alexander was only 26 years of age. The Florentines derived no advantage from this crime of Laurence, for they failed in their attempt to recover their liberty. The party of the Medicis prevailed, and Alexander was ſucceeded by Coſmo; whoſe government, it muſt be confeſſed, was as juſt and moderate, as that of his predeceſſor had been violent and tyrannical. Laurence de Medicis fled to Venice, to ſome of the leaders of the malecontents at Florence, who had taken refuge there; but not thinking himſelf in ſufficient ſecurity, he went to Conſtantinople, whence he returned ſome time after to Venice. He was there aſſaſſinated in 1547, ten years after the duke's murder, by two ſoldiers, one of whom had formerly been in Alexander's guards: And theſe ſoldiers were generous enough to refuſe a conſiderable ſum of money, which was the price put upon his head.

Medicis, Medietas.

Medicis, *Coſmo de*, grand duke of Tuſcany, joined Charles V. againſt the French, after trying in vain to continue neutral. As a reward for his ſervices, the emperor added to the duchy of Tuſcany Piombino, the iſle of Elba, and other ſtates. Coſmo ſoon after received from Pope Pius IV. the title of *grand duke;* and had it not been oppoſed by all the princes of Italy, this pontiff, who was entirely devoted to Coſmo, becauſe he had thought proper to acknowledge him to be of his houſe, would have conferred on him the title of *king*. There never was a more zealous patron of learning. Ambitious of imitating the ſecond Cæſar, he like him, was fond of learned men, kept them near his perſon, and founded for them the univerſity of Piſa. He died in 1574, at the age of 55, after governing with equal wiſdom and glory. In 1562 he inſtituted the military order of St Stephen. His ſon, Francis Mary who died in 1587, was the father of Mary of Medicis, the wife of Henry the Great and of Ferdinand I. who died in 1608.

MEDIETAS linguæ, in *Law*, ſignifies a jury, or inqueſt impanelled, of which the one half are natives of this land and the other foreigners. This jury is never uſed except where one of the parties in a plea is a ſtranger and the other a denizen. In petit treaſon, murder, and felony, foreigners are allowed this privilege; but not in high treaſon, becauſe an alien in that caſe ſhall be tried according to the rules of the common law, and not by a *medictas linguæ*. A grand jury ought not in any caſe to be of a *medietas linguæ*; and the perſon that would have the advantage of a trial in this way, is to pray the ſame, otherwiſe it will not be permitted on a challenge of the jurors.

MEDIMNUS, in Grecian antiquity, a meaſure of capacity. See MEASURE.

MEDINA TALNARI, a famous town of Arabia Petræa, between Arabia Deſerta and Arabia the Happy; celebrated for being the burial-place of Mahomet. It ſtands at a day's journey from the port of Iambo. It is of moderate ſize, ſurrounded by wretched walls, and ſituated in the midſt of a ſandy plain. It belongs to the ſcherif of Mecca, although it had of late times a particular ſovereign of the family of Dacii Barkad. At preſent, the government is confided by the ſcherif to a vizir, who muſt be taken from the family of the ſovereign. Before Mahomet, this city was called *Iathreb*; but it got the name of *Medinet en Nebbi*, "the City of the Prophet," after Mahomet, being driven from Mecca by the Koreiſchites, had taken refuge there, and paſſed in it the reſt of his days. The tomb of Mahomet at Medina is reſpected by Muſſulmans, but they are under no obligation to viſit it for the purpoſes of devotion. The caravans of Syria and Egypt alone, which on their return from Mecca paſs near Medina, go a little out of their way to ſee the tomb. It ſtands in a corner of the great ſquare, whereas the Kaba is ſituated in the middle of that at Mecca. That the people may not perform ſome ſuperſtitious worſhip to the relics of the prophet, they are prevented from approaching the tomb by grates, through which they may look at it. It conſiſts of a piece of plain maſon work in the form of a cheſt, without any other monument. The tomb is placed between two others, where the aſhes of the two firſt caliphs repoſe. Although it is not more magnificent than the tombs of the greater part of the founders of moſques, the building that covers it is decorated with a piece of green ſilk ſtuff embroidered with gold, which the pacha of Damaſcus renews every ſeven years. It is guarded by 40 eunuchs, who watch the treaſure ſaid to be depoſited there. It is ſeated in a plain abounding with palm trees, in E. Long. 39. 53. N. Lat. 25. See (*Hiſtory of*) ARABIA.

Medina Celi, an ancient town of Spain, in Old Caſtile, and capital of a conſiderable duchy of the ſame name; ſeated near the river Xalon, in W. Long. 2. 9. N. Lat. 41. 15.

Medina de-las-Torres, a very ancient town of Spain, in Eſtremadura, with an old caſtle, and the title of a duchy. It is ſeated on the confines of Andaluſia, at the foot of a mountain near Bajadoz.

Medina del-Campo, a large, rich, and ancient town of Spain, in the kingdom of Leon. The great ſquare is very fine, and adorned with a ſuperb fountain. It is a trading place, enjoys great privileges, and is ſeated in a country abounding with corn and wine. W. Long. 4. 20. N. Lat. 41. 22.

Medina-del-rio-Secco, an ancient and rich town of Spain, in the kingdom of Leon, with the title of a duchy: ſeated on a plain, remarkable for its fine paſtures. E. Long. 4. 33. N. Lat. 42. 8.

MEDINA, SIR JOHN, an eminent painter, was ſon of Medina de l'Aſturias, a Spaniſh captain who ſettled at Bruſſels, where the ſon was born in 1660. He was inſtructed in painting by Du Chatel; under whoſe direction he made great progreſs; and applying himſelf to the ſtudy of Rubens, made that eminent maſter his principal model. He painted both hiſtory and portrait; and was held in extraordinary eſteem by moſt of the princes of Germany, who diſtinguiſhed his merit by ſeveral marks of honour. He married young, and came into England in 1686, where he drew portraits for ſeveral years with great reputation; as he painted thoſe ſubjects with remarkable freedom of touch, a delicate management of tints, and ſtrong reſemblance of the perſons. The earl of Leven encouraged him go to Scotland, and procured him a ſubſcription of 500l. worth of buſineſs. He went, carrying a large number of bodies and poſtures, to which he painted heads. He returned to England for a ſhort time; but went back to Scotland, where he died, and was buried in the churchyard of the Grayfriars at Edinburgh in 1711, aged 52. He painted moſt of the Scotch nobility. Two ſmall hiſtory pieces, and the portraits of the profeſſors, in the Surgeons Hall at Edinburgh, were alſo painted by him. At Wentworth caſtle is a large piece containing the firſt duke of Argyll and his ſons, the two late dukes John and Archibald, in Roman habits; the ſtyle Italian, and ſuperior to moſt modern performers. The duke of Gordon preſented Sir John Medina's head to the great duke of Tuſcany for his collection of portraits done by the painters themſelves; the duke of Gordon too was drawn by him, with his ſon the marquis of Huntley and his daughter Lady Jane, in one piece. Medina was knighted by the duke of Queenſberry, lord high commiſſioner; and was the laſt knight made in Scotland before the union. The prints in the octavo edition of Milton were deſigned by him; and he compoſed another ſet for Ovid's Metamorphoſes, but they were never engraved.

MEDINE, an Egyptian piece of money, of iron ſilvered over, and about the ſize of a ſilver threepenee.

MEDIOLANUM, an ancient city, the capital of the Inſubres, built by the Gauls on their ſettlement in that part of Italy; a *municipium*, and a place of great ſtrength; and a ſeat of the liberal arts; whence it had the name of *Novæ Athenæ*. Now *Milan*, capital of the Milaneſe, ſituated on the rivers Olana and Lombro, E. Long. 9. 30. N. Lat. 45. 25.

Mediolanum Aulercorum, in *Ancient Geography*, a town of Gallia Celtica, which afterwards took the name of the *Eburovicum Civitas* (Antonine); corrupted to *Civitas Ebroicorum*, and this laſt to *Ebroica*; whence the modern appellation *Evreux*, a city of Normandy. E. Long. 1. 12. N. Lat. 49. 21.

Mediolanum Gugernorum, in *Ancient Geography*, a town of Gallia Belgica; now the village *Moyland*, not far from Cologne.

Mediolanum Ordovicum, in *Ancient Geography*, a town of Britain, now *Llan Vethlin*, a market town of Montgomeryſhire in Wales.

Mediolanum Santonum, in *Ancient Geography*, which afterwards taking the name of the people, was called *Santonica Urbs;* alſo *Santones* and *Santoni:* A town of Aquitaine. Now *Saintes*, capital of Saintonge in Guienne, on the river Charente.

MEDIOMATRICI, anciently a territory of Belgica. Now the dioceſe of Metz.

MEDITATION, an act by which we conſider any thing cloſely, or wherein the ſoul is employed in the ſearch or conſideration of any truth. In our religion, it is uſed to ſignify a conſideration of the objects and grand truths of the Chriſtian faith.

Myſtic divines make a great difference between *meditation* and *contemplation:* the former conſiſts in diſcurſive acts of the ſoul, conſidering methodically and with attention the myſteries of faith and the precepts of morality; and is performed by reflections and reaſonings, which leave behind them manifeſt impreſſions on the brain. The pure contemplative have no need of meditation, as ſeeing all things in God at a glance, and without any reflection. When a man, therefore, has once quitted meditation, and is arrived at contemplation, he returns no more; and, according to Alvarez, never reſumes the oar of meditation, except when the wind of contemplation is too weak to fill his ſails.

MEDITERRANEAN, ſomething encloſed within land; or that is remote from the ocean.

MEDITERRANEAN is more particularly uſed to ſignify that large ſea which flows between the continents of Europe and Africa, entering by the ſtraits of Gibraltar, and reaching into Aſia, as far as the Euxine ſea and the Palus Mæotis.

The Mediterranean was anciently called the *Grecian ſea* and the *Great ſea*. It is now cantoned out into ſeveral diviſions, which bear ſeveral names. To the weſt of Italy it is called the *Liguſtic* or *Tuſcan ſea;* near Venice, the *Adriatic;* towards Greece, the *Ionic* and *Ægean;* between the Helleſpont and the Boſphorus, the *White ſea*, as being very ſafe; and beyond, the *Black ſea*, its navigation being dangerous.

The Britiſh trade carried on by means of the Mediterranean ſea is of the laſt conſequence to Great Britain; and the permanent preſervation thereof depends on the poſſeſſion of the town and fortification of Gibraltar.

The counterfeiting of Mediterranean paſſes for ſhips to the coaſt of Barbary, &c. or the ſeal of the admiralty office to ſuch paſſes, is felony without benefit of clergy. Stat. 4. Geo. II. c. 18.

MEDITRINALIA, a Roman feſtival in honour of the goddeſs Meditrina, kept on the 30th of September. Both the deity and the feſtival were ſo called *à medendo*, becauſe on this day they began to drink new wine mixed with old by way of medicine. The mixture of wines, on this feſtival, was drank with much form and ſolemn ceremony.

MEDITULLIUM, is uſed by anatomiſts for that ſpongy ſubſtance between the two plates of the *cranium*, and in the interſtices of all laminated bones. See ANATOMY, N° 1. 11.

MEDIUM, in *Logic*, the mean or middle term of a ſyllogiſm, being an argument, reaſon, or conſideration, for which we affirm or deny any thing; or, it is the cauſe why the greater extreme is affirmed or denied of the leſs in the concluſion.

MEDIUM, in *Arithmetic*, or *arithmetical medium* or *mean*, called in the ſchools *medium rei;* that which is equally diſtant from each extreme, or which exceeds the leſſer extreme as much as it is exceeded by the greater, in reſpect of quantity, not of proportion; thus 9 is a medium betwixt 6 and 12.

Geometrical MEDIUM, called in the ſchools *medium perſonæ*, is that where the ſame ratio is preſerved between the firſt and ſecond as between the ſecond and third terms; or that which exceeds in the ſame ratio or quota of itſelf, as it is exceeded: thus 6 is a geometrical medium between 4 and 9.

MEDIUM, in *Philoſophy*, that ſpace or region through which a body in motion paſſes to any point: thus æther is ſuppoſed to be the medium through which the heavenly bodies move; air, the medium wherein bodies move near our earth; water, the medium wherein fiſhes live and move; and glaſs is alſo a medium of light, as it affords it a free paſſage. That denſity or conſiſtency in the parts of the medium, whereby the motion of bodies in it is retarded, is called the *reſiſtance of the medium;* which, together with the force of gravity, is the cauſe of the ceſſation of the motion of projectiles.

Subtle or *Ætherial* MEDIUM. Sir Iſaac Newton conſiders it probable, that, beſide the particular aëreal medium, wherein we live and breathe, there is another more univerſal one, which he calls an *æthereal medium;* vaſtly more rare, ſubtle, elaſtic, and active, than air, and by that means freely permeating the pores and interſtices of all other mediums, and diffuſing itſelf through the whole creation; and by the intervention hereof he thinks it is that moſt of the great phenomena of nature are effected. See ÆTHER, ELECTRICITY, FIRE, &c.

MEDIUM, in optics, any ſubſtance through which light is tranſmitted.

MEDLAR, See MESPILUS, BOTANY *Index*.

MEDULLA OSSIUM, or *MARROW of the bones*. See ANATOMY, N° 5.

MEDULLA cerebri and *cerebelli*, denotes the white ſoft part of the brain and cerebellum, covered on the outſide with the cortical ſubſtance, which is of a more dark or aſhy colour. See ANATOMY, N° 131—133.

MEDULLA oblongata, is the medullary part of the brain and cerebellum, joined in one; the fore part of it coming from the brain, and the hind part from the cerebellum. See ANATOMY, N° 134.

It lies on the baſis of the ſkull, and is continued through the great perforation thereof into the hollow of the vertebræ of the neck, back, and loins; though only ſo much of it retains the name *oblongata* as is included within the ſkull. After its exit thence it is diſtinguiſhed by the name of *medulla ſpinalis*. *Ibid.* N° 135.

MEDUSA, in fabulous hiſtory, one of the three Gorgons, daughter of Phorcys and Ceto. She was the only one of the Gorgons who was ſubject to mortality. She is celebrated for her perſonal charms and the beauty of her locks. Neptune became enamoured of her, and obtained her favours in the temple of Minerva. This violation of the ſanctity of the temple provoked Minerva; and ſhe changed the beautiful locks of Meduſa, which had inſpired Neptune's love, into ſerpents, the ſight of which turned the beholders into ſtones: but Perſeus, armed with Mercury's axe, with which he killed Argus, cut off Meduſa's head, from whoſe blood ſprang Pegaſus and Chryſaor, together with the innumerable ſerpents that infeſt Africa. The conqueror placed Meduſa's head on the ægis of Minerva, which he had uſed in his expedition; and the head ſtill retained the ſame petrifyng powers as before.

MEDUSA, a genus of vermes, belonging to the order of molluſca. See HELMINTHOLOGY *Index*.

MEDWAY, a river of England, riſes in the Weald of Suſſex, and entering Kent near Aſhurſt, runs by Tunbridge, and thence continues its courſe towards Maidſtone. It is navigable for large ſhips to Rocheſter bridge, and thence for veſſels and barges to Maidſtone, the tide flowing up to that town. The diſtance between the mouth of this river, where the fort at Sheerneſs is erected, and Rocheſter bridge, is between 16 and 18 miles. In this part of the river, the channel is ſo deep, the banks ſo ſoft, and the reaches ſo ſhort, that it is one of the beſt and ſafeſt harbours in the world; and ſhips of 80 guns ride afloat at low water, within muſket ſhot of Rocheſter bridge. Nor is there a ſingle inſtance upon record, that any of the royal navy ever ſuffered here by ſtorms, except in the dreadful tempeſt which happened in November 1703, when the Royal Catharine was ſunk and loſt. On the ſhore of this river are two caſtles, one at Upnor, which guards two reaches of the river, and is ſuppoſed to defend all the ſhips which ride above, between that and the bridge; on the other ſide of the river is Gillingham caſtle, built for the ſame purpoſe, and well furniſhed with cannon, which commands the river. Beſides theſe, there is a platform of guns at a place called the Swam, and another at Cockhamwood. But the principal fortification on this river is the caſtle at Sheerneſs.

MEEREN, or MEER, JOHN VANDER, called the *Old*, an eſteemed painter, was born in 1627. He choſe for his ſubjects ſea-pieces, landſcapes, and views of the ſea and its ſhores; which he painted with great truth, as he had accuſtomed himſelf to ſketch every ſcene after nature. The ſituations of his landſcapes are agreeably choſen, frequently they are ſolemn, and generally pleaſing. The forms of his trees are eaſy and natural, his diſtances well obſerved, and the whole ſcenery has a ſtriking effect, by a happy oppoſition of his lights and ſhadows. He alſo painted battles in an agreeable ſtyle, as they ſhowed good compoſition, were touched with ſpirit, and had a great deal of tranſparence in the colouring. He died in 1690.

MEEREN, or MEER, *John Vander*, called *De Jonghe*, an eminent landſcape painter, is ſuppoſed to have been the ſon of the old John Vander Meer, and of whom he learned the firſt rudiments of the art; but being in his youth deprived of his inſtructor before he had made any great progreſs, he became a diſciple of Nicholas Berghem, and was accounted the beſt of thoſe who were educated in the ſchool of that admired maſter. In the manner of his maſter, he painted landſcapes and cattle; and his uſual ſubjects are cottages, with peaſants at their rural occupations and diverſions. It is obſerved of him, that he very rarely introduced cows, horſes, or any other ſpecies of animals, except goats and ſheep; the latter of which are ſo highly finiſhed, that one would imagine the wool might be felt by the ſoftneſs of its appearance. His touch is ſcarce perceptible, and yet the colours are admirably united. He died in 1688. The genuine works of this Vander Meer bear a very high price, and are eſteemed even in Italy, where they are admitted into the beſt collections; but the ſcarcity of them has occaſioned many moderate copies after his works to be paſſed on the undiſcerning for real originals.

MEGALE POLIS, in *Ancient Geography*, dividedly (Ptolemy, Pauſanius); or conjunctly *Megalopolis*, (Strabo): A town of Arcadia, built under the auſpices of Epaminondas, after the battle of Leuctra; many inconſiderable towns being joined together in one great city, the better to withſtand the Spartans. It was the greateſt city of Arcadia, according to Strabo.

MEGALESIA, and MEGALENSES LUDI, feaſts and games in honour of Cybele or Rhea the mother of the gods, kept on the 12th of April by the Romans, and famous for great rejoicings and diverſions of various ſorts. The Galli carried the image of the goddeſs along the city, with ſound of drums and other muſic, in imitation of the noiſe they made to prevent Saturn from hearing the cries of his infant ſon Jupiter, when he was diſpoſed to devour him.

MEGARA, *Ancient Geography*, a noble city, and the capital of the teritory of Megaris, which for many years carried on war with the Corinthians and Athenians. It had for ſome time a ſchool of philoſophers, called the *Megarici*, ſucceſſors of Euclid the Socratic, a native of Megara. Their dialect was the Doric; changed from the Attic, which it formerly had been, becauſe of Peloponneſian coloniſts who ſettled there.

Megara was ſituated at a diſtance from the ſea. Its port was called *Niſæa*, from Niſus ſon of Pandion the ſecond, who obtained Megaris for his portion, when the kingdom of Athens was divided into four lots by his father. He founded the town, which was eighteen ſtadia or two miles and a quarter from the city, but united with it, as the Piræus with Athens, by long walls. It had a temple of Ceres. "The roof (ſays Pauſanias) may be ſuppoſed to have fallen through age." The ſite (as Dr Chandler informs us *) is now covered with rubbiſh, among which are ſtanding ſome ruinous churches. The place has been named from them *Dode Eccleſiais*, "The Twelve Churches;" but the number is reduced to ſeven. The acropolis or citadel, called alſo *Niſæa*, was on a rock by the ſea ſide. Some pieces of the wall remain, and a modern fortreſs has been erected on it, and alſo on a leſſer rock near it.

The village Megara (continues the doctor) conſiſt of low mean cottages pleaſantly ſituated on the ſlop of a brow or eminence indented in the middle. On each ſide of this vale was an acropolis or citadel; one named Caria; the other from Alcathous, the builder of the wall. They related, that he was aſſiſted by Apollo, who laid his harp aſide on a ſtone, which, as Pauſanias teſtifies, if ſtruck with a pebble returned a muſical ſound. An angle of the wall of one citadel is ſeen by a windmill. The maſonry is of the ſpecies called Incertum. In 1676 the city wall was not entirely demoliſhed, but comprehended the two ſummits, on which are ſome churches, with a portion of the plain toward the ſouth. The whole ſite, except the hills, was now green with corn, and marked by many heaps of ſtones, the collected rubbiſh of buildings. A few inſcriptions are found, with pedeſtals fixed in the walls and inverted; and alſo ſome maimed or

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* *Travels in Greece*, p. 192.

mutilated ſtatues. One of the former relates to Atticus Herodes, and is on a pedeſtal which ſupported a ſtatue erected to him when conſul, A. D. 143. by the council and people of Megara, in return for his benefactions and good will toward the city. In the plain behind the ſummits, on one of which was a temple of Minerva, is a large baſin of water, with ſcattered fragments of marble, the remains of a bath or of a fountain, which is recorded as in the city, and remarkable for its ſize and ornaments, and for the number of its columns. The ſpring was named from the local nymphs called Sithnides.

The ſtone of Megara was of a kind not diſcovered any where elſe in Hellas; very white, uncommonly ſoft, and conſiſting entirely of cockle ſhells. This was chiefly uſed; and, not being durable, may be reckoned among the cauſes of the deſolation at Megara, which is ſo complete, that one ſearches in vain for veſtiges of the many public edifices, temples, and ſepulchres, which once adorned the city.

Megara was engaged in various wars with Athens and Corinth, and experienced many viciſſitudes of fortune. It was the only one of the Greek cities which did not reflouriſh under their common benefactor Hadrian; and the reaſon aſſigned is, that the avenging anger of the gods purſued the people for their impiety in killing Anthemocritus, a herald, who had been ſent to them in the time of Pericles. The Athenian generals were ſworn on his account to invade them twice a-year. Hadrian and Atticus were followed by another friend, whoſe memory is preſerved by an inſcription on a ſtone lying near a church in the village:—"This too is the work of the moſt magnificent count Diogenes ſon of Archelaus, who regarding the Grecian cities as his own family, has beſtowed on that of the Megarenſians one hundred pieces of gold towards the building of their towers, and alſo one hundred and fifty more, with two thouſand two hundred feet of marble toward re-edifying the bath; deeming nothing more honourable than to do good to the Greeks, and to reſtore their cities." This perſon is not quite unnoticed in hiſtory. He was one of the generals employed by the emperor Anaſtaſius on a rebellion in Iſauria. He ſurpriſed the capital Claudiopolis, and ſuſtained a ſiege with great bravery, A. D. 494.

Megara retains its original name. It has been much infeſted by corſairs; and in 1676 the inhabitants were accuſtomed, on ſeeing a boat approach in the day time or hearing their dogs bark at night, immediately to ſecrete their effects and run away. The vaiwode or Turkiſh governor, who reſided in a forſaken tower above the village, was once carried off. It is no wonder, therefore, that Niſæa has been long abandoned. The place was burned by the Venetians in 1687.

Megara, in *Ancient Geography*, formerly called *Hybla*, a town towards the eaſt coaſt of Sicily; extinct in Strabo's time, though the name Hybla remained on account of the excellence of its honey. It was a colony of Megareans from Greece. *Riſus Megaricus* denotes a horſe laugh.

MEGARIS, in *Ancient Geography*, the country of the Megareans, is deſcribed as a rough region, like Attica: the mountain called *Oneian* or the Aſinine, now *Macriplayi* or "the long Mountain," extending through it towards Bœotia and Mount Cithæron. It belonged to Ionia or Attica, until it was taken by the Peloponneſians in the reign of Codrus, when a colony of Dorians ſettled in it. This territory had Attica to the eaſt, Bœotia to the north and weſt, and the iſthmus of Corinth to the ſouth.

Megaris, a ſmall iſland in the Tuſcan ſea, joined to Naples by a bridge, now called *Caſtello dell'Ovo.*

MEGASTHENES, a Greek hiſtorian in the age of Seleucus Nicanor, about 300 years before Chriſt. He wrote about the oriental nations, and particularly the Indians. His hiſtory is often quoted by the ancients. What now paſſes as his compoſition is ſpurious.

MEGIDDO, in *Ancient Geography*, a town of Galilee, recited (Joſhua xvii. 11.) among the cities of Manaſſeh, in the tribe of Iſſachar or Aſſer, on the weſt ſide of Jordan; famous for the defeat of Ahaziah and Joſiah, who periſhed there (2 Kings xxiii. 29.): near it was an open plain, fit for drawing up an army in battle array. It was ſituated to the north, contrary to its poſition in the common maps. The Canaanites, being tributary to the Iſraelites, dwelt in it, Joſhua xvii.—It was rebuilt by Solomon, 1 Kings ix.

MEIBOMIUS, the name of ſeveral learned Germans.—*John Henry Meibomius* was profeſſor of phyſic at Helmſtadt, where he was born, and at Lubec; he wrote the Life of Mæcenas, publiſhed at Leyden in 4to, 1653, with ſeveral other learned works. *Henry*, his ſon, was born at Lubec in 1638; became profeſſor of phyſic at Helmſtadt; and, beſides works in his own profeſſion, publiſhed *Scriptores rerum Germanicarum*, 3 vols. folio, 1688; a very uſeful collection, firſt begun by his father.—*Marcus Meibomius*, of the ſame family, publiſhed a collection of ſeven Greek authors who had written upon ancient muſic, with a Latin verſion by himſelf, dedicated to Queen Chriſtina of Sweden, who invited him to her court. But ſhe engaging him one day to ſing an air of ancient muſic, while ſomebody was ordered to dance to it, the immoderate mirth which this occaſioned in the ſpectators ſo diſguſted him, that he immediately left the court of Sweden. His edition of the Greek mythologiſts, and notes upon Diogenes Laërtius in Menage's edition, ſhow him to have been a man of learning; but he ſuffered no little raillery for his attempt to correct the Hebrew text of the Bible, by a kind of metre he fancied he had found out in thoſe ancient writings.

MEISSEN, a conſiderable town of Germany, in the electorate of Saxony, and in the margravate of Miſnia, with a caſtle. It formerly belonged to the biſhop, but is now ſecularized, and the inhabitants are Lutherans. In this place is a famous manufactory of porcelain. E. Long. 13. 33. N. Lat. 51. 15.

MEL, HONEY, in the *Materia Medica*. See HONEY.

MELA, POMPONIUS, an ancient Latin writer, was born in the province of Bætica in Spain, and flouriſhed in the reign of the emperor Claudius. His three books of Coſmography, or *De ſitu orbis*, are written in a conciſe, perſpicuous, and elegant manner; and have been thought worthy of the attention and labours of the ableſt critics. Iſaac Voſſius gave an edition of them in 1658, 4to, with very large and copious notes. To this edition is added, *Julii Honorii oratoris excerptum coſmographiæ*, firſt publiſhed from the manuſcript, and *Æthici coſmographia.* Gronovius afterwards publiſhed another edition with illuſtrations by medals. In his laſt edition are added five books, *De Geographia*, written by ſome later author; by Jornandes, as Fabricius conjectures.

MELÆNE, or BLACK FLUX, in *Medicine*. See Medicine, N° 409.

MELALEUCA, a genus of plants belonging to the polydelphia claſs. See Botany *Index*.

MELAMPODIUM, a name given to black hellebore. See Helleborus, Botany *Index*.

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

MELAMPUS, in fabulous hiſtory, a celebrated ſoothſayer and phyſician of Argos, ſon of Amythaon and Idomenea or Dorippe. He lived at Pylos in Peloponneſus. His ſervants once killed two large ſerpents who had made their neſts at the bottom of a large oak; and Melampus paid ſo much regard to their remains, that he raiſed a burning pile and burned them upon it. He alſo took particular care of their young ones, and fed them with milk. Some time after this, the young ſerpents crept to Melampus as he ſlept on the graſs near the oak; and, as if ſenſible of the favours of their benefactor, they wantonly played around him, and ſoftly licked his ears. This awoke Melampus, who was aſtoniſhed at the ſudden change which his ſenſes had undergone. He found himſelf acquainted with the chirping of the birds, and with all their rude notes, as they flew around him. He took advantage of this ſupernatural gift, and ſoon made himſelf perfect in the knowledge of futurity, and Apollo alſo inſtructed him in the art of medicine. He had ſoon after the happineſs of curing the daughters of Prœtus, by giving them hellebore, which from that circumſtance has been called *melampodium;* and, as a reward for his trouble, he married the eldeſt of theſe princeſſes. The tyranny of his uncle Neleus, king of Pylos, obliged him to leave his native country; and Prœtus, to ſhow himſelf more ſenſible of his ſervices, gave him part of his kingdom. About this time the perſonal charms of Pero, the daughter of Neleus, had gained many admirers; but the father promiſed his daughter only to him who brought into his hands the oxen of Iphiclus. This condition diſpleaſed many; but Bias, who was alſo one of her admirers, engaged his brother Melampus to ſteal the oxen and deliver them to him. Melampus was caught in the attempt, and impriſoned; and nothing but his ſervices as a ſoothſayer and phyſician to Iphiclus would have ſaved him from death. All this pleaded in the favour of Melampus; but when he had taught the childleſs Iphiclus how to become a father, he not only obtained his liberty, but alſo the oxen; and with them he compelled Neleus to give Pero in marriage to Bias. A ſevere diſtemper, which had rendered the women of Argos inſane, was totally removed by Melampus; and Anaxagoras, who then ſat on the throne, rewarded his merit by giving him part of his kingdom, where he eſtabliſhed himſelf, and where his poſterity reigned during ſix ſucceſſive generations. He received divine honours after death, and temples were raiſed to his memory.

MELAMPYRUM, COW-WHEAT, a genus of plants belonging to the didynamia claſs; and in the natural method ranking under the 40th order, *Perſonatæ*. See Botany *Index*.

MELANCHOLY, a kind of delirium attended with gloomy thoughts, heavineſs, and ſorrow. See Medicine, N° 327.

MELANCTHON, Philip, born at Bretten in the Palatinate in 1495, was one of the wiſeſt and moſt able men of his age among the reformers, though of a mild temper, and diſpoſed to accommodate rather than to inflame diſputes. In his youth he made an admirable progreſs in learning, and was made Greek profeſſor at Wittenberg in 1509. Here his lectures upon Homer, and the Greek text of St Paul's Epiſtle to Titus, drew to him a great number of auditors, and entirely effaced the contempt to which his low ſtature and mean appearance had expoſed him. Melancthon reduced the ſciences to ſyſtems; and acquired ſuch reputation, that he had ſometimes 2500 auditors. He ſoon entered into an intimate friendſhip with Luther, who taught divinity in the ſame univerſity; and in 1519 they went together to Leipſic, to diſpute with Eccius. The following years he was continually engaged in various employments; he compoſed ſeveral books; he taught divinity; took ſeveral journeys, in order to found colleges and viſit churches; and in 1530 drew up a confeſſion of faith, which goes by the name of the *Confeſſion of Augsburg*, becauſe it was preſented to the emperor at the diet held in that city. All Europe was convinced, that he was not, like Luther, backward to accommodate the differences between the various ſects of Chriſtians. He hated religious diſputes, and was drawn into them only through the neceſſity of the part he was called to act in the world; and therefore would have ſacrificed many things to have produced an union among the Proteſtants. For this reaſon, Francis I. the French king, wrote to deſire him to come and confer with the doctors of the Sorbonne, in order to agree with them about putting an end to all controverſies; but though Luther endeavoured to perſuade the elector of Saxony to conſent to that journey, and though Melancthon himſelf deſired it, that prince, whether he diſtruſted Melancthon's moderation, or was afraid of quarrelling with the emperor Charles V. would never grant his permiſſion. The king of England alſo in vain deſired to ſee him. Melancthon, in 1529, aſſiſted at the conferences of Spires. In 1541, he was at the famous conferences at Ratiſbon. In 1543, he went to meet the archbiſhop of Cologne to aſſiſt him in introducing the reformation into his dioceſe; but that project came to nothing: and in 1548, he aſſiſted at ſeven conferences on the ſubject of the interim of Charles V. and wrote a cenſure on that interim, and all the writings preſented at theſe conferences. He was extremely affected at the diſſenſions raiſed by Flaccus Illyricus. His laſt conference with thoſe of the Roman communion was at Worms, in 1557. He died at Wittenberg in 1560, and was interred near Luther. Some days before he died, he wrote upon a piece of paper the reaſons which made him look upon death as a happineſs; and the chief of them was, that it "delivered him from theological perſecutions." Nature had given Melancthon a peaceable temper, which was but ill ſuited to the time he was to live in. His moderation ſerved only to be his croſs. He was like a lamb in the midſt of wolves. Nobody liked his mildneſs; it looked as if he was lukewarm; and even Luther himſelf was ſometimes angry at it.

Melancthon was a man in whom many good as well as great qualities were wonderfully united. He had great parts, great learning, great ſweetneſs of temper, moderation, contentedneſs, and the like, which would have made him very happy in any other times but thoſe in which he lived. He never affected dignities, or honours, or riches, but was rather negligent of all theſe things; too much ſo in the opinion of ſome, conſidering he had a family; and his ſon in-law Sabinus, who was of a more ambitious temper, was actually at variance with him upon this very account. Learning was infinitely obliged to him on many accounts; on none more than this, that, as already obſerved, he reduced almoſt all the ſciences which had been taught before in a vague irregular manner, into ſyſtems. Conſidering the diſtractions of his life, and the infinity of diſputes and tumults in which he was engaged, it is aſtoniſhing how he could find leiſure to write ſo many books. Their number is prodigious, inſomuch that it was thought neceſſary to publiſh a chronological catalogue of them in the year 1582. His works indeed are not correct, and he himſelf owned it: but as he found them uſeful, he choſe rather to print a great number, than to finiſh only a few: "which however (as Bayle ſays), was poſtponing his own glory to the advantage of others." His conſtitution was very weak, and required great tenderneſs and management; which made Luther, as hot and zealous as he was, blame him for labouring too earneſtly in the vineyard.

MELANIPPIDES, in fabulous hiſtory, a Greek poet about [illegible]20 years before Chriſt. His grandſon of the ſame name flouriſhed about 60 years after at the court of Perdiccas the Second, of Macedonia. Some fragments of their poetry are ſtill extant.

MELANTERIA, an old term in *Natural Hiſtory*, which ſeems to have been applied to copper pyrites.

The Greeks uſed it externally as a gentle eſcharotic and a ſtyptic, as an ingredient in their ointments for old ulcers, and alſo to ſprinkle in the form of powder on freſh wounds in order to ſtop the hæmorrhage.

MELASSES. See MOLASSES.

MELASTOMA, the AMERICAN GOOSEBERRY-TREE, a genus of plants belonging to the decandria claſs; and in the natural method ranking under the 17th order, *Calycanthemæ*. See BOTANY *Index*.

MELCHA, a ſmall village of Barbary, ſituated about 30 miles from the city of Tunis, built on the ruins of CARTHAGE, ſome of which are ſtill viſible.

MELCHITES, in church hiſtory, the name given to the Syriac, Egyptian, and other Chriſtians of the Levant. The Melchites, excepting ſome few points of little or no importance, which relate only to ceremonies and eccleſiaſtical diſcipline, are in every reſpect profeſſed Greeks; but they are governed by a particular patriarch, who reſides at Damas, and aſſumes the title of *patriarch of Antioch*. They celebrate maſs in the Arabian language. The religious among the Melchites follow the rule of St Baſil, the common rule of all the Greek monks. They have four fine convents diſtant about a day's journey from Damas, and never go out of the cloiſter.

MELCHISEDEC, or MELCHIZEDEK, king of Salem, and prieſt of the Moſt High. The ſcripture tells us nothing either of his father, or of his mother, or of his genealogy, or of his birth, or of his death. And in this ſenſe he was a figure of Jeſus Chriſt, as St Paul affirms, who is a prieſt for ever, according to the order of Melchiſedec, and not according to the order of Aaron, whoſe original, life, and death, are known. When Abraham returned from purſuing the four confederate kings, who had defeated the kings of Sodom and Gomorrah, and had taken away Lot Abraham's nephew along with them (Gen. xiv. 17, 18, 19, &c.) Melchiſedek came to meet Abraham as far as the valley of Shaveh, which was afterwards named the King's valley, preſented him with the refreſhment of bread and wine (or he offered bread and wine in ſacrifice to the Lord, for he was a prieſt of the moſt high God), and bleſſed him. Abraham, being deſirous to acknowledge in him the quality of prieſt of the Lord, offered him the tythes of all he had taken from the enemy. After this time, there is no mention made of the perſon of Melchiſedec; only the Pſalmiſt (cx. 4.) ſpeaking of the Meſſiah, ſays, "Thou art a prieſt for ever after the order of Melchiſedec." St Paul, in his epiſtle to the Hebrews, unfolds the myſtery which is concealed in what is ſaid of Melchiſedec in the Old Teſtament. See Heb. v. 6—10. An infinite number of difficulties and ſcruples have been ſtarted upon the ſubject of Melchiſedec.—St Jerome thought that Salem, of which Melchiſedec was king, was not Jeruſalem, but the city of Salem near Scythopolis, where they ſtill pretended to ſhow the ruins of the palace of this prince. The greatneſs and extent of theſe ruins are a ſufficient proof of the magnificence of this ancient building. He thinks it was at this city of Salem or Shalem, that Jacob arrived after his paſſage over Jordan, at his return from Meſopotamia (Gen. xxxiii. 18.). Some believe that Salem, where Melchiſedec reigned, is the ſame as Salim ſpoken of in the goſpel of St John, chap. iii. 23. From the time of Epiphanes there were names invented for the father and mother of Melchiſedec. To his father was given the name of Heraclas or Heracles, and to his mother that of Aſhtaroth or Aſtaria. It is generally agreed on by the learned, that when the apoſtle ſays, he was "without father and without mother," no more is meant, than that he is introduced into the hiſtory of Abraham without acquainting us who he was, or whence he came, where he lived, or when he died. Nevertheleſs, ſome have taken St Paul's words literally, and contended that he was not of human but divine nature. Origen and Didymus took him to be an angel; and the author of the Queſtions upon the Old and New Teſtament pretends, that he was the Holy Ghoſt, who appeared to Abraham in a human form. The Arabic Catena, upon the ninth chapter of Geneſis, makes Melchiſedec to be deſcended from Shem by his father, and from Japheth by his mother. Heraclas or Heraclim his father, was, they ſay, ſon or grandſon of Phaleg, and ſon of Heber; and his mother named Salathiel, was daughter of Gomer ſon of Japheth. Cedrenus and others derive Melchiſedec from an Egyptian ſtock. They ſay his father was called Sidon or Sida, and was the founder of the city of Sidon the capital of Phœnicia. Suidas ſays he was of the curſed race of Canaan; for which reaſon the ſcripture does not mention his genealogy. The Jews and Samaritans believed Melchiſedec to be the ſame with the patriarch Shem; which opinion has been followed by a great number of modern writers. M. Jurieu has undertaken to prove that he is the ſame as Cham or Ham. It would be endleſs to ſet down all the opinions upon this matter: therefore we ſhall only add, that Peter Cunæus and Peter du Moulin have aſſerted, that Melchiſedec who appeared to Abraham was the Son of God, and that the patriarch worſhipped him and acknowledged him for the Meſſiah.

About the beginning of the third century aroſe the hereſy of the Melchiſedecians, who affirmed that Melchiſedec was not a man, but a heavenly power, ſuperior to Jeſus Chriſt: for Melchiſedec, they ſaid, was the interceſſor and mediator of the angels, but Jeſus Chriſt was ſo only for men, and his prieſthood only a copy of that of Melchiſedec, who was the Holy Ghoſt.

We ſhall only beg leave to add here one opinion more concerning Melchiſedec, which is that of the learned Heidegger, who, as the author of the *Hiſt. Patriar.* thinks, has taken the right method of explaining the accounts of Moſes and the apoſtle Paul relating to this extraordinary perſon. He ſuppoſes a twofold Melchiſedec; the one hiſtorical, whereof Moſes gives an account in the 14th chapter of Geneſis, as that he was king as well as high prieſt of Jeruſalem; the other allegorical, whom St Paul deſcribes, and this allegorical perſon is Jeſus Chriſt.

As the hiſtory of this prince and prieſt is ſo little known, it is no wonder, as Selden obſerves, that many fabulous accounts have been invented of him; of which the following may ſuffice as a ſpecimen. Eutychus patriarch of Alexandria relates, that the body of Adam having been embalmed according to his order, was depoſited in a cave under a mountain of the children of Seth; but that Adam before his death had commanded that they ſhould take away his remains from that place, and tranſport them to the middle of the earth: that Noah, to follow the orders of his anceſtors, had preſerved the bodies of Adam and all the patriarchs with him in the ark: that finding himſelf near his death, he ordered his ſon Shem to take the body of Adam, to furniſh himſelf with bread and wine for his journey, to take with him Melchiſedec the ſon of Phaleg, and to go to the place in which an angel would ſhow them where to bury the firſt man: that Noah added this order, "Command Melchiſedec to fix his reſidence in that place, and to live unmarried all his lifetime, becauſe God has choſen him to do ſervice in his preſence; command him, that he build no temple, nor ſhed the blood of birds, nor four-footed beaſts, or any other animal; and that he offer no other oblations to God but bread and wine." This is the reaſon, according to this author, why Melchiſedec, when he met Abraham, brought forth only bread and wine.

A Greek author, under the name of Athanaſius, relates, that Miſchiſedec was the ſon of an idolatrous king called Melchi and of a queen called Salem.—Melchi, having reſolved to offer a ſacrifice to the gods, ſent his ſon Melchiſedec to fetch him ſeven calves. In the way the young prince was enlightened by God, and immediately returned to his father, to demonſtrate to him the vanity of his idols. Melchi, in wrath, ſent him back to fetch the victims. While he was abſent, the king ſacrificed his eldeſt ſon, and a great many other children, to his gods. Melchiſedec returning, and conceiving great horror at this butchery, retired to Mount Tabor, where he lived ſeven years, without clothes, and fed only on wild fruits. At the end of ſeven years, God appeared to Abraham, bid him go up to Mount Tabor, where he ſhould find Melchiſedec. He ordered him to clothe him, and to aſk his bleſſing; which Abraham having done, Melchiſedec anointed him with oil, and they came down together from the mountain.

MELCOMB-REGIS, a town of Dorſetſhire, in England, 130 miles from London, is ſituated at the mouth of the river Wey, by which it is parted from Weymouth. It appears from the name to have been anciently the king's demeſne, and from the records to have paid quit-rent to the crown all along after King Edward I. till it was bought off by the inhabitants before they were united to Weymouth. It lies on the north ſide of the haven, on a peninſula ſurrounded by the ſea on all ſides except on the north. The ſtreets are broad and well paved, and many of the houſes large and high. It ſent members to parliament in the reign of King Edward I. before Weymouth had that privilege. It was by parliament appointed a ſtaple in the reign of Edward III. In the next reign the French burnt it; and it was thereby rendered ſo deſolate, that the remaining inhabitants prayed and obtained a diſcharge from cuſtoms. On account of its quarrels with Weymouth, in the reign of Henry VI. its privileges as a port were removed to Pool: but in that of Queen Elizabeth they were reſtored to it by act of parliament, which was confirmed in the next reign, on condition that Melcomb and Weymouth ſhould make but one corporation, and enjoy their privileges in common; and to this was owing the flouriſhing ſtate of both. In the two reigns laſt mentioned, a wooden bridge with ſeventeen arches was built from hence to Weymouth; to which, as well as its church, the chief contributors were certain citizens of London; and upon its decay it was rebuilt in 1770. Here is a good market-place and town-hall, to which the members of the corporation of Weymouth come to attend public buſineſs, as the inhabitants do to its church for public worſhip. For ſeveral years paſt the ſea has retired from it on the eaſt, the priory formerly being bounded by the ſea; but there is now a ſtreet beyond it, from which it is ſeveral paces to the high water mark. The priory was ſituated in the eaſt part of the town, in Maiden ſtreet, whoſe ſite occupied about an acre, now covered with tenements. On the ſouth ſide are the remains of the chapel, now converted into a malt-houſe. Near it are the remains of an ancient building, formerly a nunnery. Here are three meeting houſes and a workhouſe for the poor. The church, which is in the middle of the town, has a wooden turret for a bell, and had been an old chapel. It was rebuilt in 1605, and made parochial, and is a handſome fabric, with a beautiful altarpiece painted and given by Sir James Thornhill. The port, which generally goes by the name of Weymouth, is ſaid to be the beſt frequented in the county, and is defended by Sandford and Portland caſtles. The markets for both towns are Tueſdays and Fridays, but there are no fairs. Melcomb-regis is reckoned bigger, more thriving, and populous than Weymouth. They are both but one corporation and borough, conſiſting of a mayor, recorder, two bailiffs, an uncertain number of aldermen, and twenty-four capital burgeſſes. Whoever has been a mayor is ever after an alderman. They ſend four burgeſſes to parliament, who are elected by ſuch as have freeholds, whether they are inhabitants or not; the number of voters is near 700. Every elector, as in London, has the privilege of voting for four perſons, who when choſen are returned, in two diſtinct indentures, as the burgeſſes of Weymouth and the burgeſſes of Melcomb-regis.

MELDÆ, in *Ancient Geography*, a town of Gallia Celtica. (called *Meldorum Civitas* in the Notitia), on the Matrona. Now *Meaux*, a city of Champagne, on the Marne, in France.

MELEAGER, in fabulous hiſtory, a celebrated hero, ſon of Œneus king of Calydonia, by Althæa daughter of Theſtius. The Parcæ were preſent at the moment of his birth, and predicted his future greatneſs. Clotho ſaid that he would be brave and courageous; Lacheſis foretold his uncommon ſtrength and valour: and Atropos ſaid that he ſhould live as long as that firebrand, which was on the fire, remained entire and unconſumed. Althæa no ſooner heard this, than ſhe ſnatched the ſtick from the fire, and kept it with the moſt jealous care, as the life of her ſon totally depended upon its preſervation. The fame of Meleager increaſed with his years; he ſignalized himſelf in the Argonautic expedition, and afterwards delivered his country from the neighbouring inhabitants, who made war againſt his father at the inſtigation of Diana, whoſe altars Œneus had neglected. But Diana puniſhed the negligence of Œneus by a greater calamity. She ſent a huge wild boar, which laid waſte all the country, and ſeemed invincible on account of its immenſe ſize. It became ſoon a public concern: all the neighbouring princes aſſembled to deſtroy this terrible animal; and nothing is more famous in mythological hiſtory, than the hunting of the Calydonian boar. The princes and chiefs that aſſembled, and which are mentioned by mythologiſts, were Meleager ſon of Œneus, Idas and Lynceus ſons of Aphareus, Dryas ſon of Mars, Caſtor and Pollux ſons of Jupiter and Leda, Pirithous ſon of Ixion, Theſeus ſon of Ægeus, Anceus and Cepheus ſons of Lycurgus, Admetus ſon of Pheres, Jaſon ſon of Æſon, Peleus and Telamon ſons of Æacus, Iphicles ſon of Amphitryon, Eurytrion ſon of Actor, Atalanta daughter of Schœneus, Iolas the friend of Hercules, the ſons of Theſtius, Amphiaraus ſon of Oileus, Protheus, Cometes, the brothers of Althæa, Hippothous ſon of Cercyon, Leucippus. Adraſtus, Ceneus, Phileus, Echion, Lelex, Phœnix ſon of Amyntor, Panopeus, Hyleus, Hippaſus, Neſtor, Menœtius the father of Patroclus, Amphicides, Laërtes the father of Ulyſſes, and the four ſons of Hippocoon. This troop of armed men attacked the boar, and it was at laſt killed by Meleager.—The conqueror gave the ſkin and the head to Atalanta, who had firſt wounded the animal. This irritated the reſt, and particularly Toxeus and Plexippus the brothers of Althæa, and they endeavoured to rob Atalanta of the honourable preſent. Meleager defended her, and killed his uncles in the attempt. Meantime the news of this celebrated conqueſt had already reached Calydon, and Althæa went to the temple of the gods to return thanks for the victory which her ſon had gained: But being informed that her brothers had been killed by Meleager, ſhe in the moment of reſentment threw into the fire the fatal ſtick on which her ſon's life depended, and Meleager died as ſoon as it was conſumed. Homer does not mention the firebrand; whence ſome have imagined that this fable is poſterior to that poet's age. But he ſays, that the death of Toxeus and Plexippus ſo irritated Althæa, that ſhe uttered the moſt horrible curſes and imprecations upon her ſon's head.

MELEAGER, a Greek poet, the ſon of Eucrates, was born at Seleucia in Syria, and flouriſhed under the reign of Seleucus VI. the laſt king of Syria. He was educated at Tyre; and died in the iſland of Coos, anciently called *Merope*. He there compoſed the Greek epigrams called by us the *Anthologia*. The diſpoſition of the epigrams in this collection was often changed afterwards, and many additions have been made to them. The monk Planudes put them into the order they are in at preſent, in the year 1380.

MELEAGRIS, the TURKEY; a genus of birds belonging to the order of gallinæ. See ORNITHOLOGY *Index*.

MELES, the BADGER. See URSUS, MAMMALIA *Index*.

MELES, in *Ancient Geography*, a fine river running by the walls of Smyrna in Ionia, with a cave at its head, where Homer is ſaid to have written his poems. And from it Homer takes his original name *Meleſigenes*, given him by his mother Critheis, as being born on its banks. (Herodotus).

MELETIANS, in eccleſiaſtical hiſtory, the name of a conſiderable party who adhered to the cauſe of Meletius biſhop of Lycopolis, in Upper Egypt, after he was depoſed, about the year 306, by Peter biſhop of Alexandria, under the charge of his having ſacrificed to the gods, and having been guilty of other heinous crimes; though Epiphanius makes his only failing to have been an exceſſive ſeverity againſt the lapſed. This diſpute, which was at firſt a perſonal difference between Meletius and Peter, became a religious controverſy; and the Meletian party ſubſiſted in the fifth century, but was condemned by the firſt council of Nice.

MELIA, AZADERACH, or the *Bead tree*, a genus of plants, belonging to the decandria claſs; and in the natural method ranking under the 23d order *Trihilatæ*. See BOTANY *Index*.

MELIANTHUS, HONEY FLOWER, a genus of plants belonging to the didynamia claſs; and in the natural method ranking under the 24th order *Corydales*. See BOTANY *Index*.

MELIBOEA, in *Ancient Geography*, an iſland of Syria, at the mouth of the Orontes; which, before it falls into the ſea, forms a ſpreading lake round it. This iſland was famous for its purple dye. Thought to be a colony of Theſſalians; and hence Lucretius's epithet, *Theſſalicus*.

MELICA, ROPEGRASS, a genus of the digynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 4th order *Gramina*. See BOTANY *Index*.

MELICERES, in *Surgery*, a kind of encyſted tumour,

mour, ſo called when their contents are of the conſiſtence of honey. See Tumour, Surgery *Index*.

MELICERTA, Melicertes, or *Melicertus*, in fabulous hiſtory, a ſon of Athamas and Ino. He was ſaved by his mother from the fury of his father, who prepared to daſh him againſt a wall as he had done his brother Learchus. The mother was ſo terrified that ſhe threw herſelf into the ſea with Melicerta in her arms. Neptune had compaſſion on the misfortunes of Ino and her ſon. He changed them both into ſea deities. Ino was called *Leucothoë* or *Matuta*; and Melicerta was known among the Greeks by the name of *Palæmon*, and among the Latins by that of *Portumnus*. Some ſuppoſe that the Iſthmian games were inſtituted in honour of Melicerta.

MELILLA, an ancient town of Africa, in the kingdom of Fez, and in the province of Garet. It was taken by the Spaniards in 1469, but returned back to the Moors. W. Long. 2. 9. N. Lat. 35. 20.

MELILOT. See Trifolium, Botany and Agriculture *Index*.

MELINDA, a kingdom on the eaſt coaſt of Africa, ſituated, according to ſome, between the third and fourth degree of ſouth latitude; though there is great diſagreement among geographers as to its extent. It is allowed by all, however, that the coaſts are very dangerous; being full of rocks and ſhelves, and the ſea at ſome ſeaſons very liable to tempeſts. The kingdom of Melinda is for the moſt part rich and fertile; producing almoſt all the neceſſaries of life except wheat and ice, both which are brought thither from Cambaya and other parts; and thoſe who cannot purchaſe them make uſe of potatoes in their ſtead, which are here fine, large, and in great plenty. They likewiſe abound with great variety of fruit trees, roots, plants, and other eſculents, and with melons of exquiſite taſte. They have alſo great plenty of veniſon, game, oxen, ſheep, hens, geeſe, and other poultry, &c. and one breed of ſheep whoſe tails weigh between 30 and 40 pounds. The capital city is alſo called *Melinda*.

MELINUM, in *Natural Hiſtory*, the name of an earth famous in the earlieſt ages of painting, being the only white of the great painters of antiquity; and, according to Pliny's account, one of the three colours with which alone they performed all their works. From the deſcription given of this earth it ſeems to be aluminous, tolerably pure, and in a ſtate of minute diviſion.

MELISSA, in fabulous hiſtory, a daughter of Meliſſus king of Crete, who with her ſiſter Amalthæa fed Jupiter with the milk of goats. She firſt found out the means of collecting honey; whence it has been fabled that ſhe was changed into a bee, as her name is the Greek word for that inſect.

Melissa, *Baum*, a genus of plants, belonging to the didynamia claſs; and in the natural method ranking under the 42d order *Verticillatæ*. See Botany *Index*.

MELISSUS of Samos, a Greek philoſopher, was the ſon of Rhagines and the diſciple of Parmenides; and lived about 440 B. C. He pretended that the univerſe is infinite, immoveable, and without a vacuum. Themiſtocles was among his pupils.

MELITE, in *Ancient Geography*, an iſland referred to Africa by Scylax and Ptolemy; but nearer Sicily, and allotted to it by the Romans: commended for its commodious harbours; for a city well built, with artificers of every kind, eſpecially weavers of fine linen; all owing to the Phœnicians, the firſt coloniſts. Now *Malta*; remarkable for St Paul's ſhipwreck. See Malta.

Melite, *Melita*, or *Melitina Inſula*; an iſland on the coaſt of Illyricum in the Adriatic. The *Catuli Melitæi* (Pliny) were famous. Now *Melede*, the name of the iſland Samos. See Samos.

Melite, in *Ancient Geography*, a town of Ionia, ſtruck out of the number of Ionian towns on account of the arrogance of the people, and Smyrna admitted in lieu of it. The ſituation not ſaid.

MELITENSIS terra, the *Earth of Malta*: an earth of which there are two very different kinds; the one of which is a bole, the other a marl. The latter is that known by medical authors under this name; the former is the Malta earth now in uſe; but both being brought from the ſame place, are confuſedly called by the ſame name. The Malteſe marl, which is the *terra Melitenſis* of medical authors, is a looſe, crumbly, and light earth, of an unequal and irregular texture; and, when expoſed to the weather, ſoon falls into fine ſoft powder: but when preſerved and dried, it becomes a looſe, light maſs, of a dirty white colour, with a grayiſh caſt: it is rough to the touch, adheres firmly to the tongue, is very eaſily crumbled to powder between the fingers, and ſtains the hands. Thrown into the water, it ſwells, and afterwards moulders away into a fine powder. It ferments very violently with acids. Both kinds are found in great abundance in the iſland of Malta, and the latter has been much eſteemed as a remedy againſt the bites of venomous animals. The other has ſupplied its place in the German ſhops; and is uſed there as a cordial, ſudorific, and aſtringent.

MELITO (canonized), biſhop of Sardis in Lydia, in the ſecond century; remarkable for the apology he preſented to the emperor Aurelius, in favour of the Chriſtians; on which Euſebius and the other ancient eccleſiaſtical writers beſtow great praiſes: but that apology and all Melito's other works are loſt.

MELITUS, a Greek orator and poet, the accuſer of Socrates. The Athenians, after the death of Socrates, diſcovering the iniquity of the ſentence they had paſſed againſt that great philoſopher, put Melitus to death, 400 B. C.

MELLER, a lake of Sweden. 80 miles long, and 30 broad; on which ſtands the city of Stockholm.

MELLI, with the country of the Mundingoes, in Africa. The country formerly called *Melli*, now chiefly inhabited by the Mundingoes, who ſtill retain pretty much of the character aſcribed to the people of Melli, lies to the ſouth of the river Gambia; on the weſt it borders on the kingdom of Kabo; on the ſouth it has *Melli*, properly ſo called, and the mountains that part it from Guinea; and on the eaſt it extends to the kingdom of Gago. With a great part of this country we are little acquainted, as is thecaſe with regard to moſt of the inland territories of Africa; but towards the ſea coaſt this country is a little better known.

The firſt place of note we meet with is Kachao, a Portugueſe colony, ſituated on the river of St Domingo, which falls into the ſea about 26 leagues below this town.—About 26 leagues above Kachao, on th ſame ſide of the river, is another trading town called *Farini*, where, in the months of October and November, one may trade for about half the quantity of wax and ivory which is traded for at Kachoa. Here are alſo ſome ſlaves to be bought.—Bot is a village near the mouth of the river Geſves, where moſt of the traders buy rice; which is in great plenty there, and very good.—Geſves is a village on a river of the ſame name, on which the Portugueſe have a factory. At Geſves one may trade yearly for 250 ſlaves, 80 or 100 quintals of wax, and as many of ivory. Near the mouth of the river of Geſves is a village called *Kurbali*, where there is a conſiderable trade for ſalt; here are alſo ſome ſlaves and ivory. Rio Grande, or the Great River, runs about 10 or 12 leagues to the ſouth of the river of Geſves. About 80 leagues from the mouth of it is a nation of negroes, who are conſiderable traders in ivory, rice, millet, and ſome ſlaves. They are called *Analons*. Over againſt the mouth of Rio Grande is a cluſter of iſlands called *Biſſago Iſles;* the moſt conſiderable of which is Caſſagut, being about ſix leagues long and two broad; its ſoil is very good, and produces millet, rice, and all kinds of pulſe, beſides orange and palm trees, and many others. This iſland, with thoſe of Carache, Canabac, and La Gallina, are the only ones where the Europeans may trade with ſome ſecurity. They trade, however, ſometimes at the other iſlands, but they muſt be extremely cautious; and yet after all their precautions, they will be robbed and murdered if they venture to go aſhore. The river Nunho runs 16 leagues to the ſouth of Rio Grande; it is very conſiderable, and comes from a vaſt diſtance inland. One may buy here 300 quintals of ivory and 100 ſlaves a year. Rice grows here admirably well, and is very cheap. There are everywhere ſugar canes which grow naturally; and plants of indigo, which might turn to good account. The trade is carried on here from March till Auguſt. In the river of Sierra Leone, the late Royal African Company of England had, in the year 1728, two iſlands; the one, called *Taſſo*, a large flat iſland, near three leagues in circumference, in which the company's ſlaves had a good plantation; the reſt of the iſland is covered with wood, among which are ſilk cotton trees of an unaccountable ſize. The other iſland is *Benſe*, whereon ſtood a regular fort. It was formerly the reſidence of one of the Engliſh chiefs.

MELMOTH, WILLIAM, Eſq. a learned member of Lincoln's Inn, was born in 1666. In conjunction with Mr Peere Williams, Mr Melmoth was the publiſher of Vernon's Reports, under an order of the court of chancery. He had once an intention of printing his own Reports; and a ſhort time before his death advertiſed them at the end of thoſe of his coadjutor Peere Williams, as then actually preparing for the preſs. They have, however, not yet made their appearance. But the performance for which he juſtly deſerves to be held in perpetual remembrance is, "The Great Importance of a Religious Life;" concerning which it may be mentioned, to the credit of the age, that notwithſtanding many large editions had before been circulated, 42,000 copies of this uſeful treatiſe have been ſold in the laſt 18 years. It is a ſomewhat ſingular circumſtance, that the real author of this moſt admirable piece ſhould never before have been publicly known (it having been commonly attributed to the firſt earl of Egmont, and particularly by Mr Walpole in his Catalogue); which is the more ſurpriſing, as the author is plainly pointed out in the following ſhort character prefixed to the book itſelf: "It may add weight, perhaps, to the reflections contained in the following pages, to inform the reader, that the author's life was one uniform exemplar of thoſe precepts which, with ſo generous a zeal, and ſuch an elegant and affecting ſimplicity of ſtyle, he endeavours to recommend to general practice. He left others to contend for modes of faith, and inflame themſelves and the world with endleſs controverſy: it was the wiſer purpoſe of his more ennobled aim, to act up to thoſe clear rules of conduct which revelation hath graciouſly preſcribed. He poſſeſſed by temper every moral virtue; by religion every Chriſtian grace. He had a humanity that melted at every diſtreſs; a charity which not only thought no evil, but ſuſpected none. He exerciſed his profeſſion with a ſkill and integrity which nothing could equal but the diſintereſted motive that animated his labours, or the amiable modeſty which accompanied all his virtues. He employed his induſtry, not to gratify his own deſires; no man indulged himſelf leſs: not to accumulate uſeleſs wealth; no man more diſdained ſo unworthy a purſuit: it was for the decent advancement of his family, for the generous aſſiſtance of his friends, for the ready relief of the indigent. How often did he exert his diſtinguiſhed abilities, yet refuſe the reward of them, in defence of the widow, the fatherleſs, and him that had none to help him! In a word, few have ever paſſed a more uſeful, not one a more blameleſs life; and his whole time was employed either in doing good, or in meditating it. He died on the 6th day of April 1743, and lies buried under the cloiſter of Lincoln's Inn Chapel. MEM. PAT. OPT. MER FIL. DIC." The ſon, by whom this character is drawn, is William Melmoth, Eſq. the celebrated tranſlator of Pliny and of Cicero's Letters; and author of thoſe which paſs under the name of *Sir Thomas Fitzoſborne.*

MELOCHIA, JEWS MALLOW, a genus of plants belonging to the monodelphia claſs; and in the natural method ranking under the 37th order, *Columniferæ*. See BOTANY *Index*.

MELODUNUM, in *Ancient Geography*, a town of the Cenones in Gallia Celtica, above Lutetia; now *Melun*, in the iſle of France, on the Seine.

MELODY, in muſic, a ſucceſſion of ſounds ranged in ſuch a manner, according to the laws of rhythmus and modulation, that it may form a ſentiment agreeable to the ear. Vocal melody is called *ſinging;* and that which is performed upon inſtruments may be termed *ſymphonic melody.*

The idea of rhythmus neceſſarily enters into that of melody. An air is not an air but in proportion as the laws of meaſure and quantity are obſerved. The ſame ſucceſſion of ſounds is ſuſceptible of as many different characters, as many different kinds of melody, as the various ways by which its emphatic notes, and the quantities of thoſe which intervene, may be diverſified; and the change in duration of the notes alone, may diſguiſe that very ſucceſſion in ſuch a manner that it cannot be known. Thus, melody in itſelf is nothing; it is the rhythmus or meaſure which determines it, and there can be no air without time. If then we abſtract meaſure from both, we cannot compare melody with harmony; for to the former it is eſſential, but not at all to the latter.

Melody, according to the manner in which it is conſidered, has a relation to two different principles. When regarded only as agreeable to the proportions of ſound and the rules of modulation, it has its principle in harmony; ſince it is a harmonical analyſis, which exhibits the different gradations of the ſcale, the chords peculiar to each mode, and the laws of modulation, which are the ſole elements that compoſe an air. According to this principle, the whole power of melody is limited to that of pleaſing the ear by agreeable ſounds, as the eye may be pleaſed with an agreeable aſſemblage of ſuitable colours. But when conſidered as an imitative art, by which we may affect the mind with various images, excite different emotions in the heart, inflame or ſoothe the paſſions; by which, in a word, we produce different effects upon our moral faculties, which are not to be effectuated by the influence of external ſenſe alone, we muſt explore another principle for melody: for in our whole internal frame there appears to be no power upon which either harmony alone, or its neceſſary reſults, can ſeize, to affect us in ſuch a manner.

What then is the ſecond principle? It is as much founded on nature as the firſt; but, in order to diſcover its foundation in nature, it will require a more accurate though ſimpler obſervation, and a more exquiſite degree of ſenſibility in the obſerver. This principle is the ſame which varies the tone of the voice, when we ſpeak, according as we are intereſted in what we ſay, and according to the different emotions which we feel in expreſſing it. It is the accent of languages which determines the melody of every nation; it is the accent which determines us to employ the emphaſis of ſpeaking while we ſing, and to ſpeak with more or leſs energy according as the language which we uſe is more or leſs accented. That language whoſe accents are the moſt ſenſible, ought to produce a more paſſionate and more lively melody; that which has little accentuation, or none at all, can only produce a cold and languid melody, without character and without expreſſion. Theſe are the true principles: in proportion as we depart from them, when we ſpeak of the power of muſic upon the human heart, we ſhall become unintelligible to ourſelves and others: our words will be without meaning.

If muſic does not impreſs the ſoul with images but by melody, if from thence it obtains its whole power, it muſt follow, that all muſical ſounds which are not pleaſing by themſelves alone, however agreeable to harmony they may be, is not an intimative muſic; and, being incapable, even with its moſt beautiful chords, either to preſent the images of things, or to excite the finer feelings, very ſoon cloys the ear, and leaves always the heart in cold indifference. It follows likewiſe, that notwithſtanding the parts which harmony has introduced, and which the preſent taſte of muſic ſo wantonly abuſes, wherever two different melodies are heard at the ſame time, they counteract each other, and deſtroy the effects of both, however beautiful each may be when performed alone: from whence it may be judged with what degree of taſte the French compoſers have introduced in their operas the miſerable practice of accompanying one air with another, as well in ſinging, which is the native expreſſion of pathos and ſentiment, as in inſtrumental performances; which is the ſame thing as if whimſical orators ſhould take it in their heads to recite two orations at the ſame time, that the elegance of each might derive more force from the other.

So much for Rouſſeau. The tranſlator, however, has reaſon to fear, that the cauſes by which national melody is diverſified and characterized, are more profound and permanent than the mere accentuation of language. This indeed may have great influence in determining the nature of the rhythmus, and the place of emphatic notes; but very little in regulating the nature of the emphaſis and expreſſion themſelves. If Rouſſeau's principle be true in its full extent, he muſt of neceſſity acknowledge, that an air which was never ſet or intended for words, however melodious, cannot be imitative; he muſt likewiſe confeſs, that what is imitative in one nation cannot be ſuch in another: nor can it be denied, upon his hypotheſis, that the recitative, which is formed upon the mode of ſpeaking, is the moſt forcible of all melodies; which is abſurd. His other obſervations are at once judicious and profound. Though it is impoſſible to exhibit the beauty and variety of harmony by playing the ſame melody at the ſame time upon different keys, admitting thoſe keys to form among themſelves a perfect chord, which will of conſequence preſerve all the ſubſequent notes in the ſame intervals; yet this perfect harmony would by no means be uniformly pleaſing to the ear. We muſt therefore of neceſſity introduce leſs perfect chords to vary and increaſe the pleaſure, and theſe chords in any complex ſyſtem of muſic muſt of neceſſity produce diſſonances. It then becomes the buſineſs of the compoſer to be careful that theſe diſcords may ariſe as naturally from, and return as naturally to perfect harmony as poſſible. All theſe cauſes muſt inevitably vary the melody of the different parts; but ſtill, amidſt all theſe difficulties, the artiſt ought to be zealous in preſerving the melody of each as homogeneous with the others as poſſible, that the reſult of the whole may be in ſome meaſure uniform. Otherwiſe, by counteracting each other, the parts will reciprocally deſtroy the effects one of another.

MELOE, a genus of inſects of the order of coleoptera. See ENTOMOLOGY *Index*.

MELON, a ſpecies of CUCUMIS, in the Linnæan ſyſtem. See BOTANY and GARDENING *Index*.

Water MELON. See ANGURIA, BOTANY *Index*.

MELOS, in *Ancient Geography*, an iſland between Crete and Peloponneſus, about 24 miles from Scyllæum. It is about 60 miles in circumference, and of an oblong figure. It enjoyed its independence for about 700 years before the time of the Peloponneſian war. This iſland was originally peopled by a Lacedemonian colony, 1116 years before the Chriſtian era. For this reaſon the inhabitants refuſed to join the reſt of the iſland and the Athenians againſt the Peloponneſians. This refuſal was ſeverely puniſhed. The Athenians took Melos, and put to the ſword all ſuch as were able to bear arms. The women and children were made ſlaves, and the iſland left deſolate. An Athenian colony repeopled it, till Lyſander reconquered it and re-eſtabliſhed the original inhabitants in their poſſeſſions.

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

MELPOMENE, in *Fabulous Hiſtory*, one of the muſes, daughter of Jupiter and Mnemoſyne. She preſided over tragedy. Horace has addreſſed the fineſt of his odes to her, as to the patroneſs of lyric poetry. She was generally repreſented as a young woman with a ſerious countenance. Her garments were ſplendid; ſhe wore a buſkin, and held a dagger in one hand and in the other a ſceptre and crown.

MELROSE, a town of Scotland, in the county of Selkirk, and on the confines of Tweedale, ſeated on the ſouth ſide of the river Tweed; with an ancient abbey, now in ruins. W. Long. 2. 32. N. Lat. 55. 32.

This abbey was founded by King David I. in 1136. He peopled it with Ciſtertians brought from Rivale abbey in Yorkſhire, and dedicated it to the Virgin Mary. At the reformation James Douglas was appointed commendator, who took down much of the building, in order to furniſh materials for a large houſe to himſelf, which ſtill remains, and is dated 1590. Nothing is left of the abbey excepting a part of the cloiſter walls elegantly carved; but the ruins of the church are of moſt uncommon beauty. Part is at preſent uſed for divine ſervice, the reſt uncovered; but every part does great honour to the architect.—Alexander II. was buried beneath the great altar, and it is alſo the place of interment of the Douglaſes and other potent families.—Its ſituation is extremely pleaſant.

MELT OF FISHES. In the melt of a living cod there are ſuch numbers of thoſe animalcules ſaid to be found in the ſemen of all male animals, that in a drop of its juice no larger than a grain of ſand, there are contained more than 10,000 of them; and conſidering how many ſuch quantities there are in the whole melt of one ſuch fiſh, it is not incredible, that there are more animals in one melt of it than there are living men at one time upon the face of the earth. However ſtrange and romantic ſuch a conjecture muſt appear, a ſerious conſideration and calculation will make it very evident. An hundred ſuch grains of ſand as thoſe juſt mentioned will make about an inch in length; therefore in a cubic inch there will be a million of ſuch ſands; and if there be 10,000 animals in each of thoſe quantities, there muſt be in the whole 150,000 millions, which is a number vaſtly exceeding that of mankind, even ſuppoſing the whole as populous as Holland.

MELTING CONE, in eſſaying, an hollow cone of braſs or caſt iron, into which melted metalline ſubſtances are thrown, in order to free them from their ſcoriæ. When a ſmall quantity of matter is melted, it will be ſufficient to rub the inſide of the cone with greaſe; but when the quantity is large, eſpecially if it contains any thing ſulphureous, this caution of tallowing the moulds is not ſufficient. In this caſe the eſſayer has recourſe to a lute reduced to thin pap with water, which effectually prevents any injury to the cone.

MELTON MOUBRAY, a town of Leiceſterſhire, 108 miles from London. It is a large well-built place, in a fertile ſoil; with a market on Tueſday, the moſt conſiderable for cattle of any in this part of the iſland. It is almoſt encompaſſed with a little river called the *Eye*, over which it has two fine bridges; and has a large handſome church, with a free ſchool. Here are frequent horſe races, and three fairs in the year.

MELVIL, SIR JAMES, deſcended from an honourable Scots family, being the third ſon of the laird of Raeth, was born about the middle of the 16th century. He went to France very young, in the capacity of page to Queen Mary, then married to the dauphin; and on the death of her huſband, followed her to Scotland, where he was made gentleman of her chamber, and admitted a privy counſellor. She employed him in her moſt important concerns, till her unhappy confinement in Lochleven, all which he diſcharged with the utmoſt fidelity; and, from his own accounts, there is reaſon to conclude, that, had ſhe taken his advice, ſhe might have avoided many of her misfortunes. When ſhe was priſoner in England, ſhe recommended him ſtrongly to her ſon James; with whom he continued in favour and employment until the death of Queen Elizabeth: James would then have taken him to England; but Melvil, now grown old, was deſirous of retiring from buſineſs, and in his retirement he drew up the memoirs of his paſt life for the uſe of his ſon. Theſe Memoirs were accidentally found in Edinburgh caſtle in the year 1660, though nobody knew how they came to be depoſited there; and were publiſhed in folio in 1683.

MEMBERS, in *Anatomy*, the exterior parts, ariſing from the trunk or body of an animal, like the boughs from the trunk of a tree.

MEMBER, in *Architecture*, denotes any part of a building; as a frieze, cornice, or the like.

MEMBER is ſometimes alſo uſed for moulding.

MEMBER, in *Grammar*, is applied to the parts of a period or ſentence.

MEMBER, is alſo uſed to denote ſome particular order or rank in a ſtate or government: thus we ſay, "member of a corporation, member of parliament, member of the council, &c."

MEMBRANE, MEMBRANA, in *Anatomy*, a ſimilar part of an animal body; being a thin, white, flexible, expanded ſkin, formed of ſeveral ſorts of fibres interwoven together, and ſerving to cover or wrap up certain parts of the body. See ANATOMY *paſſim*.

MEMEL, or MEMMEL; a town of Pruſſia, ſituated on the northern extremity of the Curiſche Haf, an inlet of the ſea about 70 miles in length, which is here joined to the Baltic by a narrow ſtrait.—It is an ill built town, with narrow dirty ſtreets; but remarkable for its extenſive commerce, being provided with the fineſt harbour in the Baltic. In 1784, 996 ſhips, amongſt which were 500 Engliſh, arrived here. The imports chiefly are, ſalt, iron, and ſalted herrings; the exports, which greatly exceed the imports, are amber, corn, hemp, flax, and particularly timber. An Engliſh conſul reſides here. The trade is daily increaſing, on account of the high duties which the court of Ruſſia has laid on the imports of Riga.

MEMNON, in *Fabulous Hiſtory*, a king of Ethiopia, ſon of Tithonus and Aurora. He came with a body of 10,000 men to aſſiſt his uncle Priam, during the Trojan war. He behaved with great courage, and killed Antilochus, Neſtor's ſon. The aged father challenged the Ethiopian monarch; but Memnon refuſed it on account of the venerable age of Neſtor, and accepted that of Achilles. He was killed in the combat, in the ſight of the Grecian and Trojan armies. Aurora prayed Jupiter to grant her ſon ſuch honours as might diſtinguiſh him from other mortals. The god conſented; and immediately a numerous flight of birds iſſued from the burning pile on which the body was laid, and dividing themſelves into two ſeparate bodies, fought with ſuch fury, that above half of them fell down in the fire as victims to appeaſe the manes of Memnon. Theſe birds were called *Memnonides;* and it has been obſerved by ſome of the ancients, that they never failed to return yearly to the tomb of Memnon in Troas, and repeat the ſame bloody engagement in honour of the hero from whom they received their name. The Ethiopians or Egyptians, over whom Memnon reigned, erected a celebrated ſtatue to the honour of their monarch. This ſtatue had the wonderful property of uttering a melodious ſound every day at ſunriſing, like that which is heard at the breaking of the ſtring of a harp when it is wound up. This was effected by the rays of the ſun when they fell upon it. At the ſetting of the ſun, and in the night, the ſound was lugubrious. This is ſupported by the teſtimony of the geographer Strabo, who confeſſes himſelf ignorant whether it proceeded from the baſis of the ſtatue, or the people that were then around it. This celebrated ſtatue was diſmantled by order of Cambyſes when he conquered Egypt; and its ruins ſtill aſtoniſh modern travellers by their grandeur and beauty.

MEMNON of Rhodes, one of the generals of Darius king of Perſia, adviſed that prince to lay waſte the country, in order to deprive Alexander the Great's army of ſupport, and afterwards to attack Macedon; but this counſel was diſapproved by Darius's other generals. Memnon behaved at the paſſage of the Granicus like an experienced general. He afterwards defended the city of Miletum with great courage; ſeized the iſlands of Chio and Leſbos; ſpread terror throughout all Greece; and would have put a ſtop to the conqueſts of Alexander, if he had not been prevented by death. Barſina, Memnon's widow, was taken priſoner with Darius's wife, and Alexander had a ſon by her named *Hercules.*

MEMOIRS, in matters of literature, a ſpecies of hiſtory, written by perſons who had ſome ſhare in the tranſactions they relate; anſwering to what the Romans called *Commentarii.*—The journals of the proceedings of a literary ſociety, or a collection of matters tranſacted therein, are likewiſe called *Memoirs.*

MEMORY, a faculty of the mind, which preſents to us ideas or notions of what is paſt, accompanied with a perſuaſion that the things themſelves were formerly real and preſent. What we diſtinctly remember to have perceived, we as firmly believe to have happened, as what is now preſent to our ſenſes.

The opinions of philoſophers concerning the means by which the mind retains the ideas of paſt objects, and how thoſe ideas carry with them evidence of their objects having been actually perceived, ſhall be laid before our readers in another place: (ſee METAPHYSICS, Part I. chap. ii.) At preſent we ſhall throw together ſome obſervations on the memory, which, being of a practical rather than of a ſpeculative nature, cannot be admitted into the article where the nature of the faculty itſelf is diſcuſſed.

"When we remember with little or no effort, it is called *remembrance* ſimply, or *memory*, and ſometimes *paſſive memory* [*]. When we endeavour to remember what does not immediately (and as it were) of itſelf occur, it is called *active memory*, or *recollection*. A ready recollection of our knowledge, at the moment when we have occaſion for it, is a talent of the greateſt importance. The man poſſeſſed of it ſeldom fails to diſtinguiſh himſelf in whatever ſort of buſineſs he may be engaged." It is indeed evident, that when the power of retention is weak, all attempts at eminence of knowledge muſt be vain; for "memory is the primary and fundamental power [†], without which there could be no other intellectual operation. Judgement and ratiocination ſuppoſe ſomething already known, and draw their deciſions only from experience. Imagination ſelects ideas from the treaſures of remembrance, and produces novelty only by varied combinations. We do not even form conjectures of diſtant, or anticipations of future, events, but by concluding what is poſſible from what is paſt."

Of a faculty ſo important, many rules have been given for the regulation and improvement; of which the firſt is, that he who wiſhes to have a clear and diſtinct remembrance, ſhould be temperate with reſpect to eating, drinking, and ſleep. The memory depends very much upon the ſtate of the brain; and therefore whatever is hurtful to the latter, muſt be prejudicial to the former. Too much ſleep clouds the brain, and too little overheats it; therefore either of theſe extremes muſt of courſe hurt the memory, and ought carefully to be avoided. Intemperance of all kinds, and exceſs of paſſion, have the ſame ill effects; ſo that we rarely meet with an intemperate perſon whoſe memory is at once clear and tenacious.

"The livelieſt remembrance is not ſo vivid as the ſenſation that produced it [‡]; and ideas of memory do often, but not always, decay more and more, as the original ſenſation becomes more and more remote in time. Thoſe ſenſations and thoſe thoughts have a chance to be long remembered which are lively at firſt; and thoſe are likely to be moſt lively which are moſt attended to, or which are accompanied with pleaſure or pain, with wonder, ſurpriſe, curioſity, merriment, and other lively paſſions. The art of memory, therefore, is little more than the art of attention. What we wiſh to remember we ſhould attend to, ſo as to underſtand it perfectly, fixing our view particularly upon its importance or ſingular nature, that it may raiſe within us ſome of the paſſions above mentioned. We ſhould alſo diſengage our minds from all other things, that we may attend more effectually to the object which we wiſh to remember. No man will read with much advantage who is not able at pleaſure to evacuate his mind, or who brings not to his author an intellect defecated and pure, neither turbid with care, nor agitated with pleaſure. If the repoſitories of thought are already full, what can they receive? If the mind is employed on the paſt or the future, the book will be held before the eyes in vain.

"It is the practice of many readers, to note in the margin of their books the moſt important paſſages [§],

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[*] Beattie's Elements of Moral Science.

[†] Idler.

[‡] Beattie's Elements, &c. and Idler.

[§] Elements of Moral Science.

the ſtrongeſt arguments, or the brighteſt ſentiments. Thus they load their minds with ſuperfluous attention, repreſs the vehemence of curioſity by uſeleſs deliberation, and by frequent interruption break the current of narration or the chain of reaſon, and at laſt cloſe the volume and forget the paſſages and the marks together. Others are firmly perſuaded, that nothing is certainly remembered but what is tranſcribed; and they, therefore, paſs weeks and months in transferring large quotations to a common place-book. Yet, why any part of a book which can be conſulted at pleaſure ſhould be copied, we are not able to diſcover. The hand has no cloſer correſpondence with the memory than the eye. The act of writing itſelf diſtracts the thoughts; and what is read twice, is commonly better remembered than what is tranſcribed. This method, therefore, conſumes time, without aſſiſting the memory.' But to write an abridgement of a good book may ſometimes be a very profitable exerciſe. In general, when we would preſerve the doctrines, ſentiments, or facts, that occur in reading, it will be prudent to lay the book aſide, and put them in writing in our own words. This practice will give accuracy to our knowledge, accuſtom us to recollection, improve us in the uſe of language, and enable us ſo thoroughly to comprehend the thoughts of other men, as to make them in ſome meaſure our own."

"Our thoughts have for the moſt part a connection *; ſo that the thought which is juſt now in the mind, depends partly upon that which went before, and partly ſerves to introduce that which follows.—Hence we remember beſt thoſe things of which the parts are methodically diſpoſed and mutually connected. A regular diſcourſe makes a more laſting impreſſion upon the hearer than a parcel of detached ſentences, and gives to his rational powers a more ſalutary exerciſe: and this may ſhow us the propriety of conducting our ſtudies, and all our affairs, according to a regular plan or method. When this is not done, our thoughts and our buſineſs, eſpecially if in any degree complex, ſoon run into confuſion."

As the mind is not at all times equally diſpoſed for the exerciſe of this faculty, ſuch ſeaſons ſhould be made choice of as are moſt proper for it. The mind is ſeldom fit for attention preſently after meals; and to call off the ſpirits at ſuch times from their proper employment in digeſtion, is apt to cloud the brain, and prejudice the health. Both the mind and body ſhould be eaſy and undiſturbed when we engage in this exerciſe, and therefore retirement is moſt fit for it: and the evening, juſt before we go to reſt, is generally recommended as a very convenient ſeaſon, both from the ſtillneſs of the night, and becauſe the impreſſions will then have a longer time to ſettle before they come to be diſturbed by the acceſſion of others proceeding from external objects; and to call over in the morning what has been committed to the memory overnight, muſt, for the ſame reaſon, be very ſerviceable. For, to review thoſe ideas while they continue freſh upon the mind, and unmixed with any others, muſt neceſſarily imprint them more deeply.

Some ancient writers ſpeak of an artificial memory, and lay down rules for attaining it. Simonides the poet is ſaid firſt to have diſcovered this, or at leaſt to have given the occaſion for it. The ſtory they tell of him is this: Being once at a feaſt, he recited a poem which he had made in honour of the perſon who gave the entertainment. But having (as is uſual in poetry) made a large digreſſion in praiſe of Caſtor and Pollux; when he had repeated the whole poem, his patron would give him but half the ſum he had promiſed, telling him he muſt get the other part from thoſe deities who had an equal ſhare in the honour of his performance. Immediately after, Simonides was told that two young men were without, and muſt needs ſpeak with him. He had ſcarcely got out of the houſe, when the room where the company was fell down, killed all the perſons in it, and ſo maſhed the bodies, that, when the rubbiſh was thrown off, they could not be known one from another: upon which Simonides recollecting the place where every one had ſat, by that means diſtinguiſhed them. Hence it came to be obſerved, that to fix a number of places in the mind in a certain order, was a help to the memory: As we find by experience, that, upon returning to places once familiar to us, we not only remember them, but likewiſe many things we both ſaid and did in them. This action therefore of Simonides was afterwards improved into an art; and the nature of it is this: They bid you form in your mind the idea of ſome large place or building, which you may divide into a great number of diſtinct parts, ranged and diſpoſed in a certain order. Theſe you are frequently to revolve in your thoughts, till you are able to run them over one after another without heſitation, beginning at any part. Then you are to impreſs upon your mind as many images of living creatures, or any other inſenſible objects which are moſt likely to affect you, and be ſooneſt revived in your memory. Theſe, like characters in ſhorthand, or hieroglyphics, muſt ſtand to denote an equal number of other words, which cannot ſo eaſily be remembered. When therefore you have a number of things to commit to memory in a certain order, all that you have to do is, to place theſe images regularly in the ſeveral parts of your building. And thus they tell you, that, by going over ſeveral parts of the building, the images placed in them will be revived in the mind; which of courſe will give you the things or words themſelves in the order you deſire to remember them. The advantage of the images ſeems to be this; that, as they are more like to affect the imagination than the words for which they ſtand, they will for that reaſon be more eaſily remembered. Thus, for inſtance, if the image of a *lion* be made to ſignify *ſtrength*, and this word *ſtrength* be one of thoſe I am to remember, and is placed in the porch; when, in going over the ſeveral parts of the building, I come to the porch, I ſhall ſooner be reminded of that image than of the word *ſtrength.* Of this artificial memory, both Cicero and Quintilian ſpeak; but we know not of any modern orator that has ever made uſe of it. It ſeems indeed to have been a laborious way of improving the memory, if it ſerves that end at all, and fitter for aſſiſting us to remember any number of unconnected words than a continual diſcourſe, unleſs ſo far as the remembrance of one word may enable us to recollect more. It is, however, in alluſion to it, that we ſtill call the parts of a diſcourſe

* *Idler.*

places or *topics*, and ſay, *in the firſt place*, *in the ſecond place*, &c.

But, doubtleſs, the moſt effectual way to gain a good memory, is by conſtant and moderate exerciſe of it; for the memory, like other habits, is ſtrengthened and improved by daily uſe. It is indeed hardly credible, to what a degree both active and paſſive remembrance may be improved by long practice. *Scaliger* reports of himſelf, that in his youth he could repeat above 100 verſes, having once read them; and *Berthecus* declares, that he wrote his *Comment upon Claudian* without conſulting the text. To hope, however, for ſuch degrees of memory as theſe, would be equally vain as to hope for the ſtrength of *Hercules*, or the ſwiftneſs of *Achilles*. "But there are clergymen who can get a ſermon by heart [*] in two hours, though their memory, when they began to exerciſe it, was rather weak than ſtrong: And pleaders, with other orators who ſpeak in public and *extempore*, often diſcover, in calling inſtantly to mind all the knowledge neceſſary on the preſent occaſion, and every thing of importance that may have been advanced in the courſe of a long debate, ſuch powers of retention and recollection as, to the man who has never been obliged to exert himſelf in the ſame manner, are altogether aſtoniſhing. As habits, in order to be ſtrong, muſt be formed in early life, the memories of children ſhould, therefore, be conſtantly exerciſed; but to oblige them to commit to memory what they do not underſtand, perverts their faculties, and gives them a diſlike to learning." In a word, thoſe who have moſt occaſion for memory, as orators and public ſpeakers, ſhould not ſuffer it to lie idle, but conſtantly employ it in treaſuring up and frequently reviving ſuch things as may be of moſt importance to them; for by theſe means it will be more at their command, and they may place greater confidence in it upon any emergency."

"Men complain of nothing more frequently than of deficient memory [†]: and indeed every one finds, that after all his efforts, many of the ideas which he deſired to retain have ſlipped irretrievably away; that acquiſitions of the mind are ſometimes equally fugitive with the gifts of fortune; and that a ſhort intermiſſion of attention more certainly leſſens knowledge than impairs an eſtate. To aſſiſt this weakneſs of our nature, many methods beſides thoſe which we have mentioned have been propoſed; all of which may be juſtly ſuſpected of being ineffectual: for no art of memory, however its effects may have been boaſted or admired, has been ever adopted into general uſe; nor have thoſe who poſſeſſed it appeared to excel others in readineſs of recollection or multiplicity of attainments." The reader who is deſirous to try the effect of theſe helps, may have recourſe to a treatiſe entitled *A new Method of Artificial Memory*; but the true method of memory is attention and exerciſe.

MNEMONICA, or the art of memory, as it was called by the ancients, has been lately revived and ſtudied in Germany and France. In ſome notices concerning this ſubject which we have ſeen, it is obſerved that this ſcience is more intimately connected with the Egyptian hieroglyphics than is generally thought, and that this connection may help to explain them. In Germany this art has been revived by M. Aretin; and a pupil of his, M. Kaeſtner has been permitted to teach the new doctrine at Leipſic, but on the expreſs condition of not allowing his hearers to write down his lectures. This ſeems to be a ſingular, and we may add a ſilly prohibition. The following account is given of this art in a letter from Paris in the beginning of 1807. "During my reſidence, ſays the writer, in this metropolis I heard a great deal of a new method of *mnemonique*, or of a method to aſſiſt and fix our memory, invented by Gregor de Feinaigle. Notwithſtanding the ſimplicity with which he announced his lectures in the papers, I could not determine myſelf to become a pupil of his, as I thought to find a quack or mountebank, and to be laughed at by my friends for having thrown away my caſh in ſuch a fooliſh manner. Perhaps I ſhould heſitate to this moment about the utility of this newly invented method to aſſiſt our natural memory, had I not had the pleaſure of dining at his excellency's the Count of Metternich, the Auſtrian ambaſſador, who followed, with all his ſecretaries, the whole courſe of lectures: they all ſpoke very advantageouſly of it, likewiſe ſeveral other perſons of the firſt rank I met there: in conſequence of this I was inſerted into the liſt of pupils, and I follow, at this moment, the lectures. All I can tell you about this method is, it is a very ſimple one, and eaſy to be learned, adapted to all ages and ſexes: all difficulties in ſuch ſciences as require an extraordinary good memory, for inſtance, the names and epochs in hiſtory, are at once overcome and obviated. There is not one branch of ſcience to which this method cannot be applied. It is eaſy to be perceived that ſuch an invention cannot paſs without ſome critique, and even ſarcaſms, in the public prints: ſome of them were very injurious, and plauſible enough to miſlead the public, who, knowing nothing of the method, are always more ready to condemn than to aſſiſt. Mr Feinaigle, to anſwer all theſe critics at once, adopted a method not leſs public for Paris than the public papers, but leſs public for the reſt of Europe: he gave, the 22d of laſt month, a public exhibition to about 2000 ſpectators, in which he did not appear at all, only about 12 or 15 of his pupils: each of them made ſuch an application of the method as his ſituation in life required. The principal parts were the following: hiſtory, about names and years; geography, with reſpect to longitude, latitude, number of inhabitants, ſquare miles, &c. &c.; grammar in various languages, about different editions of the ſame work; pandects, their diviſion, and title of each book, title, &c; different ſyſtems of botany, poetry, arithmetic, &c. &c. At laſt one deſired the company to give him one thouſand words, without any connection whatſoever, and without numeric order; for inſtance, the word *aſtronomer*, for Nº. 62; *wood*, for Nº 188; *lovely*, for Nº 370; *dynaſty*, for Nº. 23; *David*, for Nº 90, &c. &c. till all the numbers were filled; and he repeated the whole (notwithſtanding he heard theſe words without order, and but once,) in the numerical order; or he told you what word was given againſt any one number, or what number any one word bore. It is ſtill more ſtriking, but certainly, likewiſe, more difficult, to retain as many numbers however great they may be. For words and numbers I could venture myſelf, with the greateſt ſafety, as far as one hundred of each; and I am ſure, after having

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[*] Idler.

[†] Elements of Moral Science.

Memphis.

having fixed them once, which is done in leſs than ten minutes, I could repeat them to you at any period, without ever thinking any more of them *."

MEMPHIS, an ancient city, and the royal reſidence of the kings in the Higher Egypt; diſtant from the Delta to the ſouth 15 miles, according to Pliny. Called alſo *Moph*, and *Noph*, in ſcripture.

Though this city is now ſo completely ruined, that authors greatly diſagree concerning its ſituation; yet Strabo informs us that in his time it was the moſt magnificent in Egypt, next to Alexandria. It was called the capital of the country; and there was an entire temple of Oſiris, where the Apis or ſacred ox was kept and worſhipped. In the ſame place was an apartment of the mother of the ox; a very magnificent temple of Vulcan; a large circus or ſpace for fighting bulls; and a great coloſſus in the middle of the city, which was thrown down. There was likewiſe a temple of Venus, and a Serapium in a very ſandy place, where the wind heaps up hills of ſand very dangerous to travellers; together with a number of ſphinxes, the heads of ſome of them only being viſible, the others covered up to the middle of their body. The ſame author likewiſe informs us, that in the front of the city there were many lakes; and that it contained a number of palaces, at that time in ruins. Theſe buildings, he ſaid, formerly ſtood upon an eminence: they lay along the ſide of the hill, ſtretching down to the lakes and groves, 40 ſtadia from the city. There was likewiſe a mountain in the neighbourhood, on which were a great number of pyramids, with the ſepulchres of the kings, among which were three remarkable, and two of them accounted wonders of the world. From this deſcription, Mr Bruce concludes that the celebrated capital of Egypt ſtood in the place where the villages of Metrahenny are now ſituated; in oppoſition to Dr Shaw's opinion, who thinks it was ſituated at Geeza or Giſa.

M. Savary has alſo ſhown, that Giſa was not the ſituation of the ancient Memphis. This ſtood, he ſays, on the weſtern bank of the Nile, on the ſpot where the village of Memph now ſtands, which ſtill preſerves the name. Large heaps of rubbiſh are ſtill to be ſeen there; but the Arabs have tranſported to Cairo the columns and remarkable ſtones, which they have diſpoſed, without taſte and without order, in their moſques and public buildings. This city extended as far as Saccara; and was almoſt wholly encompaſſed by lakes, part of which are ſtill ſubſiſting. It was neceſſary to croſs them to convey the dead to the ſepulchre of their fathers. The tombs, hewn out of the rock, were cloſed up with ſtones of a proportionable ſize, and covered with ſand. Theſe bodies embalmed with ſo much care, preſerved with ſo much reſpect, are torn from the monuments they repoſe in, and ſold without decency to ſtrangers by the inhabitants of Saccara. This place is called *the plain of mummies*. There too we find *the well of the birds*, into which one deſcends by means of a rope. It leads to ſubterraneous galleries, filled with earthen vaſes containing the ſacred birds. They are rarely met with entire, becauſe the Arabs break them in hopes of finding idols of gold. They do not conduct travellers into the places where they have found more precious articles. They even cloſe them up carefully, reſerving to themſelves ſome ſecret paſſages by which they deſcend. In a journey into Egypt made by the duke de Chaulnes, he advanced very far into theſe winding labyrinths, ſometimes crawling, and ſometimes ſcrambling on his knees. Informed by Mr Edward Wortley Montague, who has carefully viſited Egypt, he arrived at one of thoſe paſſages which had an opening ſhut up from without by branches of the date tree interwoven, and covered with ſand. He remarked there ſome hieroglyphics *in relievo*, executed in the higheſt perfection. But the Arabs reſiſted every offer he made them to permit him to take drawings of them, or to mould them, in order to preſerve their form. The duke de Chaulnes is of opinion that theſe hieroglyphics, ſculptured with ſo much art that the objects they repreſent may be diſcovered at the firſt ſight, might poſſibly furniſh the key of the others, whoſe contours are ſimply expreſſed, and form a ſort of alphabet of this unintelligible language. Several pyramids are diſtinguiſhable along the mountains which bound Saccara on the weſt, the greateſt part of which appear as lofty as thoſe of Giſa. See PYRAMIDS.

Menage, Menander.

MENAGE (Fr.), denotes a collection of animals; whence we have derived the word *menagery*.

MENANDER, an ancient Greek poet, was born at Athens in the ſame year with Epicurus, which was the third of the 109th Olympiad. His happineſs in introducing the new comedy, and refining an art which had been ſo groſs and licentious in former times, quickly ſpread his name over the world. Pliny informs us, that the kings of Egypt and Macedon gave a noble teſtimony of his merit, by ſending ambaſſadors to invite him to their courts, and even fleets to bring him over; but that Menander was ſo much of a philoſopher, as to prefer the free enjoyment of his ſtudies to the promiſed favours of the great. Of his works, which amounted to above 100 comedies, we have had a double loſs, the originals being not only vaniſhed, but the greateſt part of them, when copied by Terence, having unfortunately periſhed by ſhipwreck before they ſaw Rome. Yet the four plays which Terence borrowed from him before that accident happened, are ſtill preſerved in the Roman habit; and it is chiefly from Terence that moſt people form their judgement of Menander, the fragments that remain of him not being ſufficient to enable them to do it. The ancients have ſaid high things of Menander; and we find the old maſters of rhetoric recommending his works as the true patterns of every beauty and every grace of public ſpeaking. Quintilian declares, that a careful imitation of Menander only, will ſatisfy all the rules he has laid down in his inſtitutions. It is in Menander that he would have his orator ſearch for a copiouſneſs of invention, for a happy elegance of expreſſion. and eſpecially for that univerſal genius which is able to accommodate itſelf to perſons, things, and affections.—But Julius Cæſar has left the loftieſt as well as the juſteſt praiſe of Menander's works, when he calls Terence only a *Half Menander*. For while the virtues of the Latin poet are ſo deſervedly admired, it is impoſſible we ſhould raiſe a higher notion of excellency than to conceive the great original ſtill ſhining with half its luſtre unreflected, and preſerving an equal part of its graces, above the power of the beſt copier in the world. Menander died in the 3d year of the 122d

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* Phil. Mag. 25. 93.

Olympiad, as we are taught by the ſame old inſcription from which we learn the time of his birth. His tomb, in Pauſanias's age, was to be ſeen at Athens, in the way from the Piræus to the city, cloſe by the honorary monument of Euripides. Quintilian, in his judgement of Afranius the Roman comedian, who imitated him, cenſures Menander's morals as much as he commends his writings; and his character, according to Suidas, is, that he was a very "mad fellow after women." Phædrus has given him the gait and dreſs of a moſt affected fop:

> "Unguento delibutus, veſtitu adfluens,
> "Veniebat greſſu delicatulo et languido."
> *Lib.* v. fab. 2.

MENANDRIANS, the moſt ancient branch of Gnoſtics; thus called from Menander their chief, ſaid by ſome, without ſufficient foundation, to have been a diſciple of Simon Magus, and himſelf a reputed magician.

He taught, that no perſon could be ſaved, unleſs he were baptiſed in his name; and he conferred a peculiar ſort of baptiſm, which would render thoſe who received it immortal in the next world: exhibiting himſelf to the world, with the phrenſy of a lunatic more than the founder of a ſect, as a promiſed ſaviour. For it appears by the teſtimonies of Irenæus, Juſtin, and Tertullian, that he pretended to be one of the æons ſent from the pleroma, or eccleſiaſtical regions, to ſuccour the ſouls that lay groaning under bodily oppreſſion and ſervitude; and to maintain them againſt the violence and ſtratagems of the dæmons that hold the reins of empire in this ſublunary world. As this doctrine was built upon the ſame foundation with that of Simon Magus, the ancient writers looked upon him as the inſtructor of *Menander*. See SIMONIANS.

MENASSEH BEN ISRAEL, a celebrated rabbi, born in Portugal about the year 1604, was the ſon of Joſeph Ben Iſrael, and followed his father into Holland. Here he was educated by Rabbi Iſaac Uziel, under whom he in a ſhort time made ſuch progreſs in the Hebrew tongue, that at 18 years of age he ſucceeded him in the ſynagogue of Amſterdam. In this poſt he continued ſeveral years, and married Rachel of the family of the Abarbanels, whom the Jews imagine to be deſcended from King David. He afterwards went to his brother Ephraim, a rich merchant, who had ſettled at Baſil; by whoſe advice he entered into trade. Some time after, the hopes of a more agreeable ſettlement induced him to come into England, under the protectorſhip of Cromwell; who gave him a very favourable reception, and one day entertained him at his table with ſeveral other learned divines. However, he ſoon after paſſed into Zealand; and died at Middleburg about the year 1657. The Jews at Amſterdam obtained his body, and interred it at their expence. He was of the ſect of the Phariſees; had a lively wit, a ſolid judgement, great learning, and all the virtues that can adorn private life. He wrote many works in Hebrew, Latin, Spaniſh, and Engliſh. The principal of thoſe publiſhed in Latin, are, 1. His *Conciliator;* a learned and curious work, in which he reconciles thoſe paſſages of Scripture which ſeem to contradict each other. 2. *De reſurrectione mortuorum.* 3. *De termino vitæ.* 4. *Diſſertatio de fragilitate humana, ex lapſu Adami, deque Divino in bono opere auxilio.* 5. *Spes Iſrael.* Dr Thomas Pococke has written his life in Engliſh.

MENDELSHON, MOSES, that is, *Moſes the ſon of Mendel*, a Jew of Berlin, and one of the moſt celebrated writers in Germany, died there in the year 1785 at the age of 57. His fourth attempt as an author was ſoon after 1767, by a work entitled *Jeruſalem;* in which, beſides other bold and unjuſtifiable opinions, he maintains, that the Jews have a revealed law but not a revealed religion; that opinions are not ſubjects of revelation; and that the only religion of the Jewiſh nation is that of nature. He acquired great honour by his *Phædon*, or "Diſcourſes on the Immateriality and Immortality of the Soul," tranſlated into the French 1773, 8vo; in which he unfolds this important truth, the great foundation of all morality, with the wiſdom of an enlightened philoſopher and the charms of an elegant writer. In conſequence of this excellent work, he was ſtyled the *Jewiſh Socrates* by ſome of the periodical writers; but he wanted the firmneſs and courage of the Grecian philoſopher. His timidity, and even puſillanimity, defects too common in ſpeculative men, prevented him from being of any eſſential ſervice to his nation; of which he might have become the benefactor by being the reformer. The pliancy of his character, his ſoft, modeſt, and obliging diſpoſition, gained him the eſteem alike of the ſuperſtitious and of the incredulous. After all, he could never procure admiſſion to the Berlin ſociety, or to the converſation of the king of Pruſſia. At his death he received from his nation thoſe honours which are commonly paid to their firſt rabbins. Contrary to an imprudent cuſtom prevalent among the Jews of burying their dead before ſunſet, his interment was delayed till 24 hours after he expired. Though Mendelſhon was deſcended from a reſpectable family, he was very poor. In early life he entered into a counting-houſe of his own nation, wherein he greatly recommended himſelf by his capacity and integrity in buſineſs: But philoſophy and literature ſoon became has principal occupation; and to the famous Leſſing he was indebted for counſels which, without diverting his attention from thoſe purſuits that were neceſſary to his ſubſiſtence, accelerated his progreſs in his literary career. Even after the death of his benefactor, Mendelſhon retained for him the ſincereſt regard and the moſt lively gratitude. Notwithſtanding the very ſtrict regimen which he obſerved, he ſurvived him only a few years; for his feeble frame and weak conſtitution were gradually and inſenſibly undermined by intenſe application to ſtudy.

MENDEZ PINTO, FERDINAND, was born at Montemor o-velho in Portugal, and was at firſt ſervant to a Portugueſe gentleman. In expectation of making a fortune, he embarked for India in 1537. His veſſel being taken by the Turks on his paſſage, he was carried to Mocka, and ſold to a Greek renegado, and afterwards to a Jew, in whoſe poſſeſſion he continued till he was redeemed by the governor of Ormus, a Portugueſe fort. The governor procured him an opportunity of going out to India, agreeable to his firſt deſign. During a reſidence of twenty-one years in that country, he was witneſs to very important tranſactions, and experienced many ſingular adventures. He returned to Portugal in 1558, where he enjoyed the reward of his labours, after having been thirteen times a ſlave and ſixteen times ſold. A very curious account of his travels was written by himſelf, and publiſhed at Liſbon, A. D. 1614, in folio. This work was tranſlated into French by Bernard Figuier, a Portugueſe gentleman, and printed at Paris 1645, in 4to. It is written in a very intereſting manner, and in a ſtyle more elegant than might have been expected from a man whoſe whole life was ſpent in the camp and in ſlavery. It elucidates a great variety of particulars relating to the geography, hiſtory, and manners of the inhabitants of China, Japan, Pegu, Siam, Achem, Java, &c. Many of his facts appeared fabulous, but their truth has been ſince aſcertained. M. de Surgi compiled an intereſting hiſtory from the moſt ſingular facts in Mendez Pinto's relation, which he publiſhed in the *Viciſſitudes de la Fortune*, Paris, 2 vols. 8vo.

MENDICANTS, or Begging Friars, ſeveral orders of religious in Popiſh countries, who having no ſettled revenues, are ſupported by the charitable contributions they receive from others.

This ſort of ſociety began in the 13th century; and the members of it, by the tenor of their inſtitution, were to remain entirely deſtitute of all fixed revenues and poſſeſſions; though in proceſs of time their number became a heavy tax upon the people. Innocent III. was the firſt of the popes who perceived the neceſſity of inſtituting ſuch an order; and accordingly he gave ſuch monaſtic ſocieties, as made a profeſſion of poverty, the moſt diſtinguiſhing marks of his protection and favour. They were alſo encouraged and patronized by the ſucceeding pontiffs, when experience had demonſtrated their public and extenſive uſefulneſs. But when it became generally known, that they had ſuch a peculiar place in the eſteem and protection of the rulers of the church, their number grew to ſuch an enormous and unwieldy multitude, and ſwarmed ſo prodigiouſly in all the European provinces, that they became a burden, not only to the people, but to the church itſelf. The great inconvenience that aroſe from the exceſſive multiplication of the mendicant orders was remedied by Gregory X. in a general council, which he aſſembled at Lyons in 1272. For here all the religious orders that had ſprung up after the council held at Rome in 1215, under the pontificate of Innocent III. were ſuppreſſed; and the extravagant multitude of mendicants, as Gregory called them, were reduced to a ſmaller number, and confined to the four following ſocieties or denominations, viz. the Dominicans, the Franciscans, the Carmelites, and the Augustins or hermits of St Auguſtin.

As the pontiffs allowed theſe four mendicant orders the liberty of travelling wherever they thought proper, of converſing with perſons of every rank, of inſtructing the youth and multitude wherever they went; and as thoſe monks exhibited, in their outward appearance and manner of life, more ſtriking marks of gravity and holineſs than were obſervable in the other monaſtic ſocieties, they aroſe all at once to the very ſummit of fame, and were regarded with the utmoſt eſteem and veneration through all the countries of Europe. The enthuſiaſtic attachment to theſe ſanctimonious beggars went ſo far, that, as we learn from the moſt authentic records, ſeveral cities were divided or cantoned out into four parts, with a view to theſe four orders; the firſt part being aſſigned to the Dominicans, the ſecond to the Franciſcans, the third to the Carmelites, and the fourth to the Auguſtins. The people were unwilling to receive the ſacraments from any other hands than thoſe of the mendicants, to whoſe churches they crowded to perform their devotions, while living, and were extremely deſirous to depoſite there alſo their remains after death: nor did the influence and credit of the mendicants end here; for we find in the hiſtory of this and of the ſucceeding ages, that they were employed, not only in ſpiritual matters, but alſo in temporal and political affairs of the greateſt conſequence, in compoſing the differences of princes, concluding treaties of peace, concerting alliances, preſiding in cabinet councils, governing courts, levying taxes, and other occupations, not only remote from, but abſolutely inconſiſtent with, the monaſtic character and profeſſion. However, the power of the Dominicans and Franciſcans greatly ſurpaſſed that of the other two orders: inſomuch that theſe two orders were, before the Reformation, what the Jeſuits have been ſince that happy and glorious period, the very ſoul of the hierarchy, the engines of the ſtate, the ſecret ſprings of all the motions of the one and the other, and the authors and directors of every great and important event, both in the religious and political world. By very quick progreſſion their pride and confidence arrived at ſuch a pitch, that they had the preſumption to declare publicly, that they had a divine impulſe and commiſſion to illuſtrate and maintain the religion of Jeſus; they treated with the utmoſt inſolence and contempt all the different orders of the prieſthood; they affirmed, without a bluſh, that the true method of obtaining ſalvation was revealed to them alone; proclaimed, with oſtentation, the ſuperior efficacy and virtue of their indulgencies; and vaunted beyond meaſure their intereſt at the court of heaven, and their familiar connexions with the Supreme Being, the Virgin Mary, and the ſaints in glory. By theſe impious wiles, they ſo deluded and captivated the miſerable, and blinded the multitude, that they would not intruſt any other but the mendicants with the care of their ſouls. They retained their credit and influence to ſuch a degree, towards the cloſe of the 14th century, that great numbers of both ſexes, ſome in health, others in a ſtate of infirmity, and others at the point of death, earneſtly deſired to be admitted into the mendicant order, which they looked upon as a ſure and infallible method of rendering heaven propitious. Many made it an eſſential part of their laſt wills, that their bodies after death ſhould be wrapped in old ragged Dominican or Franciſcan habits, and interred among the mendicants. For ſuch was the barbarous ſuperſtition and wretched ignorance of this age, that people univerſally believed they ſhould readily obtain mercy from Chriſt, at the day of judgement, if they appeared before his tribunal aſſociated with the mendicant friars.

About this time, however, they fell under an univerſal odium; but being reſolutely protected againſt all oppoſition, whether open or ſecret, by the popes, who regarded them as their beſt friends and moſt effectual ſupports, they ſuffered little or nothing from the efforts of their numerous adverſaries. In the 15th century, beſides their arrogance, which was exceſſive, a quarrelſome and litigious ſpirit prevailed among them, and drew upon them juſtly the diſpleaſure and indignation of many. By affording refuge at this time to the Beguins in their order, they became offenſive to the biſhops, and were hereby involved in difficulties and perplexities of various kinds. They loſt their credit in the 16th century by their ruſtic impudence, their ridiculous ſuperſtitions, their ignorance, cruelty, and brutiſh manners. They diſcovered the moſt barbarous averſion to the arts and ſciences, and expreſſed a like abhorrence of certain eminent and learned men, who endeavoured to open the paths of ſcience to the purſuits of the ſtudious youth, recommended the culture of the mind, and attacked the barbariſm of the age in their writings and diſcourſe. Their general character, together with other circumſtances, concurred to render a reformation deſirable, and to accompliſh this happy event.

Among the number of mendicants are alſo ranked the Capuchins, Recollects, Minims, and others, who are branches or derivations from the former.

Buchanan tells us, the mendicants in Scotland, under an appearance of beggary, lived a very luxurious life; whence one wittily called them, not *Mendicant* but *Manducant* friars.

MENE, a Chaldean word, which ſignifies "he has numbered or counted;" being one of the three words that were written upon the wall by the hand that appeared to Belſhazzar, the laſt king of Babylon, the night that he was put to death. See BELSHAZZAR.

MENECRATES, a phyſician of Syracuſe, who flouriſhed about 360 B. C. is famous for his ſkill in his profeſſion, but much more for his vanity. He would always be followed by ſome of the patients he had cured, and with whom he previouſly ſtipulated that they ſhould follow him wherever he went. One appeared with the attributes of Hercules, another with thoſe of Apollo, and others again with thoſe of Mercury or Æſculapius; while he, clad in a purple robe, with a golden crown on his head, and a ſceptre in his hand, preſented himſelf, to the admiration of the public, under the name of *Jupiter*, and travelled through different countries eſcorted by theſe counterfeit deities. He once wrote the following letter to the king of Macedon: Menecrates Jupiter to Philip, greeting. Thou reigneſt in Macedonia, and I in medicine; thou giveſt death to thoſe who are in good health, I reſtore life to the ſick; thy guard is compoſed of Macedonians; the gods themſelves conſtitute mine." Philip anſwered him in a word, that he wiſhed him reſtored to reaſon. Learning ſome time after that he was in Macedon, Philip ſent for him, and invited him to an entertainment. Menecrates and his companions were placed on rich and lofty couches; before which was an altar, covered with the firſt fruits of the harveſt; and whilſt an excellent repaſt was ſerved up to the other gueſts, perfumes and libations only were offered to theſe new gods, who, unable to endure the affront, haſtily left the palace, in which they never more made their appearance.

MENEDEMUS, a Greek philoſopher, born at Erythreum, was the ſon of Caliſthenes, and one of Phedo's followers. He was in the greateſt eſteem, and enjoyed ſeveral important poſts, in his own country. He ſeveral times defended Erythreum with great bravery, and died of grief when Antigonus became maſter of it. A perſon one day ſaying to him, "It is a great happineſs to have what we deſire," he replied, "It is a much greater to deſire nothing but what we have." He flouriſhed about 300 B. C.

MENELAUS, the ſon of Atreus, and the brother of Agamemnon, reigned at Sparta, when Paris deprived him of his wife Helen. This rape occaſioned the famous war of Troy. See HELEN.

MENELAUS, a mathematician in the reign of the emperor Trajan, wrote three books on the *Sphere*, which have been publiſhed by Father Marſenne.

MENES, born at This, a town of Thebais in Upper Egypt, was the founder of the Egyptian empire. He had three ſons, viz. Athotis, who ruled after him, at This and Thebes; Curudes, who in Lower Egypt founded the kingdom of Heliopoli, which afterward was the kingdom of Dioſpoli; and Necherophes, who reigned at Memphis. It is thought this Menes reigned 117 years after the birth of Phaleg, ſon of Heber, which was the very year of the diſperſion of the people throughout the whole earth. In building Memphis, he ſtopped the Nile near it, by the invention of a cauſeway 100 furlongs broad, and cauſed it to run through the mountains.

MENIALS, domeſtic or houſehold ſervants, who live under their lord or maſter's roof.

MENINGES, or MENYNGES, in *Anatomy*, a name given to the dura and pia mater of the brain. See ANATOMY, N° 129.

MENINX, an iſland in the Mediterranean, to the weſt of the Syrtis Minor. Suppoſed by Strabo and Polybius to be Homer's country of the Lotophagi; and hence Ptolemy and Eratoſthenes denominate the iſland *Lotophagitis*, with a cognominal town *Meninx*. It was the country of Vibius Gallus the emperor, and of Voluſianus. Now called *Gerbi* and *Zarbi*.

MENIPPUS, a cynic philoſopher of Phœnicia. He was originally a ſlave, but obtained his liberty with a ſum of money, and became one of the greateſt uſurers at Thebes. He grew ſo deſperate from the continual reproaches and inſults to which he was daily expoſed on account of his meanneſs, that he deſtroyed himſelf. He wrote 13 books of ſatires, which have been loſt.

MENIPPEAN (*ſatira* MENIPPEA), a kind of ſatire conſiſting of proſe and verſe intermixed. It is thus called from Menippus a cynic philoſopher who delighted in compoſing ſatirical letters, &c. In imitation of him, Varro alſo wrote ſatires under the title of *Satiræ Menippeæ*: whence this ſort of compoſition is alſo denominated *Varronian ſatire*.

Among the moderns there is a famous piece under this title firſt publiſhed in 1594, againſt the chiefs of the league, called alſo the *Catholicon* of Spain. It is eſteemed a maſterpiece for the time.

MENISCUS, in *Optics*, a glaſs or lens, concave on one ſide and convex on the other; ſometimes alſo called *lunula*. See OPTICS.

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

MENNITH, or MINNITH, Judges xi. 33. a town near Heſhbon (Jerome), in Arabia Petræa; in a diſtrict named *Ecoſipolis*, or *twenty-towns*, (Cellarius). There is alſo a Minnith mentioned Ezekiel xxvii. as being in a good wheat country: but whether the ſame with the foregoing is uncertain; though ſome think that the firſt Minnith lay in the country of Ammon, (Wells).

MENNONITES, a ſect in the United Provinces, in moſt reſpects the ſame with thoſe in other places called *Anabaptiſts*.

They had their riſe in 1536, when Menno Simon, a native of Frieſland, who had been a Romiſh prieſt, and a notorious profligate, reſigned his rank and office in the Romiſh church, and publicly embraced the communion of the Anabaptiſts.

Menno was born at Witmarſum, a village in the neighbourhood of Bolſwert in Frieſland, in the year 1505, and died in 1561 in the duchy of Holſtein, at the country ſeat of a certain nobleman not far from the city of Oldeſloe, who, moved with compaſſion by a view of the perils to which Menno was expoſed, and the ſnares that were daily laid for his ruin, took him with certain of his aſſociates into his protection, and gave him an aſylum. The writings of Menno, which are almoſt all compoſed in the Dutch language, where publiſhed in folio at Amſterdam in the year 1651. About the year 1637, Menno was earneſtly ſolicited by many of the ſect with which he connected himſelf, to aſſume among them the rank and functions of a public teacher; and as he looked upon the perſons who made this propoſal to be exempt from the fanatical phrenſy of their brethren at Munſter (though according to other accounts they were originally of the ſame ſtamp, only rendered ſomewhat wiſer by their ſufferings), he yielded to their entreaties. From this period to the end of his life, he travelled from one country to another with his wife and children, exerciſing his miniſtry, under preſſures and calamities of various kinds, that ſucceeded each other without interruption, and conſtantly expoſed to the danger of falling a victim to the ſeverity of the laws. Eaſt and Weſt Frieſland, together with the province of Groningen, were firſt viſited by this zealous apoſtle of the Anabaptiſts; from whence he directed his courſe into Holland, Guelderland, Brabant, and Weſtphalia, continued it through the German provinces that lie on the coaſts of the Baltic ſea, and penetrated as far as Livonia. In all theſe places his miniſterial labours were attended with remarkable ſucceſs, and added to his ſect a prodigious number of followers. Hence he is deſervedly conſidered as the common chief of almoſt all the *Anabaptiſts*, and the parent of the ſect that ſtill ſubſiſts under that denomination. Menno was a man of genius, undirected by a very ſound judgement; he poſſeſſed a natural and perſuaſive eloquence, and ſuch a degree of learning as made him paſs for an oracle in the eſtimation of the multitude. He appears, moreover, to have been a man of probity, of a meek and tractable ſpirit, gentle in his manners, pliable and obſequious in his commerce with perſons of all ranks and characters, and extremely zealous in promoting practical religion and virtue, which he recommended by his example as well as by his precepts. The plan of doctrine and diſcipline drawn up by Menno was of a much more mild and moderate nature than that of the furious and fanatical ANABAPTISTS, whoſe tumultuous proceedings have been recited under that article, but ſomewhat more ſevere, though more clear and conſiſtent, than the doctrine of the wiſer branches of that ſect, who aimed at nothing more than the reſtoration of the Chriſtian church to its primitive purity. Accordingly he condemned the plan of eccleſiaſtical diſcipline that was founded on the proſpect of a new kingdom, to be miraculouſly eſtabliſhed by Jeſus Chriſt on the ruins of civil government and the deſtruction of human rulers, and which had been the fatal and peſtilential ſource of ſuch dreadful commotions, ſuch execrable rebellions, and ſuch enormous crimes. He declared publicly his diſlike of that doctrine, which pointed out the approach of a marvellous reformation in the church by the means of a new and extraordinary effuſion of the Holy Spirit. He expreſſed his abhorrence of the licentious tenets, which ſeveral of the Anabaptiſts had maintained, with reſpect to the lawfulneſs of polygamy and divorce; and finally, conſidered as unworthy of toleration thoſe fanatics who were of opinion that the Holy Ghoſt continued to deſcend into the minds of many choſen believers, in as extraordinary a manner as he did at the firſt eſtabliſhment of the Chriſtian church, and that he teſtified this peculiar preſence to ſeveral of the faithful by miracles, predictions, dreams, and viſions of various kinds. He retained indeed the doctrines commonly received among the Anabaptiſts, in relation to the baptiſm of infants, the *millennium*, or 1000 years reign of Chriſt upon earth, the excluſion of magiſtrates from the Chriſtian church, the abolition of war, and the prohibition of oaths enjoined by our Saviour, and the vanity as well as the pernicious effects of human ſcience. But while Menno retained theſe doctrines in a general ſenſe, he explained and modified them in ſuch a manner as made them reſemble the religious tenets that were univerſally received in the Proteſtant churches; and this rendered them agreeable to many, and made them appear inoffenſive even to numbers who had no inclination to embrace them. It however ſo happened, that the nature of the doctrines conſidered in themſelves, the eloquence of Menno which ſet them off to ſuch advantage, and the circumſtances of the times, gave a high degree of credit to the religious ſyſtem of this famous teacher among the Anabaptiſts, ſo that it made a rapid progreſs in that ſect. And thus it was in conſequence of the miniſtry of Menno, that the different ſorts of Anabaptiſts agreed together in excluding from their communion the fanatics that diſhonoured it, and in renouncing all tenets that were detrimental to the authority of civil government, and by an unexpected coalition formed themſelves into one community.

Though the Mennonites uſually paſs for a ſect of Anabaptiſts, yet M. Herman Schyn, a Mennonite miniſter, who has publiſhed their hiſtory and apology, maintains, that they are not Anabaptiſts either in principle or by origin. However, nothing can be more certain than this fact, viz. that the firſt Mennonite congregations were compoſed of the different ſorts of Anabaptiſts, of thoſe who had been always inoffenſive and upright, and of thoſe who, before their converſion by the miniſtry of Menno, had been ſeditious fanatics; beſides, it is alleged, that the Mennonites do actually retain, at this day, ſome of thoſe opinions and doctrines, which led the ſeditious and turbulent Anabaptiſts of old to the commiſſion of ſo many and ſuch enormous crimes: ſuch particularly is the doctrine concerning the nature of Chriſt's kingdom, or of the church of the New Teſtament, though modified in ſuch a manner as to have loſt its noxious qualities, and to be no longer pernicious in its influence.

The Mennonites are ſubdivided into ſeveral ſects; whereof the two principal are the *Flandrians* or FLEMINGIANS, and the WATERLANDIANS. The opinions, ſays Moſheim, that are held in common by the Mennonites, ſeem to be all derived from this fundamental principle, that the kingdom which Chriſt eſtabliſhed upon earth is a viſible church or community, into which the holy and juſt alone are to be admitted, and which is conſequently exempt from all thoſe inſtitutions and rules of diſcipline that have been invented by human wiſdom, for the correction and reformation of the wicked. This principle, indeed, was avowed by the ancient Mennonites, but it is now almoſt wholly renounced: nevertheleſs, from this ancient doctrine, many of the religious opinions that diſtinguiſh the Mennonites from all other Chriſtian communities, ſeem to be derived: in conſequence of this doctrine, they admit none to the ſacrament of baptiſm but perſons that are come to the full uſe of their reaſon; they neither admit civil rulers into their communion, nor allow any of their members to perform the functions of magiſtracy; they deny the lawfulneſs of repelling force by force, and conſider war, in all its ſhapes, as unchriſtian and unjuſt; they entertain the utmoſt averſion to the execution of juſtice, and more eſpecially to capital puniſhments; and they alſo refuſe to confirm their teſtimony by an oath. The particular ſentiments that divided the more conſiderable ſocieties of the Mennonites are the following: The rigid Mennonites, called the *Flemingians*, maintain with various degrees of rigour, the opinions of their founder Menno, as to the human nature of Chriſt, alleging that it was produced in the womb of the Virgin by the creating power of the Holy Ghoſt; the obligation that binds us to waſh the feet of ſtrangers, in conſequence of our Saviour's command; the neceſſity of excommunicating and avoiding, as one would do the plague, not only avowed ſinners, but alſo all thoſe who depart, even in ſome light inſtances pertaining to dreſs, &c. from the ſimplicity of their anceſtors; the contempt due to human learning, and other matters of leſs moment. However this auſtere ſyſtem declines, and the rigid Mennonites are gradually approaching towards the opinions and diſcipline of the more moderate or *Waterlandians*.

The firſt ſettlement of the Mennonites, in the United Provinces, was granted them by William prince of Orange, towards the cloſe of the 16th century; but it was not before the following century that their liberty and tranquillity were fixed upon ſolid foundations, when, by a confeſſion of faith publiſhed in the year 1626, they cleared themſelves from the imputations of thoſe pernicious and deteſtable errors that had been laid to their charge. In order to appeaſe their inteſtine diſcords, a conſiderable part of the Anabaptiſts of Flanders, Germany, and Frieſland, concluded their debates in a conference held at Amſterdam, in the year 1630, and entered into the bonds of fraternal communion, each reſerving to themſelves a liberty of retaining certain opinions. This aſſociation was renewed and confirmed by new reſolutions, in the year 1649; in conſequence of which the rigorous laws of Menno and his ſucceſſors were, in various reſpects, mitigated and corrected.

MENOLOGY, MENOLOGIUM, (from μην, *month*, and λογος, *diſcourſe*), is much the ſame as martyrology, or calendar, in the Latin.

The Greek menologium is divided into the ſeveral months in the year; and contains an abridgment of the lives of the ſaints, with a bare enumeration of the names of ſuch whoſe lives were never written. The Greeks have various menologies; and the Romans tax them with inſerting divers heretics in their menologies as ſaints.—Baillet treats of them at large.

MENSA, in law books, a term that includes in it all patrimony, and neceſſaries for livelihood.

MENSALS, MENSALIA, in church hiſtory, ſuch livings as were formerly united to the tables of religious houſes, and hence called *menſal benefices*. See the article BENEFICE.

MENSES, CATAMENIA, in *Medicine*, the monthly evacuations from the uterus of women not with child or not giving ſuck. They are ſo called from *menſis* "month," the period wherein they return. They are alſo called *flowers*, *courſes*, &c. By the Jewiſh law a woman was unclean while the menſtrual blood flowed; and the man who touched her, or the moveables ſhe had touched, was declared unclean.—Lev. xv. See MIDWIFERY and MEDICINE.

MENSORES, among the Romans, were harbingers, whoſe buſineſs it was to go before the emperor, and fix upon lodgings for him when he travelled into any of the provinces. They alſo marked out encampments, and aſſigned every regiment its poſt.

Menſores were alſo land-ſurveyors, architects, or appraiſers of houſes and public buildings. The diſtributors of proviſions in the army were called *menſores frumentarii*. And menſores was alſo an appellation given to ſervants who waited at table.

MENSURATION.

EVERY branch of the mathematics which has for its object the compariſon of geometrical quantities, and the determination of their proportions to each other, may be comprehended under the general name *Menſuration*. So that, taking the term in its moſt extenſive ſenſe, whatever is delivered in this work under the titles GEOMETRY, TRIGONOMETRY, CONIC SECTIONS, part of ALGEBRA, and a very conſiderable portion of FLUXIONS, may be conſidered as conſtituting particular branches of this general theory.

Tables of Meaſures.

The term menſuration, however, is alſo frequently uſed in a leſs extenſive ſenſe, and is applied to a ſyſtem of rules and methods by which numerical meaſures of geometrical quantities are obtained. And it is to this limited view of the ſubject that we propoſe to confine our attention in the preſent treatiſe. In general, it will only be neceſſary to give the practical rules, as we have already explained their foundation when treating of GEOMETRY, CONIC SECTIONS, and FLUXIONS; but, in addition to the rules, in a few inſtances, we ſhall give their demonſtrations.

In all practical applications of mathematics it is neceſſary to expreſs magnitudes of every kind by numbers. For this purpoſe a line of ſome determinate length, as one inch, one foot, &c. is aſſumed as the meaſuring unit of lines, and the number expreſſing how often this unit is contained in any line, is the numerical value or meaſure of that line.

A ſurface of ſome determinate figure and magnitude is aſſumed as the meaſuring unit of ſurfaces, and the number of units contained in any ſurface is the numerical meaſure of that ſurface, and is called its *area*. It is uſual to aſſume, as the meaſuring unit of ſurfaces, a ſquare, whoſe ſide is the meaſuring unit of lines.

A ſolid of a determinate figure and magnitude is in like manner aſſumed as the meaſuring unit of ſolids, and the number of units contained in any ſolid is its ſolidity or content. The unit of ſolids is a cube, each of whoſe edges is the meaſuring unit of lines, and conſequently each of its faces the meaſuring unit of ſurfaces.

A right angle is conceived to be divided into 90 equal angles; and one of theſe, called an angle of one degree, is aſſumed as the meaſuring unit of angles.

The meaſures generally employed in the application of menſuration to the common affairs of life, and their proportions to each other, are expreſſed in the following tables.

Table of Lineal Meaſures.

12 Inches = 1 Foot.
3 Feet = 1 Yard.
6 Feet = 1 Fathom.
$5\frac{1}{2}$ Yards = 1 Pole, Rod, or Perch.
40 Poles = 1 Furlong.
8 Furlongs = 1 Mile.
3 Miles = 1 League.
$69\frac{1}{6}$ Miles nearly = 1 Degree.
360 degrees = The earth's circumference.

Note. An inch is ſuppoſed equal to three barley-corns in length.

4 Inches = 1 Hand, or handsbreadth.
5 Feet = 1 Geometrical Pace.
4 Poles or 66 Feet } = 1 Engliſh chain.
100 links each $7\frac{92}{100}$ inches } = 1 Engliſh chain.
74 Feet = 1 Scots chain.

Table of Square Meaſures.

144 Square Inches = 1 Foot ſquare.
9 Square Feet = 1 Yard.
$30\frac{1}{4}$ Square Yards = 1 Pole.
40 Square Poles = 1 Rood.
4 Roods or 160 Square Poles = 1 Acre.
10 Square Chains } = 1 Acre.
or 100,000 Square Links } = 1 Acre.
640 Square Acres = 1 Square Mile.

Of Right Lines and Angles.

Note. The Scots acre is to the Engliſh acre as 100000 to 78694.

Table of Solid Meaſures.

1728 Cubic Inches = 1 Cubic Foot.
27 Cubic Feet = 1 Cubic Yard.

Note. 282 Cubic inches make 1 Ale Gallon.
231 1 Wine Gallon.
2150.42 a Wincheſter Buſhel.
105 Cubic inches 1 Scots Pint.
The Wheat Firlot contains $21\frac{1}{4}$ Scots Pints.
The Barley Firlot 31 Scots Pints.

SECTION I.

OF THE MENSURATION OF RIGHT LINES AND ANGLES.

THE rules by which certain of the ſides or angles of a triangle are to be found, when other ſides and angles are given, might be conſidered as belonging to this part of menſuration. But as theſe are fully inveſtigated and explained in the article PLANE TRIGONOMETRY, it is not neceſſary to deliver them alſo here. Referring therefore to that article, we ſhall employ the remainder of this ſection in the application of trigonometry to the menſuration of heights and diſtances.

Menſuration of Heights and Diſtances.

By the application of geometry the meaſurement of lines, which, on account of their poſition or other circumſtances, are inacceſſible, is reduced to the determination of angles, and of other lines which are acceſſible, and admit of being meaſured by methods ſufficiently obvious.

A line conſidered as traced on the ground may be meaſured with rods or a Gunter's chain of 66 feet; but more expeditiouſly with meaſuring tapes of 50 or 100 feet. By theſe, if the ground be tolerably even, and the direction of the line be traced pretty correctly, a diſtance may, by uſing proper care, be meaſured within about 3 inches of the truth in every 50 feet, ſo that the error may not exceed the 200th part of the whole line.

Plate CCCXXXIII.

Vertical angles may be meaſured with a quadrant furniſhed with a plummet and ſights in the manner indicated by fig. 1. and fig. 2. If an angle of elevation is to be meaſured, as the angle contained by a horizontal line AC, and a line drawn from A to B the top of a tower, hill, or other eminence; or to a celeſtial body, as a ſtar, &c.; the centre of the quadrant muſt be fixed at A, and the inſtrument moved about A, in the vertical plane, till to an eye placed at G the object B be ſeen through the two ſights D, *d*. Then will the arch EF, cut off by the plumb-line AF, be the meaſure of the angle CAB.

An angle of depreſſion CAB (fig. 2.) is to be meaſured exactly in the ſame manner, except that here the eye is to be placed at A the centre of the inſtrument, and the meaſure of the angle is the arch EF.

But the moſt convenient inſtrument of any for obſerving angles, whether vertical or horizontal, is the *Theodolite.* This inſtrument is variouſly conſtructed, ſo as to admit of being ſold at a higher or lower price, according to the degree of accuracy the purchaſer may wiſh to attain in his obſervations with it. An inſtrument of this kind is repreſented in fig. 3. Its principal parts are, 1. A teleſcope and its level C C, D. 2. The vertical arc BB. 3. The horizontal limb and compaſs AA. The limb is generally about 7 inches in diameter. 4. The ſtaff with its parallel plates E.

The teleſcope CC in the beſt inſtruments is generally of the achromatic kind, in order to obtain a larger field and greater magnifying power. In the focus of the eye glaſs are two very fine hairs or wires, at right angles to each other, whoſe interſection is in the plane of the vertical arc. The object glaſs may be moved to different diſtances from the eye glaſs by turning the milled nut *a*, and thus may be accommodated to the eye of the obſerver and diſtance of the object. The ſcrews for moving and adjuſting the croſs hairs, are ſunk a little within the eye tube. On the outſide of the teleſcope are two metal rings which are ground perfectly true. Theſe are to lie on the ſupporters *e*, *e*, called Y's, which are fixed to the vertical arc. The vertical arc BB is firmly fixed to a long axis which is at right angles to the plane of the arc. This axis is ſuſtained by, and moveable on, the two ſupporters, which are fixed firmly to the horizontal plate. On the upper part of the vertical arc are the two Y's for holding the teleſcope; the inner ſides of theſe are ſo framed as to be tangents to the cylindric rings of the teleſcope, and therefore bear only on one part. The teleſcope is confined to the Y's by two loops which turn on a joint, and may therefore be readily opened and turned back when the two pins are taken out.

One ſide of the vertical arc is graduated to half degrees, which are ſubdivided to every minute of a degree by a *nonius*. It is numbered each way from the middle from 0 to 90°; towards the eye end for angles of altitude, and towards the object end for angles of depreſſion. On the other ſide of the vertical arc are two ranges of diviſions, one for taking the upright height of timber in 100th parts of the diſtance between the inſtrument and tree whoſe height is to be meaſured; and the other for reducing hypothenuſal lines to ſuch as are horizontal.

The vertical arc is cut with teeth or a rack, and may be moved regularly, and with eaſe, by turning the milled nut *b*.

The compaſs is fixed to the upper horizontal plate, its ring is divided into 360°, and the bottom of the box is divided into four parts or quadrants, each of which is ſubdivided into 10°. The magnetic needle is ſupported in the middle of the box upon a ſteel pin finely pointed, and there is a wire trigger for throwing the needle off the point when not in uſe.

The horizontal limb AA conſiſts of two plates, one moveable on the other, the outermoſt edge of the upper plate is chamfered to ſerve as an index to the degrees on the lower. The upper plate, together with the compaſs, vertical arc, and teleſcope, are eaſily turned round by a pinion fixed to the ſcrew *c*; *d* is a nut for fixing the index to any part of the limb, and thereby rendering it ſecure, while the inſtrument is moved from one ſtation to another. The horizontal limb is divided into half degrees, and numbered from the right hand towards the left; the diviſions are ſubdivided by the nonius ſcale to every minute of a degree.

On the upper plate, towards the nonius, are a few diviſions ſimilar to thoſe on the vertical arc, giving the 100th parts, for meaſuring the diameter of trees, buildings, &c.

The whole inſtrument fits on the conical ferril of a ſtrong braſs-headed ſtaff, with three ſubſtantial wooden legs. The top or head of the ſtaff conſiſts of two braſs plates E, parallel to each other: four ſcrews paſs through the upper plate and reſt on the lower plate; by the action of theſe the horizontal limb may be ſet truly level, and for this purpoſe a ſtrong pin is fixed to the outſide of the plate, and connected with a ball that fits into a ſocket in the lower plate; the axis of the pin and ball are ſo framed as to be perpendicular to the plate, and conſequently to the horizontal limb.

There are three adjuſtments neceſſary before the inſtrument is applied to the menſuration of angles. In the firſt place, care muſt be taken that the line of collimation (that is, the line of viſion paſſing through the croſs hairs) be exactly in the centre of the cylindric rings round the teleſcope; in the next place, that the level be parallel to this line; and, laſtly, the horizontal limb muſt be ſo ſet, that when the vertical arc is at *zero*, and the upper part moved round, the bubble of the level will remain in the middle of the open ſpace.

When theſe adjuſtments are made, and the inſtrument is to be applied to practice, the lower plate of the horizontal limb AA being ſuppoſed to remain unmoved and parallel to the horizon, the teleſcope is to be directed ſucceſſively to the different objects, whoſe angular poſitions are to be determined, by means of the pinions at *c* and *b*; (the former of which turns the upper part of the inſtrument round in a horizontal plane, and the latter turns the arc BB in a vertical plane). Then, the angle which a line paſſing through the axis of the teleſcope and any object makes with the horizon, will be indicated by the arc of the vertical circle between 0° and the index engraved on the nonius ſcale H fixed to the upper plate of the horizontal limb of the inſtrument. Alſo, the horizontal angle contained by two vertical planes conceived to paſs through any two objects and the centre of the inſtrument, will be ſhewn by the arc of the lower plate of the horizontal limb over which the index engraved on the upper plate has paſſed by the direction of the teleſcope being changed from the one object to the other.

Having thus explained ſhortly the nature of the inſtruments by which acceſſible lines and angles are to be meaſured, and the manner of applying them, we ſhall now ſhew, by a few examples, how to find from theſe other lines which cannot be determined by a direct meaſurement.

Example 1. Having meaſured AE, a diſtance of 200 feet in a direct horizontal line from the bottom of a tower, the angle BCD, contained by the horizontal line CD: and a line drawn from C to the top of the Fig. 4.

tower, was meaſured by a quadrant, or theodolite placed at C, and found to be 47° 30′. The centre C of the inſtrument was five feet above the line AE at its extremity E. It is required hence to determine AB the height of the tower.

In the right-angled triangle CBD we have given the ſide CD = 200 feet, and the angle C = 47° 30′. And ſince by the rules of PLANE TRIGONOMETRY,

rad : tan. BCD :: DC : DB ;

By employing the logarithmic tables (ſee LOGARITHMS), and proceeding as is taught in PLANE TRIGONOMETRY, we ſhall find DB = 218.3 feet. To which add DA=EC=5 feet, the height of the inſtrument, and we have AB = 223.3 feet, the height of the tower.

Fig. 5. *Ex.* 2. Suppoſe a cloud, or balloon C, is ſeen at the ſame time by two obſervers at A and B, and that theſe ſtations are in the ſame vertical plane with the object C, and on the ſame ſide of it. Alſo, ſuppoſe that its angles of elevation, viz. the angles A and B, are 35° and 64°, and that AB, the diſtance between the obſervers, is 880 feet. It is required hence to determine CD the height of the object, alſo AC, BC its diſtances from the two obſervers.

In the triangle CAB, there are given the outward angle CBD=64°, and one of the inward angles A=35°; hence the other inward angle ACB, which is their difference, is given, and = 64°—35°=29°.

Now in the triangle CAB

Sin. ACB : ſin. A :: AB : BC,
and ſin. ACB : ſin. B :: AB : AC.

From theſe proportions, by actual calculation, BC will be found = 1041 feet, and AC = 1631 feet.

Again, in the right-angled triangle BCD

rad. : ſin. B :: BC : CD,

Hence CD will be found = 936 feet.

Fig. 6. *Ex.* 3. Wanting to know the breadth CD of a river, and alſo the diſtance of an object A cloſe by its ſide from another object C on its oppoſite ſide, a baſe AB of 400 yards was meaſured along the bank. Then, by means of a theodolite, the angles CBA and CAB were meaſured, and found to be 37° 40′ and 59° 15′ reſpectively. It is required thence to determine the breadth CD, and the diſtance AC between the objects A and C.

This example differs from the laſt only by the given angles, and diſtances required, lying in a horizontal inſtead of a vertical plane.

In the triangle ABC we have the baſe AB, alſo the angles A and B, and conſequently the angle C given.

And by Plane Trigonometry,

Sin. ACB : ſin. B :: AB : AC.

Hence AC is found to be 246.2 yards.

Alſo, in the right-angled triangle ACD,

rad. : ſin. A :: AC : CD.

Hence CD is found to be 211.6 yards.

Fig. 7. *Ex.* 4. At B the top of a tower, which ſtood on a hill near the ſea ſhore, the angle of depreſſion of a ſhip at anchor (viz. the angle HBS), was 4° 52′; and at R, the bottom of the tower, its depreſſion (namely, the angle NRS) was 4° 2′. Required AS the horizontal diſtance of the veſſel; and alſo RA, the height of the bottom of the tower above the level of the ſea, ſuppoſing RB the height of the tower itſelf to be 54 feet.

From the angle BSA = HBS = 4° 52′ ſubtract the angle RSA = NRS = 4° 2′, and there remains the angle BSR=50′. Alſo, from the angle HBA = 90° ſubtract HBS=4° 52′, and there remains SBR=85° 8′.

In the triangle SBR,

Sin. BSR : ſin. SBR :: BR : SR ;

Hence SR is found. Again, in the triangle SRA,

rad. : ſin. RSA :: SR : AR,
and rad. : coſ. RSA :: SR : AS.

From the firſt of theſe proportions we find AR = 260 feet; and from the ſecond, AS=3690 feet.

Fig. 8. *Ex.* 5. To meaſure the height of an obeliſk CD, ſtanding on the top of a declivity, two ſtations at A and B were taken, one at the diſtance of 40, and the other at the diſtance of 100 feet from the centre of its baſe, which was in a ſtraight line with the ſtations. At the nearer ſtation A, a line drawn from it to the top of the obeliſk was found to make an angle of 41° with the plane of the declivity; and at B, the more remote ſtation, the like angle was found to be 23° 45′. Hence it is required to find the height of the obeliſk.

From the angle CAD = 41°, ſubtract the angle B = 23° 45′, and there remains the angle BCA = 17° 15′.

In the triangle BCA,

Sin. BCA : ſin. B :: AB : AC. Hence AC=81.49 feet.

And in the triangle ACD,

$$AC+AD : AC-AD :: \tan.\tfrac{1}{2}(D+C) : \tan.\tfrac{1}{2}(D-C).$$

Hence $\tfrac{1}{2}(D-C) = 42^\circ\ 24'\tfrac{1}{2}$, which, ſubtracted from $\tfrac{1}{2}(D+C)$, gives the angle ACD = $27^\circ\ 5'\tfrac{1}{2}$.

Laſtly, in the triangle ACD,

Sin. ACD : ſin. A :: AD : DC.

Hence DC, the height required, will be found to be 57.62 feet.

Fig. 9. *Ex.* 6. Wanting to know the diſtance between two inacceſſible objects H and M, a baſe AB of 670 yards was meaſured in the ſame plane with the objects, and the following angles were taken at its extremities.

$$\text{At A}\begin{cases}\text{BAM}=40^\circ\ 16'\\ \text{MAH}=57\ \ \ 40\end{cases}\qquad \text{At B}\begin{cases}\text{ABH}=42^\circ\ 22'\\ \text{HBM}=71\ \ \ 7\end{cases}$$

Hence it is required to determine HM, the diſtance between the objects.

In the triangle HAB we have the angle HBA = 42° 22′, the angle HAB (= HAM + MAB) = 97°

$97^\circ 56'$, and therefore the remaining angle $AHB = 39^\circ 42'$. We have alſo the ſide $AB = 670$ yards. Hence, by this proportion,

$$\text{Sin. } AHB : \text{ſin. } HBA :: AB : AH.$$

we find $AH = 706.8$ yards.

Again, in the triangle MAB we have the angle $MAB = 40^\circ 16'$, the angle ABM $(= ABH + HBM) = 113^\circ 29'$, and therefore the angle $AMB = 26^\circ 15'$. Hence, from the proportion,

$$\text{Sin. } AMB : \text{ſin. } ABM :: AB : AM$$

we get $AM = 1389.4$.

In the triangle HAM, beſides the angle $HAM = 57^\circ 40'$ we have now the ſides $AH = 706.8$, and $AM = 1389.4$ yards, to find the remaining ſide HM. Therefore, proceeding according to the rules of trigonometry, we ſtate this proportion,

$$AM + AH : AM - AH :: \text{tan. } \tfrac{1}{2}(AHM + AMH) : \text{tan. } \tfrac{1}{2}(AHM - AMH).$$

Hence we find half the difference of the angles AHM and AMH to be $30^\circ 36'$, which taken from $61^\circ 10'$, half the ſum, leaves $30^\circ 34'$ for AMH the leaſt of the two angles. Laſtly, from the proportion

$$\text{Sin. } HMA : \text{ſin. } HAM :: HA : HM,$$

we get $HM = 1174$ yards, the anſwer to the queſtion.

Ex. 7. There are three objects A, B, C, whoſe diſtances aſunder are known to be as follows; namely, from A to B $106\frac{1}{2}$, from A to C 202, and from B to C 131 fathoms. Now to determine the diſtance of D a fourth object, or ſtation, from each of the other three, the angle ADB was meaſured with a theodolite, or other ſuitable inſtrument; and found to be $13^\circ 30'$, and the angle CDB was found $29^\circ 50'$. Hence it is required to determine the diſtances DA, DB and DC, ſuppoſing DB the leaſt of the three.

Let a circle be deſcribed about the points A, D and C; and let DB be produced to meet the circle again in E, and draw AE, CE.

In the triangle AEC there are given the ſide $AC = 202$ fathoms, the angle ACE ($=$ ADE, Geom. Sect. II. Theor. 15.) $= 13^\circ 30'$, and the angle CAE $(= CDE) = 29^\circ 50'$. Hence (by Trigon.) we ſhall have $AE = 68.716$ fathoms.

In the triangle ABC, all its ſides are given, and hence the angle BAC will be found $= 35^\circ 35' 54''$; to this, add the angle CAE, and the ſum is the angle $EAB = 65^\circ 25' 54''$.

In the triangle ABE, we have given $AB = 106.5$, $AE = 68.716$, the angle $BAE = 65^\circ 25' 54''$; hence we ſhall have the angle $ABE = 38^\circ 43' 41''$. and the angle $AEB = 75^\circ 51' 25''$.

In the triangle ADE we have the ſide $AE = 68.716$, the angle $ADE = 13^\circ 30'$, and the angle $AED = 75^\circ 51' 25''$. Hence we have $AD = 285.43$ fathoms, which is one of the diſtances required.

In the triangle ABD we have $AB = 106.5$, the angle $ADB = 13^\circ 30'$, the angle DAB $(= ABE - ADB)$ $25^\circ 13' 45''$. Hence BD, another of the diſtances ſought, will be found $= 194.45$ fathoms.

Laſtly, In the triangle ADC, there is given $AC = 202$, the angle ADC $(= ADB + BDC) = 43^\circ 20'$, the angle DCA $(= DEA) = 75^\circ 15' 25''$. Hence we get $DC = 256.97$ fathoms, which is the remaining diſtance ſought.

Ex. 8. From a ſhip at ſea a point of land was obſerved to bear E. by S. and after ſailing N. E. 12 miles, the ſame point was found to bear S. E. by E. How far was the laſt obſervation made from the point of land?

Let A be the firſt poſition of the ſhip, B the ſecond, and C the point of land. In the triangle ABC we have given the angle $A = 5$ points or $56^\circ 15'$, the angle $B = 9$ points, or $101^\circ 15'$, and the angle $C = 2$ points or $22^\circ 30'$. Alſo the ſide $AB = 12$ miles. Hence (by Trigon.) the ſide BC is readily found to be 26.073 miles.

There are various other inſtruments and methods by which the heights or diſtances of objects may be found. One of the moſt ſimple inſtruments, both in reſpect of its conſtruction and application, is a ſquare, ABCD, made of ſome ſolid material, and furniſhed with two Fig. 12. ſights on AB, one of its edges, and a plummet faſtened to A, one of its angles, and having the two ſides BC, CD, which contain the oppoſite angle divided into 10, or 100, or 1000 equal parts.

To meaſure any altitude HK with this inſtrument. Fig. 13. Let it be held in ſuch a poſition that K, the top of the object may be ſeen through the ſights on its edge AB, while its plane is perpendicular to the horizon; then the plummet will cut off from the ſquare a triangle ſimilar to that formed by the horizontal line AI, the vertical line IK, and the line AK drawn from the eye to the top of the object.

If the line of the plummet paſs through D the oppoſite angle of the ſquare, then the height KI will be equal to AI, the diſtance of the eye from the vertical line to be meaſured. If it meet AD, the ſide of the ſquare next the eye, in ſome point E between A and D, then the triangles ABE, AIK being ſimilar, and the angle ABE equal to the angle AKI, we have $AE : AB :: AI : IK$. Let us now ſuppoſe $AD = AB$ to be divided into 1000 equal parts; then the length of AE will be expreſſed by a certain number of theſe parts; thus the proportion of AE to AB, and conſequently that of AI to IK will be given; therefore if AI be determined by actual meaſurement, we may from the above proportion immediately find IK.

If again the line of the plummet meet DC the ſide of the ſquare oppoſite to the ſights in F, then, in the ſimilar triangles AIK, BCF, the angle AKI is equal to BFC thus we have $BC : CF :: AI : IK$. Hence IK is determined as before, and in each caſe by adding HI the height of the eye, we ſhall have HK the whole height required.

SECTION II.

MENSURATION OF PLANE FIGURES.

Problem I.

To find the area of a parallelogram, whether it be a ſquare, a rectangle, a rhombus, or a rhomboid.

RULE I.

Multiply the length by the perpendicular breadth, and the product will be the area.

This rule is demonſtrated in GEOMETRY, Sect. IV. Theor. 5.

Fig. 14. *Ex.* 1. Required the area of a ſquare ABCD, whoſe ſide AB is 10½ inches.

Here 10½ × 10½ or 10.5 × 10.5 = 110.25 ſquare inches is the area required.

Fig. 15. *Ex.* 2. Required the area of a rectangle EFGH whoſe length EF is 13.75 chains, and breadth FG is 9.5 chains.

Here 13.75 × 9.5 = 130.625 ſquare chains is the area, which, when reduced to acres, &c. is 13 *ac.* 0 *ro.* 10 *po.*

Ex. 3. Required the area of a parallelogram KLMN, whoſe length KL is 37 feet, and perpendicular breadth NO is 5¼ or 5.25 feet.

Fig. 16. In this example the area is 37 × 5.25 = 194.25 ſquare feet, or 21.583 ſquare yards.

RULE II.

As radius,
To the ſine of any angle of the parallelogram,
So is the product of the ſides including the angle,
To the area of the parallelogram.

To ſee the reaſon of this rule it is only neceſſary to obſerve, that in the parallelogram KLMN, the perpendicular breadth NO is a fourth proportional to *radius*, *ſine* of the angle K, and the oblique line KN, (TRIGONOMETRY), and is therefore equal to $\frac{\text{ſin. K}}{\text{rad.}}\times \text{KN}$; therefore the area of the figure is $\frac{\text{ſin. K}}{\text{rad.}}\times \text{KN}\times \text{KL}$, which expreſſion is the ſame as the reſult obtained by the above rule.

Ex. Suppoſe the ſides KL and KN are 36 feet, and 25.5 feet, and the angle K is 58°, required the area.

Here it will be convenient to employ the table of logarithms given at the end of the article LOGARITHMS. The operation may ſtand thus,

log. rad.	10.00000
log. ſin. 58°	9.92842
log. (36 × 25.5) = log. 36 + log. 25.5	2.96284
log. of area	2.89126

area = 778.5 ſquare feet.

PROBLEM II.

Having given any two ſides of a right-angled triangle, to find the remaining ſide.

RULE.

1. When the ſides about the right angle are given, to find the hypothenuſe.

Add together the ſquares of the ſides about the right angle, and the ſquare root of the ſum will be the hypothenuſe.

2. When the hypothenuſe and one of the ſides about the right angle is given, to find the other ſide.

From the ſquare of the hypothenuſe ſubtract the ſquare of the given ſide, and the ſquare root of the remainder will be the other ſide.

This rule is deduced from Theor. 13. Sect. IV. GEOMETRY.

Example 1. In a right-angled triangle ABC, the ſides AB and AC, about the right angle, are 33 feet and 56 feet; what is the length of the hypothenuſe BC? Fig. 17.

Here $33^2+56^2=3136+1089=4225$,
and $\sqrt{(4225)}=65$ feet, = the hypothenuſe BC.

Ex. 2. Suppoſe the hypothenuſe BC to be 65 feet, and AB one of the ſides about the right angle to be 33 feet; what is the length of AC the other ſide?

Here $65^2-33^2=4225-1089=3136$;
and $\sqrt{(3316)}=56$ feet = the ſide AC.

PROBLEM III.

To find the area of a triangle.

RULE I.

Multiply any one of its ſides by the perpendicular let fall upon it from the oppoſite angle, and half the product will be the area.

The truth of this rule is proved in GEOMETRY, Sect. IV. Theor. 6.

Example. What is the area of a triangle ABC, whoſe baſe AC is 40, and perpendicular BD is 14.52 chains.

The product of the baſe by the perpendicular, or 40 × 14.52, is 580.8 ſquare chains, the half of which, or 290.4 *ſq. ch.* = 29 *ac.* 0 *r.* 6.4 *po.* is the area of the triangle. Fig. 18.

RULE II.

As radius,
To the ſine of any angle of a triangle,
So is the product of the ſides including the angle,
To twice the area of the triangle.

This rule follows immediately from the ſecond rule of Prob. I. by conſidering that the triangle KNL (fig. 16) is half the parallelogram KNML.

Example. What is the area of a triangle ABC, whoſe two ſides AB and AC are 30 and 40, and the included angle A is 28° 57′? Fig. 18.

Operation by Logarithms.

log. rad.	10.00000
log. (30 × 40) = log. 30 + log. 40	3.07918
log. ſin. 28° 57′	9.68489
log. of twice area	2.76407

twice area = 580.85
area 290.42

Rule III.

When the three ſides are given, add together the three ſides, and take half the ſum. Next, ſubtract each ſide ſeverally from the ſaid half ſum, thus obtaining three remainders. Laſtly, multiply the ſaid half ſum, and thoſe three remainders all together, and extract the ſquare root of the laſt product for the area of the triangle.

This practical rule is deduced from the following geometrical theorem. *The area of a triangle is a mean proportional between two rectangles, one of which is contained by half the perimeter of the triangle, and the exceſs of half the perimeter above any one of its ſides; and the other is contained by the exceſſes of half the perimeter above each of the other two ſides.* As this theorem is not only remarkable, but alſo of great utility in menſuration, we ſhall here give its demonſtration.

Fig. 19. Let ABC then be any triangle; produce AB, any one of its ſides, and take BD, and B d, each equal to BC; join CD and C d, and through A draw a line parallel to BC, meeting CD and C d produced in E and e; thus the angle AED will be equal to the angle BCD, (Geometry, Sect. I. Theor. 21.), that is, to the angle BDC or ADC, (Sect. I. Theor. 11.); and hence $AE = AD$ (Sect. I. Theor. 12.); and in like manner, becauſe the angle A e d is equal to the angle BC d, that is, to the angle B d C, or A d e, therefore $Ae = Ad$.

On A as a centre, at the diſtance AD or AE, deſcribe a circle meeting AC in F and G; and on the ſame centre, with the diſtance A d or A e, deſcribe another circle meeting AC in f and g, and draw BH and B h perpendicular to CD and C d. Then, becauſe BD, BC, B d are equal, the point C is in the circumference of a circle, of which D d is the diameter, therefore CD and C d are biſected at H and h (Sect. II. Theor. 6.) and the angle DC d is a right angle, (Sect. II. Theor. 17.), and hence the figure CHB h is a rectangle, ſo that $Bh = CH = \frac{1}{2}CD$, and $BH = Ch = \frac{1}{2}Cd$.

Join BE, and B e, then the triangle BAC is equal to each of the triangles BEC, B e C (Sect. IV. Theor. 2. Cor. 2); but the triangle BEC is equal to $\frac{1}{2} EC \times BH$ (Sect. IV. Theor. 2.), that is to $\frac{1}{4} EC \times Cd$; and in like manner the triangle B e C is equal to $\frac{1}{2} eC \times Bh$, that is to $\frac{1}{4} eC \times CD$, therefore the triangle ABC is equal to $\frac{1}{4} EC \times Cd$, and alſo to $\frac{1}{4} eC \times CD$.

Now ſince $CD : Cd :: CE \times CD : CE \times Cd$ ⎧ Sect. IV.
and alſo $CD : Cd :: Ce \times CD : Ce \times Cd$ ⎩ Theor. 3.

Therefore $CE \times CD : CE \times Cd :: Ce \times CD : Ce \times Cd$; that is, becauſe $CE \times CD = FC \times CG$, and $Ce \times Cd = fC \times Cg$ (Sect. IV. Corollaries to Theor. 28 and 29.).

$$FC \times CG : CE \times Cd : Ce \times CD : fC \times Cg;$$

which laſt proportion (by taking one-fourth of each of its terms, and ſubſtituting the triangle ABC for its equivalent values $\frac{1}{4} CE \times Cd$ and $\frac{1}{4} Ce \times CD$) gives us

$$\tfrac{1}{2} FC \times \tfrac{1}{2} CG : \textit{trian.}\ ABC :: \textit{trian.}\ ABC : \tfrac{1}{2} fC \times \tfrac{1}{2} Cg.$$

Now, if it be conſidered that the radius of the circle DGE is $AB + BC$, and that the radius of the circle gde is $AB - BC$, it will readily appear that, putting $2s$ for the perimeter of the triangle ABC, we have

$$\begin{aligned}
FC\ (&= AB + BC + AC) = 2s\\
CG\ (&= AB + BC - AC) = 2s - 2AC,\\
fC\ (&= AC + \{AB - BC\}) = 2s - 2BC,\\
gC\ (&= AC - \{AB - BC\}) = 2s - 2AB.
\end{aligned}$$

Put now a, b, c for the ſides AC, BC, and AB reſpectively, then $\frac{1}{2} FC = s$, $\frac{1}{2} GC = s - a$, $\frac{1}{2} fC = s - b$, $\frac{1}{2} Cg = s - c$; thus the laſt proportion becomes

$$s \times (s - a) : \textit{trian.}\ ABC :: \textit{trian.}\ ABC : (s - b) \times (s - c),$$

which concluſion, when expreſſed in words at length, is evidently the proportion to be demonſtrated.

And as a mean proportional between two quantities is found by taking the ſquare root of the product, it follows that the area of the triangle ABC, which is a mean between $s \times (s - a)$ and $(s - b) \times (s - c)$, is equal to

$$\sqrt{\left\{ s \times (s - a) \times (s - b) \times (s - c) \right\}}$$

which formula, when expreſſed in words at length, gives the preceding rule.

Example. Required the area of a triangle whoſe three ſides are 24, 36, and 48 chains reſpectively.

Here $24 + 36 + 48 = 108$ = the ſum of the three ſides.

And $\frac{108}{2} = 54$ = half that ſum.

Alſo $54 - 24 = 30$, the firſt remainder; $54 - 36 = 18$, the ſecond remainder; and $54 - 48 = 6$, the third remainder.

The product of the half ſum and remainders is

$$54 \times 30 \times 18 \times 6 = 174960.$$

And the ſquare root of this product is

$\sqrt{(174960)} = 418.28$ ſq. ch. the area required.

Problem IV.

To find the area of a trapezoid.

Rule.

Add together the two parallel ſides, then multiply their ſum by the perpendicular breadth, or diſtance between, and half the product will be the area.

This rule is demonſtrated in Geometry, Sect. IV. Theor. 7.

Example. Required the area of the trapezoid ABCD whoſe parallel ſides AB and DC are 7.5 and 12.25 chains, and perpendicular breadth DE is 15.4 chains. Fig. 20.

The ſum of the parallel ſides is $7.5 + 12.25 = 19.75$; which multipled by the breadth is

$$19.75 \times 15.4 = 304.15;$$

and half this product is

$$\frac{304.15}{2} = 152.075\ \textit{ſq. ch.} = 15\ \textit{ac.}\ 33.2\ \textit{po.}$$

the area required.

Problem V.

To find the area of any trapezium.

Rule.

Divide the trapezium into two triangles by a diagonal, then find the areas of theſe triangles, and add them together.

Note. If two perpendiculars be let fall on the diagonal from the other two oppoſite angles, the ſum of theſe perpendiculars being multiplied by the diagonal, half the product will be the area of the trapezium. The reaſon of this rule is ſufficiently obvious.

Fig. 21. *Example.* In the trapezium ABCD the diagonal AC is 42, and the two perpendiculars BE, DF are 16 and 18: What is its area?

Here the ſum of the perp. is $16+18=34$, which multiplied by 42, and divided by 2 gives

$$\frac{34\times42}{2}=714 \text{ the area.}$$

Problem VI.

To find the area of an irregular polygon.

Rule.

Draw diagonals dividing the propoſed polygon into trapeziums and triangles; then find the areas of all theſe ſeparately, and add them together for the content of the whole polygon. The reaſon of this rule, and the manner of applying it, are ſufficiently obvious.

Problem VII.

To find the area of a regular polygon.

Rule.

Multiply the perimeter of the polygon, or ſum of its ſides, by the perpendicular drawn from its centre on one of its ſides, and take half the product for the area.

This rule is only in effect reſolving the polygon into as many triangles as it has ſides, by drawing lines from its centre to all its angles, then taking the ſum of their areas for the area of the figure.

Fig. 22. *Example.* Required the area of a regular pentagon ABCDE, whoſe ſide AB, or BC, &c. is 25 feet, and perpendicular HK is 17.2 feet.

Here $25\times5=125=$the perimeter,
And $125=17.2=2150$,
And its half $1075=$the area required.

Note. If only the ſide of the polygon be given, its perpendicular may be found by the following proportion.

As radius.
To the tan. of half the angle of the polygon,
So is half the ſide of the polygon,
To the perpendicular.

And here, as well as in all other trigonometrical calculations, we may employ the table of logarithmic ſines and tangents given in the article LOGARITHMS.

The angle of the polygon, that is, the angle contained by any two of its adjacent ſides, will be found from this theorem, *The ſum of all its interior angles is equal to twice as many right angles, wanting four, as it has ſides*, which is demonſtrated in Theor. 25. Sect. I. GEOMETRY.

Problem VIII.

To find the diameter and circumference of a circle, the one from the other.

Rule I.

As 7 is to 22, ſo is the diameter to the circumference, nearly.

As 22 is to 7, ſo is the circumference to the diameter, nearly.

Rule II.

As 113 is to 355, ſo is the diameter to the circumference, nearly.

As 355 is to 113, ſo is the circumference to the diameter, nearly.

Rule III.

As 1 is to 3.1416, ſo is the diameter to the circumference, nearly.

As 3.1416 is to 1, ſo is the circumference to the diameter, nearly.

Note. The reſult obtained by the firſt rule, which is the leaſt accurate of the three, will not differ from the true anſwer by ſo much as its 2400th part. But that obtained by the ſecond rule, which is the moſt accurate, will not differ by ſo much as its 100000000th part.

The proportion of the diameter of a circle to its circumference is inveſtigated in GEOMETRY, Sect. VI. Prop. 6. Alſo in FLUXIONS, § 137 and § 140. The manner of finding the firſt and ſecond rules, and others of the ſame kind, is explained in ALGEBRA, Sect. XXI. But it is impoſſible to expreſs exactly, by finite numbers, the proportion of the diameter of the circle to its circumference.

Example. 1. To find the circumference of a circle whoſe diameter is 20.

By the firſt rule,

$$7 : 22 :: 20 : \frac{20\times22}{7}=62\tfrac{6}{7} \text{ the anſwer.}$$

Or by the third rule $3.1416\times20=62.832$ the anſwer.

Ex. 2. The circumference of a circle is 10 feet, what is its diameter?

By the ſecond rule

$$355 : 113 :: 10 : \frac{113\times10}{355}=3.1831 \text{ the anſwer.}$$

Problem IX.

To find the length of any arch of a circle

Rule I.

As 180 is to the number of degrees in the arch, ſo is 3.1416 times the radius to its length.

To ſee the reaſon of this rule it is only neceſſary to conſider, that 3.1416 times the radius is (by laſt rule) equal to half the circumference, or to an arch of 180°, and that the length of an arch is proportional to the number of degrees it contains.

Example.

Fig. 23. *Example.* Required the length of the arch AEB, whoſe chord AB is 6, the radius AC or CB being 9. Draw CD perpendicular to the chord, then CD will biſect the chord in D, and the arch in E. Now in the right-angled triangle ACD, there is given the hypothenuſe AC = 9, and the ſide AD = 3; hence, by trigonometry, the angle ACE will be found to contain $19^\circ\ 28'\frac{3}{10}$ = 19.471 degrees. The double of this, or 38.942, is the number of degrees in the whole arch AEB. Then by the rule

$$180 : 38.942 :: 9 \times 3.1416 : \frac{9 \times 3.1416 \times 38.942}{180}$$

= 6.11701 the anſwer.

RULE II.

From 8 times the chord of half the arch ſubtract the chord of the whole arch, and $\frac{1}{3}$ of the remainder will be the length of the arch nearly.

This rule may be demonſtrated briefly thus. Let a denote an arch of a circle; then from the ſeries expreſſing the ſine of an arch in terms of the arch, (ſee FLUXIONS, § 70. *Ex.* 3. alſo TRIGONOMETRY) we have, putting rad. = 1,

$$\text{Sin. } \tfrac{1}{2}a = \tfrac{1}{2}a - \frac{a^3}{48} + \frac{a^5}{3840} - \&\text{c.}$$

Therefore, if the arch a be ſmall, ſo that a^5 is a very ſmall quantity, then

$$\text{Sin. } \tfrac{1}{2}a = \tfrac{1}{2}a - \frac{a^3}{48} \text{ nearly.}$$

In like manner we have

$$\text{Sin. } \tfrac{1}{4}a = \tfrac{1}{4}a - \frac{a^3}{384} \text{ nearly.}$$

By means of the two laſt equations exterminate the quantity a^3, and the reſulting equation is

$$16 \text{ ſin. } \tfrac{1}{4}a - 2 \text{ ſin. } \tfrac{1}{2}a = 3a.$$

But 16 ſin. $\frac{1}{4}a$ = 8 chord $\frac{1}{2}a$, and 2 ſin. $\frac{1}{2}a$ = chord a.

Therefore 8 chord $\frac{1}{2}a$ — chord $a = 3a$.

Here we have ſuppoſed the radius of the circle to be unity; but the ſame muſt evidently be true, whatever be the radius of the circle.

Fig. 23. *Example.* Suppoſe as before, that the chord AB is 6, and the radius AC is 9. Then CD = $\sqrt{(CA^2 - AD^2)} = \sqrt{72} = 8.4852814$, and DE = 9 — 8.4852814 = 0.5147186,

and hence AE = $\sqrt{(AD^2 + DE^2)} = 3.043836$.

Then by the rule

$$\frac{3.043836 \times 8 - 6}{3} = 6.116896$$

is the length of the arch, nearly the ſame as before.

PROBLEM X.

To find the area of a circle.

RULE I.

Multiply half the circumference by half the diameter, and the product will be the area.

RULE II.

Multiply the ſquare of the diameter by .7854, and the product will be the area.

The firſt of theſe rules has been demonſtrated in GEOMETRY, Sect. VI. Prop. 3. And the ſecond rule is deduced from the firſt, as follows. It appears from Prop. 6. Sect. VI. GEOMETRY, that the diameter of a circle being unity, its circumference is 3.1416 nearly; therefore, by the firſt rule, its area is 1 × 3.1416 ÷ 4 = .7854. But circles are to one another as the ſquares of their diameters, (Prop. 4.) therefore, putting d for the diameter of any circle, $1 : d^2 :: .7844 : .7854\, d^2$ = the area of the circle whoſe diameter is d.

Example. What is the area of a circle whoſe diameter is 7.

By the ſecond rule $7 \times 7 \times .7854 = 38.4846$ the area.

By the firſt rule $7 \times 3.1416 =$ the circumference.

Then $\frac{7 \times 3.1416 \times 7}{4} = 7 \times 7 \times .7854$ the area, the ſame as before.

PROBLEM XI.

To find the area of any ſector of a circle.

RULE I.

Multiply the radius by half the arch of the ſector, and the product will be the area, as in the whole circle.

RULE II.

As 360 is to the degrees in the arc of the ſector, ſo is the area of the whole circle to the area of the ſector.

The firſt of theſe rules follows eaſily from the rule for the whole area, by conſidering that the whole circumference is to the arch of the ſector, as the whole area to the area of the ſector, that is,

circum. :: arch of ſect. :: rad. × $\frac{1}{2}$ circum. : area of ſect.

Hence area of ſect. = rad. × $\frac{1}{2}$ arch of ſect.

The ſecond rule is too obvious to need any formal proof.

Example. To find the area of a circular ſector ACB whoſe arch AEB contains 18 degrees, the diameter being 3 feet. Fig. 23.

1. By the firſt rule.

Firſt $3.1416 \times 3 = 9.4248$ the circum.

And 360 : 18 :: 9.4248 : .47124 the arch of ſect.

Then $.47124 \times 3 \div 4 = .35343$ the area.

2. By the ſecond rule.

Firſt $.7854 \times 3^2 = 7.0686$ the area of the circle.

Then 360 : 18 :: 7.0686 : .35343 the area.

PROBLEM XII.

To find the area of a ſegment of a circle.

RULE I.

Find the area of the ſector having the ſame arch with the ſegment by the laſt problem. Find alſo the area contained by the chord of the ſegment and the two radii of the ſector. Then take the ſum of theſe two for the anſwer when the ſegment is greater than a ſemicircle, or take their difference when it is leſs than a ſemicircle. As is evident by inſpection of the figure of a ſegment.

Fig. 23. *Example.* To find the area of the ſegment AEBDA, its chord AB being 12, and the radius AC or BC 10.

Firſt, as AC : AD :: rad. : ſin. $36° \, 52'\frac{1}{3} = 36.87$ degrees, the degrees in the angle ACE or arch AE. And their double, or $73.74 =$ the degrees in the whole arch AEB.

Now $.7854 \times 400 = 314.16$ the area of the whole circle.

Therefore $360° : 73.74 :: 314.16 : 64.3504 =$ area of the ſector CAEB.

Again $\sqrt{(CA^2 - AD^2)} = \sqrt{(100 - 36)} = \sqrt{64} = 8 = DC$.

Therefore $AD \times DC = 6 \times 8 = 48 =$ area of the triangle.

Hence ſector ACBA — triangle $ACB = 16.3504$ the area of ſeg. AEBDA.

PROBLEM XIII.

To find the area of any ſegment of a parabola, that is the ſpace included by any arch of a parabola, and the ſtraight line joining its extremities.

RULE.

Multiply the baſe of the ſegment by its height, and take $\frac{2}{3}$ of the product for the area.

This rule is demonſtrated in Prop. 12. Part. I. CONIC SECTIONS.

Fig. 24. *Example.* The baſe AB of a parabolic ſegment ACB is 10, and its altitude CD, (that is, the greateſt line that can be drawn in the ſegment perpendicular to the baſe AB) is 4: What is its area?

$$\text{Here } 10 \times 4 \times \tfrac{2}{3} = \frac{80}{3} = 26\tfrac{2}{3} \text{ the area.}$$

PROBLEM XIV.

To find the area of an ellipſe.

RULE.

Multiply the product of the two axes by the number .7854 for the area of the ellipſe.

For the area of an ellipſe is equal to the area of a circle whoſe diameter is a mean proportional between the axes of the ellipſe, (CONIC SECTIONS, Part II. Prop. 22.) that is, to the area of a circle, the ſquare of whoſe diameter is equal to the product of the axes. But by Prob. X. the area of a circle is equal to the ſquare of the diameter multiplied by .7854; therefore the area of an ellipſe is equal to the product of the axes multiplied by the ſame number .7854.

Example. If the axes of an ellipſe, ACBD, be 35 and 25. What is the area? Fig. 25.

$$35 \times 25 \times .7854 = 687.225 \text{ the area.}$$

Note. As to hyperbolic areas, the mathematical reader will find formulas for their exact menſuration in FLUXIONS, § 152. Ex. 4. and 5.

PROBLEM XV.

To find nearly the area of a figure bounded by any curve line $Aa\,a''\,a''$ &c. P, and a ſtraight line BQ and AB, PQ two other ſtraight lines drawn from the extremities of the curve perpendicular to BQ.

RULE.

Let BQ, the baſe of the figure, be divided into any even number of equal parts by the perpendiculars ba, $b'a'$, $b''a''$, &c. which meet the curve in the points a, a', a'', &c. Fig. 26.

Let F and L denote the firſt and laſt perpendiculars AB and PQ.

Let E denote the ſum of all the remaining even perpendiculars, viz. ab, $a''b''$, $a''''b''''$, the ſecond, fourth, ſixth, &c.

Let R denote the ſum of the remaining perpendiculars, viz. $a'b'$, $a'''b'''$, &c.

And put D for Bb, or bb', &c. the common diſtance between the perpendiculars.

Then the area of the figure will be nearly equal to

$$\tfrac{1}{3}D \times (F + 4 \times 4E + 2R);$$

and the approximation will be ſo much the more accurate according as the number of perpendiculars is the greater.

Demonſtration. Join the tops of the firſt and third perpendiculars by the line Aa' meeting the ſecond perpendicular in E, and draw CD through a ſo as to form the parallelogram $Aa'DC$; then the ſpace bounded by the curve line Aaa' and the three ſtraight lines AB, Bb', $b'a'$ will be made up of the trapezoid $ABb'a'$, and the ſpace bounded by the arch Aaa' and its chord Aa'. Now if the arch Aaa' be ſmall, this laſt ſpace will be nearly two-thirds of the parallelogram AD, for it will be nearly equal to the area contained by the ſtraight line Aa', and an arch of a parabola paſſing through the points A, a, a', and having ab for a diameter, which area is $\frac{2}{3}$ of its circumſcribing parallelogram. (CONIC SECTIONS, Part I. Prop. xii.) Therefore the ſpace $Aaa'b'BA$ will be nearly equal to the ſum of the trapezoid $ABb'a'$ and $\frac{2}{3}$ of the parallelogram AD, which ſum is evidently equal to $\frac{1}{3}$ of the trapezoid $ABb'a'$ together with $\frac{2}{3}$ of the trapezoid $CBb'D$.

Of Plane Figures.

CB b' D. Now the area of the trapezoid AB b' a' is $\frac{\mathrm{AB}+a'b'}{2}\times \mathrm{B}b'$ (GEOMETRY, Sect. IV. Théor. 7.) $=\frac{\mathrm{AB}+a'b'}{2}\times 2\mathrm{B}b$; and in like manner the area of the trapezoid CB b' D is $\frac{\mathrm{CB}+\mathrm{D}b'}{2}\times \mathrm{B}b'=ab\times 2\mathrm{B}b$; therefore the area of the figure A a a' b' B is nearly

$$\tfrac{1}{3}\times\frac{\mathrm{AB}+a'b'}{2}\times 2\mathrm{B}b+\tfrac{2}{3}\times ab\times 2\mathrm{B}b$$
$$=\tfrac{1}{3}(\mathrm{AB}+4ab+a'b')\times\mathrm{B}b.$$

In the very ſame way it may be ſhewn that the area of the figure $a'\,a''\,a'''\,b'''\,b'$ is nearly

$$\tfrac{1}{3}(a'b'+4a''b''+a'''b''')\times\mathrm{B}b,$$

and that the area of the figure $a'''\,a^{\mathrm{iv}}$ PQ b''' is nearly

$$\tfrac{1}{3}(a'''b'''+4a^{\mathrm{iv}}b^{\mathrm{iv}}+\mathrm{PQ})\times\mathrm{B}b.$$

Therefore, the area of the whole figure bounded by the curve line AP, and the ſtraight lines AB, BQ, QP, is nearly equal to the ſum of theſe three expreſſions, namely to

$$\tfrac{1}{3}\mathrm{B}b\times\left\{\begin{array}{c}\mathrm{AB}+\mathrm{PQ}\\ +4(ab+a''b''+a^{\mathrm{iv}}b^{\mathrm{iv}})\\ +2(a'b'+a'''b''')\end{array}\right\}$$

as was to be demonſtrated.

Fig. 27. *Example* 1. Let it be required to find the area of the quadrant ABC, whereof the radius AC=1.

Let AC be biſected by the perpendicular DE, and let CD be divided into four equal parts by the perpendiculars mn, pq, rs. Now becauſe CA=1, therefore $\mathrm{CD}=\frac{1}{2}$, $\mathrm{C}r=\frac{3}{8}$, $\mathrm{C}p=\frac{1}{4}$, $\mathrm{C}m=\frac{1}{8}$. Hence $\mathrm{DE}=\sqrt{(\mathrm{EC}^2-\mathrm{CD}^2)}=\sqrt{(1-\frac{1}{4})}=\frac{1}{2}\sqrt{3}$; and in like manner $rs=\frac{1}{8}\sqrt{55}$, $pq=\frac{1}{4}\sqrt{15}$, $mn=\frac{1}{8}\sqrt{63}$. Therefore

$$\begin{array}{rl}\mathrm{F}+\mathrm{L}=1+\frac{1}{2}\sqrt{3} & =1.8660\\ 4\mathrm{E}=\frac{1}{2}\sqrt{55}+\frac{1}{2}\sqrt{63} & =7.6767\\ 2\mathrm{R}=\frac{1}{2}\sqrt{15} & =1.9365\end{array}$$

The ſum	11.4792
Multiply by $\frac{1}{3}$ D =	$\frac{1}{24}$
The product is	.4783
Subtract the triangle CDE =	.2165
There remains the ſector CBE =	.2618
The triple of which is the quadrant ABC =	.7854

Fig. 28. *Ex.* 2. To find the area of the hyperbola FDM, of which the abſciſs FM=10, the ſemiordinate MD=12, and ſemitranſverſe CF=15.

Let FM be divided into five equal parts by the ſemiordinates HI, mn, pq, rs. Thus CH=17, Cm=19, Cp=21, Cr=23, CM=25. Now, ſince from the nature of the curve, $\sqrt{(\mathrm{CM}^2-\mathrm{CF}^2)}:\mathrm{MD}::\sqrt{(\mathrm{CH}^2-\mathrm{CF}^2)}:\mathrm{HI}$ (CONIC SECTIONS, Part III. Prop. 19. and GEOMETRY, Sect. IV. Theor. 12.), that is, in numbers, 20 : 12 :: 8 : HI, therefore $\mathrm{HI}=\frac{24}{5}$. In like manner we find $mn=\frac{6}{5}\sqrt{34}$, $pq=\frac{18}{5}\sqrt{6}$, and $rs=\frac{12}{5}\sqrt{19}$. Therefore

$$\begin{array}{rl}\mathrm{F}+4(\mathrm{HI}+\mathrm{MD}) & =16.8\\ 4\mathrm{E}(=4mn+4rs) & =68.8399\\ 2\mathrm{R}(=2pq) & =17.6363\end{array}$$

The figure HIDM $=103.2762\times\frac{2}{3}=68.8508$

to which adding FIH, conſidered as a portion of a parabola, we have 75.245 for the area of the hyperbola.

OF LAND SURVEYING.

THE inſtruments moſt commonly employed in land ſurveying are the Chain, the Plane Table, and Croſs.

A ſtatute acre of land being 160 ſquare poles, the chain is made 4 poles or 66 feet in length, that 10 ſquare chains, (or 100,000 ſquare links) may be equal to an acre. Hence each link is 7.92 inches in length.

The plane table is uſed for drawing a plan of a field, and taking ſuch angles as are neceſſary to calculate its area. It is of a rectangular form, and is furrounded by a moveable frame, by means of which a ſheet of paper may be fixed to its ſurface. It is furniſhed with an index by which a line may be drawn on the paper in the direction of any object in the field, and with ſcales of equal parts by which ſuch lines may be made proportional to the diſtances of the objects from the plane table when meaſured by the chain, and its frame is divided into degrees for obſerving angles.

The croſs conſiſts of two pair of ſights ſet at right angles to each other upon a ſtaff having a pike at the bottom to ſtick into the ground. Its uſe is to determine the points where a perpendicular drawn from any object to a line will meet that line; and this is effected by finding by trials a point in the line, ſuch that the croſs being fixed over it ſo that one pair of the ſights may be in the direction of the line, the object from which the perpendicular is to be drawn may be ſeen through the other pair; then the point thus found will be the bottom of the perpendicular, as is evident.

A theodolite may alſo be applied with great advantage to land-ſurveying, more eſpecially when the ground to be meaſured is of great extent.

In addition to theſe, there are other inſtruments employed in ſurveying, as the perambulator, which is uſed for meaſuring roads and other great diſtances. Levels, with teleſcopic or other ſights, which are uſed to determine how much one place is higher or lower than another. An ofsett-ſtaff for meaſuring the ofsetts and other ſhort diſtances. Ten ſmall arrows, or rods of iron or wood, which are uſed to mark the end of every chain length. Pickets or ſtaves with flags to be ſet up as marks or objects of direction; and laſtly, ſcales, compaſſes, &c. for protracting and meaſuring the plan upon paper.

The obſervations and meaſurements are to be regularly entered as they are taken, in a book which is called the Field-book, and which ſerves as a regiſter of all that is done or occurs in the courſe of the ſurvey.

To

To Meaſure a Field by the Chain.

Fig. 29. Let A m BCD q repreſent a field to be meaſured. Let it be reſolved into the triangles A m B, ABD, BCD, A q D. Let all the ſides of the large triangles ABD, BCD, and the perpendiculars of the ſmall ones A m B, A q D from their vertices m, q be meaſured by the chain, and the areas calculated by the rules delivered in this ſection, and their amount is the area of the whole. But if, on account of the curvature of its ſides the field cannot be wholly reſolved into triangles, then, either a ſtraight line may be drawn over the curve ſide, ſo that the parts cut off from the field, and thoſe added to it, may be nearly equal. Or, without going beyonds the bounds of the field, the curvilineal ſpaces may be meaſured by the rule given in Prob. XV. of this ſection.

To Meaſure a Field with the Plane Table.

Fig. 30. Let the plane table be fixed at F, about the middle of the field ABCDE, and its diſtances FA, FB, FC, &c. from the ſeveral corners of the field meaſured by the chain. Let the index be directed from any point aſſumed on the paper to the points A, B, C, D, &c. ſucceſſively, and the lines Fa, Fb, Fc, drawn in theſe directions. Let the angles contained by theſe lines be obſerved, and the lines themſelves made proportional to the diſtances meaſured. Then their extremities being joined, there will be formed a figure $a\,b\,c\,d\,e$ ſimilar to that of the field; and the area of the field may be found by calculating the areas of the ſeveral triangles of which it conſiſts.

To Plan a Field from a given Baſe Line.

Fig. 31. Let two ſtations A, B be taken within the field, but not in the ſame ſtraight line with any of its corners; and let their diſtance be meaſured. Then the plane table being fixed at A, and the point a aſſumed on its ſurface directly above A, let its index be directed to B, and the ſtraight line $a\,b$ drawn along the ſide of it to repreſent AB. Alſo, let the index be directed from a to an object at the corner C, and an indefinite ſtraight line drawn in that direction, and ſo of every other corner ſucceſſively. Next, let the plane table be ſet at B, ſo that b may be directly over B, and $b\,a$ in the ſame direction with BA, and let a ſtraight line be drawn from b in the direction BC. The interſection of this line with the former, it is evident, will determine the point C, and the triangle $a\,b\,c$ on the paper will be ſimilar to ABC in the field. In this manner all the other points are to be determined, and theſe being joined there will be an exact repreſentation of the field.

If the angles at both ſtations were obſerved, as the diſtance between them is given, the area of the field might be calculated from theſe data, but the operation is too tedious for practice. It is uſual therefore to meaſure each lines in the figure that has been conſtructed as will render the calculation eaſy.

SECTION III.

MENSURATION OF SOLIDS.

PROBLEM I.

To find the ſurface of a right priſm, or cylinder.

RULE.

Multiply the perimeter of the end by the length or height of the ſolid, and the product will be the ſurface of all its ſides; to which add alſo the area of the two ends of the priſm when required.

The truth of this rule will be evident, if it be conſidered that the ſides of a right priſm are rectangles, whoſe common length is the ſame as the length of the ſolid, and their breadths taken all together make up the perimeter of the ends of the priſm. And as a cylinder may be conſidered as the limit of all the priſms which can be inſcribed in or circumſcribed about its baſe; ſo the ſurface of the cylinder will be the limit of the ſurfaces of theſe priſms, and the expreſſion for that limit is evidently the product of the circular baſe by its height. Or a cylinder may be conſidered as a priſm of an indefinitely great number of ſides.

Fig. 32. *Ex.* 1. What is the ſurface of a cube, the length of its ſide AB being 20 feet?

Here $4\times20=$ 80 the perim. of end.

And $80\times20=$ 1600 the four ſides.
And $2\times20\times20=$ 800 the top and bottom.

The ſum 2400 = the area or ſurface.

Fig. 33. *Ex.* 2. What is the convex ſurface of a cylinder whoſe length AB is 20 feet, and the circumference of its baſe 3 feet?

Here $3\times20=60$ feet, the anſwer.

PROBLEM II.

To find the ſurface of a right pyramid or cone.

RULE.

Multiply the perimeter of the baſe by the ſlant height or length of the ſide, and half the product will evidently be the ſurface of the ſides, or the ſum of the areas of all the triangles which form it. To which add the area of the end or baſe, if required.

Fig. 34. *Note.* Here a cone is conſidered as a cylinder of an indefinitely great number of ſides.

Ex. 1. What is the upright ſurface of a triangular pyramid, ABCD, the ſlant height, AE, being 20 feet, and each ſide of the baſe 3 feet?

Here $\frac{3\times3\times20}{2}=90$ feet, the ſurface.

Fig. 35. *Ex.* 2. Required the convex ſurface of a cone, the ſlant height AB being 50 feet, and the diameter of its baſe $8\frac{1}{2}$ feet.

Here $8.5\times3.1416=$ circum. of baſe.

And $\frac{8.5\times3.1416\times50}{2}=667.59$, the anſwer.

PROBLEM

Problem III.

To find the ſurface of the fruſtum of a right pyramid or cone, being the lower part, when the top is cut off by a plane parallel to the baſe.

Rule.

Add together the perimeters of the two ends, and multiply their ſum by the ſlant height, and take half the product for the anſwer.

The truth of this rule will be evident if it be conſidered that the ſides of the fruſtum are trapezoids, whoſe parallel ſides bound its top and baſe, and whoſe common breadth is its ſlant height.

Fig. 36. *Example.* How many ſquare feet are in the ſurface of a fruſtum AG of a ſquare pyramid, whoſe ſlant height AE is 10 feet; alſo each ſide of the greater end AC is 3 feet 4 inches, and each ſide of the leſſer end EG 2 feet 2 inches?

Here $3\frac{1}{3}\times 4=13\frac{1}{3}$ the per. of gr. end.

And $2\frac{1}{6}\times 4=8\frac{2}{3}$ the per. of leſs end.

And their ſum is 22 feet.

Therefore $\frac{22\times 10}{2}=110$ feet, is the anſwer.

Problem IV.

To find the ſolid content of any priſm or cylinder.

Rule.

Find the area of the baſe or end of the figure, and multiply it by the height or length, and the product will be the area.

This rule follows immediately from Theor 11. Sect. VIII. and Theor 2. Sect IX. Geometry.

Fig. 32. *Ex.* 1. What is the ſolid content of a cube AG, the length of whoſe ſide is 24 inches?

Here $24\times 24=576$ ſq. inches, the area of the end.

And $576\times 24=13824$ cub. inches is the ſolidity.

Fig. 33. N° 2. *Ex.* 2. Required the content of a triangular priſm, whoſe length AD is 20 feet, and the ſides of its triangular baſe ABC are 3, 4, and 5 feet.

Firſt, the area of the triangular baſe is found by Rule 3. of Prob. 3. Sect. II. to be

$\sqrt{(6\times 3\times 2\times 1)}=6$ ſq. feet.

Therefore $6\times 20=120$ cub. feet the ſolidity.

Ex. 3. The Wincheſter buſhel is a cylinder $18\frac{1}{2}$ inches in diameter, and eight inches deep. How many cubic inches does it contain?

By Prob. 10. of Sect. II. the area of its baſe is

$$.7854\times 18.5^2=268.803 \text{ ſq. inches;}$$

Therefore $268.803\times 8=2150.424$ is the ſolid content.

Problem V.

To find the ſolid content of any pyramid or cone.

Rule.

Find the area of the baſe, and multiply that area by the height, and one-third of the product will be the content of the ſolid.

This rule is demonſtrated in Theor. 16. Sect. VIII. and Theor. 3. Sect. IX. Geometry.

Ex. 1. What is the content of a triangular pyramid ABCD, whoſe perpendicular height AF is 30 feet, and each ſide of its baſe BCD is three feet. Fig. 34.

Firſt, the area of the baſe, as found by Rule 3. of Prob. 3. Sect. II. is

$$\sqrt{(4.5\times 1.5\times 1.5\times 1.5)}=3.89711.$$

Therefore $\frac{3.89711\times 30}{3}=38.9711$ cub. feet is the ſolid content.

Ex. 2. What is the ſolid content of a cone, the radius BC of its baſe being nine inches, and its height AC 15 feet. Fig. 35.

Here $.7854\times\frac{3^2}{2^2}=1.76715$ is the area of the baſe in ſquare feet.

And $\frac{1.76715\times 15}{3}=8.8357$ cub. feet is the ſolid content.

Problem VI.

To find the ſolidity of the fruſtum of a cone or pyramid.

Rule.

Add into one ſum the areas of the two ends, and the mean proportional between them, that is, the ſquare root of their product, and one-third of that ſum will be a mean area, which being multiplied by the perpendicular height or length of the fruſtum will give the content.

Demonſtration. Let PABCD be any pyramid, and AG a fruſtum of it contained between ABCD its baſe, and EFGH a plane parallel to the baſe. Put a for the ſide of a ſquare equal to AC the baſe of the fruſtum; b for the ſide of a ſquare equal to EG its top; h for LM the height of the fruſtum, and c for PL the height of the part of the pyramid above the fruſtum. Then a^2 is the area of the baſe of the fruſtum; b^2 is the area of its top; $\frac{1}{3}a^2(h+c)$ is the ſolid content of the whole pyramid; (Geom. Sect. VIII. Theor. 16.) $\frac{1}{3}b^2c$ is the content of its upper part; and therefore Fig 36.

$$\tfrac{1}{3}\left\{a^2(h+c)-b^2c\right\}$$

is the ſolid content of the fruſtum itſelf. Now the baſe and top of the fruſtum being ſimilar figures, (Sect. VIII.

Theor. 13.) their areas are to one another as the ſquares of AB and EF their homologous ſides, (Sect. IV. Theor. 27.) But AB : EF : : BP : PF (Sect. VII. Theor. 7. and Sect. IV. Theor. 20.) : : PM : PL, (Sect. VII. Theor. 14.); therefore the area of the baſe of the fruſtum is to the area of its top as PM² : PL², that is, $a^2 : b^2 :: (h+c)^2 : c^2$, and conſequently $a : b :: h+c : c$; hence $ac=bh+bc$, and $c=\frac{bh}{a-b}$, and $h+c=\frac{ah}{a-b}$. Let theſe values of c and $h+c$ be now ſubſtituted in the preceding expreſſion for the content of the fruſtum, and it will become, by proper reduction,

$$\tfrac{1}{3}h\frac{a^3-b^3}{a-b}.$$

Let the numerator of the fractional part of this formula be actually divided by its denominator, and we ſhall obtain for the area of the fruſtum this more ſimple expreſſion,

$$\tfrac{1}{3}h\,(a^2+ab+b^2),$$

which formula, when expreſſed in words, is the rule. And as a cone may be conſidered as the limit of all the pyramids that can be inſcribed in it, when the number of ſides is conceived indefinitely increaſed, it is evident that the rule will apply alike to the cone and pyramid.

Ex. 1. Required the ſolidity of the fruſtum of a hexagonal pyramid, the ſide of whoſe greater end is four feet, and that of its leſſer end is three feet, and its height nine feet.

Firſt, by Prob. 7. Sect. II. the area of the baſe of the fruſtum is found to be 41.569, and the area of its leſſer end 23.383 ſquare feet. And the mean proportional between theſe is

$$\sqrt{(41.569\times23.383)}=31.177.$$

Hence the mean area is

$$\tfrac{1}{3}(23.383+41.569+31.177)=32.043.$$

And the ſolid content of the fruſtum is

$$32.043\times9=288.387 \text{ cubic feet.}$$

Ex. 2. What is the ſolidity of the fruſtum of a cone, the diameter of the greater end being five feet, that of the leſſer end three feet, and the altitude nine feet.

Here the area of the greater end is (by Prob. 10. Sect. II.) $5^2\times.7854$, and the area of the leſſer end is $3^2\times.7854$, and the mean proportional between them is $\sqrt{(5^2\times3^2\times.7854^2)}=5\times3\times.7854$; therefore the mean area is

$$\frac{.7854}{3}\times(5^2+3^2+5\times3)=12.8282.$$

And the content of the fruſtum

$$12.8282\times9=115.4538 \text{ cub. feet.}$$

Problem VII.

To find the ſurface of a ſphere, or of any ſegment or zone of it.

Rule.

Multiply the circumference of the ſphere by the height of the part required, and the product will be the curve ſurface, whether it be a ſegment, a zone, or the whole ſphere.

Note. The height of the whole ſphere is its diameter.

The truth of this rule has been already ſhown in the article Fluxions, §. 165. It may however be deduced from principles more elementary, by reaſoning as follows. Let PCQ be a ſemicircle, and ABCDE ſeveral ſucceſſive ſides of a regular polygon inſcribed in it. Fig. 37. Conceive the ſemicircle to revolve about the diameter PQ as an axis, then the arch ABCDE will generate a portion of the ſurface of a ſphere, and the chords AB, BC, CD, &c. will generate the ſurfaces of fruſtums of cones; and it is eaſy to ſee that the number of chords may be ſo great that the ſurface which they generate ſhall differ from the ſurface generated by the arch ACE by a quantity which is leſs than any aſſigned quantity. Biſect AB in L, and draw AF, LM, BG, CH, &c. perpendicular to PQ. For the ſake of brevity, let *circ.* AF denote the circumference of a circle whoſe radius is AF. Then becauſe AF, BG, LM, are to each other reſpectively as *circ.* AF, *circ.* BG, *circ.* LM (Geom. Sect. VI. Prop. 4.), and becauſe $\frac{1}{2}$(AF+BG)=LM, therefore $\frac{1}{2}$ (*circ.* AF+*circ.* BG) = *circ.* LM. Now the area of the ſurface generated by the chord AB is $\frac{1}{2}$ (*circ.* AF+*circ.* BG(×AB, (Prob. 3.) therefore the ſame area is alſo equal to (*circ.* LM)×AB. Draw AO parallel to FG, and draw LN to the centre of the circle. Then the triangles AOB, LMN are manifeſtly ſimilar; therefore AB : AO :: NL : LM :: *circ.* NL : *circ.* LM; and hence AO×*circ.* NL=AB×*circ.* LM. But this laſt quantity has been proved equal to the ſurface generated by AB, therefore the ſame ſurface is equal to AO× *circ.* NL, or to FG×*circ.* NL, that is, to the rectangle contained by FG and the circumference of a circle inſcribed in the polygon. In the ſame way it may be ſhown that the ſurfaces generated by BC, CD, DE, are reſpectively equal to GH×*circ.* LN, HI×*circ.* LN, IK×*circ.* LN. Therefore the whole ſurface generated by the chords AB, BC, CD, DE, &c. is equal to (FG+GH+HI+IK)×*circ.* LN=FK×*circ.* LN. Conceive now the number of chords between A and E to be indefinitely increaſed; then, obſerving that the limit of the ſurface generated by the chords is the ſurface generated by the arch ABCDE, and that the limit of NL is NP, the radius of the generating circle, it follows that the ſpherical ſurface or zone generated by the arch ACE is equal to the product of the circumference of the ſphere by FK the height of the zone.

Ex. 1. What is the ſuperficies of a globe whoſe diameter is 17 inches?

Firſt 17×3.1416=53.4072 inches=the circum.

Then 53.4072×17=907.9224 ſq. inches=6.305 ſquare feet the anſwer.

Ex. 2. What is the convex ſurface of a ſegment 8 inches in height cut off from the ſame globe?

Here $53.4072 \times 8 = 427.2576$ ſq. inches $= 2.967$ ſq. feet the anſwer.

PROBLEM VIII.

To find the ſolidity of a ſphere.

RULE I.

Multiply the area of a great circle of the ſphere by its diameter, and take $\frac{2}{3}$ of the product for the content.

RULE II.

Multiply the cube of the diameter by the decimal .5236 for the content.

The firſt of theſe rules is demonſtrated in GEOMETRY, Sect. IX. Theor. 6. And the ſecond is deduced from the firſt, thus: put d for the diameter of the ſphere, then $d^2 \times .7854$ is the area of a great circle of the ſphere, and by the firſt rule $\frac{2}{3}d \times d^2 \times .7854 = d^3 \times .5236$ is its content.

Example. What is the content of a ſphere whoſe diameter is 6 feet. ?

Anſwer $6^3 \times .5236 = 113.0976$ cub. feet.

PROBLEM IX.

To find the ſolid content of a ſpherical ſegment.

RULE.

From 3 times the diameter of the ſphere take double the height of the ſegment, then multiply the remainder by the ſquare of the height, and the product by the decimal .5236 for the content.

This rule has been inveſtigated in FLUXIONS, §. 163. But it may be proved in a more elementary manner by means of the following axiom. *If two ſolids be contained between two parallel planes; and if the ſections of theſe ſolids by a third plane parallel to the other two, at any altitude, be always equal to one another, then the ſolids themſelves are equal. Or more generally thus. If two ſolids between two parallel planes be ſuch, that any ſections of them by a third plane parallel to the other two have always to each other the ſame given ratio, then the ſolids themſelves are to one another in that ratio.* We have given this propoſition in the form of an axiom for the ſake of brevity, but its truth may be ſtrictly demonſtrated, as has been done when treating of pyramids and the ſphere, in GEOMETRY, Sect. 8. and 9.

Fig 38. Let us now ſuppoſe ABE to be a quadrant; C the centre of the circle; AFEC a ſquare deſcribed about the quadrant; and CF the diagonal of the ſquare. Suppoſe the figures to revolve about AC as an axis, then the quadrant will generate a hemiſphere, the triangle ACF will generate a cone, and the ſquare AE a cylinder. Let theſe three ſolids be cut by a plane perpendicular to the axis, and meeting the plane of the ſquare, in the line DHBG; and join CB. Then, becauſe CDB is a right-angled triangle, a circle deſcribed with CB as a radius is equal to two circles deſcribed with CD and DB as radii (GEOMETRY, Sect. VI. Prop. 4. Cor. 2). But CB=DG, and ſince CA=AF, therefore CD=DH; therefore the circle deſcribed with the radius DG, is equal to the ſum of the circles deſcribed with the radii DH, DB; that is, the ſection of the cylinder at any altitude, is equal to the correſponding ſections of the ſphere and cone taken together. Conſequently, by the foregoing axiom, the cylinder is equal to the hemiſphere and cone taken together, and alſo the ſegment of the cylinder between the planes AF, DG is equal to the ſum of the ſegments of the hemiſphere and cone contained between the ſame planes. Put 2CE, or 2AF, the diameter of the circle, $= d$, and AD, the height of the ſpherical ſegment, $= h$. Then $AC = \frac{1}{2}d$ and $2CA - 2AD = 2CD = d - 2h$. Let n denote the number .7854. Then the area of the baſe common to the conic fruſtum AH, and cylinder AG, is $n\,d^2$, (Sect. II. Prob. 10.), and the area of the top of the fruſtum is $n\,(d-2h)^2$, and the mean proportional between theſe areas is $n\,(d-2h)\,d$. Therefore the ſolid content of the fruſtum is (by Prob. 3. of this ſect.)

$$\tfrac{1}{3}\left\{ n\,d^2 + n\,(d-2h)^2 + n\,d\,(d-2h) \right\} \times h.$$

$$= n\,d^2 h - 2\,n\,d\,h^2 + \tfrac{4}{3}\,n\,h^3.$$

Now the ſolid content of the cylinder is $n\,d^2 h$: (Prob. 1.) Therefore the ſolid content of the ſpherical ſegment, (which is equal to the difference between the cylinder AG and conic fruſtum AH) is equal to

$$n\,d^2 h - (n\,d^2\,h - 2\,n\,d\,h^2 + \tfrac{4}{3}\,n\,h^3),$$

that is, to $2\,n\,d\,h^2 - \frac{4}{3}\,n\,h^3$, or to

$$\frac{2n}{3}\,(3\,d - 2\,h)\,h^2,$$

which expreſſion, if it be conſidered that $\frac{2n}{3}$ or $\frac{2 \times .7854}{3}$ is equal to .5236, is evidently the ſame as that given by the rule.

Example. In a ſphere whoſe diameter is 21, what is the ſolidity of a ſegment whoſe height is 4.5 inches ?

Firſt $3 \times 21 - 2 \times 4.5 = 54$.

Then $54 \times 4.5 \times 4.5 \times .5236 = 572.5566$ inches, the ſolidity required.

PROBLEM X.

To find the ſolid content of a paraboloid, or ſolid, produced by the rotation of a parabola about its axis.

RULE.

Multiply the area of the baſe by the height, and take half the product for the content.

To demonſtrate this rule, let AGC and BHD be two equal ſemi-parabolas lying in contrary directions, and having their vertices at the extremity of the line AB. Fig. 39. Let AD, BC be ordinates to the curves. Complete the rectangle ABCD, and conceive it to revolve about AB as an axis; then the rectangle will generate a cylinder, the radius of whoſe baſe will be AD, and the two ſemi-parabolas will generate two equal paraboloids having the ſame baſe and altitude as the cylinder. Let a plane be drawn perpendicular to the axis, and let FHGE be the common ſection of this plane and the generating figure. Let P denote the parameter of the axis. Then ſince

$$EG^2 = P \times AE,$$
$$\text{and } EH^2 = P \times EB,$$
$$EG^2 + EH^2 = P \times AB = CB^2.$$

Hence it appears, as in the demonſtration of the preceding rule, that of the ſolids deſcribed by ADCB, ACB, ADB between the ſame parallel planes, the ſection of the cylinder at any altitude is equal to the correſponding ſections of the paraboloids taken together. Conſequently (by the Axiom) the cylinder is equal to both the paraboloids taken together; hence each is half a cylinder of the ſame baſe and altitude agreeing with the rule.

The ſame thing is alſo proved in FLUXIONS, §. 163.

Example. If the diameter of the baſe of a paraboloid be 10 and its height 12 feet; what is its content?

Here $10 \times .7854 = 7.854$ the area of the baſe.

And $\frac{1}{2} \times 7.854 \times 12 = 47.124$ cub. feet is the ſolidity.

PROBLEM X.

To find the ſolid content of a fruſtum of a paraboloid.

RULE.

Add together the areas of the circular ends, then multiply that ſum by the height of the fruſtum, and take half the product for its ſolid content.

To prove this rule put A and a for the greater and leſſer ends of the fruſtum, and h for its height; alſo let c denote the height of the portion cut off from the complete paraboloid, ſo as to form the fruſtum. Then, by the laſt problem, the content of the complete paraboloid is $\frac{1}{2} A (h+c)$, and the content of the part cut off is $\frac{1}{2} a c$, therefore the content of the fruſtum is

$$\tfrac{1}{2}\left\{A(h+c)-a c\right) = \tfrac{1}{2}\left\{A h + c(A-a)\right\}$$

But from the nature of the parabola, $c : h+c :: a : A$;

hence $A c = a b + a c$ and $c = \frac{a h}{A-a}$.

Let this value of c be ſubſtituted inſtead of it in the above expreſſion for the content of the fruſtum, and it becomes

$$\tfrac{1}{2}(A h + a h) = \tfrac{1}{2} h(A+a),$$

and hence is derived the rule.

Example. Required the ſolidity of the fruſtum of a paraboloid, the diameter of the greater end being 58, and that of the leſſer end 30, and the height 18.

Firſt, (by Prob. 10. Sect. II.) we find the areas of the ends to be $58^2 \times .7854$, and $30^2 \times .7854$; therefore their ſum is $(58^2 + 30^2) \times .7854 = 4264 \times .7854$. And the content of the figure is $\frac{1}{2} \times 4264 \times .7854 \times 18 = 30140.5104$, the anſwer.

PROBLEM XI.

To find the ſolid content of a parabolic ſpindle or ſolid generated by the rotation of AEB an arc of a parabola, about AB an ordinate to the axis. Fig. 40.

RULE.

Multiply the area of the middle ſection by the length, and take $\frac{8}{15}$ of the product for the content of the ſolid.

For the inveſtigation of this rule we muſt refer the reader to FLUXIONS, § 163. *Ex.* 2.

Example. The length of the parabolic ſpindle AEB*e*A is 60, and the middle diameter E*e* 34; what is the ſolidity?

Here $34^2 \times .7854$ is area of the middle ſection.

Therefore $34^2 \times .7854 \times 60 \times \frac{8}{15} = 29053.5168$ is the ſolidity required.

PROBLEM XII.

To find the ſolid content of the fruſtum of a parabolic ſpindle, one of the ends of the fruſtum paſſing through the centre of the ſpindle.

RULE.

Add into one ſum eight times the ſquare of the diameter of the greater end, and three times the ſquare of the leſſer end, and four times the product of the diameters; multiply the ſum by the length, and the product multiplied by .05236, or $\frac{1}{15}$ of .7854, will be the content.

For, referring the reader to FLUXIONS, § 163. Ex. 2. as before, and ſubſtituting h for $AC = \frac{1}{2} b$, but, in other reſpects, retaining the figure and notation, we have this general expreſſion for the ſegment AP*p*,

$$\frac{\pi x^3}{a^2}\left(\frac{4 h^2}{3} - h x + \frac{x^2}{5}\right),$$

which, when $x = h$ gives $\frac{8 \pi h^5}{15 a^2}$ for the value of the ſemi-ſpindle. From this quantity let the former be ſubtracted, and there will remain

$$\frac{8 \pi h^5}{15 a^2} - \frac{\pi x^3}{a^2}\left(\frac{4 h^2}{3} - h x + \frac{x^2}{5}\right)$$

for the content of the fruſtum. In this expreſſion let z be put inſtead of $h-x$ or CD, and, denoting CE the radius of the greater end of the ſpindle by d, let $\frac{h^2}{d}$ be ſubſtituted inſtead of its value a. Then we ſhall have the content of the fruſtum otherwiſe expreſſed by

$$\frac{\pi d^2 z}{h^4}\left\{h^4 - \frac{2 h^2 z^4}{3} + \frac{z^4}{5}\right\}$$

which value, by putting $h\sqrt{\frac{d-y}{d}}$ in its two laſt terms

inſtead

Of Solids. inſtead of z, is changed to

$$\pi z \times \frac{8d^2+4dy+3y^2}{15},$$

and hence is derived the preceding rule.

Example. Suppoſe the diameter of the greater end to be 8, and the diameter of the leſſer end 6, and the length 10, required the content?

Firſt $8\times8^2+3\times6^2+4\times8\times6=812$.

Then, $812\times10\times.05236=425.1632$, the content.

PROBLEM XIII.

To find the ſolid content of a ſpheroid, or ſolid generated by the rotation of an ellipſe about either axis.

RULE.

Multiply continually together the fixed axis, and the ſquare of the revolving axis, and the number .5236 or $\frac{1}{6}$ of 3.1416, and the laſt product will be the ſolidity.

Fig. 41. For, let the ſemiellipſe, ADB, and ſemicircle AEB revolve about the ſame fixed axis AB, and thus generate a ſpheroid and ſphere. Let CD the revolving ſemiaxis of the ellipſe meet the circle in E, and draw QP any ordinate to the fixed axis meeting the circle in R. Then, from the nature of the ellipſe $PQ^2 : PR^2 :: CD^2 : CE^2$ or CA^2 (CONIC SECTIONS, Part II. Prop. 11. Cor. 3.) Hence it follows, (GEOMETRY, Sect. VI. Prop. 4.), that every ſection of the ſpheroid is to the correſponding ſection of the ſphere in the ſame given ratio, namely, that of the ſquare of the revolving axis to the ſquare of the fixed axis; therefore (Axiom in the dem. of Prob. 9.) the whole ſpheroid is to the whole ſphere in the ſame ratio. That is, (becauſe the content of the ſphere is $AB^3\times.5230$) $AB^2 : (2CD)^2 :: AB^3\times.5236$: (the cont. of ſpheroid). Hence the content of the ſpheroid is $AB\times(2CD)^2\times.5236$.

Ex. 1. What is the ſolid content of an oblong ſpheroid, or ſolid generated by the rotation of an ellipſe about its greater axis, the axes being 50, and 30?

Here $50\times30^2\times.5236=23562$, the content.

Ex. What is the ſolid content of an oblate ſpheroid, or ſolid generated by the rotation of an ellipſe about its leſſer axis, the two axes being as before.

Here $30\times50^2\times.5236=39270$ the anſwer.

PROBLEM XIV.

To find the ſolid content of the fruſtum of a ſpheroid, its ends being perpendicular to the fixed axis, and one of them paſſing through the centre.

RULE.

To the area of the leſs end add twice that of the greater, multiply the ſum by the altitude of the fruſtum, and $\frac{1}{3}$ of the product will be the content.

Note. This rule will alſo apply to the ſphere.

Demonſtration. Let ABE be a quadrant of an ellipſe, C its centre, CAFE its circumſcribed rectangle, and CF its diagonal. Draw any ſtraight line DG parallel to CE, meeting AC, CF, ABE and EF in D, H, B, and G. Then by CONIC SECTIONS, Part II. Prop. 11. Of Solids. Fig. 42.

$$CE^2 \text{ or } AF^2 : DB^2 :: CA : CA^2-CD^2,$$

and by ſim. tr. $AF^2 : DH^2 :: CA^2 : CD^2$.

Therefore (GEOMETRY, Sect. III. Theor. 8),

$$AF^2 : DB^2+DH^2 :: CA^2 : CA^2;$$
$$\text{Hence } DE^2+DH^2=AF^2=DG^2.$$

Conceive now the figure to revolve about AC as an axis, ſo that the elliptic quadrant may generate the half of a ſpheroid, the rectangle AE a cylinder, and the triangle ACF a cone; then it is evident (as was ſhown in the caſe of the ſphere in Prob. 9.) that every ſection of the firſt of theſe ſolids by a plane perpendicular to the axis is equal to the difference of the ſections of the other two, and conſequently that the fruſtum of the ſpheroid between CE and DG is equal to the difference between the cylinder having DG or CE for the radius of its baſe, and CD for its altitude, and the cone having DH for the radius of its baſe, and DC for its altitude.

Put n for the number 3.1416, then (Prob. 4.) the content of the cylinder is $4n\times DG^2\times CD$, and (Prob. 5.) the content of the cone is $\frac{4}{3}n\times DH^2\times CD$, and therefore the content of the fruſtum of the ſpheroid is

$$4n\times CD\,(DG^2-\tfrac{1}{3}DH^2).$$

But it was ſhewn that $DH^2=DG^2-DB^2$; therefore the content of the fruſtum is alſo equal to

$$\tfrac{4}{3}n\times CD\,(2CE^2+DB^2),$$

and hence is derived the rule.

Ex. Suppoſe the greater end of the fruſtum to be 15, the leſs end 9, and the length 10 inches, required the content?

The area of the greater end is $15^2\times.7854$, and the area of the leſs $9^2\times.7854$, therefore the content is

$.7854\,(9^2+2\times15^2)\times\frac{10}{3}=1390.158$ cubic inches.

PROBLEM XV.

To find the ſolid content of a hyperboloid, or ſolid generated by the rotation of a hyperbola about its tranſverſe axis.

RULE.

As the ſum of the tranſverſe axis and the height of the ſolid is to the ſum of the ſaid tranſverſe axis and $\frac{2}{3}$ of the height, ſo is half the cylinder of the ſame baſe and altitude to the ſolidity of the hyperboloid.

Demonſtration. Let BAb be a hyperbola, Aa its tranſverſe axis, C its centre, CF,Cf its aſymptotes, FAf a tangent at its vertex. Draw FE parallel to CA, and draw any ſtraight line parallel to Ff, meeting the aſymptotes in H and h, the curve in B and b, the axis in D, and the line FE in G. Then, becauſe $AF^2=BH\times hB$ (CONIC SECTIONS, Part III. Prop 11.) Fig. 43.

and HB × hE = DH² — DB² (Geometry, Sect. IV. Theor. 12.), therefore AF² = DH² — DB² and DB² = HD² — DG². Hence it appears, that if the figure be conceived to revolve about CA as an axis, ſo that the hyperbolic arc AB may generate a hyperboloid, the triangle DCH a cone, and the rectangle DAFG a cylinder, any ſection of the firſt of theſe ſolids by a plane Hh, perpendicular to the axis, will be equal to the difference of the ſections of the other two by the ſame plane. Therefore the hyperboloid BAb is equal to the difference between the conic fruſtum FHhf and the cylinder FGgf. Let Aa the tranſverſe axis be denoted by p, Ff = its conjugate axis by q, AD the height of the ſolid by h, Bb its baſe by b. Then, becauſe by ſimilar triangles, &c,

$$\mathrm{CA} : \mathrm{CD} :: \mathrm{F}f : \mathrm{H}h :: \mathrm{F}f^2 : \mathrm{F}f \times \mathrm{H}h,$$

therefore $\mathrm{F}f \times \mathrm{H}h = \frac{\mathrm{CD}}{\mathrm{CA}} \times \mathrm{F}f^2 = \frac{(\frac{1}{2}p + h)q^2}{\frac{1}{2}p} = q^2 + \frac{2hq^2}{p}$.

Now $\mathrm{F}f^2 = q^2$, and $\mathrm{H}h^2\ (= \mathrm{B}b^2 + \mathrm{F}f^2) = b^2 + q^2$, therefore putting n for .7854, we have (by Prob. 6.) the content of the conic fruſtum FHhf equal to

$$\frac{nh}{3}\left(q^2 + b^2 + q^2 + q^2 + \frac{2hq^2}{p}\right) = \frac{nh}{3}\left(3q^2 + b^2 + \frac{2hq^2}{p}\right);$$

from this ſubtract nhq^2, the expreſſion for the content of the cylinder FGgf, and there will remain

$$\frac{nh}{3}\left(b^2 + \frac{2hq^2}{p}\right)$$

for the content of the hyperboloid. But from the nature of the hyperbola

$$\mathrm{A}a^2 : \mathrm{F}f^2 :: \mathrm{AD} \times \mathrm{D}a : \mathrm{BD}^2,$$

that is $p^2 : q^2 :: (p+h)\,h : \frac{1}{4}b^2$;

therefore $\frac{2hq^2}{p} = \frac{pb^2}{2(p+h)}$; and hence the content of the hyperboloid is alſo equal to

$$\frac{nh}{3}\left(b^2 + \frac{pb^2}{2(p+h)}\right) = \frac{nhb^2}{2} \times \frac{p + \frac{2}{3}h}{p+h}.$$

Now if it be conſidered that the quantity nhb^2 is the expreſſion for the content of a cylinder whoſe baſe is b and height h, it will appear evident, that this laſt formula is the ſame as would reſult from the foregoing rule.

Ex. Suppoſe the height of the hyperboloid to be 10, the radius of its baſe 12, and its tranſverſe axis 30. What is its content?

1. Becauſe a cylinder of the ſame baſe and altitude is 24² × .7854 × 10, therefore, we have the proportion,

$$40 : \frac{110}{3} :: \frac{24^2 \times .7854 \times 10}{2} :$$
$$\frac{24^2 \times .7854 \times 10 \times 110}{40 \times 3 \times 2} = 2073\ 456,$$ the content of the ſolid as required.

Of GAUGING.

Gauging treats of the meaſuring of caſks, and other things falling under the cognizance of the officers of the exciſe, and it has received its name from a gauge or rod uſed by the practitioners of the art.

From the way in which caſks are conſtructed, they are evidently ſolids of no determinate geometrical figure. It is, however, uſual to conſider them as having one or other of the four following forms:

1. The middle fruſtum of a ſpheroid.
2. The middle fruſtum of a parabolic ſpindle.
3. The two equal fruſtums of a paraboloid.
4. The two equal fruſtums of a cone.

We have already given rules by which the content of each of theſe ſolids may be found in cubic feet, inches, &c. But as it is uſual to expreſs the contents of caſks in gallons, we ſhall give the rules again in a form ſuited to that mode of eſtimating capacity. Obſerving that in each caſe the lineal dimenſions of the caſk are ſuppoſed to be taken in inches.

Problem. I.

To find the content of a caſk of the firſt, or ſpheroidal variety.

Rule.

To the ſquare of the head diameter add double the ſquare of the bung diameter, and multiply the ſum by the length of the caſk. Then let the product be multiplied by .0009¼, or divided by .1077 for ale gallons, or multiplied by .0011⅓ or divided by 882 for wine gallons.

Fig. 44. The truth of this rule may be proved thus. Put B for FG, the bung diameter, H for AH the head diameter, and L for AD, the length of the caſk, then (by Prob. 14.) the content of the caſk is $(2\mathrm{B}^2 + \mathrm{H}^2)\mathrm{L} \times \frac{.7854}{3}$, which being divided by 282 (the cubic inches in an ale gallon) gives $(2\mathrm{B}^2 + \mathrm{H}^2)\,\mathrm{L} \times .00928371$, or $(2\mathrm{B}^2 + \mathrm{H}^2) \times \frac{1}{1077.157} \times \mathrm{L}$, for the content in ale gallons. And being divided by 231, (the cubic inches in a wine gallon) gives $(2\mathrm{B}^2 + \mathrm{H}^2) \times .00113333\,\mathrm{L}$, or $(2\mathrm{B}^2 + \mathrm{H}^2) \times \frac{1}{882\ 355} \times \mathrm{L}$, for the content in wine gallons.

Ex. Suppoſe the bung and head diameters to be 32 and 24, and the length 40 inches. Required the content?

Here $(2 \times 32^2 + 24^2) \times 40 \times .0009\frac{1}{4} = 97.44$ ale gallons, is the content required.

And $(2 \times 32^2 + 24^2) \times 40 \times .0011\frac{1}{3} = 118.95$ wine gallons is the ſame content.

Problem II.

To find the content of a caſk of the ſecond, or parabolic ſpindle form.

Rule.

To the ſquare of the head diameter add double that of the bung diameter, and from the ſum take ⅖, or $\frac{4}{10}$

Of Gauging

of the ſquare of the difference of the ſaid diameters. Then multiply the remainder by the length, and the product multiplied, or divided by the ſame numbers as in the rule to laſt problem, will give the content.

For by Problem 12. the content in inches is

$$\frac{8B^2+4BH+3H^2}{15}\times .7854\,L;$$

and this formula may be otherwiſe expreſſed thus,

$$\left\{2B^2+H^2-\tfrac{2}{5}(B-H)^2\right\}\times\frac{.7854}{3}\times L,$$

and hence is derived the rule, the multipliers or diviſors being evidently the ſame as in laſt problem.

Ex. The dimenſions of a caſk being the ſame as in laſt problem; required the content.

Anſwer. $(2\times 32^2+24^2-\tfrac{2}{5}\times 8^2)\times 40\times .0009\tfrac{1}{4}$ $=96.49$ the content in ale gallons.

And $10393.6\times .0011\tfrac{1}{3}=117.79$ the content in wine gallons.

Problem III.

To find the content of a caſk of the third or paraboloidal variety.

Rule.

To the ſquare of the bung diameter add the ſquare of the head diameter, and multiply the ſum by the length; then, if the product be multiplied by .0014, or divided by 718, the reſult will be the content in ale gallons; or if it be multiplied by .0017, or divided by 588, the reſult will be the content in wine gallons.

For by Problem 10. the content in inches is $\frac{1}{2}(B^2+H^2)\times .7854\,L$; and this expreſſion being divided by 282 gives $(B^2+H^2)\times .00139255\,L$ or $(B^2+H^2)\times\frac{1}{718.105}\times L$ for the content in ale gallons; and divided by 231 gives $(B^2+H^2)\times .0017\,L$ or $(B^2\times H^2)\times\frac{1}{588.233}$ for the content in wine gallons.

Ex. Suppoſe the dimenſions of a caſk, as before; required the content.

Anſwer. $(32^2+24^2)\times 40\times .0014=89.1$ the content in ale gallons.

And $64000\times .0017=108.8$ the content in wine gallons.

Problem IV.

To find the content of a caſk of the fourth or conical variety.

Rule.

To three times the ſquare of the ſum of the diameters add the ſquare of the difference of the diameters; multiply the ſum by the length; and multiply the reſult by $.00023\tfrac{1}{3}$ or divide it by 4308 for the content in ale gallons; or multiply the reſult by $.0028\tfrac{1}{3}$, or divide it by 3529, for the content in wine gallons.

Of Gauging

For by Problem 6. the content in inches is $\frac{1}{3}(B^2+BH+H^2)\times .7854\,L$ which expreſſion is equivalent to

$$\left\{3(B+H)^2+(B-H)^2\right\}\times\frac{.7854}{12}L.$$

Now $\frac{.7854}{12}$ divided by 282 gives $.00023209=\frac{1}{4308.628}$ the multiplier for ale gallons, and divided by 231 gives $.00028333=\frac{1}{3529.42}$ the multiplier for wine gallons.

Ex. Suppoſing the dimenſions of a caſk as before, What is its content?

Anſwer, $(3\times 56^2+8^2)\times 40\times .00023\tfrac{1}{5}=87.93$, the content in ale gallons.

And $378880\times .00028\tfrac{1}{3}=107.35$, is the content in wine gallons.

As theſe four forms of caſks are merely hypothetical, it may reaſonably be expected that ſome degree of uncertainty will attend the application of the rules to actual meaſurement. The following rule, however, given by Dr Hutton in his excellent treatiſe on menſuration will apply equally to any caſk whatever. And as the ingenious author obſerves, that its truth has been proved by ſeveral caſks which have been actually filled with a true gallon-meaſure after their contents were computed by it, we preſume that it is more to be depended upon in practice than the others.

Rule.

Add into one ſum 39 times the ſquare of the bung diameter, 25 times the ſquare of the head diameter, and 26 times the product of the diameters; multiply the ſum by the length, and the product by .00034; then the laſt product divided by 9 will give the wine gallons, and divided by 11 will give the ale gallons.

In inveſtigating this rule the ingenious author aſſumed as a hypotheſis, that one-third of a caſk at each end is nearly the fruſtum of a cone, and that the middle part may be taken as the middle fruſtum of a parabolic ſpindle. This being ſuppoſed, let AB and CD Fig. 44. be the two right-lined parts, and BC the parabolic part; produce AB and DC to meet in E, and draw lines as in the figure. Let L, B, and H denote the ſame as before. Then, ſince AB has the ſame direction as EB at A, ABE will be a tangent to a parabola BF, and therefore $FI=\frac{1}{2}EI$. But $BI=\frac{1}{3}AK$, and hence, by ſim. triangles $EI=\frac{1}{3}EK$; conſequently $FI=\frac{1}{2}EI=\frac{1}{6}EK=\frac{1}{5}FK=\frac{1}{10}(B-H)$; ſo that the common diameter $BL=FG-2FI=B-\frac{1}{5}(B-H)=\frac{1}{5}(4B+H)$, which call c. Now by the rules for parabolic ſpindles and conic fruſtums we obtain (putting n for .7854)

$$\frac{8B^2+4BC+3C^2}{15}\times\frac{Ln}{3}=\frac{328B^2+44BH+3H^2}{25\times 45}\times Ln$$

for the parabolic or middle part; and

$$\frac{C^2+CH+H^2}{3}\times\frac{2Ln}{3}=\frac{160B^2+280BH+310H^2}{25\times 45}\times Ln$$

for the two

ends, and the ſum of theſe two gives after proper reduction $(39B^2 + 26BH + 25H^2) \times \frac{Ln}{90}$, nearly, for the content in inches. And the quantity $\frac{n}{90}$ or $\frac{.7854}{90}$ being divided by 231 gives $\frac{.00034}{9}$ the multiplier for wine gallons; and ſince 231 is to 282 as 9 to 11 nearly, $\frac{.00034}{11}$ will be the multiplier for ale gallons as in the rule.

Ex. Suppoſe a caſk to have the ſame dimenſions as in the four former rules; required the content.

Here $(39^2 \times 32^2 + 26 \times 32 \times 24 + 25 \times 24^2) \times 40 \times .00034 - 1010.5$; which being divided by 9 and by 11 we obtain 112.3 wine gallons or 91.9 ale gallons for the content required.

MENSTRUAL, or MENSTRUOUS, in *Phyſiology*, is applied to the blood which flows from women in their ordinary monthly purgations. See MIDWIFERY and MEDICINE *Index*.

MENSTRUUM, in *Chemiſtry*, any body which in a fluid or ſubtilized ſtate is capable of interpoſing its ſmall parts betwixt the ſmall parts of other bodies, ſo as to divide them ſubtly, and form a new uniform compound of the two.

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

MENTOR, in fabulous hiſtory, a faithful friend of Ulyſſes; a ſon of Hercules; a king of Sidonia, who revolted againſt Artaxerxes Ochus, and afterwards was reſtored to favour by his treachery to his allies, &c. *Diod.* 16. An excellent artiſt in poliſhing cups and engraving flowers on them. *Plin.* 33. c. 11.—*Mart.* 9. ep. 60. v. 16.

MENTZ, an archbiſhopric and electorate in Germany. It lies on the banks of the river Maine, between the electorate of Triers on the weſt, the Palatinate on the ſouth, Franconia on the eaſt, and the Wetterau on the north. It is about 60 miles in length from north-eaſt to ſouth-weſt, and about 50 in breadth. A conſiderable part of the elector's revenue ariſes from the toll on the Rhine and Maine, and from the tax on the excellent wines produced in this country. The chief towns of any trade are, 1. Mentz; (ſee the next article.) In its neighbourhood is Hockheim, ſo celebrated for good wines, that the beſt Rheniſh is from thence called *old hock*. It is a pretty village, containing about 300 families; and belongs to the chapter of Mentz, the dean of which enjoys the revenue of it: in a good year he makes from twelve to fifteen thouſand guilders of his wine. He and the Auguſtins of Mentz and Francfort have the excluſive enjoyment of the beſt Hockheimer wine, of which, in good years, a piece, conſiſting of 100 meaſures, ſells for from 900 to 1000 guilders from the preſs. "This (ſays the Baron Rieſbeck) is certainly one of the deareſt wines in the world. Having a deſire to taſte it on the ſpot, we were obliged to pay a rixdollar; it was, however, of the beſt vintage in this century, viz. that of 1766. Nor ſhould we have had it, but for an advocate of Mentz, to whom the hoſteſs meant to ſhew favour. This was the firſt German wine I had met with which was entirely without any ſour taſte: it was quite a perfume to the tongue: whereas the other wine of Hockheim, let it be as good as it may, is not quite clear of vinegar; though for this alſo, if it has any age, you are forced to pay a guilder and a half." 2. Bingen is a pleaſant town, which ſtands in the diſtrict called *Rhinegau*. This town, which, together with the toll on the Rhine, is worth about 30,000 guilders, belongs to the chapter of Mentz, is extremely beautiful, and contains about 4500 inhabitants. A great part of the corn which is carried into the Rhinegau from the neighbouring Palatinate, comes through this place, which, on the other hand, ſupplies the Palatinate with drugs, and various foreign commodities. This traffic alone would make the place very lively; but, beſides this, it has very fruitful vineyards. The hill, at the foot of which it lies, and one ſide of which is made by the gullet through which the Nahe runs into the Rhine, forms another ſteep rock behind this gullet parallel to the Rhine and the golden Rudeſheimer mountain; it therefore enjoys the ſame ſun as this does, which makes the Budeſheimer wine that grows on it little inferior to the Rudeſheimer. See RUDESHEIM. The riſing grounds about it produce wines that are eſteemed preferable to thoſe of Baccharac, ſo much in vogue heretofore.—3. Elfeld, five miles weſt from Mentz, is a ſtrong fortified town, on the north ſide of the Rhine, and the chief of the Rhinegau.—Here is Rudeſheim, a place noted for the growth of the beſt wines in theſe parts. 4. Weiſbaden lies between ſix and ſeven leagues from Francfort, and about five or ſix miles north of Mentz; it is the metropolis of a country belonging to the branch of Naſſau-Saarbrak, and is famous for its mineral waters.

According to Rieſbeck, the ſee of Mentz is indebted for its increaſe of riches to St Boniface, who may be called, with great juſtice, the apoſtle of the Germans. It was this man, an Engliſhman by birth, who in the time of Charlemagne baptized Witikind and the other brave Saxons who had ſo long reſiſted baptiſm with their ſwords, and ſpread the empire of the vicar of Jeſus Chriſt as far as the northern and eaſtern ſeas. He it was who introduced the Roman liturgy into Germany, and made the ſavage inhabitants abſtain from eating horſe's fleſh. He raiſed the papal power to a higher pitch than it had been raiſed in any other country in Chriſtendom; and, in recompence of his ſervices, the pope made all the new founded biſhoprics in the north of Germany ſubject to the ſee of Mentz, which Boniface

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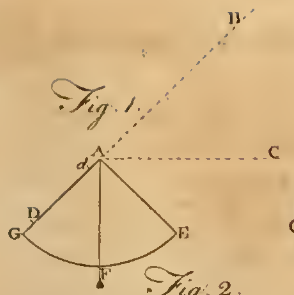

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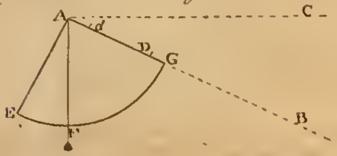

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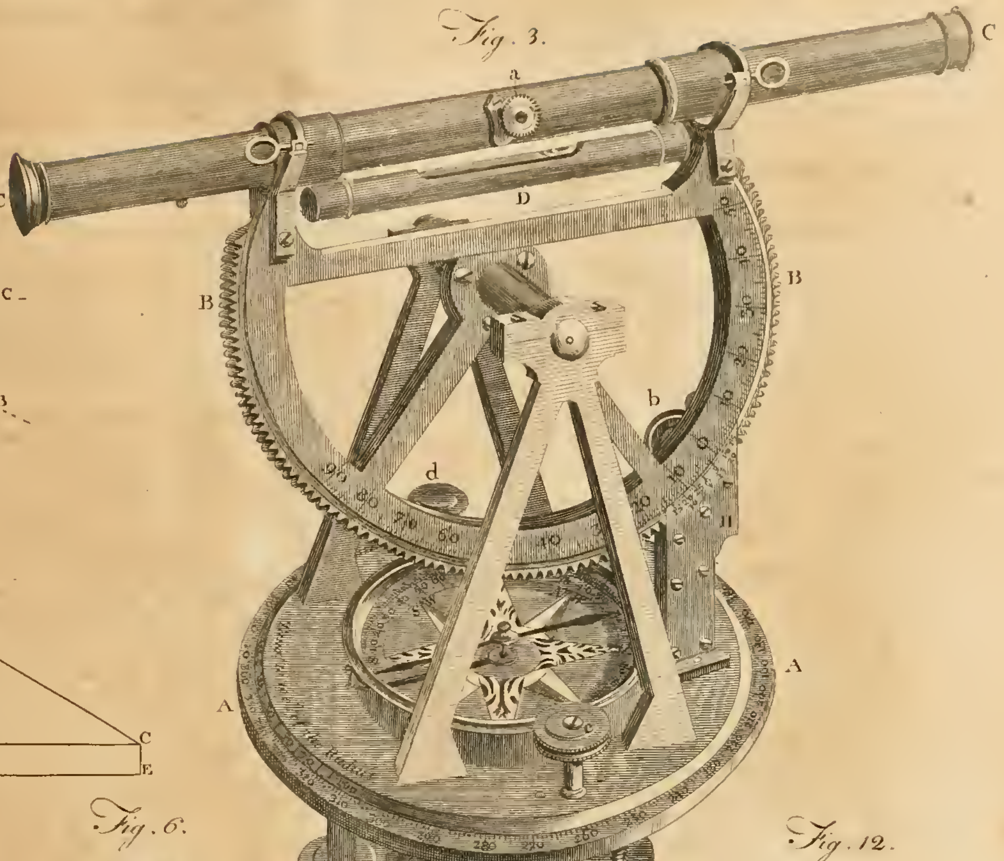
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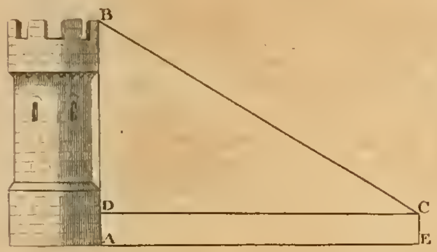

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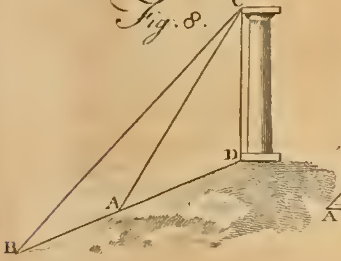

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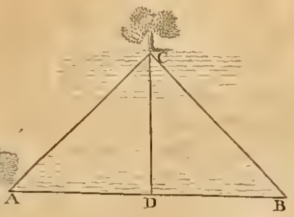

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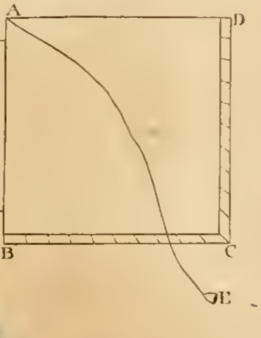

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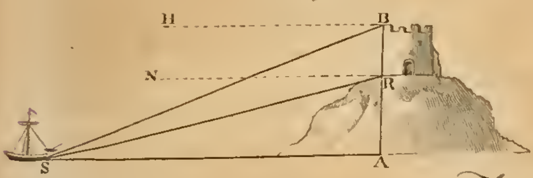

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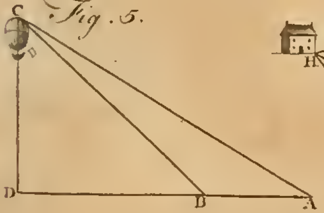

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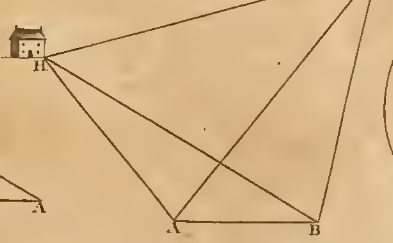
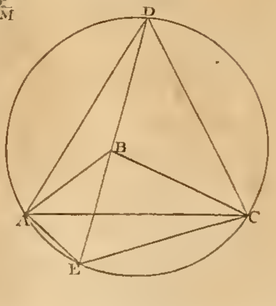


Fig. 10.



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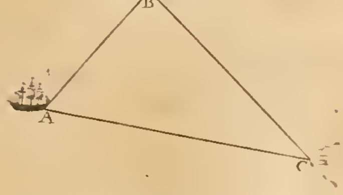

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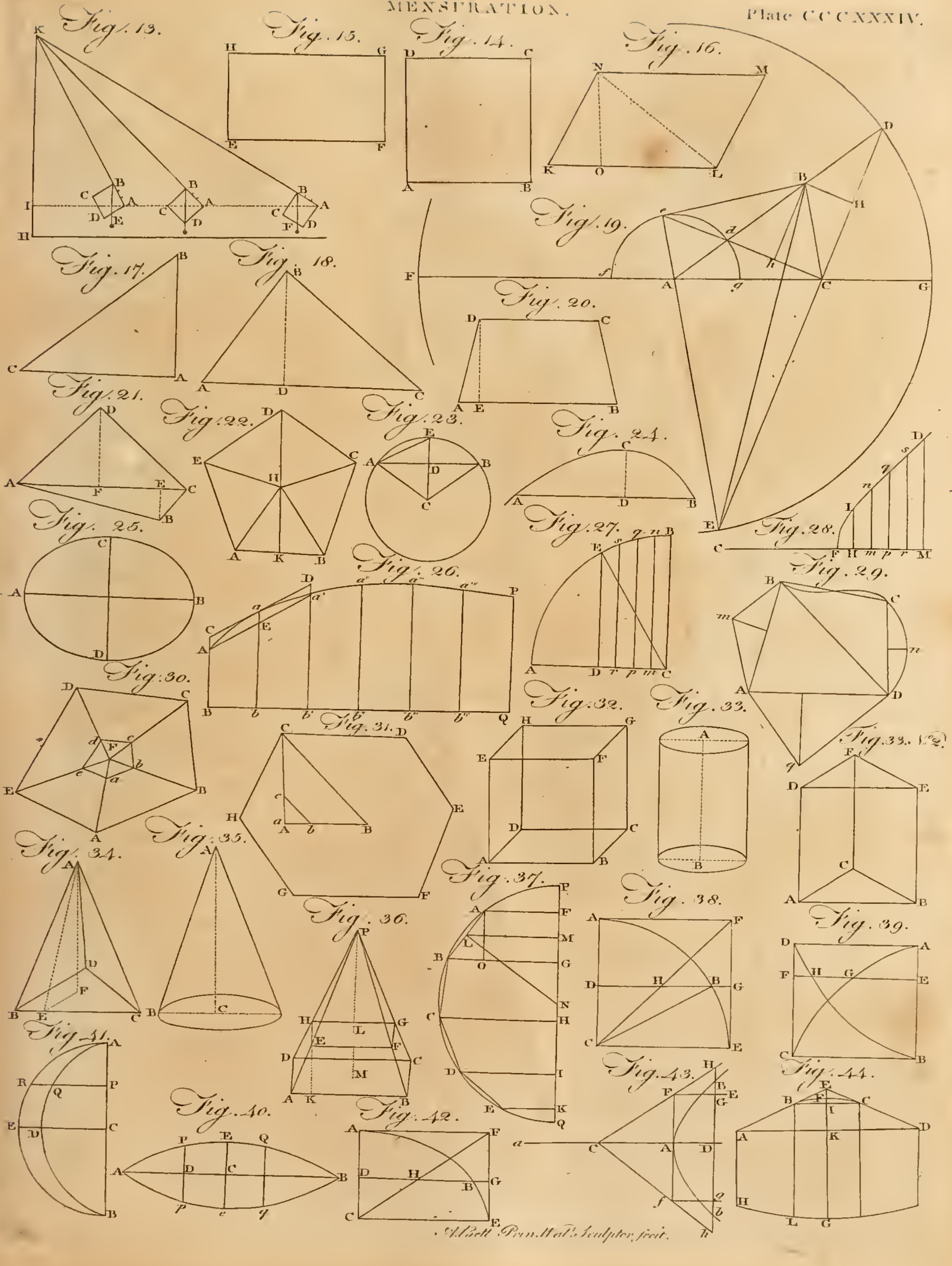
Fig. 13.
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Mentz.

face had choſen for his reſidence. The provinces, the moſt conſiderable in the whole papal dominions, all Suabia, Franconia, Bohemia, and almoſt all Saxony, with a part of Switzerland, Bavaria, and the Upper Rhine, belong to this dioceſe. Though the reformation, and revenge of the kings of Bohemia, have leſſened it one-third, it ſtill contains the archbiſhopric of Sprengel, and eleven biſhoprics, moſt of which are the moſt conſiderable of Germany, as Wurzburg, Paderborn, Hildeſheim, Augſburg, &c. When the building of the papal monarchy was completed by Gregory VII. the archbiſhops of Mentz became powerful enough to be at the head of the empire. In the 13th and 14th centuries, they were ſo eminent as to be able to make emperors without any foreign aſſiſtance; and it was to one of them that the houſe of Hapſburg was indebted for its firſt elevation. Since the boundaries of the two powers have been more acurately aſcertained, and the temporal has ſo much got the better of the ſpiritual, the power and influence of the archbiſhops of this place have of courſe been much reduced; ſtill, however, they are poſſeſſed of very important prerogatives, which they might exert with much more efficacy than they do, were it not that various circumſtances have rendered them too dependent on the emperors. They are ſtill the ſpeakers in the electoral college, have the appointment of the diets under the emperors, and may order a re-examination of the proceedings of the imperial courts. Theſe high privileges are, however, too much ſubject to the controul of the houſe of Auſtria; nor are their ſpiritual powers any longer what they once were. Their ſuffragan biſhops have taken it into their heads that all biſhops are alike as to power, and that the title of archbiſhop only entitles its poſſeſſor to the firſt place amongſt brothers who are equal. The temporals, however, which are ſtill annexed to this chair, make him who ſits in it rich amends for the diminution of his ſpiritual and political ſplendor. Though he does not abſolutely poſſeſs the largeſt, yet he certainly has the richeſt and moſt peopled domain of any eccleſiaſtical potentate in Germany. The country, it is true, does not contain more than 125 German miles ſquare, whereas the archbiſhopric of Saltzburg contains 240; but then Saltzburg has only 250,000 inhabitants, whereas Mentz has 320,000. The natural riches of the territory of Mentz, and its advantageous ſituation, make a ſubject of Mentz much richer than one of Saltzburg, the greateſt part of which is only inhabited by herdſmen. In the territory of Mentz there are 40 cities; in that of Saltzburg only ſeven. The tax on veſſels which go down the Rhine of itſelf produces 60,000 guilders, or 6000l. a-year, which is nearly as much as all the mines of Saltzburg put together, excepting only the ſalt mine at Halle. The tax on wine, here and in the country round, produces the court above 100,000 guilders, or 10,000l. a-year, in which ſum we do not reckon the cuſtoms of the countries which lie at a greater diſtance. Upon the whole, the income of the preſent archbiſhop may be valued at 1,700,000 guilders, or 170,000l.

If the lands of the elector lay all together, they would produce a ſufficiency of corn and all the prime neceſſaries of life; but as ſeveral parts of them lie wide aſunder, the people are compelled to purchaſe a great deal from foreigners. The capital itſelf, as well as the adjacent Rhinegau, depends on the Palatinate for its corn, notwithſtanding the great abundance of that and every other ſpecies of grain in its own poſſeſſions in Wetterau. The nobleſt production of the elector's territory on the Rhine is the wine, which is almoſt the only true Rheniſh. Connoiſſeurs, indeed, allow the wines of Neirſtein, Baccarach, and a very few other places out of this country, to be true Rheniſh: but they do not give this name to the wines of the Palatinate, of Bardon, and of Alſatia. There is a great deal of wine made in the countries which lie on the ſouth and weſt of the Rhine, at Laubenheim, Bodenheim, Budeſheim, and Bingen; but the true Rheniſh, that which inſpires ſo many who are and ſo many who are not poets, comes only from the Rhinegau, which lies on the northern banks of the Rhine. See RHINEGAU.

The civil liſt of the archbiſhop (according to Baron Rieſbeck), is by much too immoderate and expenſive. "He has his miniſters, his counſellors of ſtate, and eighty or ninety privy counſellors of various denominations. The expence of this eſtabliſhment is very diſproportionate to the revenue of the ſtate. This is owing to the large number of poor nobility, who can only accept of employments of this kind. Ignorance of the true principles of government are the cauſes of this evil. The conſequences are, that a great number of perſons, who might be uſefully employed, live in idleneſs. Even the military eſtabliſhment of the country appears to me more calculated for the purpoſe of feeding a hungry nobility than for real uſe. At the acceſſion of the preſent elector, though the whole army only conſiſted of 2200 men, there were ſix generals. The regular eſtabliſhment paid for and ſupported by the country is 8000 men; but though there are only 2000 men kept up, the money expended for their ſupport, particularly that given to numberleſs uſeleſs officers, might be made uſe of more for the benefit of the country. The army of the archbiſhop conſiſts of a German guard of 50 men and 25 horſes, a Swiſs guard, a ſquadron of huſſars of 130 men (the moſt uſeful troops, as they purge the land of robbers and murderers), a corps of artillery of 104 men, three regiments of infantry of 600 men each, and ſome companies belonging to the armies of Franconia and the Upper Palatinate. Of the fortifications of the capital we may ſay much the ſame as of the army. Were they, indeed, improved and kept up as they ought to be, they would vie with Luxemburg, and be the moſt powerful of all the barriers againſt France. It is true, that the nature of the ground does not allow of a regular plan; but for ſingle parts, I have ſeen no place of the ſame capabilities, where greater advantages have been taken of the ground for the erection of the ſeveral works. The beauty, as well as ſize of them, is indeed an object of great wonder; but though the circle of the Upper Rhine, and even the empire in general, has laid out great ſums on the building theſe fortifications, parts of them are not finiſhed, and parts of them are ready to fall to pieces. Their extent, indeed, would require a great army to man them. But this, as well as the maintaining and keeping them up, is evidently beyond the power of this court, or indeed of the whole circle of the Upper Rhine united. They are, therefore, alſo to be looked upon as one of the things which ſerve more for magnificence than real uſe."

MENTZ, a conſiderable town of Germany, in the circle of the Lower Rhine, and capital of the electorate of the ſame name, is ſituated on the Rhine near its confluence with the Maine, 20 miles north-weſt of Worms, 15 weſt of Francfort, and 75 eaſt of Triers, in E. Long. 8. 20. N. Lat. 40. 51. This city claims a right to the invention of the art of printing: (ſee *Hiſtory of* PRINTING). Here is a very beautiful quay along the river, defended by ſeveral works well fortified with cannon. That part of the city which extends towards the river is moſt populous. The beſt vineyards for Rheniſh wine being in this neighbourhood, Mentz has a flouriſhing trade in that commodity more particularly; and its commerce is the briſker, by reaſon that all the merchandiſe which paſſes up and down the Rhine ſtops in its harbour to change bottoms.

The northern part of the city, in which the archbiſhop reſides, is full of very regular buildings. Here are three regular ſtreets, called the *Blerchen*, which run parallel to each other from the banks of the Rhine to 600 yards within the city, and are cut almoſt regularly by very pretty croſs ſtreets. The archbiſhop's palace has a moſt commanding view of theſe ſtreets, the Rhine, and the Rhinegau. There are alſo ſome good buildings in the old part of the city. The market of beaſts is extremely well worth ſeeing; and you here and there meet with other agreeable ſpots. The market in the middle of the town, though not regular, is one of the prettieſt places in Germany. The cathedral is well worth notice. It is an immenſe large old Gothic building, the ſpire of which was ſtruck with lightning about 20 years ago, and entirely laid in aſhes. As it was made of a foreſt of wood, it burned 14 hours before it was entirely conſumed. To prevent theſe accidents for the future, the chapter had the preſent one built to the ſame height in ſtone, an undertaking which coſt them 40,000 guilders or 4000l. It is a great pity (Baron Rieſbeck obſerves) that it is overloaded with ſmall ornaments: and a ſtill greater, that this wonderful edifice is ſo choked up with ſhops and houſes as to be hardly more than half viſible. As, however, houſes and ſhops are very dear in this part of the town, one cannot be very angry with the chapter for chooſing rather to make the moſt of its ground, than to ſhow off the church to the beſt advantage. The rent of a ſhop and a ſingle room to live in is 150 guilders or 15l. per annum in this part of the town. There is hardly another church in Germany of the height and length of this cathedral; and the inſide of it is decorated with ſeveral magnificent monuments of princes and other great perſonages. Beſides the cathedral, the city of Mentz contains ſeveral other churches in the modern ſtyle, very well worth ſeeing. St Peter's, and the Jeſuits church, though both too much loaded with ornament, are among this number. The church of the Auguſtins, of which the inhabitants of Mentz are ſo proud, is a maſterpiece of bad taſte; but that of Ignatius, though little is ſaid about it, would be a model of the antique, if here likewiſe there had not been too much ornament laviſhed. Upon the whole, the palaces of the nobleſſe want that noble ſimplicity which alone conſtitutes true beauty and magnificence. In another century the externals of the city will be quite changed. The late prince built a great deal, and the preſent has a taſte for the ſame ſort of expence. The monks and governors of hoſpitals alſo have been forced to rebuild their houſes; ſo that when a few more ſtreets are made broader and ſtraighter, the whole will have no bad appearance. The inhabitants, who together with the garriſon amount to 30,000, are a good kind of people, and, like all the catholics of Germany, make great account of a good table. Their faces are intereſting, and they are not deficient either in wit or activity.

There are few cities in Germany beſides Vienna which contain ſo rich and numerous a nobility as this does: there are ſome houſes here which have eſtates of 100,000 guilders, or 10,000l. a-year. The counts of Baſſenheim, Schonborn, Stadion, Ingelheim, Elz, Oſtein, and Walderdorf, and the lords of Dahlberg, Breitenbach, with ſome others, have incomes of from 30,000 to 100,000 guilders. Sixteen or eighteen houſes have from 15,000 to 30,000 guilders annual revenue.—The nobility of this place are ſaid to be ſome of the oldeſt and moſt untainted in Germany. There are amongſt them many perſons of extraordinary merit, who join uncommon knowledge to all the duties of active life. Upon the whole, they are far ſuperior to the greater part of the German nobility. Their education, however, is ſtill too ſtiff. The firſt miniſter of the court was refuſed admittance into their aſſemblies for not being ſufficiently noble; and they think they degrade themſelves by keeping company with bourgeois.

The clergy of this place are the richeſt in Germany. A canonry brings in 3500 Rheniſh guilders in a moderate year. The canonry of the provoſt brings him in 40,000 guilders a-year; and each of the deaneries is worth 2600 guilders. The income of the chapter altogether amounts to 300,000 guilders. Though it is forbidden by the canons of the church for any one to have more than a ſingle prebend, there is not an eccleſiaſtic in this place who has not three or four; ſo that there is hardly a man amongſt them who has not at leaſt 8000 guilders a-year. The laſt provoſt, a count of Elz, had prebends enough to procure him an income of 75,000 guilders. Excluſive of the cathedral, there are ſeveral other choirs in which the canonries bring in from 1200 to 1500 guilders a-year. To give an idea of the riches of the monaſteries of this place, Baron Rieſbeck informs us, that at the deſtruction of the Jeſuits, their wine, which was reckoned to ſell extremely cheap, produced 120,000 rixdollars. A little while ago the elector aboliſhed one Carthuſian convent and two nunneries, in the holy cellars of which there was found wine for at leaſt 500,000 rixdollars. "Notwithſtanding this great wealth (continues our author), there is not a more regular clergy in all Germany. There is no dioceſe, in which the regulations made by the council of Trent have been more ſtrictly adhered to than they have here; the archbiſhops having made a particular point of it both at the time of the reformation and ever ſince. One thing which greatly contributes to keep up diſcipline is the not ſuffering any prieſt to remain in the country who has not fixed and ſtated duties, and a revenue annexed to them. Moſt of the irregularities in Bavaria, Auſtria, and other countries, ariſe from abbés who are obliged to ſubſiſt by their daily induſtry and any maſſes which they can pick up. Theſe creatures are entirely unknown here. The theological tenets of this court are alſo much purer than thoſe of any other eccleſiaſtical prince in Germany. I was pleaſed to ſee the Bible in the hands of ſo many common people, eſpecially in the country. I was told that the reading of it was not forbidden in any part of the dioceſe; only perſons were enjoined not to read it through, without the advice of their confeſſors. For a long time ſuperſtition has been hunted through its utmoſt receſſes; and though it is not quite poſſible to get entirely clear of pilgrimages and wonder-working images, you will meet with no prieſt bold enough to exorciſe or to preach ſuch nonſenſe as we hear in the pulpits of other German churches."

Though the trade of this place has been conſtantly on the increaſe for theſe 18 or 20 years paſt, yet it is by no means what it ought to be from the ſituation and other advantages. The perſons here who call themſelves merchants, and who make any conſiderable figure, are in fact only brokers, who procure their livelihood at the expence of the country or territory round, or who act for the merchants of Francfort. A few toy-ſhops, five or ſix druggiſts, and four or five manufacturers of tobacco, are all that can poſſibly be called traders. There is not a banker in the whole town; and yet this country enjoys the ſtaple privilege, and commands by means of the Maine, Necker, and Rhine, all the exports and imports of Alſatia, the Palatinate, Franconia, and a part of Suabia and Heſſe, as far as the Netherlands. The port too is conſtantly filled with ſhips, but few of them contain any merchandiſe belonging to the inhabitants of the place. The French took it by ſurpriſe in October 1792; it ſurrendered to the king of Pruſſia in 1793; the French made a fruitleſs attack upon it in 1795; it was relieved from a blockade by the Auſtrians in 1796, and the French got poſſeſſion of it in October 1797.

MENTZEL, Christian, born at Fruſtenwall in the Mittel-mark, is celebrated for his ſkill in medicine and botany, in purſuit of which he travelled through many countries. He had correſpondents in the moſt diſtant parts of the world. He died A. D. 1701, about the 79th year of his age. He was a member of the academy *des Curieux de la Nature*. His works are, 1. *Index nominum plantarum*, printed at Berlin in folio, 1696; and reprinted with additions in 1715, under the title of *Lexicon plantarum polyglotton univerſale*. 2. A Chronology of China, in German, printed at Berlin 1696 in 4to. The following manuſcripts of his compoſition are preſerved in the royal library at Berlin. 1. *Sur l'Hiſtoire Naturelle du Braſil*, in four volumes folio. 2. *Sur les Fleurs et les Plantes du Japon*, with coloured plates, two vols folio.

MENUS, in *Ancient Geography*, a river of Germany; now the *Maine*, riſing in Franconia, and running from eaſt to weſt into the Rhine at Mentz.

MENUTHIAS, in *Ancient Geography*, an iſland adjoining to the north-eaſt of the promontory Praſum of Ethiopia beyond Egypt. Some take it to be *Madagaſcar*, or the iſland *St Laurence*. Iſaac Voſſius will have it to be *Zanzibar*; Madagaſcar being at a greater diſtance from the continent than the ancients ever ſailed to, whereas Menuthias was nearer: yet though Zanzibar be nearer the continent, it is however nearer the equator than Ptolemy's Menuthias, placed in ſouth latitude 12½ degrees.

MENYANTHES, Marsh trefoil, or *Bogbean*; a genus of plants belonging to the pentandria claſs; and in the natural method ranking under the 21ſt order, *Preciæ*. See Botany *Index*.

MENZIKOFF, Alexander, was originally an apprentice to a paſtry-cook near the palace of Moſcow; but by a fortunate circumſtance was drawn from that ſituation in early life, and placed in the houſehold of Peter the Great. Having made himſelf maſter of ſeveral languages, and being formed for war and for buſineſs, he firſt rendered himſelf agreeable, and afterwards became neceſſary, to his maſter. He aſſiſted Peter in all his projects; and was rewarded for his ſervices with the government of Ingria, the rank of prince, and the title of *major general*. He ſignalized himſelf in Poland in 1708 and 1709; but in 1713 he was accuſed of embezzling the public money, and fined in 300,000 crowns. The czar remitted the fine; and having reſtored him to favour, gave him the command of an army in the Ukraine in 1719, and ſent him as his ambaſſador into Poland in 1722. Conſtantly employed about the means of preſerving his influence after the death of his maſter, who was then evidently on the decline, Menzikoff diſcovered the perſon to whom the czar intended to leave the ſucceſſion. The emperor was highly offended, and his penetration coſt him the principality of Pleſcoff. Under the czarina Catherine, however, he was higher in favour than ever; becauſe, on the death of the czar in 1725, he was active in bringing different parties in Ruſſia to agree to her ſucceſſion. This princeſs was not ungrateful. In appointing her ſon-in-law Peter II. to be her ſucceſſor, ſhe commanded him to marry the daughter of Menzikoff, and gave the czar's ſiſter to his ſon. The parties were actually betrothed: and Menzikoff was made duke of Cozel and grand ſteward to the czar. But this ſummit of elevation was the prelude to his fall. The *Dolgoroukis*, favourites of the czar, had influence enough to procure his baniſhment, together with that of his family, to one of his own eſtates at the diſtance of 250 leagues from Moſcow. He had the imprudence to leave the capital with the ſplendor and magnificence of a governor going to take poſſeſſion of his province. His enemies took advantage of this circumſtance to inflame the indignation of the czar. At ſome diſtance from Moſcow he was overtaken by a detachment of ſoldiers. The officer who commanded them made him alight from his chariot, which he ſent back to Moſcow; and placed him and his whole family in covered waggons, to be conducted into Siberia, in the habit of peaſants. When he arrived at the place of his deſtination, he was preſented with cows and ſheep big with young, and poultry, without knowing from whom he received the favour. His houſe was a ſimple cottage; and his employment was to cultivate the ground, or to ſuperintend its cultivation. New cauſes of ſorrow were added to the ſeverities of exile. His wife died in the journey; he had the misfortune to loſe

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one of his daughters by the ſmallpox; and his other two children were ſeized with the ſame diſeaſe, but recovered. He ſunk under his misfortunes, November 2. 1729; and was buried beſide his daughter, in a little chapel which he had built. His misfortunes had inſpired him with ſentiments of devotion, which, amid the ſplendor of his former ſituation, he had altogether neglected. His two ſurviving children enjoyed greater liberty after the death of their father. The officer permitted them to attend public worſhip on Sundays by turns. One day when his daughter was returning from the village, ſhe heard herſelf accoſted by a peaſant from the window of a cottage, and, to her great ſurpriſe, recogniſed in this peaſant the perſecutor of her family, Dolgorouki; who, in his turn, had fallen a ſacrifice to the intrigues of the court. She communicated this intelligence to her brother, who could not behold, without emotion, this new inſtance of the vanity and inſtability of honours and power. Young Menzikoff and his ſiſter were ſoon after recalled to Moſcow by the czarina Ann; and left Dolgorouki in poſſeſſion of their cottage. He was made captain of the guards, and received the fifth part of his father's poſſeſſions. His ſiſter was appointed maid of honour to the empreſs, and afterwards married to great advantage.

MENZINI, Benedict, a celebrated Italian poet, born at Florence, was profeſſor of eloquence at the college Della Sapienza at Rome, where he died in 1704. He wrote, 1. The art of poetry. 2. Satires, elegies, hymns, and the Lamentations of Jeremiah. 3. *Academia Tuſculana*, a work in verſe and proſe, which paſſes for his maſterpiece.

MEOTIS, or Palus Meotis, a ſea of Turkey, which divides Europe from Aſia; extending from Crim Tartary to the mouth of the river Don or Tanais.

MEPHITIC, a name expreſſing any kind of noxious vapour; but generally applied to that ſpecies of vapour called *fixed air*. See Carbonic Acid, Chemistry *Index*.

MEPHITIS Fanum, a temple erected to the goddeſs Mephitis, near Lacus Amſancti; who was worſhipped alſo at Cremona. Figuratively, *Mephitis* denotes a noiſome or peſtilential exhalation, (Virgil).

MEQUINEZ, or Miquinez, the northern capital of the Morocco empire, ſtands at the extremity of the province of Beni Haſſen, 80 leagues north from the city of Morocco (which is the ſouthern imperial city), and 20 to the eaſt of Sallee and the ocean. Maknaſſa, its founder, built it firſt at the bottom of a valley; but Muley Iſmael extended it conſiderably over the plain that lies to the weſt of the valley. It is ſurrounded with well cultivated fields and hills, adorned with gardens and olive plantations, and abundantly watered with rivulets. Accordingly, fruits and kitchen ſtuffs thrive here exceedingly, and even the ſuperior urbanity of the inhabitants announces the temperature of the climate. The winter indeed is very inconvenient, on account of the dirtineſs of the town, the ſtreets not being paved, and the ſoil being ſlimy.

Mequinez is ſurrounded with walls; the palace itſelf is fortified with two baſtions, on which formerly ſome ſmall guns were mounted. Muley Iſmael, and Muley Abdallah, often in this city reſiſted the efforts of the Brebes, the ſworn enemies of their tyranny. To the weſt are ſeen ſome walls of circumvallation, ſix feet in height, which were probably mere intrenchments for the infantry; the attacks of the Brebes being only ſudden and momentary inroads, which did not require a long defence. There is at Mequinez, as well as at Morocco, a walled and guarded ſuburb for the Jews. The houſes are neater here than at Morocco. The Jews here are more numerous; and they can turn their induſtry to greater account, becauſe the Moors in this city are more poliſhed, and (being nearer to Europe) more viſited, than thoſe in the ſouthern parts. Near the Jewry, there is another encloſed and ſeparate quarter, called the *Negro town*. It was built by Muley Iſmael, for the accommodation of thoſe black families which compoſed his ſoldiery. This town is now uninhabited, as are all thoſe deſtined for the ſame uſe through the reſt of the empire.

At the ſouth-eaſt extremity of the city ſtands the palace of the emperor, which was built by Muley Iſmael. The ſpace occupied by this palace is very great; it includes ſeveral gardens, elegantly diſpoſed, and well watered. There is a large garden in the centre, ſurrounded by a vaſt and pretty regular gallery, reſting on columns, which communicates with the apartments. Thoſe of the women are very ſpacious, and have a communication with a large chamber which looks into the garden. As you paſs from one apartment to another, you find at intervals regular courts paved with ſquare pieces of black and white marble; in the middle of theſe courts is a marble baſin, from the centre of which riſes a *jet d'eau*, and the water falls down into this baſin. Theſe fountains are numerous in the palace; they are uſeful for domeſtic purpoſes, and they ſerve for the ablutions, which the ſcruples of the Mahometans have exceedingly multiplied. The palaces of the Mooriſh kings are large, becauſe they are compoſed only of one range of apartments; theſe are long and narrow, from 18 to 20 feet high; they have few ornaments. and receive the light by two large folding doors, which are opened more or leſs as occaſion requires. The rooms are always lighted from a ſquare court in the centre, which is generally encompaſſed with a colonnade.

The Moors here are more courteous than thoſe in the ſouthern parts; they are civil to ſtrangers, and invite them into their gardens, which are very neat. The women in this part of the empire are beautiful; they have a fair complexion, with fine black eyes, and white teeth. I have ſometimes ſeen them taking the air on the terraces; they do not hide themſelves from Europeans, but retire very quickly on the appearance of a Moor.

MERA-de-Asta, formerly a large town of Andaluſia, ſeated on the river Guadaleta, between Arcos and Xeres de la Frontera; but now only a large heap of ruins. Here the Arabs conquered Roderick the laſt king of the Goths, and by that victory became maſters of Spain in 713.

MERCATOR, Gerard, one of the moſt celebrated geographers of his time, was born at Ruremonde in 1512. He applied himſelf with ſuch induſtry to geography and mathematics, that he is ſaid to have frequently forgot to eat and drink. The emperor Charles V. had a particular eſteem for him, and the duke of Juliers made him his coſmographer. He compoſed a chronology, ſome geographical tables, an atlas, &c. engraving and colouring the maps himſelf. He died in 1594. His method of laying down charts is ſtill uſed, and bears the name of *Mercator's charts*.

MERCATOR, *Nicholas*, an eminent mathematician in the 17th century, was born at Holſtein in Denmark; and came to England about the time of the reſtoration, where he lived many years. He was fellow of the Royal Society; and endeavoured to reduce aſtrology to rational principles, as appeared from a MS. of his in the poſſeſſion of William Jones, Eſq. He publiſhed ſeveral works, particularly *Coſmographia*. He gave the quadrature of the hyperbole by an infinite ſeries; which was the firſt appearance in the learned world of a ſeries of this ſort drawn from the particular nature of the curve, and that in a manner very new and abſtracted.

Mercator's Sailing, that performed by Mercator's chart. See NAVIGATION.

MERCATORUM FESTUM, was a feſtival kept by the Roman merchants on the 15th of May, in honour of Mercury, who preſided over merchandiſe. A ſow was ſacrificed on the occaſion, and the people preſent ſprinkled themſelves with water fetched from the fountain called *aqua Mercurii*; the whole concluding with prayers to the god for the proſperity of trade.

MERCHANT, a perſon who buys and ſells commodities in groſs, or deals in exchanges; or that traffics in the way of commerce, either by importation or exportation. Formerly every one who was a buyer or ſeller in the retail way was called a *merchant*, as they ſtill are both in France and Holland; but here ſhopkeepers, or thoſe who attend fairs or markets, have loſt that appellation.

Previous to a perſon's engaging in a general trade, and becoming an univerſal dealer, he ought to treaſure up ſuch a fund of uſeful knowledge as will enable him to carry it on with eaſe to himſelf, and without riſking ſuch loſſes as great ill-concerted undertakings would naturally expoſe him to. A merchant ſhould therefore be acquainted with the following parts of commercial learning: 1. He ſhould write properly and correctly. 2. Underſtand all the rules of arithmetic that have any relation to commerce. 3. Know how to keep books of double and ſingle entry, as journals, a leger, &c. 4. Be expert in the forms of invoices, accounts of ſales, policies of inſurance, charter parties, bills of lading, and bills of exchange. 5. Know the agreement between the money, weights, and meaſures of all parts. 6. If he deal in ſilk, woollen, linen, or hair manufactures, he ought to know the places where theſe different ſorts of merchandiſes are manufactured, in what manner they are made, what are the materials of which they are compoſed, and from whence they come, the preparations of theſe materials before working up, and the places to which they are ſent after their fabrication. 7. He ought to know the lengths and breadths which ſilk, woollen, or hair ſtuffs, linen, cottons, fuſtians, &c. ought to have according to the ſeveral ſtatutes and regulations of the places where they are manufactured, with their different prices, according to the times and ſeaſons; and if he can add to his knowledge the different dyes and ingredients which form the various colours, it will not be uſeleſs. 8. If he confines his trade to that of oils, wines, &c. he ought to inform himſelf particularly of the appearances of the ſucceeding crops, in order to regulate his diſpoſing of what he has on hand; and to learn as exactly as he can what they have produced when got in, for his direction in making the neceſſary purchaſes and engagements. 9. He ought to be acquainted with the ſorts of merchandiſe found more in one country than another, thoſe which are ſcarce, their different ſpecies and qualities, and the propereſt method for bringing them to a good market either by land or ſea. 10. To know which are the merchandiſes permitted or prohibited, as well on entering as going out of the kingdoms or ſtates where they are made. 11. To be acquainted with the price of exchange, according to the courſe of different places, and what is the cauſe of its riſe and fall. 12. To know the cuſtoms due on importation or exportation of merchandiſes, according to the uſage, the tariffs, and regulations, of the places to which he trades. 13. To know the beſt manner of folding up, embaling, or tunning, the merchandiſes for their preſervation. 14. To underſtand the price and condition of freighting and inſuring ſhips and merchandiſe. 15. To be acquainted with the goodneſs and value of all neceſſaries for the conſtruction and repairs of ſhipping, the different manner of their building; what the wood, the maſts, cordage, cannons, ſails, and all requiſites, may coſt. 16. To know the wages commonly given to the captains, officers, and ſailors, and the manner of engaging with them. 17. He ought to underſtand the foreign languages, or at leaſt as many of them as he can attain to; theſe may be reduced to four, viz. the Spaniſh, which is uſed not only in Spain but on the coaſt of Africa, from the Canaries to the Cape of Good Hope: the Italian, which is underſtood on all the coaſts of the Mediterranean, and in many parts of the Levant: the German, which is underſtood in almoſt all the northern countries; and the French, which is now become almoſt univerſally current. 18. He ought to be acquainted with the conſular juriſdiction, with the laws, cuſtoms, and uſages of the different countries he does or may trade to; and in general all the ordinances and regulations both at home and abroad that have any relation to commerce. 19. Though it is not neceſſary for a merchant to be very learned, it is proper that he ſhould know ſomething of hiſtory, particularly that of his own country; geography, hydrography, or the ſcience of navigation; and that he be acquainted with the diſcoveries of the countries in which trade is eſtabliſhed, in what manner it is ſettled, of the companies formed to ſupport thoſe eſtabliſhments, and of the colonies they have ſent out.

All theſe branches of knowledge are of great ſervice to a merchant who carries on an extenſive commerce; but if his trade and his views are more limited, his learning and knowledge may be ſo too: but a material requiſite for forming a merchant is, his having on all occaſions a ſtrict regard to truth, and his avoiding fraud and deceit as corroding cankers that muſt inevitably deſtroy his reputation and fortune.

Trade is a thing of ſo univerſal a nature, that it is impoſſible for the laws of Britain, or of any other nation, to determine all the affairs relating to it; therefore all nations, as well as Great Britain, ſhow a particular regard to the law-merchant, which is a law made by the merchants among themſelves: however, merchants and other ſtrangers are ſubject to the laws of the country in which they reſide. Foreign merchants are to ſell their merchandiſe at the port where they land, in groſs, and not by retail; and they are allowed to be paid in gold or ſilver bullion, in foreign coin or jewels, which may be exported. If a difference ariſes between the king and any foreign ſtate, the merchants of that ſtate are allowed ſix months time to ſell their effects and leave the kingdom; during which time they are to remain free and unmoleſted in their perſons and goods. See the articles Commerce, and *Mercantile Law*.

MERCHET (Merchetum), a fine or compoſition paid by inferior tenants to the lord, for liberty to diſpoſe of their daughters in marriage. No baron, or military tenant, could marry his ſole daughter and heir, without ſuch leave purchaſed from the king, *pro maritanda filia.* And many of our ſervile tenants could neither ſend their ſons to ſchool, nor give their daughters in marriage, without expreſs leave from the ſuperior lord. See Kennet's Gloſſary *in Maritagium.* See alſo Marchet, under which word it is ſtated, and very generally underſtood, that this was a right claimed by the lord of the manor in the time of the feudal ſyſtem of paſſing the firſt night after marriage with his female villain. According to Mr Aſtle, the mercheta was a compact between the lord and his vaſſal for the redemption of an offence committed by the vaſſal's unmarried daughter; and alſo a fine paid by a ſokeman or a villain to his lord for permiſſion to marry his daughter to a free man; and in caſes where the vaſſal gave away his daughter without having obtained this licenſe, he ſubjected himſelf to a heavier fine.

MERCIA, the name of one of the ſeven kingdoms founded in England by the Saxons. Though the lateſt formed, it was the largeſt of them all, and grew by degrees to be by far the moſt powerful. On the north it was bounded by the Humber and the Merſey, which ſeparated it from the kingdom of Northumberland; on the eaſt by the ſea, and the territories of the Eaſt Angles and Saxons; on the ſouth by the river Thames; and on the weſt by the rivers Severn and Dee. It comprehended well nigh 17 of our modern counties, being equal in ſize to the province of Languedoc in France; very little, if at all, leſs than the kingdom of Arragon in Spain; and ſuperior in ſize to that of Bohemia in Germany.

Penda is regarded as its firſt monarch; and the kingdom is thought to derive its name from the Saxon word *merc*, which ſignifies "a march, bound, or limit," becauſe the other kingdoms bordered upon it on every ſide; and not from the river Merſey, as ſome would perſuade us. Penda aſſumed the regal title A. D. 626, and was of the age of 50 at the time of his acceſſion; after which he reigned near 30 years. He was of a moſt furious and turbulent temper, breaking at different times with almoſt all his neighbours, calling in the Britons to his aſſiſtance, and ſhedding more Saxon blood than had been hitherto ſpilled in all their inteſtine quarrels. He killed two kings of Northumberland, three of the Eaſt Angles, and compelled Kenwall king of the Weſt Saxons to quit his dominions. He was at length ſlain, with moſt of the princes of his family, and a multitude of his ſubjects, in a battle fought not far from Leeds, by Oſwy king of Northumberland. This battle, which the Saxon chronicle tells us was fought at Winwidfield, A. D. 655, made a great change in the Saxon affairs, which the unbridled fury of Penda had thrown into great confuſion. He had the year before killed Anna king of the Eaſt Angles in battle, whoſe brother Ethelred notwithſtanding took part with Penda. On the other hand, Penda the eldeſt ſon of Penda, to whom his father had given the ancient kingdom of the Mid Angles, had two years before married the natural daughter of King Oſwy, and had been baptized at his court. At that time it ſhould ſeem that Oſwy and Penda were upon good terms; but after the latter had conquered the Eaſt Angles, he reſolved to turn his arms againſt the kingdom of Northumberland. Oſwy by no means had provoked this rupture; on the contrary, Bede tells us that he offered large ſums of money, and jewels of great value, to purchaſe peace: theſe offers being rejected, he was reduced to the neceſſity of deciding the quarrel by the ſword. The river near which the battle was fought overflowing, there were more drowned than killed. Amongſt theſe, as the Saxon chronicle ſays, there were 30 princes of the royal line, ſome of whom bore the title of *kings;* and alſo Ethelred king of the Eaſt Angles, who fought on the ſide of Penda againſt his family and country.

His ſon Penda, who married the daughter of that conqueror, became a Chriſtian, and was not long after murdered, as is ſaid, by the malice of his mother. His brother Wolfher becoming king of Mercia, embraced in proceſs of time the faith of the goſpel, and proved a very victorious and potent monarch; and is, with no fewer than ſeven of his immediate ſucceſſors, commonly ſtyled *king of the Anglo-Saxons*, though none of them are owned in that quality by the Saxon chronicle. But though poſſibly none of them might enjoy this honour, they were undoubtedly very puiſſant princes, maintaining great wars, and obtaining many advantages over the ſovereigns of other Saxon ſtates, and eſpecially the Eaſt Angles, whom they reduced. The extent of the Mercian territories was ſo ample as to admit, and ſo ſituated as to require, the conſtituting ſubordinate rulers in ſeveral provinces; to whom, eſpecially if they were of the royal line, they gave the title of *kings;* which occaſions ſome confuſion in their hiſtory. Beſides the eſtabliſhing epiſcopal ſees and convents, the Saxon monarchs took other methods for improving and adorning their dominions; and as Mercia was the largeſt, ſo theſe methods were moſt conſpicuous therein. Coventry, as being ſituated in the centre, was uſually, but not always, the royal reſidence. Penda, who was almoſt continually in a ſtate of war, lived as his military operations directed, in ſome great town on the frontiers. Wolfher built a caſtle or fortified palace for his own reſidence, which bore his name.—Offa kept his court at Sutton Walls near Hereford.

In each of the provinces there reſided a chief magiſtrate; and if he was of the royal blood, had uſually the title of *king*. Penda, at the time he married Oſwy's daughter, had the title of *king of Leiceſter*.—

Ethelred made his brother Merowald king of Hereford; who, dying without iſſue, bequeathed it to his younger brother Mercelm. The like honours were ſometimes conferred upon the princeſſes; and hence, in Mercia eſpecially, we occaſionally read of *vice-queens*. By theſe means the laws were better executed, the obedience of the ſubjects more effectually ſecured, and the ſplendor of theſe reſidences conſtantly kept up and augmented.

At length, the crown devolving ſometimes on minors and ſometimes on weak princes, inteſtine factions alſo prevailing, the force of this hitherto mighty kingdom began ſenſibly to decline. This falling out in the days of Egbert, the moſt prudent as well as the moſt potent monarch of the Weſt Saxons, he took advantage of theſe circumſtances; and having encouraged the Eaſt Angles to make an attempt for the recovery of their independence, he, in a conjuncture every way favourable to his deſign, broke with the Mercians, and after a ſhort war obliged them to ſubmit. But this was not an abſolute conqueſt, the kings of Mercia being allowed by him and his ſucceſſors to retain their titles and dominions, till the invaſion of the Danes put an end to their rule, when this kingdom had ſubſiſted above 250 years; and when the Danes were afterwards expelled by the Weſt Saxons, it ſunk into a province, or rather was divided into many.

MERCURIAL, ſomething conſiſting of, or relating to, mercury.

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

MERCURIFICATION, in metallurgic chemiſtry, the obtaining the mercury from metallic minerals in its fluid form. See CHEMISTRY and MINERALOGY *Index*.

MERCURY, or QUICKSILVER. See CHEMISTRY and MINERALOGY *Index*.

MERCURY, in the heathen mythology. See HERMES.

Moſt of the actions and inventions of the Egyptian Mercury have likewiſe been aſcribed to the Grecian, who was ſaid to be the ſon of Jupiter and Maia, the daughter of Atlas. No one of all the heathen divinities had ſo many functions allotted to him as this god: he had conſtant employment both day and night, having been the common miniſter and meſſenger of the whole Pantheon; particularly of his father Jupiter, whom he ſerved with indefatigable labour, and ſometimes, indeed, in a capacity of no very honourable kind. Lucian is very pleaſant upon the multitude of his avocations; and, according to the confeſſion of the emperor Julian, Mercury was no hero, but rather one who inſpired mankind with wit, learning, and the ornamental arts of life, than with courage. The pious emperor, however, omits ſome of his attributes; for this god was not only the patron of trade, but alſo of theft and fraud.

Amphion is ſaid, by Pauſanias, to have been the firſt that erected an altar to this god; who, in return, inveſted him with ſuch extraordinary powers of muſic (and maſonry), as to enable him to fortify the city of Thebes in Bœotia, by the mere ſound of his lyre. Horace gives us the beſt part of his character:

Thou god of wit, from Atlas ſprung,
Who by perſuaſive pow'r of tongue,
And graceful exerciſe, refin'd
The ſavage race of human kind,
Hail! winged meſſenger of Jove,
And all th' immortal pow'rs above.
Sweet parent of the bending lyre,
Thy praiſe ſhall all its ſounds inſpire.
  Artful and cunning to conceal
Whate'er in ſportive theft you ſteal,
When from the god who gilds the pole,
E'en yet a boy, his herds you ſtole;
With angry voice the threat'ning power
Bade thee thy fraudful prey reſtore;
But of his quiver too beguil'd,
Pleas'd with the theft, Apollo ſmil'd.
  You were the wealthy Priam's guide,
When ſafe from Agamemnon's pride,
Through hoſtile camps, which round him ſpread
Their watchful fires, his way he ſped.
Unſpotted ſpirits you conſign
To bliſsful ſeats and joys divine;
And, pow'rful, with thy golden wand,
The light, unbodied crowd command;
Thus grateful does thy office prove
To gods below, and gods above. FRANCIS.

This ode contains the ſubſtance of a very long hymn to Mercury, attributed to Homer. Almoſt all the ancient poets relate the manner in which the Grecian Mercury diſcovered the lyre; and tell us that it was an inſtrument with ſeven ſtrings; a circumſtance which makes it eſſentially different from that ſaid to have been invented by the Egyptian Mercury, which had but three. However, there have been many claimants beſides Mercury to the ſeven-ſtringed lyre. See LYRE.

His moſt magnificent temple was on Mount Cylene, in Arcadia. He is deſcribed by the poets as a fair beardleſs youth, with flaxen hair, lively blue eyes, and a ſmiling countenance. He has wings fixed to his cap and ſandals, and holds the caduceus (or ſtaff ſurrounded with ſerpents, with two wings on the top), in his hand; and is frequently repreſented with a purſe, to ſhow that he was the god of gain. The animals ſacred to him, were the dog, the goat, and the cock. In all the ſacrifices offered to him, the tongues of the victims were burnt; and thoſe who eſcaped imminent danger ſacrificed to him a calf with milk and honey.

MERCURY, ☿ in *Aſtronomy*. See ASTRONOMY *Index*.

This planet is brighteſt between his elongations and ſuperior conjunction, very near to which laſt he can generally be ſeen. He becomes inviſible ſoon after he has found his elongation, going towards his inferior conjunction; and becomes viſible again a few days before his next elongation. The brightneſs of this planet alters ſometimes very conſiderably in 24 hours. It has been obſerved when leſs than three degrees diſtant from the ſun, and may, perhaps, ſometimes be ſeen even in conjunction with it.

Mercury and Venus appear brighteſt and moſt beautiful in the oppoſite parts of their orbits: the firſt, between his elongations and ſuperior conjunction; and the other, between her elongations and inferior conjunction. Therefore, Venus is ſeen in great perfection as a creſcent, particularly in her inferior conjunction, whilſt Mercury is ſeldom ſeen in ſuch perfect phaſes. Mercury ſhould be always obſerved on or near the meridian. When fartheſt from the ſun, he always appears with a very faint light; and when he has a great ſouth declination, or the atmoſphere is not perfectly clear, he ſeldom can be ſeen in thoſe parts of his orbit, where he only begins to recover his brightneſs, or where it is much diminiſhed. He has frequently been ſeen on the meridian even with a ſmall teleſcope and ſmall power; and it appears from the above ſtatement that he may be obſcured in a clear day rather more than half his orbit, or near one hundred and fourſcore days in the year.

Mercury, in *Heraldry*, a term uſed in blazoning by planets, for the purple colour uſed in the arms of ſovereign princes.

MERCY, a virtue that inſpires us with compaſſion for our brethren, and which inclines us to give them aſſiſtance in their neceſſities. Mercy is alſo taken for thoſe favours and benefits that we receive either from God or man, particularly in the way of forgiveneſs of injuries or of debts. Nothing can be more beautiful than the deſcription of mercy given us by Shakeſpeare, in the pleading between Portia and the Jew:

Por. Then muſt the Jew be merciful.
Shy. On what compulſion muſt I? tell me that.
Por. The quality of mercy is not ſtrain'd;
It droppeth as the gentle rain from heav'n
Upon the place beneath. It is twice bleſs'd:
It bleſſeth him that gives, and him that takes.
'Tis mightieſt in the mightieſt; it becomes
The throned monarch better than his crown:
The ſceptre ſhows the force of temporal power,
The attribute to awe and majeſty,
Wherein doth ſit the dread and fear of kings;
But mercy is above this ſcepter'd ſway,
It is enthroned in the hearts of kings;
It is an attribute to God himſelf,
And earthly power doth then ſhow likeſt God's,
When mercy ſeaſons juſtice. Therefore, Jew,
Though juſtice be thy plea, conſider this,
That in the courſe of juſtice none of us
Should ſee ſalvation. We do pray for mercy;
And that ſame prayer doth teach us all to render
The deeds of mercy. *Merchant of Venice*, act iv.

MERCY-SEAT, or Propitiatory, in Jewiſh antiquity, the covering of the ark of the covenant.—The Hebrew name of this cover, which we tranſlate mercy-ſeat, is *Capporeth* (Exod. xxv. 17, 22.), from *Cappor*, which ſignifies *to cover*, *to ſhut up*, *to expiate*, *to pay*. This cover was of gold, and at its two ends were fixed the two cherubims of the ſame metal, which by their wings extended forwards, ſeemed to form a throne for the majeſty of God, who in ſcripture is repreſented to us as ſitting between the cherubims, and the ark itſelf was as it were his footſtool. It was from hence that God gave his oracles to Moſes, or to the high prieſt that conſulted him, Exod. xxv. 22. Numb. vii. 89.)

MERETRIX, among the Romans, differed from the *proſtibulæ*. The *proſtibulæ* were common courteſans, with bills over their doors, ſignifying their profeſſion, and were ready at all times to entertain cuſtomers; whereas the *meretrices* entertained none but at night.—The *meretrices* differed in their dreſs from the *matrons*; the former wore the *toga* and ſhort *tunics*, like thoſe of the men: the latter wore the *palla* and the *ſtola* of ſuch a length as to reach to their feet.

MERGANSER. See Mergus.

MERGUS, a genus of birds of the order of anſeres. See Ornithology *Index*.

MERIAN, Maria Sibylla, a celebrated paintreſs, born at Frankfort in 1647, was the daughter of Matthias Merian, a noted engraver and geographer.—As ſhe ſhowed a very early fondneſs for painting, ſhe was inſtructed by Abraham Mignon; from whom ſhe learned great neatneſs of handling and delicacy of colour. Her genius particularly led her to paint reptiles, flowers, and inſects, which ſhe deſigned after nature, and ſtudied every object with a moſt curious and inquiſitive obſervation; ſo that her works roſe every day more and more into reputation. Frequently ſhe painted her ſubjects in water colours on vellum, and finiſhed an aſtoniſhing number of deſigns, as ſhe was equally indefatigable in her work and in her inquiries into the curioſities of nature. She drew the flies and caterpillars in all the variety of changes and forms in which they ſucceſſively appear from their quieſcent ſtate till they become butterflies; and alſo drew frogs, toads, ſerpents, ants, and ſpiders, after nature, with extraordinary exactneſs and truth. She even undertook a voyage to Surinam, to paint thoſe inſects and reptiles which were peculiar to that climate; and at her return to her own country publiſhed two volumes of engravings after her deſigns, which are well known to the curious. She died in 1717. Her daughter Dorothea Henrietta Graff, who painted in the ſame ſtyle, and had accompanied her mother to Surinam, publiſhed a third volume collected from the deſigns of Sibylla; which complete work has been always admired by the learned, as well as by the profeſſors of painting.

MERIDA, a ſtrong town of Spain, in Eſtremadura, built by the Romans before the birth of Chriſt. Here are ſome fine remains of antiquity, particularly a triumphal arch, but which is conſiderably decayed. It is ſeated in an extenſive and fertile plain, 47 miles eaſt of Elva, and 45 ſouth by eaſt of Alcantara. W. Long. 6. 4. N. Lat. 38. 42.

Merida, a town of North America, in New Spain, and capital of the province of Yucatan, where the biſhop and the governor of the province reſide. It is inhabited by Spaniards and native Americans; is 30 miles ſouth of the ſea, and 120 north-eaſt of Campeachy. W. Long. 89. 25. N. Lat. 20. 15.

Merida, a town of South America, in the kingdom of New Granada, ſeated in a country abounding with all kinds of fruits, 130 miles north-eaſt of Pampeluna. W. Long. 71. 0. N. Lat. 8. 30.

MERIDEN, or Mireden, a town of Warwickſhire, 97 miles from London on the London road, near Coventry. It is pleaſantly ſituated, though in a wet clayey ſituation, and is not ill built. The church ſtands on an elevated ſpot, and contains ſome good monuments. There is an inn here, about half way from St Clement's foreſt to Coventry, one of the fineſt in this part of Engand, being built like a nobleman's ſeat.

MERIDIAN, in *Geography*, a great circle ſuppoſed to be drawn through any part on the ſurface of the earth, and the two poles; and to which the ſun is always perpendicular at noon. See GEOGRAPHY.

In aſtronomy, this circle is ſuppoſed to be in the heavens, and exactly perpendicular to the terreſtrial one. See ASTRONOMY.

MERIDIANI, in antiquity, a name which the Romans gave to a kind of gladiators who entered the arena about noon after the beſtiarii (who fought in the morning againſt beaſts) had finiſhed. They were thus called from *meridies*, i. e. *noon*, the time when they exhibited their ſhows. The meridiani were a ſort of artleſs combatants, who fought man with man, ſword in hand. Hence Seneca takes occaſion to obſerve, that the combats of the morning were full of humanity compared with thoſe which followed.

MERIDIONAL DISTANCE, in *Navigation*, the ſame with departure, or eaſting and weſting; being the difference of longitude between the meridian under which the ſhip now is, and any other meridian which ſhe was under before.

MERIDIONAL parts, miles, or minutes, in *Navigation*, are the parts by which the meridians in a Mercator's chart do increaſe, as the parallels of latitude decreaſe.

MERIONETHSHIRE, a county of North Wales, is bounded on the north by Caernarvonſhire and Denbighſhire; on the eaſt by Montgomeryſhire; on the weſt by St George's channel, or the Iriſh ſea; and on the ſouth by the river Dyffi, which parts it from Cardiganſhire; extending 40 miles in length and 36 in breadth. It is divided into ſix hundreds, in which are four market towns, 37 pariſhes, about 5787 houſes, and 29,506 inhabitants in 1801. It lies in the dioceſe of Bangor, and ſends one member to parliament. The air is very ſharp in winter, on account of its many high barren mountains; and the ſoil is as bad as any in Wales, it being very rocky and mountainous. However, this county feeds large flocks of ſheep, many goats, and large herds of horned cattle, which find pretty good paſture in the valleys. Beſides theſe, among their other commodities may be reckoned Welch cotton, deer, fowl, fiſh, and eſpecially herrings, which are often taken on this coaſt in great plenty.

MERIT, ſignifies *deſert*. This term is more particularly applied to ſignify the moral goodneſs of the actions of men, and the rewards to which thoſe actions entitle them.

MERLIN, AMBROSE, a famous Engliſh poet and reputed prophet, flouriſhed at the end of the 5th century. Many ſurpriſing and ridiculous things are related of him. Several Engliſh authors have repreſented him as the ſon of an incubus, and as tranſporting from Ireland to England the great ſtones which form Stonehenge on Saliſbury plain. Extravagant prophecies and other works are alſo attributed to him, on which ſome authors have even written commentaries.

MERLIN. See FALCO, ORNITHOLOGY *Index*.

MERLON, in *Fortification*, is that part of a parapet which is terminated by two embraſures of a battery.

MERLUCIUS, the HAKE. See GADUS, ICHTHYOLOGY *Index*.

MERMAID, or MERMAN, a ſea-creature frequently talked of, ſuppoſed half human and half a fiſh.

However naturaliſts may doubt of the reality of *mermen* or *mermaids*, we have teſtimony enough to eſtabliſh it; though, how far theſe teſtimonies may be authentic, we cannot take upon us to ſay. In the year 1187, as Lary informs us, ſuch a monſter was fiſhed up in the county of Suffolk, and kept by the governor for ſix months. It bore ſo near a conformity with man, that nothing ſeemed wanting to it but ſpeech. One day it took the opportunity of making its eſcape; and plunging into the ſea, was never more heard of. *Hiſt. de Angleterre*, P. I. p. 403.

In the year 1430, after a huge tempeſt, which broke down the dikes in Holland, and made way for the ſea into the meadows, &c. ſome girls of the town of Edam in Weſt Frieſland, going in a boat to milk their cows, perceived a mermaid embarraſſed in the mud, with a very little water. They took it into their boat, and brought it with them to Edam, dreſſed it in woman's apparel, and taught it to ſpin. It fed like one of them, but could never be brought to offer at ſpeech. Some time afterwards it was brought to Haerlem, where it lived for ſome years, though ſtill ſhowing an inclination to the water. Parival relates, that they had given it ſome notion of a Deity, and that it made its reverences very devoutly whenever it paſſed by a crucifix. *Delices de Hollande.*

In the year 1560, near the iſland of Manaar, on the weſtern coaſt of the iſland of Ceylon, ſome fiſhermen brought up, at one draught of a net, ſeven mermen and mermaids; of which ſeveral Jeſuits, and among the reſt F. Hen. Henriques and Dimas Boſquez, phyſicians to the viceroy of Goa, were witneſſes. The phyſician, who examined them with a great deal of care, and made diſſection thereof, aſſerts, that all the parts both internal and external were found perfectly conformable to thoſe of men. See the *Hiſt. de la compagnie de Jeſus*, P. II. T. iv. Nº 276. where the relation is given at length.

We have another account of a merman, ſeen near the great rock called *Diamond*, on the coaſt of Martinico. The perſons who ſaw it, gave in a preciſe deſcription of it before a notary. They affirmed that they ſaw it wipe its hand over its face, and even heard it blow its noſe.

Another creature of the ſame ſpecies was caught in the Baltic in the year 1531, and ſent as a preſent to Sigiſmund king of Poland, with whom it lived three days, and was ſeen by all the court. Another very young one was taken near Rocca de Sintra, as related by Damian Goes. The king of Portugal and the grand maſter of the order of St James, are ſaid to have had a ſuit at law to determine which party theſe monſters belong to.

In Pontopidan's Natural Hiſtory of Norway, alſo, we have accounts of mermaids; but not more remarkable or any way better atteſted than the above, to which we have given a place, merely to ſhew how far the folly and extravagance of credulity have been carried by weak minds.

MERNS, Mearns, or Kincardineshire, a county of Scotland. See Kincardineshire.

MERODACH was an ancient king of Babylon, who was placed among the gods, and worſhipped by the Babylonians. Jeremiah (chap. l. 2.), ſpeaking of the ruin of Babylon, ſays, "Babylon is taken, Bel is confounded, Merodach is broken in pieces; her idols are confounded, her images are broken in pieces." We find certain kings of Babylon, in whoſe names that of Merodach is contained: for example, Evil-merodach and Merodach baladan. Evil-merodach was the ſon of Nebuchadnezzar the Great, and had for his ſucceſſor the wicked Belſhazzar. Merodach-baladan, ſon of Baladan king of Babylon, having heard that Hezekiah had been cured miraculouſly (Iſa. xxxix.), and that the ſun had gone backwards to give him an aſſurance of his recovery, ſent him preſents, and made him compliments upon the recovery of his health. Ptolemy calls him *Mardoc-empadus;* and ſays, that he began to reign at Babylon 26 years after the beginning of the era of Nabonaſſar, that is, in the year of the world 2283.

MEROE, in *Ancient Geography*, an iſland of Ethiopia beyond Egypt, in the Nile; with a cognominal town, the metropolis of the Ethiopians.

The Jeſuits have endeavoured to prove, that the province of Gojam in Abyſſinia is the Meroë of the ancients; but this is ſtrongly conteſted by Mr Bruce, who is of opinion, that it muſt be looked for ſomewhere between the ſource of the Nile and its union with the Atbara. The latter, he thinks, is very plainly the Aſtaboras of the ancients; and Pliny ſays, that this ſtream encloſes the left ſide of Meroë as the Nile does the right, in which caſe we muſt ſuppoſe him looking ſouthward from Alexandria, otherwiſe the words would not apply.

We are told by Diodorus Siculus, that Meroë had its name from a ſiſter of Cambyſes king of Perſia, who died there in the expedition undertaken by that prince againſt the Ethiopians. His army periſhed with hunger and thirſt in the deſerts beyond Meroë, which could not have happened if they had reached Gojam, the latter being one of the moſt plentiful countries in the world. A further proof that Gojam cannot be the ancient Meroë is, that the latter was encloſed between the rivers Nile and Aſtaboras, while Gojam is almoſt entirely ſurrounded by the Nile. If the ancients were acquainted with Gojam, they muſt alſo have been acquainted with the fountains of the Nile, which we certainly know they were not. Pliny ſays that Meroë, the moſt conſiderable of all the iſlands of the Nile, was called *Aſtaboras*, from the name of its left channel, which cannot be ſuppoſed any other than the junction of the Nile and Atbara. He informs us moreover, that the ſun was vertical twice in the year, viz. when proceeding northward he entered the 18th degree of Taurus, and when returning he came to the 14th degree of Leo; but this could never be the caſe with Gojam, which lies in about 10 degrees north latitude.

Again, the poet Lucan deſcribes Meroë by two circumſtances which cannot apply to any other than the peninſula of Atbara. One is, that the inhabitants were black; which was the caſe with the Gymnoſophiſts and firſt inhabitants, and which has been the caſe with all the reſt down to the Saracen conqueſt: but the inhabitants of Gojam, as well as the other Abyſſinians, are fair, at leaſt greatly different in complexion from the blacks; they are alſo long haired, and nobody imagined that they ever had philoſophers or ſcience among them, which was eminently the caſe with the ancient inhabitants of Meroë. The other circumſtance is, that the ebony tree grew in the iſland of Meroë, which at this day grows plentifully in the peninſula of Atbara, and part of the province of Kuara, but not in Gojam, where the tree could not ſubſiſt on account of the violent rains which take place during ſix months of the year. Mr Bruce mentions another circumſtance quoted from the poet Lucan, which likewiſe tends to prove the identity of Meroë and Atbara; viz. that though there are many trees in it, they afford no ſhade. This our traveller found by experience, when returning from Abyſſinia through Atbara. "The country (ſays he) is flat, and has very little water. The foreſts, though thick, afforded no ſort of ſhade, the hunters for the ſake of their ſport, and the Arabs for deſtroying the flies, having ſet fire to all the dry graſs and ſhrubs; which paſſing with great rapidity in the direction of the wind from eaſt to weſt, though it had not time to deſtroy the trees, did yet wither, and occaſion every leaf that was upon them to fall, unleſs in thoſe ſpaces where villages had been, and where water was. In ſuch ſpots a number of large ſpreading trees remained full of foliage; which, from their great height and being cleared of underwood, continued in full verdure, loaded with large, projecting, and exuberant branches. But even here the pleaſure that their ſhade afforded was very temporary, ſo as to allow us no time for enjoyment. The ſun, ſo near the zenith, changed his azimuth ſo rapidly, that every few minutes I was obliged to change the carpet on which I lay, round the trunk of the tree to which I had fled for ſhelter; and though I lay down to ſleep perfectly ſcreened by the trunk or branches, I was preſently awakened by the violent rays of a ſcorching ſun, the ſhade having paſſed beyond me. In all other places, though we had travelled conſtantly in a foreſt, we never met with a tree that could ſhade us for a moment, the fire having deprived them of all their leaves." The heat of Atbara is exceſſive, the thermometer having been obſerved at 119½°: two of Mr Bruce's company died of thirſt, or at leaſt of the conſequences of drinking after extreme thirſt. The inhabitants live in the greateſt miſery, and are continually in danger from the neighbouring Arabs, who, by deſtroying and burning their corn, are able to reduce them to a ſtarving condition. Notwithſtanding all their diſadvantages, however, they have a manufacture of coarſe cotton towels, of a ſize juſt ſufficient to go round the waiſt, which paſs current as money throughout the whole country.

MEROM, in *Ancient Geography*. The waters of Merom, at which place Jabin and the other confederate kings met to fight Joſhua (xi. 5.), are generally ſuppoſed by the learned to be the lake Semechon, which lies between the head of the river Jordan and the lake Genneſareth; ſince it is agreed on all hands, that the city Hazor, where Jabin reigned, was ſituated upon this lake. But others think, that the waters of Merom or Merome were ſomewhere about the brook Kiſhon, ſince there is a place of that name mentioned in the account of the battle againſt Siſera (Judg. v. 21.) And it is more rational to think, that the confederate kings advanced as far as the brook Kiſhon, and to a paſs which led into the country, to hinder Joſhua from penetrating it, or even to attack him in the country where he himſelf lay encamped, than to imagine that they waited for him in the midſt of their own country; leaving all Galilee at his mercy, and the whole tract from the brook Kiſhon to the lake Semechon.

MEROPE, in *Fabulous Hiſtory*, one of the Atlantides. She married Siſyphus the ſon of Æolus, and like her ſiſters was changed into a conſtellation after death. It is ſaid that in the conſtellation of the Pleiades the ſtar of Merope appears more dim and obſcure than the reſt, becauſe ſhe, as the poets obſerve, married a mortal, while her ſiſters married ſome of the gods or their deſcendants.

MEROPS, in *Fabulous Hiſtory*, a king of the iſland of Cos, who married Clymene, one of the Oceanides. He was changed into an eagle, and placed among the conſtellations. Alſo a celebrated ſoothſayer of Percoſus in Troas, who foretold the death of his ſons Adraſtus and Amphius, who were engaged in the Trojan war. They ſlighted their father's advice, and were killed by Diomedes.

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

MEROVINGIAN CHARACTER, derives its name from Meroüée, the firſt king of France of that race, which reigned 333 years, from Pharamond to Charles Martel. This race is ſaid by ſome to have terminated in Childeric III. A. D. 751. There are many MSS. in the French libraries ſtill extant in this character.

MEROZ, in *Ancient Geography*, a place in the neighbourhood of the brook Kiſhon, whoſe inhabitants refuſing to come to the aſſiſtance of their brethren when they fought with Siſera, were put under an anathema (Judges v. 23.) "Curſe ye Meroz, ſays the angel of the Lord; curſe ye bitterly the inhabitants thereof: becauſe," &c. Some have thought that Meroz is the ſame as Merus or Merom; and this F. Calmet thinks the moſt probable opinion in this matter. Others will have it, that Meroz was a mighty man, who dwelt near the Kiſhon, and not caring to come to the aſſiſtance of Barak and Deborah, was excommunicated by the angel of the Lord by the ſound of 400 trumpets. The angel of the Lord, according to ſome, was Barak, the general of the Lord's army; but according to others he was the high prieſt for the time being, or a prophet.

MERSA, a town of Barbary, pleaſantly ſituated about 11 miles from the city of Tunis, and two from Melcha the ſite of ancient Carthage. The bey has here two country houſes, one of them very coſtly work, built by Haſſan Bey ſurnamed the *Good*. From theſe are orange gardens reaching almoſt to the ſeaſhore; on the edge of which is a famous well of ſweet water, eſteemed the beſt and lighteſt in the kingdom. Cloſe to this is a coffeehouſe, whither numbers of people from the neighbouring places reſort to drink coffee, and a glaſs of this natural luxury ſo peculiarly enjoyed in the eaſtern countries. In the middle of the court is a large mulberry tree, under the ſhade of which they ſit and ſmoke and play at cheſs; inhaling the comfortable ſea breeze that refreſhes this delightful ſpot. The water is drawn up by a camel with the Perſian wheel.

There are the remains of an ancient port, or cothon, (ſuppoſed to be an artificial one), built by the Carthaginians after Scipio had blocked up the old port, nothing but the turret or lighthouſe being left.

MERS or MERSE, a county of Scotland, called alſo *Berwickſhire*. This laſt name it derives from the town of Berwick, which was the head of the ſhire before it fell into the hands of the Engliſh, and obtained the appellation of *Mers* or *March*, becauſe it was one of the borders towards England. See BERWICK, *County of*.

MERSENNE, MARIN, in Latin *Merſennus*, a learned French author, born at Oyſé, in the province of Maine, anno 1588. He ſtudied at La Fleche at the ſame time with Des Cartes; with whom he contracted a ſtrict friendſhip, which laſted till death. He afterwards went to Paris, and ſtudied at the Sorbonne; and in 1611 entered himſelf among the Minims. He became well ſkilled in Hebrew, philoſophy, and mathematics. He was of a tranquil, ſincere, and engaging temper; and was univerſally eſteemed by perſons illuſtrious for their birth, their dignity, and their learning. He taught philoſophy and divinity in the convent of Nevers, and at length became ſuperior of the convent; but being willing to apply himſelf to ſtudy with more freedom, he reſigned all the poſts he enjoyed in his order, and travelled into Germany, Italy, and the Netherlands. He wrote a great number of excellent works; the principal of which are, 1. *Quæſtiones celeberrimæ in Geneſim.* 2. *Harmonicorum libri.* 3. *De ſonorum natura, cauſis, et effectibus.* 4. *Cogitata phyſico-mathematica.* 5. *La verité des Sciences.* 6. *Les queſtions inouies.* He died at Paris in 1648. He had the reputation of being one of the beſt men of his age. No perſon was more curious in penetrating into the ſecrets of nature, and carrying all the arts and ſciences to their utmoſt perfection. He was in a manner the centre of all the men of learning, by the mutual correſpondence which he managed between them. He omitted no means to engage them to publiſh their works; and the world is obliged to him for ſeveral excellent diſcoveries, which, had it not been for him, would perhaps have been loſt.

MERSY, a river of England, which runs through the counties of Lancaſter, York, and Cheſter, and empties itſelf into the Iriſh ſea at Liverpool. By means of inland navigation, it has communication with the rivers Dee, Ribble, Ouſe, Trent, Darwent, Severn, Humber Thames, Avon, &c.; which navigation, including its windings, extends above 500 miles, in the counties of Lincoln, Nottingham, York, Lancaſter, Weſtmorland Cheſter, Stafford, Warwick, Leiceſter, Oxford, Worceſter, &c.

MERSEY *Iſland*, an iſland of Eſſex, at the mouth of the Coln, ſouth of Colcheſter. It was ſeized by the Danes in the reign of King Alfred, for their winter quarters. It had eight pariſhes, now reduced to two, viz. Eaſt and Weſt Merſey. There was formerly a blockhouſe on the iſland.

MERULA, or *Blackbird*. See TURDUS, ORNITHOLOGY *Index*.

MERUS, in *Ancient Geography*, a mountain of the Hither India, hanging over the city Nyſſa, built by Bacchus, and ſituated between the rivers Cophen and Indus. The name, denoting the *thigh*, gave riſe to the fable of Bacchus being inſerted into Jupiter's thigh, and being born twice; becauſe in this mountain he and his army are ſaid to have been preſerved, when diſeaſe and peſtilence raged in the plains below.

MESARAIC VESSELS, in the general ſenſe, are the ſame with MESENTERIC.

In common uſe, meſaraic is more frequently applied to the veins, and meſenteric to the arteries, of the meſentery. See ANATOMY.

MESCHED, a conſiderable town of Perſia, and in the province of Choraſſan; fortified with ſeveral towers, and famous for the magnificent ſepulchre of Iman Riſa, of the family of Ali, to whom the Perſians pay great devotion. It is ſeated on a mountain near this town, in which are fine turquoiſe ſtones; in E. Long. 59. 25. N. Lat. 37. 0.

MESEMBRYANTHEMUM, FIG-MARIGOLD, a genus of plants, belonging to the icoſandria claſs; and in the natural method ranking under the 13th order, *Succulentæ*. See BOTANY *Index*.

MESENTERIC, or MESARAIC, an epithet given to two arteries ariſing from the deſcending aorta, and proceeding to the meſentery. See MESENTERY.

MESENTERITIS, or *Inflammation of the* MESENTERY. See MEDICINE *Index*.

MESENTERY, MESENTERIUM, (formed of *μεσος*, *middle*, and *εντερον*, *inteſtine*), in anatomy, a fatty membranous body, thus called as being placed in the middle of the inteſtines, which it connects to one another. See ANATOMY, N° 94.

MESHES *of* NETS, the openings or interſtices between the threads.

MESN, or MESNE, a term in law, ſignifying him who is lord of a manor, and ſo hath tenants holding of him; yet he himſelf holds of a ſuperior lord.

The word is properly derived from *maiſne*, *quaſi minor nátu*; becauſe his tenure is derived from another, from whom he holds.

MESN alſo denotes a writ, which lieth where there is lord meſn and tenant; and the tenant is diſtrained for ſervices due from the meſn to the ſuperior lord.

This is in the nature of a writ of right; and in this caſe the tenant ſhall have judgement to be acquitted or indemnified by the meſne lord; and if he makes default therein, or does not appear originally to the tenant's writ, he ſhall be forejudged of his meſnalty, and the tenant ſhall hold immediately of the lord paramount himſelf.

MESOCHRI, were muſicians among the ancients, who preſided in concerts, and by beating a wooden deſk regularly with their feet, directed the meaſure of the muſic. For the purpoſe of beating time, they wore wooden clogs, called by the ancients *crupezia*, which occaſioned the ſound to be better heard.

MESOCOLON, in *Anatomy*, that part of the meſentery, which, having reached the extremity of the ileum, contracts and changes its name. See ANATOMY, N° 94.

MESOLOGARITHMS, according to Kepler, are the logarithms of the co-ſines and co-tangents; the former of which were called by Baron Napier *anti-logarithms*, and the latter *differentials*.

MESOPOTAMIA, the ancient name of the province of DIARBECK, in Turkey in Aſia. It is ſituated between the rivers Euphrates and Tigris; having Aſſyria on the eaſt, Armenia on the north, Syria on the weſt, and Arabia Deſerta with Babylonia on the ſouth. The Hebrews called it *Padan-aram*, (Gen. xxviii. 2. &c.), and *Aram Naharaim* (title of Pſal. lx.) or Aram *of the two rivers*, becauſe it was firſt peopled by Aram father of the Syrians, and is ſituated between the two rivers already mentioned. This country is much celebrated in Scripture, as being the firſt dwelling of men both before and after the deluge; and becauſe it gave birth to Phaleg, Heber, Terah, Abraham, Nahor, Sarah, Rebekah, Rachel, Leah, and to the ſons of Jacob. Babylon was in the ancient Meſopotamia, till, by vaſt labour and induſtry, the two rivers of the Tigris and Euphrates were united into one channel. The plains of Shinar were in the ſame country. Often they gave it the name of Meſopotamia (Deut. xxiii. 4. &c.) and ſometimes that of Syria, (Hoſea xii. 12.). Balaam ſon of Beor was of Meſopotamia, Deut. xxiii. 4. Chuſhan-riſhathaim king of Meſopotamia kept the Hebrews in ſubjection ſome time after the death of Joſhua, Judg. iii. 8.

MESOPTERYGIUS, a term applied to ſuch fiſhes as have only one back-fin, which is ſituated in the middle of the back.

MESPILUS, the MEDLAR, a genus of plants belonging to the icoſandria claſs; and in the natural method ranking under the 36th order, *Pomaceæ*. See BOTANY *Index*.

MESS, in a military ſenſe, implies a number of ſoldiers, who, by laying away a certain proportion of their pay towards proviſions, meſs together: ſix or eight is generally the number of each meſs. Experience proves, that nothing contributes more to the health of a ſoldier, than a regular and well choſen diet, and his being obliged every day to boil the pot: it corrects drunkenneſs, and in a great meaſure prevents gaming, and thereby deſertion.

MESSALINA, VALERIA, a daughter of Meſſala Barbatus. She married the emperor Claudius, and diſgraced herſelf by her cruelties and incontinence. Her huſband's palace was not the only ſeat of her laſciviouſneſs, but ſhe proſtituted herſelf in the public ſtreets, and few men there were at Rome who could not boaſt of having enjoyed the favours of the impure Meſſalina. Her extravagances at laſt irritated her huſband, who commanded her to appear and anſwer all the accuſations which were brought againſt her: upon which ſhe attempted to deſtroy herſelf; and when her courage failed, one of the tribunes who had been ſent to her deſpatched her with his ſword. It is in ſpeaking of her debaucheries and lewdneſs that Juvenal ſays,

> *Et laſſata viris, necdum ſatiata, receſſit.*

Her name has become a common appellation to denote a woman of ſhameleſs and inordinate luſt.

MESSANA, in *Ancient Geography*, the firſt town of Sicily on croſſing over from Italy, ſituated on the ſtrait now called the *Faro*, (Italicus). Anciently called *Zancle*, according to Diodorus Siculus, from King Zanclus; or, according to others, from the Sicilian term *Zanclon*, denoting a ſickle, alluding to the curvity of the coaſt; a name appropriated by the poets; and hence *Zanclæi*, the people, (Herodotus, Pauſanias).

The other name *Meſſana* is from the *Meſſenii* of Peloponneſus, (Strabo). Thucydides aſcribes its origin to Anaxilas the Meſſenian, tyrant of Rhegium, who received all comers, calling the town after the name of his country. The Greeks always call it *Meſſene;* the Romans *Meſſena* conſtantly, to diſtinguiſh it from *Meſſene* of Peloponneſus. Now Messina, lately ruined by earthquakes.

MESSENA, or Messene, an inland town, and the capital of Meſſenia, a country of Peloponneſus; erroneouſly replaced by Ptolemy on the coaſt. It was built by Epaminondas, who called all the Meſſenian exiles, and gave the town the name of *Meſſene.* A place vying in point of ſtrength and ſituation with Corinth, according to Strabo; and therefore Demetrius Phalereus adviſed Philip, father of Perſeus, that if he wanted to have Peloponneſus in his power, he ſhould make himſelf maſter of theſe two towns, as thus he would have the ox by both horns.

MESSENGERS, are certain officers chiefly employed under the direction of the ſecretaries of ſtate, and always in readineſs to be ſent with all kinds of deſpatches foreign and domeſtic. By virtue of the ſecretaries warrants, they alſo take up perſons for high treaſon, or other offences againſt the ſtate. The priſoners they apprehend are uſually kept at their own houſes, for each of which they are allowed 6s. 8d. per day by the government: and when they are ſent abroad, they have a ſtated allowance for their journey, viz. 30l. for going to Paris, Edinburgh, or Dublin; 25l. for going to Holland; and to other places in the ſame proportion; part of which money is advanced for the expence of their journey. Their ſtanding ſalary is 45l. per annum; and their poſts, if purchaſed, are eſteemed worth 300l. But theſe ſums have now probably been increaſed. The meſſengers wait 20 at a time, monthly, and are diſtributed as follows, viz. four at court, five at one ſecretary's office, five at another, two at the third for North Britain, three at the council office, and one at the lord chamberlain's of the houſehold.

Messengers, in Scotland. See Law, Part III.

Messengers of the Exchequer, are four officers who attend the exchequer, in the nature of purſuivants, and carry the lord treaſurer's letters, precepts, &c.

Messenger of the Preſs, a perſon who, by order of the court, ſearches printing-houſes, bookſellers ſhops, &c. in order to diſcover the printers or publiſhers of ſeditious books, pamphlets, &c.

MESSENIA, a country in the ſouth of Peloponneſus, moſtly maritime, ſituated between Elea to the weſt, and Laconia to the eaſt. Anciently a part of Laconia under Menelaus, and called *Meſſene* by Homer; interpreted by the ſcholiaſt, *Meſſenæa Regia. Meſſenii*, the people, reduced to a ſtate of ſlavery and ſubjection by the Spartans; *Meſſenius*, the epithet.

This country is famous in hiſtory, on account of the reſiſtance made by the Meſſenians againſt the Spartans, and the exploits of their hero Ariſtomenes. The firſt hoſtilities commenced about the year 652 B. C. on what occaſion is uncertain. Though the Meſſenians were inferior in the knowledge of the art of war to the Spartans; yet, by keeping for ſome time on the defenſive, they improved ſo much, that in three years time they found themſelves in a capacity of giving battle to their enemies in the open field; nor did they appear to be in any degree inferior either in courage or conduct: the war was therefore protracted, with various ſucceſs, on both ſides. At laſt, both conſulted the oracle at Delphi; and received for anſwer, "that whoever ſhould firſt dedicate 100 tripods in the temple of Jupiter at Ithome, a ſtrong hold of the Meſſenians, ſhould be maſters of the country." The inhabitants of Meſſenia, on hearing this, having no money to make the tripods of braſs, fell to cutting them out in wood; but before this could be accompliſhed, a Spartan having got into the city by ſtratagem, dedicated 100 little tripods of clay: which threw the Meſſenians into ſuch deſpair, that they at laſt ſubmitted to the Spartans.

The new ſubjects of Sparta were treated with the utmoſt barbarity by theſe cruel tyrants; ſo that a new war commenced under Ariſtomenes, a man of unconquerable valour, and enthuſiaſtically fond of liberty. He perceived that the Argives and Arcadians, who were called the *allies* of the Lacedæmonians, adhered to them only through fear of their power; but that in reality they hated them, and wiſhed to revenge the injuries they had done them. To theſe Ariſtomenes applied; and receiving an anſwer conformable to his wiſhes, he engaged his countrymen unanimouſly to take up arms. About a year after the revolt began, and before either party had received any auxiliaries, the Spartans and Meſſenians met at a village called *Deræ*, where an obſtinate engagement enſued. Ariſtomenes was conceived to have performed more than mortal achievements: in gratitude therefore, reſpect being alſo had to his royal deſcent, his countrymen unanimouſly ſaluted him *king;* which title be modeſtly waved, alleging, that he took up arms to ſet them free, and not to make himſelf great: he conſented, however, to accept the title of *general*, with a power of doing whatſoever he thought requiſite for the ſervice of the public. Knowing well the ſuperſtition of the age in which he lived, he reſolved to intimidate the Spartans, by ſhowing them what he was ſure they would take for an ill omen. Diſguiſing himſelf therefore, he went privately to the city, where, in the night, he hung up a ſhield on the wall of the temple of Minerva, with this inſcription: *Ariſtomenes dedicates this, out of the ſpoils of the Spartans, to the goddeſs.* It was eaſily perceived that this war would be both long and bloody; the Lacedæmonians therefore ſent deputies to Delphi, to inquire of the oracle concerning its event: the anſwer they received was, *That it behoved the Spartans to ſeek a leader from Athens.* The Athenians naturally envious of the Spartans, granted their requeſt indeed, but in ſuch a manner as manifeſted their ſpite; for they ſent them for a general Tyrtæus, a ſchoolmaſter and poet, lame of one foot, and who was ſuſpected to be a little out of his wits. But here their ſkill failed them; for this captain, notwithſtanding his deſpicable appearance, proved of great conſequence to Sparta, teaching them how to uſe good, and how to bear up under ill fortune.

In the mean time, Ariſtomenes had drawn together a mighty army, the Eleans, Argives, Sicyonians, and Arcadians, having ſent troops to his aſſiſtance; the Spartans in this, as in the former war, having no ally but Corinth. The Spartan kings, according to the

cuſtom

Meſſenia.

cuſtom of their city, no ſooner took the field, than, notwithſtanding their inferiority in number, they offered the enemy battle, which Ariſtomenes readily accepted. It was long, obſtinate, and bloody; but in the end the Meſſenians were victorious, and the Lacedæmonians put to flight with a great ſlaughter. It is ſcarce to be conceived how much the Spartans were ſtruck with this defeat: they grew weary of the war, diſſatisfied with their kings, diffident of their own power, and in a word ſunk into a ſtate of general uneaſineſs and want of ſpirit. It was now that the Athenian general convinced them, that he was capable of fulfilling all the promiſes of the oracle; he encouraged them by his poems, directed them by his counſels, and recruited their broken armies with choſen men from among the Helotes. Ariſtomenes, on the other hand, acted with no leſs prudence and vigour. He thought it not enough to reſtore the reputation of the Meſſenians, if he did not alſo reſtore their wealth and power: he therefore taught them to act offenſively againſt their enemies; and, entering the territories of Sparta, he took and plundered Pharæ, a conſiderable borough in Laconia, putting all ſuch as made any reſiſtance to the ſword, carrying off at the ſame time an immenſe booty. This, however, was an injury which the Spartans could not brook with patience; they therefore ſent immediately a body of forces to overtake the Meſſenians, which accordingly they did: but Ariſtomenes routed theſe purſuers, and continued to make a mighty ſlaughter of them, till ſuch time as he was diſabled by having a ſpear thruſt in his ſide, which occaſioned his being carried out of the battle. His cure, which took up ſome time, being finiſhed, he reſolved to carry the war even to the gates of Sparta; and to that purpoſe raiſed a very great army: but, whether he found his deſign impracticable, or was really diverted by ſome dream, he gave out, that Caſtor and Pollux, with their ſiſter Helena, had appeared to him, and commanded him to deſiſt. A ſhort time after this retreat, going with a ſmall party to make an incurſion, and attempting to take priſoners ſome women who were celebrating religious rites near Egila, a village in Laconia, thoſe zealous matrons fell upon him and his ſoldiers with ſuch fury, that they put them to flight, and took him priſoner: however, he ſoon afterwards made his eſcape, and rejoined his forces. In the third year of the war, the Spartans with a great force entered Meſſenia, whither Ariſtocrates king of Arcadia was come, with a great body of troops, to the aſſiſtance of his allies: Ariſtomenes therefore made no difficulty of fighting when the Spartans approached; but they entering privately into a negociation with Ariſtocrates, engaged him with bribes and promiſes to betray his confederates. When the battle began, the deceitful Arcadian repreſented to the forces under his command the mighty danger they were in, and the great difficulty there would be of retreating into their own country, in caſe the battle ſhould be loſt: he then pretended, that the ſacrifices were ominous; and, having terrified his Arcadians into the diſpoſition of mind fitteſt to ſerve his purpoſe, he not only drew them off from both wings, but, in his flight, forced through the Meſſenian ranks, and put them too in confuſion. Ariſtomenes and his troops, however, drew themſelves into cloſe order, that they might defend themſelves the beſt they could: and indeed they had need of all their valour and ſkill; for the Lacedæmonians, who expected this event, immediately attacked and ſurrounded them on all ſides. Fortune was, on this occaſion, too powerful either for the courage or the conduct of the Meſſenians; ſo that, notwithſtanding their utmoſt efforts, moſt of their army were cut to pieces, and amongſt them the chief of their nobility. Ariſtomenes, with the poor remains of his ſhattered forces, retired as well as he could; and, perceiving that it was now impoſſible to maintain the war againſt the Lacedæmonians upon equal terms, he exhorted his countrymen to fortify Mount Era, and to make the beſt diſpoſitions poſſible for a long defence. He likewiſe placed garriſons in Pylus and Methone on the ſea coaſts; and to theſe three places he gathered all the inhabitants, leaving the reſt of Meſſenia to the mercy of the Spartans. They, on the other hand, looked on the war as now in a manner finiſhed; for which reaſon they divided the lands among their citizens, and cauſed them to be carefully cultivated, while they beſieged Era. But Ariſtomenes quickly convinced them that the war was far from being over: he choſe out of all the Meſſenians 300 men, with whom he ravaged all the adjacent country: carried off a prodigious booty; and, when Meſſenia could no longer ſupply the wants of his garriſon, penetrated into Laconia, and bore away corn, wine, cattle, and whatever elſe was neceſſary to the ſubſiſtence of his countrymen ſhut up in Era: ſo that at laſt the Spartans were conſtrained to iſſue a proclamation, forbidding the cultivation, not only of the Meſſenian territory in their hands, but alſo of Laconia in its vicinity; whereby they diſtreſſed themſelves more than their enemies, inducing at laſt a famine in Sparta itſelf, which brought with it its uſual attendant, ſedition. Here again all things had gone wrong, if the wiſdom of the poet Tyrtæus had not ſupported the Spartan courage; nor was it without much difficulty that he influenced them to continue the blockade of Era, and to maintain a flying camp for the ſecurity of the country.

Ariſtomenes, in ſpite of all theſe precautions, committed terrible depredations with his ſmall corps of 300 men. Amongſt other places which he plundered, the city of Amyclæ was one; from whence he carried not only a great quantity of riches, but alſo many carriages laden with proviſions. The kings of Sparta lying with their troops in its neighbourhood, as ſoon as they heard of this expedition, marched after Ariſtomenes with the utmoſt diligence; and, as the Meſſenians were encumbered with their booty, came up with them before they could reach Era. In this ſituation of things, Ariſtomenes, prompted rather by deſpair than prudence, diſpoſed his troops in order of battle; and, notwithſtanding they were ſo few, made a long and vigorous reſiſtance againſt the whole Lacedæmonian army. At length, however, numbers prevailed: the greateſt part of the Meſſenians were ſlain on the ſpot; and Ariſtomenes, with about 50 of his men who ſurvived the ſlaughter, were taken priſoners; that chief having received ſo many wounds, that he was ſenſeleſs when they carried him away. The Lacedæmonians expreſſed the loudeſt joy at the ſight of this illuſtrious captive; who for ſo many years, by his ſingle abilities, had enabled his exhauſted country to defend itſelf againſt the whole force of Sparta. When he was recovered of his wounds, they decreed him and all his fellow priſoners to be thrown together into a deep cavern, which was the common puniſhment of the loweſt kind of offenders. This judgement was executed with the utmoſt ſeverity, excepting that Ariſtomenes had leave to put on his armour. Three days he continued in this diſmal place, lying upon and covered over with dead bodies. The third day, he was almoſt famiſhed through want of food, and almoſt poiſoned with the ſtench of corrupted carcaſes, when he heard a fox gnawing a body near him. Upon this he uncovered his face, and perceiving the fox juſt by him, he with one hand ſeized one of its hind legs, and with the other defended his face, by catching hold of its jaw when it attempted to bite him. Following as well as he could his ſtruggling guide, the fox at laſt thruſt his head into a little hole; and Ariſtomenes then letting go his leg, he ſoon forced his way through, and opened a paſſage to the welcome rays of light, from which the noble Meſſenian had been ſo long debarred. Feeble as he was, Ariſtomenes wrought himſelf an outlet with his nails; and travelling by night with all the expedition he could, at length arrived ſafe at Era, to the great joy and amazement of his countrymen. When this news was firſt blazed abroad, the Spartans would have had it paſs for a fiction; but Ariſtomenes ſoon put the truth of it out of doubt, by falling on the poſts of the Corinthians, who, as allies of the Spartans, had a conſiderable body of troops before Era. Moſt of their officers, with a multitude of private men, he ſlew; pillaged their camp; and, in ſhort, did ſo much miſchief, that the Spartans, under the pretence of an approaching feſtival, agreed to a ceſſation of arms for 40 days, that they might have time to bury their dead. On this occaſion, Ariſtomenes for the ſecond time celebrated the *hecatomphonia*, or the ſacrifice appointed for thoſe who had killed 100 of the enemy with their own hands. He had performed the ſame before and after his ſecond battle; and he lived to do it a third time: which muſt appear wonderful to the reader, when he is informed, that, notwithſtanding this truce, certain Cretan archers in the ſervice of the Spartans ſeized Ariſtomenes as he was walking without the walls, and carried him away a priſoner. There were nine of them in all; two of them immediately flew with the news to Sparta, and ſeven remained to guard their prize, whom they bound, and conducted to a lone cottage inhabited only by a widow and her daughter. It ſo fell out, that the young woman dreamt the night before, that ſhe ſaw a lion without claws, bound, and dragged along by wolves; and that ſhe having looſed his bonds, and given him claws, he immediately tore the wolves to pieces. As ſoon as Ariſtomenes came into the cottage, and her mother, who knew him, had told her who he was, ſhe inſtantly concluded that her dream was fulfilled; and therefore plied the Cretans with drink, and, when they were aſleep, took a poniard from one of them, cut the thongs with which Ariſtomenes was bound, and then put it into his hands. He preſently verified her viſion, by putting all his guards to death; and then carried her and her mother to Era, where, as a reward for her ſervice, he married the young woman to his ſon Gorgus, then about 18 years of age.

When Era had held out near eleven years, it fell into the hands of Sparta by an accident: the ſervant of one Empiramus, a Spartan commander, driving his maſter's cattle to drink at the river Neda, met frequently with the wife of a Meſſenian, whom he engaged in an amour. This woman gave him notice, that her huſband's houſe was without the wall; ſo that he could come to it without danger, when the good man was abroad; and ſhe likewiſe gave him intelligence when her huſband was upon duty in the garriſon. The Spartan failed not to come at the time appointed; but they had not been long in bed before the huſband returned, which put the houſe into great confuſion: the woman, however, ſecured her gallant; and then let in her huſband, whom ſhe received in appearance with great joy, inquiring again and again by what exceſs of good fortune ſhe was bleſſed with his return. The innocent Meſſenian told her, that Ariſtomenes being detained in his bed by a wound, the ſoldiers knowing that he could not walk the rounds, had a grant to retire to their houſes, to avoid the inclemency of the ſeaſon. The Spartan no ſooner heard this, than he crept ſoftly out of doors, and haſtened away to carry the news to his maſter. It ſo happened, that the kings were at this time abſent from the camp, and Empiramus had the chief command of the army. As ſoon as he received this information, he ordered his army to begin its march, though it rained exceſſively, and there was no moon light. The fellow guided them to the ford, and managed matters ſo well that they ſeized all the Meſſenian poſts: yet, after all, they were afraid to engage; darkneſs, and high wind, heavy rain, together with the dread of Ariſtomenes, keeping them quiet in the places they had ſeized. As ſoon as it was light, the attack began; and Era had been quickly taken, if only the men had defended it; but the women fought with ſuch fury, and by their mingling in the fray, brought ſuch an acceſſion of numbers, as made the event doubtful. Three days and two nights this deſperate engagement laſted: at laſt, all hopes of preſerving the city being loſt, Ariſtomenes drew off his wearied troops. Early in the fourth morning, he diſpoſed the women and children in the centre, the Meſſenian youth in the front and rear, the leſs able men in the main body: himſelf commanded the van; the rear-guard was brought up by Gorgus and Manticlus, the former the ſon of Ariſtomenes, the latter of Theocles, a Meſſenian of great merit, who fell with much glory in this attack, fighting valiantly in the cauſe of his country. When all things were ready, Ariſtomenes cauſed the laſt barrier to be thrown open; and, brandiſhing his ſpear, marched directly towards the Spartan troops, in order to force a paſſage. Empiramus, perceiving his intent, ordered his men to open to the right and left, and fairly gave them a paſſage; ſo that Ariſtomenes marched off in triumph, as it were, to Arcadia.

The Arcadians, when they heard that Era was taken, were very deſirous of ſuccouring their old confederates in this deep diſtreſs: they therefore entreated their king Ariſtocrates to lead them into

Meſſenia. But he, corrupted by the Lacedæmonians, perſuaded them that it was too late; that the Meſſenians were all cut off; and that ſuch a ſtep would only expoſe them to the fury of the conquerors. When the thing appeared to be otherwiſe, and it was known that Ariſtomenes was on the frontiers of Arcadia, they went in crowds to carry him proviſions, and to teſtify their readineſs to afford him and thoſe under his command all the aſſiſtance in their power. Ariſtomenes deſired to be heard before a general aſſembly; which being accordingly convoked, he there opened one of the boldeſt and beſt laid ſchemes recorded in hiſtory: he ſaid, that he had yet 500 undaunted ſoldiers, who, at his command, would undertake any thing; that it was very probable moſt of the Spartans were employed in pillaging Era, and that therefore he determined to march and ſurpriſe Sparta; which appeared ſo ſenſible, that all the aſſembly loudly commended his great capacity and unſhaken courage. Ariſtocrates, however, took care to betray him; having, by various pretences, retarded the execution of the project. The Arcadians, who began to ſuſpect him, waited for and ſurpriſed the meſſengers as they came back. They took the letters from them, and read them openly in the aſſembly. The purport of them was, that they acknowledged his great kindneſs both now and in the battle; and promiſed, that the Lacedemonians would be grateful. As ſoon as the letters were read, the Arcadians fell to ſtoning their king, frequently calling upon the Meſſenians to aſſiſt them; which, however, they did not, waiting for Ariſtomenes's orders; who, far from triumphing in this ſpectacle, ſtood ſtill, with his eyes fixed on the ground, which he wet with his tears, his ſoul pierced with ſorrow to ſee a crowned head ſo ſhamefully and ſo deſervedly put to death. The Arcadians afterwards erected a monument over him, with an inſcription to perpetuate his infamy. As for the Meſſenians under the command of Gorgus and Manticlus, they paſſed over into Sicily; where they founded the city of Meſſene, one of the moſt famous in the iſland. Ariſtomenes remained, however, in Greece; where he married all his daughters, except the youngeſt, to perſons of great rank. A prince of Rhodes, inquiring of the oracle at Delphi whom he ſhould eſpouſe, that his ſubjects might be happy under his poſterity, was directed to marry the daughter of the moſt worthy of the Greeks; which anſwer was immediately underſtood to point at the virgin daughter of Ariſtomenes. Her therefore he demanded, and received; Ariſtomenes accompanying him back to his dominions, where he formed a ſcheme of uniting the Lydians and Medes againſt the Spartans, reſolving with this view to go into Media, and to the court of Sardis; but while he meditated theſe great things, death ſurpriſed him, and thereby freed Lacedæmon from the moſt formidable enemy ſhe ever had.

MESSIAH, a word ſignifying one *anointed*, or inſtalled into an office by unction. It was uſual among the Jews to anoint kings, high prieſts, and ſometimes prophets, at the deſignation or inſtallment of them, to ſignify emblematically the mental qualifications neceſſary for diſcharging theſe offices. Saul, David, Solomon, and Joaſh, kings of Judah, received the royal unction. Aaron and his ſons received the ſacerdotal, and Eliſhah the diſciple of Elijah received the prophetic unction.—The name MESSIAH, *Anointed* or *Chriſt* (Χριςος), was given to the kings and high-prieſts of the Jews. The patriarchs and prophets are alſo called by the name of *Meſſiahs*, or the *Lord's anointed*. See 1 Sam. xii. 3, 5. 1 Chron. xvi. 22. Pſ. cv. 15.

But this name MESSIAH was principally and by way of eminence given by the Jews to their expected great Deliverer, whoſe coming they ſtill vainly wait; and is a name the Chriſtians apply to *Jesus Chriſt*, in whom the prophecies relating to the Meſſiah were accompliſhed. The ſum of theſe prophecies is, That there ſhould be a glorious perſon named *Meſſiah*, deſcended from Abraham, Iſaac, and Jacob, who ſhould be born at Bethlehem, of a virgin of the family of David, then in its decline, before the Jews ceaſed to be a people, while the ſecond temple was ſtanding, and about 500 years after Ezra's time; who, though appearing in mean circumſtances, ſhould be introduced by a remarkable forerunner, whoſe buſineſs it ſhould be to awaken the attention and expectation of the people. That this illuſtrious perſon called *Meſſiah* ſhould himſelf be eminent for the piety, wiſdom, and benevolence of his character, and the miraculous works he ſhould perform: yet that, notwithſtanding all this, he ſhould be rejected and put to death by the Jews; but ſhould afterwards be raiſed from the dead, and exalted to a glorious throne, on which he ſhould through all generations continue to rule, at the ſame time making interceſſion for ſinners. That great calamities ſhould for the preſent be brought on the Jews for rejecting him: whereas the kingdom of God ſhould by his means be erected among the Gentiles, and diſperſe itſelf even unto the ends of the earth; wherever it came, deſtroying idolatry, and eſtabliſhing true religion and righteouſneſs. In a word, That this glorious perſon ſhould be regarded by all who believed in him as a divine teacher, an atoning ſacrifice, and a royal governor: by means of whom God would make a covenant with his people, very different from that made with Iſrael of old; in conſequence of which they ſhould be reſtored to, and eſtabliſhed in, the divine favour, and fixed in a ſtate of perpetual happineſs. See *Jesus Chriſt*, and CHRISTIANITY.

The Jews, as was already obſerved, ſtill wait for the coming of the *Meſſiah*, being impreſſed with the notion of a temporal *Meſſiah*, who is to be a mighty conqueror, and to ſubdue all the world. Moſt of the modern rabbins, according to Buxtorf, believe that the *Meſſiah* is already come, but that he keeps himſelf concealed, and will not manifeſt himſelf becauſe of the ſins of the Jews. Some of the Jews, however, in order to reconcile thoſe prophecies that ſeem to contradict each other as to the character and condition of the *Meſſiah*, have had recourſe to the hypotheſis of two *Meſſiahs*, who are yet to ſucceed each other; one in a ſtate of humiliation and ſuffering; the other of glory, ſplendor, and power. The firſt, they ſay, is to proceed from the tribe of Ephraim, who is to fight againſt Gog, and to be ſlain by Annillus, Zech. xii. 10. The ſecond is to be of the tribe of Judah, and lineage of David, who is to conquer and kill Annillus, and reſtore the kingdom of Iſrael, reigning over it in the higheſt glory and felicity.

Jeſus Chriſt aſſerts himſelf the *Meſſiah*. In St John iv. 25. the Samaritan woman ſays to Jeſus, *I know that when* Meſſiah *comes, who is called the* Chriſt, *he will tell us all things. Jeſus anſwered her, I that ſpeak to thee am he.*

There are ſeveral impoſtors, who have endeavoured to paſs for *Meſſiahs*, as Chriſt himſelf predicted. J. Lent, a Dutchman, has written a hiſtory *De Pſeudomeſſiis*, "Of Falſe Meſſiahs." The firſt he mentions was one Barcochab, who appeared under the empire of Adrian. The laſt was Rabbi Mordecai, who began to be talked of in 1682. A little before him, viz. in 1666, appeared Sabbethai Sebi, who was taken by the Turks, and turned Mahometan.

MESSINA, an ancient, large, handſome, and ſtrong city of Sicily, and in the Val di-Demona, with a citadel, ſeveral forts, a fine ſpacious harbour, and an archbiſhop's ſee. It is ſeated on the ſea ſide, 110 miles eaſt of Palermo, 260 ſouth by eaſt of Rome, and 180 ſouth-eaſt of Naples. E. Long. 15. 50. N. Lat. 38. 10. The public buildings and the monaſteries were numerous and magnificent, and it contained about 60,000 inhabitants; the harbour is one of the ſafeſt in the Mediterranean, and extremely deep; the viceroy of Sicily reſides here ſix months in the year; and it was a place of great trade in ſilk, oil, fruit, corn, and excellent wine, eſpecially ſince it was declared a free port. This city in the beginning of the year 1783 ſuffered moſt dreadfully by the earthquakes which ſhook great part of Calabria and Sicily to their foundations, overturned many rich and populous towns, and buried thouſands in their ruins: (ſee Calabria, and Earthquake, Geology *Index*).—The following account of Meſſina, as it ſtood before the above period, is extracted from Mr *Swinburne's Travels in Sicily*.

A large chain of mountains preſſes upon the ſhore, and part of the city ſtands upon elevated ground. The mountains are many of them nobly wooded; the hills before them finely chequered with groves and fields. As the town runs in a ſweep along the edge of a declivity, every building of conſequence is ſeen to advantage, while the leſs noble parts are hidden by the Palazzata. This is a regular ornamental range of lofty houſes, with 19 gates, anſwering to as many ſtreets: it follows the ſemicircular bend of the port for one mile and five poles, and would have been the handſomeſt line of buildings in Europe had the deſign been completed; but a conſiderable part of the extent is not finiſhed, except merely in the front wall, and that ſeems to be in a very ruinous condition. Philibert Emmanuel of Savoy, viceroy of Sicily, in 1622, began this princely work. Before it is a broad quay, decorated with ſtatues and fountains; ſhips of any burden can moor cloſe to the parapet in great depth of water. At the weſt extremity is a ſmall fort and a gate; the other end is cloſed by the governor's houſe and the citadel, a modern pentagonal fortreſs, built on the point where the iſthmus or *braccio di San Ranicro* iſſues from the main land. On this ſlip of low ground, which with the Palazzato forms the circular harbour of Meſſina, is placed the lighthouſe (*lazaretto*), and on the point the old caſtle of St Salvatore. The circumference of the port is four miles: it probably owes its formation to an earthquake, which opened an immenſe chaſm, and then filled it with water. Near the lighthouſe is a kind of whirlpool in the ſea, ſhown as the Charybdis of the ancients.

The inner part of Meſſina is dirty, though it contains a conſiderable number of neat churches and large ſubſtantial dwellings. The cathedral is Gothic, enriched with Saracenic moſaics on the altars and ſhrines; the front of the high altar is particularly ſplendid: Gagini has embelliſhed the pulpit and ſome tombs with excellent ſpecimens of his art.—In the treaſury of this church is preſerved the palladium of Meſſina, a letter from the Virgin Mary to its citizens (A). This is the title upon which the Meſſineſe build their

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(A) The ſtory is as follows: After St Paul had made ſome ſtay at Meſſina (a circumſtance of his travels unnoticed by St Luke), the Meſſineſe prevailed upon him to return to Jeruſalem with an embaſſy of four perſons ſent by the city to the Virgin Mary. Their excellencies were graciouſly received by her, and brought back a letter written with her own hand in the Hebrew tongue, which St Paul tranſlated into Greek. By the irruption of the Saracens this invaluable treaſure was loſt, and utterly forgotten till the year 1467, when Conſtantine Laſcaris, a refugee Greek, found a copy of it, and turning it into Latin, made it known to the citizens, and then to all the Catholic world. Its authenticity is now ſo well eſtabliſhed at Meſſina, that Regna the hiſtorian candidly acknowledges, that whoever was to confeſs even a doubt on the ſubject in that city would be treated as an infidel.

This curious epiſtle is conceived in theſe terms:—Maria Virgo, Joachim filia, Dei humillima Chriſti Jeſu crucifixi mater, ex tribu Judæ, ſtirpe David, Meſſanenſibus omnibus ſalutem, et Dei Patris Omnipotentis benedictionem. Vos omnes fide magna legatos ac nuncios per publicum documentum ad nos miſiſſe conſtat. Filium noſtrum Dei genitum Deum et hominem eſſe fatemini, et in cœlum poſt ſuam reſurrectionem aſcendiſſe, Pauli apoſtoli electi prædicatione mediante viam veritatis agnoſcentes. Ob quod vos et ipſam civitatem benedicimus, cujus perpetuam protectricem nos eſſe volumus. Anno filii noſtri XLII. Indict. I. III. Nonas Junii, luna XXVII. feria V. ex Hyeroſolymis.

Thus tranſlated:—"The Virgin Mary, daughter of Joachim, moſt humble mother of God, Jeſus Chriſt crucified, of the tribe of Juda and the family of David, health and the bleſſing of God the Father Almighty to all the people of Meſſina. Out of the abundance of your faith, you have, in conſequence of a public deliberation, ſent a deputation to me; and ſince you acknowledge that my Son is both God and man, and that he aſcended into heaven after his reſurrection, as you have learned from the preaching of St Paul the apoſtle, pretenſions to pre-eminence over the whole iſland, nay over the whole world; to its virtues and patronage they attribute every piece of good fortune, and to their own unworthineſs all ſiniſter events that have befallen them. The authenticity of this epiſtle has been ſeriouſly impugned, and of courſe vigorouſly defended by many Sicilian divines and diſputators.

There is another church in this city that deſerves particular notice, not ſo much on account of its architecture or ornaments, as for its being the laſt refuge of the Greek liturgy, which was once the predominant ſervice of the iſland, but gradually aboliſhed by different conquerors. It is dedicated to the Virgin Mary de Grapheo, or of the *Letter*, which denomination may perhaps have furniſhed Laſcaris with the idea of his letter. It is known at preſent by the name of *la Cottolica.* According to the Greek canons, the entrance of monaſtic churches was reciprocally forbidden to each ſex, and the cathedrals were the only places of worſhip where a daily ſacrifice was offered up by the biſhop and clergy, and where both men and women were preſent at the ſame time, but in different parts of the church. From this general admittance the building acquired the title of *Catholic* or *univerſal.*

Meſſina is all paved with lava, cut into large flags of two feet ſquare: a material which the vicinity of lavas renders it eaſy to procure, and which being very hard reſiſts friction better than any other.

During a ſeries of ages, notwithſtanding the various revolutions and calamities to which it has been expoſed, this city has ſtill maintained its original ſituation; while moſt other cities have ſhifted their ground more or leſs from the place where they were firſt founded. But its ſituation enjoys advantages which have ſtill tempted ſuch of its inhabitants as eſcaped from the ravages of war and the deſolation of earthquakes, to prefer it to every other ſpot, however delightful or ſecure. It is of very ancient origin; it has been under many different races of monarchs; and its name has been repeatedly changed: It has been at different times called *Zancle*, *Mamertina*, *Meſſana.* Its firſt name *Zancle*, which in the old language of Sicily meant "a ſickle;" alluding, as ſome authors ſuppoſe, to the form of the port; or, according to others, to the fertility of the country. Allured by the advantages of its ſituation, the Cumæans, a commercial and enterpriſing people, invaded the iſland and drove the Siculi from this ſettlement; they were in their turn overpowered by a band of Samian adventurers, who made way for a colony of citizens of Meſſene, and under theſe maſters it changed its name to *Meſſana.* Their government was of ſhort duration; for in the 289th year before Chriſt it was deſtroyed by the Mamertines, a warlike unprincipled nation inhabiting the ſouth part of Bruttium. Theſe ſoldiers being received into Meſſana on their return to Italy from Syracuſe, where they had ſerved as mercenaries in the army of Agathocles, took an opportunity of maſſacring the inhabitants and uſurping their poſſeſſions. The city was now called *Mamertina;* and, in order to ſupport themſelves againſt the reſentment of the Sicilian powers, the Mamertines implored the protection of the Romans, who, eager to extend their dominion beyond the limits of Italy, and jealous of the growing power of Carthage, made no ſcruple to ſuccour theſe aſſaſſins with a conſular army. This ſtep brought on the firſt Punic war. The Mamertines reaped no other fruit from the alliance but a more honourable degree of ſlavery; for ſuch was the real nature of their connexion with Rome, whatever name it might be diſguiſed under.

Meſſina was, however, always diſtinguiſhed by particular attentions and favours from the ſenate; and, excepting a ſhort period during the wars of the triumvirate, appears to have taſted all the ſweets of Roman proſperity, without partaking of the bitter draughts of adverſity. Its fate, in the ruin of the empire, was ſimilar to that of the reſt of Sicily. In 829 Meſſina fell into the hands of the Saracens, but obtained very honourable terms of capitulation; for half the city was left to the Chriſtians, where they were to be governed by their own laws, and profeſs their own religion undiſturbed. In the other reſided the bey of one of the five provinces into which the Arabian conquerors had divided the iſland. Notwithſtanding this indulgence, Meſſina was the firſt to caſt off the yoke in 1037, when George Maniaces landed an army of Greeks and Normans on the ſhore of the Faro. It afterwards held out againſt the whole Muſſulman force, till the feeble ſtate of a diſtracted empire ſhut out all hopes of aſſiſtance from Conſtantinople. This unfortunate city then opened its gates to the army of the caliph, and felt very ſeverely the weight of his reſentment, but it did not long groan under the yoke; for in leſs than 20 years Roger the Norman took it by ſurpriſe and delivered it from Mahometan oppreſſion. During the cruſado our Richard Cœur de Lion and Philip Auguſtus king of France wintered here in their way to Paleſtine; a ſojourn marked by continual quarrels, conflagration, and bloodſhed. The Meſſineſe were particularly tardy in entering into the national conſpiracy of 1282, but afterwards exceeded the reſt of the inſurgents in deeds of cruelty: This, and the importance of their ſituation, ſingled them out for the firſt objects of Charles's vengeance. He inveſted their city very cloſely, and declared ſo openly his determination to refuſe all terms whatever to the beſieged, that they ſaw no hopes of ſafety but in an obſtinate defence. Their courage, perſeverance, and ſufferings, were exceſſive; at length their ſtrength and reſources began to fail rapidly, and every circumſtance ſeemed to denounce their ſpeedy deſtruction, when Roger Lauria appeared off the harbour with the Arragonian fleet, forced the king to retire with precipitation acroſs the

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I give my bleſſing to you and all your city, and agree to become your protectreſs. In the 42d year of my Son, the 1ſt of the Indiction, the 3d day of June, and the 27th of the moon, at Jeruſalem."

Not to dwell upon the aſtronomical blunders in theſe dates, let it ſuffice to obſerve, that Laſcaris was not aware that Denis the Little, a Syrian monk in the 6th century, was the firſt who made uſe of the era that commences at our Saviour's birth.

the ſtraits, and in his ſight defeated and deſtroyed his naval armament. Robert, grandſon of Charles I. alſo made a fruitleſs attack; but in the diſturbed reign of Frederick III. Meſſina was delivered up to Louis king of Naples and his conſort Queen Joan, who entered it in triumph. In a few years it returned to its former poſſeſſors. The year 1672 was remarkable for the revolt of the Meſſineſe.—They threw off the Spaniſh yoke, and ſwore allegiance to Louis XIV. king of France. They were for ſome time vigorouſly aſſiſted by the French; but before the Spaniards had gained the leaſt advantage to excite any hopes of recovering ſo valuable a poſſeſſion, Louis found himſelf neceſſitated from motives of political intereſt to deſert his new ſubjects, and leave them to the mercy of their old incenſed maſters. The horror of being thus abandoned, and the chaſtiſement inflicted by Spain, broke the fierce ſpirit of the Meſſineſe; they were ſtill ſtunned with the remembrance and effects of this blow, when the plague in 1743 was introduced from the Levant, and ſwept away more than half the inhabitants. From this chain of calamities, the opulence, trade, and population of Meſſina, have been gradually ſinking; and unleſs very favourable circumſtances happen, will every year fall lower. The number of its inhabitants does not now exceed 30,000.

The following particulars are added from M. Houel, who viſited this city ſince the late earthquakes, which completed its deſtruction.

On the front of the cathedral there is a ſquare, which, though not regular, is far from being mean. This was not the largeſt ſquare in Meſſina before its overthrow; but it was the moſt elegant, the moſt ſplendidly adorned, and the beſt frequented. There ſtands in this ſquare an equeſtrian ſtatue of Charles II. of Spain, in bronze, which has been ſpared by the earthquake. It ſtands on a marble pedeſtal, in the middle of the ſquare. Oppoſite to this ſtatue is an elegant marble fountain, ornamented with a variety of figures, repreſenting men and other animals, all of them ſpouting out water in great abundance; which uſed, in ſummer, to ſpread an agreeable and refreſhing coolneſs over the ſquare, that induced company to aſſemble here. Seven ſtreets terminated here. The cathedral forms a part of the ſquare. It is dedicated to the bleſſed Virgin; the occaſion of which has been already mentioned.

There is an anniverſary feaſt celebrated in Meſſina, which is called *the feaſt of the Letter*. A lock of the Virgin's hair, which ſhe ſent to the Meſſenians at the ſame time with the letter, is carried through the city in proceſſion in a cryſtal veſſel. She made alſo a preſent of her picture to the Meſſenian deputies. It is placed over the tabernacle. None but the canons of the cathedral are permitted to touch, or take up on their ſhoulders, the ſilver ſhrine in which the cryſtal veſſel with the Virgin's hair is depoſited. Eight of thoſe canons, with mitres on their heads, bear this ſhrine in the proceſſion. The canopy ſuſpended over it is ſupported by ſix ſenators in their robes. The picture and the hair are ſhown to ſtrangers. This proceſſion, and the other religious ceremonies of this feſtival, are followed by horſe races. The ſpirits of the people being already elevated by their religious exerciſes, they engage with amazing eagerneſs in theſe and the other diverſions with which they are accompanied. a tumultuous joy reigns over the city; and the evening concludes with illuminations and fireworks. The ſhips in the harbour pay the citizens the compliment of entertaining them with a diſcharge of their guns on the occaſion.

Through a ſquare called the *Square of the Great Hoſpital*, runs a large and impetuous torrent, the *Porto delle Legni*. It is precipitated from thoſe lofty mountains which overlook this city on the ſouth ſide. The channel which it has cut out for itſelf is at times entirely full. It would, on ſuch occaſions, overflow the ſquare and other parts of the city, were it not confined by walls which have been built on both ſides to prevent ſuch accidents.—Another ſtream of a ſimilar origin, called the *Torrent of La Bocetta*, runs through another part of the city, it is alſo confined within walls to prevent it from overflowing.

The *Square of St John of Malta* is one of the largeſt in Meſſina. In the middle of this ſquare is a fine marble fountain, ornamented with a variety of ſculptured figures and jets d'eau. Beſide the fountain there uſed to ſtand a large reſervoir for horſes to drink out of.

In the time of the annual feſtivals, there uſed to be exhibited on the water of the reſervoir a galley, or rather a fictitious repreſentation of a galley, with galley-ſlaves, ſoldiers, officers, and a commander on board, all in arms, and the galley properly equipped as a ſhip of war. This galley was decorated with great art; and by night the maſts, and every other ſuitable part, were hung with lamps, which illumined it in a very ſplendid manner. Every thing around was ſo artificially diſpoſed, that when the fireworks were played off, the ſpectator was led to think, though he perceived only one galley, that the noiſe which he heard was produced by a naval combat; and that the other ſhips were concealed from his view by the ſmoke occaſioned by the guns and fireworks. This, when properly conducted, was a noble ſpectacle. The ſenate repaired thither from the cathedral, attended with a guard and a numerous company. In one carriage ſat ſix ſenators, the governor of the city, and ſometimes the archbiſhop. It was exceedingly large, and drawn by ſix white horſes very richly harnaſſed. Other carriages followed, with the train who attended the governor and the ſenators.

Almoſt all feſtivals owe their origin to ſome extraordinary event, or ſome ſingular ſtory either true or falſe. It is ſaid, that when the ſplendor with which the feaſt of the *Aſſumption de la Bara* was celebrated at Meſſina, firſt began to attract foreigners to the city, on that occaſion ſuch crowds repaired thither as to alarm the inhabitants with the fears of a famine: But one year, when the number of ſtrangers was greater than uſual at the time of this feſtival, the magiſtrates were very much at a loſs how to ſupply them with proviſions; and at length, every other reſource failing, no hopes of relief remained but from the kindneſs of the Bleſſed Virgin. Fervent prayers were addreſſed to their patroneſs: and next morning by day-break three brigantines appeared entering the harbour with full ſails. They proved to be loaded with corn. It was eagerly purchaſed: and the people of the city haſted to appeaſe their hunger. But when they came after refreſhing themſelves to pay the corn-merchants their money, neither ſhips nor merchants could be found. After their firſt emotions of ſurpriſe had ſubſided, they naturally concluded that ſuch a ſeaſonable ſupply muſt undoubtedly be a preſent from the Virgin, who, being pleaſed with the zeal of her Meſſenian votaries, and deſirous to prevent the concourſe of ſtrangers who attended the feſtival from diminiſhing, had interpoſed in this miraculous manner to ſave them from the diſtreſſes of famine. A new feſtival was celebrated in gratitude to their generous benefactreſs. Three ſmall veſſels of ſilver were made, and dedicated to the Virgin in memory of the event; and theſe are at preſent uſed as lamps in the cathedral The ſenate likewiſe decreed, that the clergy ſhould pay annually a ſmall tax, to be laid out in conſtructing a ſmall galley to ſwim on the fountain, and in defraying the expences of the fireworks. The profits of the clergy are ſo conſiderable on the occaſion of the feſtival, that they may be ſuppoſed to pay the tax with great cheerfulneſs.

In Meſſina, as in the other cities of Sicily, the women wrap themſelves in a large black mantle above the reſt of their dreſs. The ſtuffs are richer or plainer according to rank and circumſtances. People who are not rich enough to have fine clothes of their own, hire them at ſo much an hour. There are women who make a livelihood by lending out their clothes. The mantle covers the wearer from head to foot.—It reduces the old and the young, the ill-ſhaped and the handſome, pretty much to an equality in point of appearance. This muſt naturally appear very unfavourable to the influence of beauty. But yet, on proper occaſions, at church or in a public walk, the ladies of Meſſina find means to open and adjuſt the mantle ſo as to diſplay all their beauties of face and ſhape, and to attract the affections of lovers, perhaps more powerfully than if their dreſs were ſuited to diſplay their charms in a more oſtentatious manner.

Between Meſſina and the tower of Faro there ſtands a ſmall church called the *Madona of the Grotto*. It was anciently a temple of a round ſtructure, and ornamented with columns like the temple of the ſun at Rome. Modern columns now ſupply the place that was occupied by the ancient. There are large niches in the rock adjoining to the temple, which are thought to be of equal antiquity. Theſe contain no ſculptured figures; but in Pagan times they might poſſibly contain ſome.

Meſſina being ſituated between Mount Ætna and the gulf of Charybdis, and being likewiſe at no great diſtance from the volcanoes of Lipari and Stromboli, muſt have been in all ages liable to ſuffer by earthquakes. Such terrible events, however, appear to have been more unfrequent in ancient than in modern times, and have actually alarmed the preſent age oftener than any other. In the year 1693 a fourth part of the cities of Sicily was deſtroyed by an earthquake. Meſſina merely felt the ſhock; all its buildings, however, ſuffered. In the year 1742 it ſuffered another equally violent. A plague which followed in 1743 retarded the repairs neceſſary after the earthquake. In the year 1780 this city continued, for more than ſix months, to ſuffer from new earthquakes.

Were the ſtate of the elements, previous to theſe dreadful events, carefully examined, it might perhaps be found to undergo certain changes which might be conſidered as prognoſticating them.

The autumn of the year 1782 was unuſually cold and rainy. Fahrenheit's thermometer was often as low as 56 degrees. The ſucceeding winter was dry; and the mercury never fell under 25 degrees: And, what is uncommon in that ſeaſon, ſtorms were now and then obſerved to ariſe from the weſt. The pilots in the channel obſerved that the tides no longer roſe at the uſual periods, and the gulf of Charybdis raged with extraordinary fury.

On the 5th of February 1783, the air was heavy and calm; the ſky obſcured with thick clouds, and the atmoſphere ſeemingly all in a flame. About half after twelve at noon, the earth began to ſhake with a dreadful noiſe. The ſhocks continually increaſed, and became at length ſo violent as to open the ground, and to overturn in two or three minutes a conſiderable part of the buildings.

A long white cloud appeared to the north-weſt; and ſoon after another, very dark, in the ſame quarter of the heavens. The latter in a moment ſpread over the whole horizon, and deluged the city with rain and hail, accompanied with dreadful claps of thunder. The inhabitants fled in the utmoſt terror to the fields and the ſhips in the harbour.

From mid-day till five in the afternoon the earthquake continued almoſt without interruption. The ſhocks then became ſomewhat leſs frequent. The cries of the dying; the ſhrieks of thoſe who were half buried under the ruins; the wild terror with which others, who were ſtill able, attempted to make their eſcape; the deſpair of fathers, mothers, and huſbands, bereft of thoſe who were deareſt to them; then formed altogether a ſcene of horror, ſuch as can but ſeldom occur in the hiſtory of the calamities of the human race. Amid that awful ſcene, inſtances of the moſt heroic courage and the moſt generous affection were diſplayed. Mothers, regardleſs of their own ſafety, ruſhed into every danger to ſnatch their children from death. Conjugal and filial affection prompted deeds not leſs deſperate and heroic. But no ſooner did the earthquake ceaſe, than the poor wretches who had eſcaped began to feel the influence of very different paſſions. When they returned to viſit the ruins, to ſeek out the ſituation of their fallen dwellings, to inquire into the fate of their families, to procure food and collect ſome remains of their former fortunes—ſuch as found their circumſtances the moſt wretched became ſuddenly animated with rage, which nothing but wild deſpair could inſpire. The diſtinction of ranks, and the order of ſociety were diſregarded, and property eagerly violated. Murder, rapine, and lawleſs robbery, reigned among the ſmoking ruins.

About one in the morning another ſhock of the earthquake was felt, which overturned moſt of the houſes that were ſtill ſtanding. Moſt of thoſe whom want, or avarice, or humanity, ſtill detained among the ruins, now ſhared the ſame fate with their friends whom the former ſhocks had buried under them.

The ſucceeding day ſcarce alleviated the diſtreſs of this diſmal night: the few wretches who ſtill ſurvived found themſelves deſtitute of every neceſſary. At length order was in ſome degree re eſtabliſhed; and in two days after every perſon was ſupplied at leaſt with ſome ſmall portion of the neceſſaries for ſubſiſtence.

None yet thought of returning to take up their abode among the ruins. The common people fixed their reſidence on the plain of Porto Salvo, near the town of Salleo. The nobles, magiſtrates, and merchants, took up their abode on another plain, on the other ſide of the ſtream Porto de Legno; the ſoldiers at Terra Nuova.

Some violent ſhocks which were again felt on the 7th of February and the 28th of March completed the deſtruction of the city. The corn magazines, however, eſcaped without damage; and the public ovens and the aqueducts were but little injured. From theſe facts it may perhaps be inferred, that had not the houſes of Meſſina been, in general, haſtily built at the firſt, and afterwards careleſsly repaired, fewer of them would have been overthrown by the earthquake.

The neighbouring villages having ſuffered but little, were the firſt to relieve the remaining inhabitants of Meſſina in their diſtreſs. Malteſe gallies for ſome days ſupplied neceſſaries to the poor and the ſick with a generoſity which merits the higheſt praiſe. They brought ſurgeons and whatever was needful for the cure of the wounded. The ſupplies ſent by the king of France were refuſed, for what reaſon we know not. What money was needed for the ſupport of the people was taken from the treaſury of the city of Meſſina; for what the king of Naples ſent was ſeized and ſpent by the garriſon.

It is ſaid that not more than 800 or 900 perſons periſhed by this earthquake. The ſea during that convulſion of the land was ſlightly agitated in the harbour. Farther out the ſea was more violently agitated; but none of the ſhips in the harbour were daſhed to pieces. The waters roſe ſo high as to be injurious in a very conſiderable degree to Pharo, as well as along the coaſt of Scylla and Bagnara.

This earthquake was not of a momentary duration, like that by which Liſbon was deſtroyed, and like many others; for more than ſixty days, from the 5th of February to the beginning of April, Meſſina continued to be ſhaken, and in that time felt more than 200 ſhocks; and even after that period the alarm was again and again renewed. Not only the magiſtrates, the ſoldiers, and the people, but the prieſts likewiſe, with their tabernacle and altar, retired to the barracks. The nuns, too, deſerted their cloiſters, and ſought a retreat without the walls. Some of them confined themſelves to the gardens of their convents; others mixed indiſcriminately with the people.

The chief damage which the public buildings within the city ſuffered was the fall of the dome of the church of Purgatory. Only the walls were left ſtanding; and even theſe had ſuffered conſiderably. One half of the ſteeple of the cathedral was beaten to the ground. The magazines of Porto Franco were likewiſe very much ſhattered. The fort of St Salvator, being built on an artificial foundation, the ſide next the ſea is there fallen down; but on the other ſide, where it is founded on a rock, it has ſtood unmoved by all the ſhocks of the earthquake.

On the 5th of February, when the earthquake was more violent than at any time afterwards, a ſtrong ſmell of ſulphur was felt. The earth was affected ſomewhat in the ſame way as if it had been borne upon a fluid; and ſeemed to reel with the ſhocks much like a ſhip toſſed with the waves. This tremulous motion was felt all over Sicily; but towards Pharo it became weaker. On the following days the ſky was cloudy; the mountains of Sicily and the ſhores of Calabria continued covered with a thick fog like ſmoke. North and north eaſt winds raged with the moſt violent impetuoſity.

The diſaſtrous year of this earthquake was ſcarce concluded, the chaſms which it had opened in the ground were ſtill yawning, and the poor inhabitants of the adjacent country ſtill trembled with terror, when the elements again renewed their fury to ravage this miſerable land.

On Tueſday the 6th of January 1784, about ſunriſe, the wind began to blow ſoftly from the north-eaſt. The ſea gradually ſwelled, roſe beyond its bed with rapid impetuoſity, overflowed the quay of Meſſina, and laſhed with its billows the ruins of the Palazzata. It looſened and diſplaced many of the ſtones of the mole, ſpread over the whole ſtreet, and attacked the pedeſtals of the ſtatues which had been ſpared by the earthquake, and ſtill ſtood firm among the ruins. The ſame furious wind which ſwelled the ſea in ſo extraordinary a manner, ravaged the whole coaſt from Meſſina all the way to Syracuſe.

MESSUAGE, Messuagium, in *Law*, a dwelling-houſe, with ſome land adjoining aſſigned for its uſe. By the name of *meſſuage* may a garden, ſhop, mill, cottage, chamber, cellar, or the like, paſs.—In Scotland, *meſſuage* denotes what is called in England the *manor-houſe*, viz. the principal dwelling-houſe within any barony.

MESOPORPHYRON, a name given by the Greeks to the Roman *laticlave*; becauſe that garment, being edged on each ſide, where it opened before, with purple, appeared when cloſed with two purple ſtripes down the middle. The ſame term was alſo applied to the *anguſticlave*.

META, in the Roman circus, was a pile of ſtones of a pyramidical form, intended as a boundary of the *ſtadium*, or chariot courſe.—When the meta was paſſed the ſeventh time, the race was concluded. The greateſt art and management were required in avoiding the meta, and yet going as near it as poſſible. If they went too near, they were in the greateſt danger of breaking the chariot to pieces; and if they took too large a circuit in the turn, they gave their rivals an opportunity of getting within them, beſides loſing a great deal of ground. The boundary of the Grecian *ſtadium*, or courſe, was called τεγος, τερμα, γραμμη and ακρα γραμμη; to which laſt name Horace probably alludes, in calling death "*ultima linea rerum.*"

The *metæ* at Rome were firſt of wood, afterwards of ſtone; but the emperor Claudius made them of gold, or rather gilded them. In the Roman circus there were two *metæ*, one at the entrance of the courſe, and the other at the end of it. An egg was placed upon the top of the *metæ*.

METACARPUS, or Metacarpium, (from μετα, *behind*, and καρπος, *hand*), in *Anatomy*, that part of the hand between the wriſt and the fingers. See Anatomy, N° 55

METAGITNION, the ſecond month of the Athenian year, anſwering to the latter part of our July and the beginning of Auguſt, and ſo called from *metagitnia*, a feſtival in honour of Apollo, which was kept in it. The Bœotians called this month *panemus*, and the Syracuſans, *carnius*.

METAL, in *Natural Hiſtory*, is a ſubſtance which is diſtinguiſhed from others by its ductility, malleability, tenacity, opacity, &c. for an account of which, ſee CHEMISTRY.

METAL, in *Heraldry*. There are two metals uſed in heraldry, by way of colours, viz. gold and ſilver, in blazon called *or* and *argent*.

In the common painting of arms theſe metals are repreſented by white and yellow, which are the natural colours of thoſe metals. In engraving, gold is expreſſed by dotting the coat, &c. all over; and ſilver, by leaving it quite blank.

It is a general rule in heraldry, never to place metal upon metal, or colour upon colour: ſo that if the field be of one of the metals, the bearing muſt be of ſome colour; and if the field be of any colour, the bearing muſt be one of the metals.

METALEPSIS. See ORATORY, N° 59.

METALLISATION, is defined to be the natural proceſs by which metals are formed in the bowels of the earth.

METALLURGY, in a more general ſenſe, comprehends the whole art of working metals, from the ſtate of ore to the utenſil; and in this ſenſe, eſſaying, ſmelting, refining, parting, ſmithery, gilding, &c. are only branches of metallurgy. But in a more limited ſenſe it includes only the operations which are followed in ſeparating metals from their ores. For an account of theſe proceſſes, ſee MINERALOGY *Index;* and for the practical branches, ſee GILDING, PARTING, PURIFYING, REFINING, SMITHERY.

METAMORPHOSIS, in general, denotes the changing of ſomething into a different form; in which ſenſe it includes the transformation of inſects, as well as the mythological changes related by the ancient poets.

Mythological metamorphoſes were held to be of two kinds, apparent and real: thus, that of Jupiter into a bull, was only apparent; whereas that of Lycaon into a wolf, was ſuppoſed to be real.

Moſt of the ancient metamorphoſes include ſome allegorical meaning, relating either to phyſics or morality; ſome authors are even of opinion that a great part of the ancient philoſophy is couched under them; and Lord Bacon and Dr Hooke have attempted to unriddle ſeveral of them.

METAPHOR, in *Rhetoric*. See ORATORY, N° 54.

METAPHOR *and Allegory*, in poetry.—A metaphor differs from a ſimile, in form only, not in ſubſtance: in a ſimile the two ſubjects are kept diſtinct in the expreſſion, as well as in the thought; in a metaphor, the two ſubjects are kept diſtinct in the thought only, not in the expreſſion. A hero reſembles a lion, and upon that reſemblance many ſimilies have been raiſed by Homer and other poets. But inſtead of reſembling a lion, let us take the aid of the imagination, and feign or figure the hero to be a lion; by that variation the ſimile is converted into a metaphor; which is carried on by deſcribing all the qualities of a lion that reſemble thoſe of the hero. The fundamental pleaſure here, that of reſemblance, belongs to the thought. An additional pleaſure ariſes from the expreſſion: the poet, by figuring his hero to be a lion, goes on to deſcribe the lion in appearance, but in reality the hero; and his deſcription is peculiarly beautiful, by expreſſing the virtues and qualities of the hero in new terms, which, properly ſpeaking, belong not to him, but to the lion. This will better be underſtood by examples. A family connected with a common parent, reſembles a tree, the trunk and branches of which are connected with a common root: but let us ſuppoſe, that a family is figured, not barely to be like a tree, but to be a tree; and then the ſimile will be converted into a metaphor, in the following manner:

Edward's ſev'n ſons, whereof thyſelf art one,
Were ſev'n fair branches, ſpringing from one root;
Some of theſe branches by the deſt'nies cut:
But Thomas, my dear lord, my life, my Glo'ſter,
One flouriſhing branch of his moſt royal root,
Is hack'd down, and his ſummer leaves all faded,
By Envy's hand and Murder's bloody axe.
Richard II. act i. ſc. 3.

Figuring human life to be a voyage at ſea.

There is a tide in the affairs of men,
Which, taken at the flood, leads on to Fortune:
Omitted, all the voyage of their life
Is bound in ſhallows and in miſeries.
On ſuch a full ſea are we now afloat;
And we muſt take the current when it ſerves,
Or loſe our ventures. *Julius Cæſar*, act iv. ſc. 5.

Figuring glory and honour to be a garland of flowers;

Hoſpur.——————Wou'd to heav'n,
Thy name in arms were now as great as mine!
Pr. Henry. I'll make it greater ere I part from thee;
And all the budding honours on thy creſt
I'll crop, to make a garland for my head.
Firſt Part of Henry IV. act v. ſc. 9.

Figuring a man who hath acquired great reputation and honour to be a tree full of fruit:

——————Oh, boys, this ſtory
The world may read in me; my body's mark'd
With Roman ſwords; and my report was once
Firſt with the beſt of note. Cymbeline lov'd me;
And when a ſoldier was the theme, my name
Was not far off; then was I as a tree,
Whoſe boughs did bend with fruit. But in one night,
A ſtorm or robbery, call it what you will,
Shook down my mellow hangings, nay, my leaves;
And left me bare to wither.
Cymbeline, act iii. ſc. 3.

"Bleſt by thy ſoul, thou king of ſhells, ſaid Swaran of the dark-brown ſhield. In peace, thou art the gale of ſpring; in war, the mountain-ſtorm. Take now my hand in friendſhip, thou noble king of Morven."
Fingal.

"Thou dwelleſt in the ſoul of Malvina, ſon of mighty Oſſian. My ſighs ariſe with the beam of the eaſt: my tears deſcend with the drops of night. I was a lovely tree in thy preſence, Oſcar, with all my branches round me: but thy death came like a blaſt from the

deſert, and laid my green head low; the ſpring returned with its ſhowers, but no leaf of mine aroſe."
Fingal.

An *allegory* differs from a metaphor; and a *figure of ſpeech* differs from both. A metaphor is defined above to be an act of the imagination, figuring one thing to be another. An allegory requires no ſuch operation, nor is one thing figured to be another: it conſiſts in chooſing a ſubject having properties or circumſtances reſembling thoſe of the principal ſubject: and the former is deſcribed in ſuch a manner as to repreſent the latter: the ſubject thus repreſented is kept out of view: we are left to diſcover it by reflection; and we are pleaſed with the diſcovery, becauſe it is our own work. (See the word ALLEGORY.)

Quintilian gives the following inſtance of an allegory.

O navis, referent in mare te novi
Fluctus. O quid agis? fortiter occupa portum.
Horat. Lib. i. ode 14.

and explains it elegantly in the following words: "Totuſque ille Horatii locus, quo navim pro republica, fluctuum tempeſtates pro bellis civilibus, portum pro pace atque concordia, dicit."

In a *figure of ſpeech*, there is no fiction of the imagination employed, as in a metaphor; nor a repreſentative ſubject introduced, as in an allegory. This figure, as its name implies, regards the expreſſion only, not the thought; and it may be defined, the uſing a word in a ſenſe different from what is proper to it.—Thus youth, or the beginning of life, is expreſſed figuratively by *morning of life:* morning is the beginning of the day; and in that view it is employed to ſignify the beginning of any other ſeries, life eſpecially, the progreſs of which is reckoned by days. See FIGURE *of Speech.*

Metaphor and *allegory* are ſo much connected, that it ſeemed proper to handle them together: the rules particularly for diſtinguiſhing the good from the bad, are common to both. We ſhall therefore proceed to theſe rules, after adding ſome examples to illuſtrate the nature of an *allegory*, which, with a view to this article, was but ſlightly illuſtrated under its proper name.

Horace, ſpeaking of his love to Pyrrha, which was now extinguiſhed, expreſſed himſelf thus:

————Me tabulâ ſacer
Votivâ paries indicat uvida
Suſpendiſſe potenti
Veſtimenta maris Deo. *Carm.* lib. i. ode 5.

Again:
Phœbus volentem prælia me loqui,
Victas et urbes, increpuit, lyra
Ne parva Tyrrhenum per æquor
Vela darem. *Carm.* lib. iv. ode 15.

Queen. Great lords, wiſe men ne'er ſit and wail their loſs,
But cheerly ſeek how to redreſs their harms.
What though the maſt be now blown overboard,
The cable broke, the holding anchor loſt,
And half our ſailors ſwallowed in the flood!
Yet lives our pilot ſtill. Is't meet that he
Should leave the helm, and, like a fearful lad,
With tearful eyes add water to the ſea,
And give more ſtrength to that which hath too much;
While in his moan the ſhip ſplits on the rock,
Which induſtry and courage might have ſav'd?
Ah, what a ſhame! ah, what a fault were this!
Third Part of Henry VI. act v. ſc. 5.

Oroonoko. Ha! thou haſt rous'd
The lion in his den; he ſtalks abroad,
And the wide foreſt trembles at his roar.
I find the danger now. *Oroonok,* act iii. ſc. 2.

"My well beloved hath a vineyard in a very fruitful hill. He fenced it, gathered out the ſtones thereof, planted it with the choiceſt vine, built a tower in the midſt of it, and alſo made a wine preſs therein; he looked that it ſhould bring forth grapes, and it brought forth wild grapes. And now, O inhabitants of Jeruſalem, and men of Judah, judge, I pray you, betwixt me and my vineyard. What could have been done more to my vineyard, that I have not done? Wherefore, when I looked that it ſhould bring forth grapes, brought it forth wild grapes? And now go to, I will tell you what I will do to my vineyard: I will take away the hedge thereof, and it ſhall be eaten up; and break down the wall thereof, and it ſhall be trodden down. And I will lay it waſte: it ſhall not be pruned, nor digged, but there ſhall come up briars and thorns: I will alſo command the clouds that they rain no rain upon it. For the vineyard of the Lord of hoſts is the houſe of Iſrael, and the men of Judah his pleaſant plant." *Iſaiah* v. 1.

The rules that govern metaphors and allegories are of two kinds. The conſtruction of theſe figures comes under the firſt kind: the propriety or impropriety of introduction comes under the other.—To begin with rules of the firſt kind; ſome of which coincide with thoſe already given for ſimilies; ſome are peculiar to metaphors and allegories.

In the firſt place, It has been obſerved, that a ſimile cannot be agreeable where the reſemblance is either too ſtrong or too faint. This holds equally in metaphor and allegory; and the reaſon is the ſame in all. In the following inſtances, the reſemblance is too faint to be agreeable.

Malcolm. ————But there's no bottom, none,
In my voluptuouſneſs: your wives, your daughters,
Your matrons, and your maids, could not fill up
The ciſtern of my luſt. *Macbeth,* act iv. ſc. 4.

The beſt way to judge of this metaphor, is to convert it into a ſimile: which would be bad, becauſe there is ſcarce any reſemblance between luſt and a ciſtern, or betwixt enormous luſt and a large ciſtern.

Again:

He cannot buckle his diſtemper'd cauſe
Within the belt of rule. *Macbeth,* act v. ſc. 2.

There is no reſemblance between a diſtempered cauſe and any body that can be confined within a belt.

Again:

Steep me in poverty to the very lips.
Othello, act iv. ſc. 9.

Metaphor.

Poverty here muſt be conceived a fluid, which it reſembles not in any manner.

Speaking to Bolingbroke baniſh'd for ſix years:

> The ſullen paſſage of thy weary ſteps
> Eſteem a foil, wherein thou art to ſet
> The precious jewel of thy home-return.
> *Richard* II. act ii. ſc. 6.

Again:

> Here is a letter, lady,
> And every word in it a gaping wound
> Iſſuing life-blood.
> *Merchant of Venice*, act iii. ſc. 3.

> Tantæ *molis* erat Romanam condere gentem.
> *Æneid.* i. 37.

The following metaphor is ſtrained beyond all endurance: Timur-bec, known to us by the name of *Tamerlane the Great*, writes to Bajazet emperor of the Ottomans in the following terms:

"Where is the monarch who dares reſiſt us? where is the potentate who doth not glory in being numbered among our attendants? As for thee, deſcended from a Turcoman ſailor, ſince the veſſel of thy unbounded ambition hath been wreck'd in the gulf of thy ſelf-love, it would be proper, that thou ſhouldſt take in the ſails of thy temerity, and caſt the anchor of repentance in the port of ſincerity and juſtice, which is the port of ſafety; leſt the tempeſt of our vengeance make thee periſh in the ſea of the puniſhment thou deſerveſt."

Such ſtrained figures, as obſerved above, are not unfrequent in the firſt dawn of refinement; the mind in a new enjoyment knows no bounds, and is generally carried to exceſs, till taſte and experience diſcover the proper limits.

Secondly, Whatever reſemblance ſubjects may have, it is wrong to put one for another, where they bear no mutual proportion. Upon comparing a very high to a very low ſubject, the ſimile takes on an air of burleſque: and the ſame will be the effect where the one is imagined to be the other, as in a metaphor; or made to repreſent the other, as in an allegory.

Thirdly, Theſe figures, a metaphor eſpecially, ought not to be crowded with many minute circumſtances; for in that caſe it is ſcarcely poſſible to avoid obſcurity. A metaphor above all ought to be ſhort: it is difficult, for any time, to ſupport a lively image of a thing being what we know it is not; and for that reaſon, a metaphor drawn out to any length, inſtead of illuſtrating or enlivening the principal ſubject, becomes diſagreeable by overſtraining the mind. Here Cowley is extremely licentious. Take the following inſtance.

> Great and wiſe conqu'ror, who where'er
> Thou com'ſt, doſt fortify, and ſettle there!
> Who canſt defend as well as get;
> And never hadſt one quarter beat up yet;
> Now thou art in, thou ne'er wilt part
> With one inch of my vanquiſh'd heart;
> For ſince thou took'ſt it by aſſault from me
> 'Tis garriſon's ſo ſtrong with thoughts of thee,
> It fears no beauteous enemy.

For the ſame reaſon, however agreeable long allegories may at firſt be by their novelty, they never afford any laſting pleaſure: witneſs the *Faëry Queen*, which with great power of expreſſion, variety of images, and melody of verſification, is ſcarce ever read a ſecond time.

In the fourth place, The compariſon carried on in a ſimile, being in a metaphor ſunk by imagining the principal ſubject to be that very thing which it only reſembles; an opportunity is furniſhed to deſcribe it in terms taken ſtrictly or literally with reſpect to its imagined nature. This ſuggeſts another rule, That in conſtructing a metaphor, the writer ought to make uſe of ſuch words only as are applicable literally to the imagined nature of his ſubject: figurative words ought carefully to be avoided; for ſuch complicated figures, inſtead of ſetting the principal ſubject in a ſtrong light, involve it in a cloud, and it is well if the reader, without rejecting by the lump, endeavour patiently to gather the plain meaning, regardleſs of the figures:

> A ſtubborn and unconquerable flame
> Creeps in his veins, and drinks the ſtreams of life.
> *Lady Jane Gray*, act i. ſc. 1.

Copied from Ovid:

> Sorbent avidæ præcordia flammæ.
> *Metamorph.* lib. ix. 172.

Let us analyze this expreſſion. That a fever may be imagined a flame, we admit: though more than one ſtep is neceſſary to come at the reſemblance: a fever, by heating the body, reſembles fire; and it is no ſtretch to imagine a fever to be a fire: again, by a figure of ſpeech, flame may be put for fire, becauſe they are commonly conjoined; and therefore a fever may be termed a *flame*. But now admitting a fever to be a flame, its effects ought to be explained in words that agree literally to a flame. This rule is not obſerved here; for a flame drinks figuratively only, not properly.

King Henry to his ſon Prince Henry:

> Thou hid'ſt a thouſand daggers in thy thoughts,
> Which thou haſt whetted on thy ſtony heart
> To ſtab at half an hour of my frail life.
> *Second Part Henry IV.* act iv. ſc. 11.

Such faulty metaphors are pleaſantly ridiculed in the *Rehearſal*:

"*Phyſician.* Sir, to conclude, the place you fill has more than amply exacted the talents of a wary pilot; and all theſe threatening ſtorms, which, like impregnate clouds, hover o'er our heads, will, when they once are graſp'd but by the eye of reaſon, melt into fruitful ſhowers of bleſſings on the people.

"*Bayes.* Pray mark that allegory. Is not that good.

"*Johnſon.* Yes, that graſping of a ſtorm with the eye is admirable." Act ii. ſc. 1.

Fifthly, The jumbling different metaphors in the ſame ſentence, beginning with one metaphor and ending with another, commonly called a *mixt metaphor*, ought never to be indulged.

K. Henry. ———Will you again unknit
This churliſh knot of all-abhorred war,
And move in that obedient orb again,
Where you did give a fair and natural light?
Firſt Part Henry VI. act v. ſc. 1.

Whether 'tis nobler in the mind, to ſuffer
The ſtings and arrows of outrageous fortune;
Or to take arms againſt a ſea of troubles,
And by oppoſing end them.
Hamlet, act iii. ſc. 2.

In the ſixth place, It is unpleaſant to join different metaphors in the ſame period, even where they are preſerved diſtinct: for when the ſubject is imagined to be firſt one thing and then another in the ſame period without interval, the mind is diſtracted by the rapid tranſition; and when the imagination is put on ſuch hard duty, its images are too faint to produce any good effect:

At regina gravi jamdudum ſaucia cura,
Vulnus alit venis, et cæco carpitur igni.
Æneid. iv. 1.

—————Eſt mollis flamma medullas
Interea, et tacitum vivit ſub pectore vulnus.
Æneid. iv. 66.

Motum ex Metello conſule civicum,
Bellique cauſas, et vitia, et modos,
Ludumque fortunæ, graveſque
Principum amicitias, et arma
Nondum expiatis uncta cruoribus,
Periculoſæ plenum opus aleæ,
Tractas, et incedis per ignes
Suppoſitos cineri doloſo.
Horat. Carm. lib. ii. ode 1.

In the laſt place, It is ſtill worſe to jumble together metaphorical and natural expreſſion, ſo as that the period muſt be underſtood in part metaphorically, in part literally; for the imagination cannot follow with ſufficient eaſe changes ſo ſudden and unprepared: a metaphor begun and not carried on, hath no beauty; and inſtead of light, there is nothing but obſcurity and confuſion. Inſtances of ſuch incorrect compoſition are without number: we ſhall, for a ſpecimen, ſelect a few from different authors. Speaking of Britain,

——This precious ſtone ſet in the ſea,
Which ſerves it in the office of a wall,
Or as a moat defenſive to a houſe,
Againſt the envy of leſs happier lands.
Richard II. act ii. ſc. 1.

In the firſt line Britain is figured to be a precious ſtone: in the following line, Britain, diveſted of her metaphorical dreſs, is preſented to the reader in her natural appearance.

Theſe growing feathers pluck'd from Cæſar's wing,
Will make him fly an ordinary pitch,
Who elſe would ſoar above the view of men,
And keep us all in ſervile fearfulneſs.
Julius Cæſar, act i. ſc. 1.

Rebus anguſtis animoſus atque
Fortis appare: ſapienter idem
Contrahes vento nimium ſecundo
Turgida vela. *Hor. Carm.* lib. ii. ode 10.

The following is a miſerable jumble of expreſſions, ariſing from an unſteady view of the ſubject, between its figurative and natural appearance:

But now from gath'ring clouds deſtruction pours,
Which ruins with mad rage our halcyon hours:
Miſts from black jealouſies the tempeſt form,
Whilſt late diviſions reinforce the ſtorm.
Diſpenſary, canto iii.

To thee the world its preſent homage pays,
The harveſt early, but mature the praiſe.
Pope's Imitation of Horace, book ii.

Oui, ſa pudeur ne'ſt que franche grimace,
Qu'une ombre de vertu qui garde mal la place,
Et qui s'evanouit, comme l'on peut ſavoir,
Aux rayons du ſoleil qu'une bourſe vait voir.
Moliere, L'Etourdi, act iii. ſc. 2.

Et ſon feu, de pourvû de ſenſe et de lecture,
S'éteint à chaque pas, faut de nourriture.
Boileau, L'Art Poctique, chant. iii. l. 319.

Dryden, in his dedication of the tranſlation of *Juvenal*, ſays, "When thus, as I may ſay, before the uſe of the loadſtone, or knowledge of the compaſs, I was ſailing in a vaſt ocean, without other help than the pole-ſtar of the ancients, and the rules of the French ſtage among the moderns," &c.

"There is a time when factions, by the vehemence of their own fermentation, ſtun and diſable one another." *Bolingbroke.*

This fault of jumbling the figure and plain expreſſion into one confuſed maſs, is not leſs common in allegory than in metaphor.

Take the following examples:

—————Heu! quoties fidem,
Mutatoſque Deos flebit, et aſpera
Nigris æquora ventis
Emirabitur inſolens,
Qui nunc te fruitur credulus aureâ:
Qui ſemper vacuam, ſemper amabilem
Sperat, neſcius auræ
Fallacis. *Horat. Carm.* lib. i. ode 5.

Pour moi ſur cette mer, qu'ici bas nous courons,
Je ſonge à me pourvoir d'eſquif et d'avirons,
A regler mes deſires, à prévenir l'orage,
Et ſauver, s'il ſe peut, ma Raiſon du naufrage.
Boileau, epitre 5.

Lord Halifax, ſpeaking of the ancient fabuliſts: "They (ſays he) wrote in ſigns, and ſpoke in parables: all their fables carry a double meaning: the ſtory is one, and entire; the characters the ſame throughout; not broken or changed, and always conformable to the nature of the creature they introduce. They never tell you, that the dog which ſnapped at a ſhadow, loſt his troop of horſe; that would be unintelligible. This is his (Dryden's new way of telling a ſtory, and confounding the moral and the fable together." After inſtancing from the Hind and Panther, he goes on thus: "What relation has the hind to our Saviour? or what notion have we of a panther's bible? If you ſay he means the church, how does the church feed on lawns, or range in the foreſt? Let it be always a church, or always a cloven-footed beaſt; for we cannot bear his ſhifting the ſcene every line."

A few words more upon allegory. Nothing gives greater pleaſure than this figure, when the repreſentative ſubject bears a ſtrong analogy, in all its circumſtances, to that which is repreſented: but the choice is ſeldom ſo lucky; the analogy being generally ſo faint and obſcure, as to puzzle and not pleaſe. An allegory is ſtill more difficult in painting than in poetry: the former can ſhow no reſemblance but what appears to the eye; the latter hath many other reſources for ſhowing the reſemblance. And therefore, with reſpect to what the abbé du Bos terms *mixt allegorical compoſitions*, theſe may do in poetry; becauſe, in writing, the allegory can eaſily be diſtinguiſhed from the hiſtorical part: no perſon, for example, miſtakes Virgil's Fame for a real being. But ſuch a mixture in a picture is intolerable; becauſe in a picture the objects muſt appear all of the ſame kind, wholly real or wholly emblematical. For this reaſon, the hiſtory of Mary de Medicis, in the palace of Luxembourg, painted by Rubens, is unpleaſant by a perpetual jumble of real and allegorical perſonages, which produce a diſcordance of parts, and an obſcurity upon the whole: witneſs, in particular, the tablature repreſenting the arrival of Mary de Medicis at Marſeilles; where, together with the real perſonages, the Nereids and Tritons appear ſounding their ſhells: ſuch a mixture of fiction and reality in the ſame group is ſtrangely abſurd. The picture of Alexander and Roxana, deſcribed by Lucian, is gay and fanciful; but it ſuffers by the allegorical figures. It is not in the wit of man to invent an allegorical repreſentation deviating farther from any ſhadow of reſemblance, than one exhibited by Louis XIV. anno 1664; in which an enormous chariot, intended to repreſent that of the ſun, is dragged along, ſurrounded with men and women, repreſenting the four ages of the world, the celeſtial ſigns, the ſeaſons, the hours, &c. a monſtrous compoſition, and yet ſcarcely more abſurd than Guido's tablature of Aurora.

In an allegory, as well as in a metaphor, terms ought to be choſen that properly and literally are applicable to the repreſentative ſubject: nor ought any circumſtance to be added that is not proper to the repreſentative ſubject, however juſtly it may be applicable properly or figuratively to the principal. The following allegory is therefore faulty:

Ferus et Cupido,
Semper ardentes acuens ſagittas
Cote *cruentâ*. *Horat.* lib. ii. ode 8.

For though blood may ſuggeſt the cruelty of love, it is an improper or immaterial circumſtance in the repreſentative ſubject: water, not blood, is proper for a whetſtone.

We proceed to the next head, which is, to examine in what circumſtances theſe figures are proper, in what improper. This inquiry is not altogether ſuperſeded by what is ſaid upon the ſame ſubject in the article COMPARISON; becauſe, upon trial, it will be found, that a ſhort metaphor or allegory may be proper, where a ſimile, drawn out to a greater length, and in its nature more ſolemn, would ſcarcely be reliſhed.

And, in the firſt place, A metaphor, like a ſimile, is excluded from common converſation, and from the deſcription of ordinary incidents. Secondly, In expreſſing any ſevere paſſion that totally occupies the mind, metaphor is unnatural.

The following example, of deep deſpair, beſide the highly figurative ſtyle, has more the air of raving than of ſenſe:

Caliſta. Is it the voice of thunder, or my father?
Madneſs! confuſion! let the ſtorm come on,
Let the tumultuous roar drive all upon me,
Daſh my devoted bark; ye ſurges, break it;
'Tis for my ruin that the tempeſt riſes.
When I am loſt, ſunk to the bottom low,
Peace ſhall return, and all be calm again.
Fair Penitent, act v.

The following metaphor is ſweet and lively; but it ſuits not the fiery temper of Chamont, inflamed with paſſion: parables are not the language of wrath venting itſelf without reſtraint:

Chamont. You took her up a little tender flow'r,
Juſt ſprouted on a bank, which the next froſt
Had nipp'd; and with a careful loving hand,
Tranſplanted her into your own fair garden,
Where the ſun always ſhines: there long ſhe flouriſh'd,
Grew ſweet to ſenſe, and lovely to the eye;
Till at the laſt a cruel ſpoiler came,
Cropt this fair roſe, and rifled all its ſweetneſs,
Then caſt it like a loathſome weed away.
Orphan, act iv.

The following ſpeech, full of imagery, is not natural in grief and dejection of mind.

Gonſalez. O my ſon! from the blind dotage
Of a father's fondneſs theſe ills aroſe.
For thee I've been ambitious, baſe, and bloody:
For thee I've plung'd into this ſea of ſin;
Stemming the tide with only one weak hand,
While t'other bore the crown (to wreathe thy brow),
Whoſe weight has ſunk me ere I reach'd the ſhore.
Mourning Bride, act v. ſc. 6.

There is an enchanting picture of deep diſtreſs in Macbeth, where Macduff is repreſented lamenting his wife and children, inhumanly murdered by the tyrant. Stung to the heart with the news, he queſtions the meſſenger over and over: not that he doubted the fact, but that his heart revolted againſt ſo cruel a misfortune. After ſtruggling ſome time with his grief, he turns from his wife and children to their ſavage butcher: and then gives vent to his reſentment, but ſtill with manlineſs and dignity:

O, I could play the woman with mine eyes,
And braggart with my tongue. But, gentle Heav'n!
Cut ſhort all intermiſſion; front to front
Bring thou this fiend of Scotland and myſelf;

Within my ſword's length ſet him. If he 'ſcape,
Then Heav'n forgive him too.

Metaphorical expreſſion, indeed, may ſometimes be uſed with grace where a regular ſimile would be intolerable: but there are ſituations ſo ſevere and diſpiriting, as not to admit even the ſlighteſt metaphor. It requires great delicacy of taſte to determine with firmneſs, whether the preſent caſe be of that nature: perhaps it is; yet who could with a ſingle word of this admirable ſcene altered?

But metaphorical language is proper when a man ſtruggles to bear with dignity or decency a misfortune however great; the ſtruggle agitates and animates the mind:

Wolſey. Farewell, a long farewell to all my greatneſs;
This is the ſtate of man: to day he puts forth
The tender leaves of hope; to-morrow bloſſoms,
And bears his bluſhing honours thick upon him;
The third day comes a froſt, a killing froſt,
And when he thinks, good eaſy man, full ſurely
His greatneſs is a-ripening, nips his root,
And then he falls as I do. *Henry VIII.* act iii. ſc. 6.

METAPHRAST, a tranſlator, or perſon who renders an author into another form or another language, word for word.

METAPHYSICS.

1 Definition. METAPHYSICS has been defined, by a writer deeply read in the ancient philoſophy, "The ſcience of the principles and cauſes of all things exiſting." This definition, we think, extremely proper: and hence it is, that *mind* or intelligence, and eſpecially the *ſupreme intelligence*, which is the cauſe of the univerſe, and of every thing which it contains, is the principal ſubject of this ſcience; and hence, too, the ſcience itſelf received its name. Ariſtotle, indeed, who, of all the ancient metaphyſicians whoſe works have come down to us, was unqueſtionably the greateſt, calls this ſcience THE FIRST PHILOSOPHY, as being not only ſuperior, but alſo prior in the order of nature, to the whole circle of the other arts and ſciences. But, "what is firſt to nature, is not firſt to man." Nature begins with *cauſes*, which produce *effects*. Man begins with *effects*, and by them aſcends to *cauſes*. Thus all human ſtudy and inveſtigation proceed of neceſſity in the reverſe of the natural order of things, from *ſenſible* to *intelligible*, from *body* the effect, to *mind*, which is both the firſt and the final cauſe. Now, PHYSICS being the name given by the Stagyrite to the philoſophy of body, ſome of his interpreters, from this neceſſary courſe of human ſtudies, called that of mind METAPHYSICS, implying by that term, not only that its ſubject is more ſublime and difficult, but alſo that the ſtudy of it would be moſt properly and ſucceſsfully entered upon AFTER THAT OF PHYSICS. To this name, which, though it has ſometimes been treated with ridicule, is abundantly ſignificant, the followers of Ariſtotle were led by their maſter, who, to the books in which he pretends to elevate the mind above things corporeal to the contemplation of God and things ſpiritual, prefixed the Greek words μετα τα φυσικα (A).

2 Diviſion of the ſcience into The ſcience of Metaphyſics has been divided, according to the objects which it conſiders, into ſix principal parts, which are called, 1. *Ontology*; 2. *Coſmology*; 3. *Anthropoſophy*; 4. *Pſychology*; 5. *Pneumatology*; and, 6. *Metaphyſical theology.*

3 Ontology; 1. That part of the ſcience which is named *ontology*, inveſtigates and explains the nature and eſſence of all beings, as well as the qualities and attributes that eſſentially appertain to them. Hence it has been ſaid that ontology ſhould proceed in its operations from the moſt ſimple ideas; ſuch as do not admit of any other qualities of which they may be compounded. Theſe ſimple ideas are of *being*, of *eſſence*, of *ſubſtance*, of *mode*, of *exiſtence* as well with regard to time as place, of a *neceſſary cauſe* of *unity*; the idea of *negation*; the difference between a *being* that is *ſimple* or *compound*, *neceſſary* or *accidental*, *finite* or *infinite*; the ideas of *eſſential* and *abſtract properties*, ſuch as of the *greatneſs*, *perfection*, and *goodneſs* of *beings*, &c. The buſineſs therefore of ontology, is to make us acquainted with every kind of being in its nature and eſſential qualities, which diſtinguiſh it from all other beings. This knowledge being once eſtabliſhed on ſimple principles, juſt conſequences may thence be drawn, and thoſe things proved after which the metaphyſician inquires, and which is the buſineſs of his ſcience to prove.

It is eaſy to conceive, that even a clear knowledge of beings, and their eſſential properties, would be ſtill defective and uſeleſs to man, if he did not know how to determine and fix his ideas by proper denominations, and conſequently to communicate his perceptions to thoſe whom he would inſtruct, or againſt whom he is obliged to diſpute. To render our ideas therefore intelligible to others, we muſt have determinate words or denominations for each being, and the qualities of each being; and ontology teaches us thoſe terms which are ſo neceſſary to fix our ideas, and to give them the requiſite perſpicuity and preciſion, that when we endeavour to extend the ſphere of

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(A) ΤΩΝ ΜΕΤΑ ΤΑ ΦΥΣΙΚΑ. Cujus inſcriptionis hæc ratio eſt, quod in hoc opere ea tractantur quorum theoria poſterior eſt doctrinæ naturali ſaltem quoad nos, qui à corporum cognitione rerumque caducarum in ſubſtantiarum immaterialium atque immortalium contemplationem provehimur.

Du Val. Synopſ. Doctr. Peripat.

of our knowledge, we may not waſte our time in diſputes about words.

4 Coſmology; 2. Metaphyſics, having, in as ſolid a manner as poſſible, explained and eſtabliſhed the principles above mentioned, continues its inquiries to the ſecond part, which is called *coſmology*, and examines into the eſſence of the world and all that it contains; its eternal laws; of the nature of matter; of motion; of the nature of tangible bodies, their attributes and adjuncts; and of all that can be known by reaſoning and experience. It is alſo in coſmology that the metaphyſicians of this ſchool examine the Leibnitzian ſyſtem; that is, whether God, in creating the world, muſt neceſſarily have created the beſt world; and if this world be ſo in fact. In this manner they purſue the argument, from conſequence to conſequence, to its laſt reſort, frequently with very little advantage to truth and ſcience.

5 Anthropoſophy; 3. *Anthropoſophy*, or the knowledge of man, forms the third branch of metaphyſics. It is ſubdivided into two parts. The firſt, which conſiſts in the knowledge of the exterior parts of the human frame, belongs not to this ſcience, but to Anatomy and Phyſiology. The buſineſs of the metaphyſician is here to aſcertain the nature of thoſe powers by which all the motions eſſential to life are produced; and to diſcover, if poſſible, whether they be corporeal or ſpiritual. This inquiry leads at the ſame time to

6 Pſychology; 4. *Pſychology;* which conſiſts in the knowledge of the intellectual ſoul in particular; concerning which the moſt profound, the moſt ſubtle, and moſt abſtract reſearches, have been made that human reaſon is capable of: and concerning the ſubſtance of which, in ſpite of all theſe efforts, it is yet extremely difficult to ſupport any poſitive opinion with concluſive or probable arguments.

7 Pneumatology; 5. The fifth part of metaphyſics is called *pneumatology*. By this term, which has not been long in uſe, metaphyſicians mean the knowledge of all ſpirits, *angels*, &c. It is eaſy to conceive what infinite art is neceſſary to give an account of that, of which nothing poſitive can ever be known in the preſent ſtate of human exiſtence. But the metaphyſician of this ſchool readily offers to ſhow us, "what is the idea of a ſpirit; the effective exiſtence of a ſpirit; what are its general qualities and properties; that there are rational ſpirits, and that theſe rational ſpirits have qualities that are founded in the moral attributes of God:" for this is in ſo many words what is attempted to be taught in pneumatology.

8 Metaphyſical theology. 6. *Metaphyſical theology*, which Leibnitz and ſome others call *theodicy*, is the ſixth and laſt branch of the ſcience of metaphyſics. It teaches us the knowledge of the exiſtence of God; to make the moſt rational ſuppoſitions concerning his divine eſſence, and to form a juſt idea of his attributes and perfections, and to demonſtrate them by abſtract reaſoning. Theodicy differs from natural theology, in as much as this laſt borrows, in fact, from theodicy proofs and demonſtrations to confirm the exiſtence of a ſupreme Being: but after having ſolidly eſtabliſhed that great truth, by extending its conſequences natural theology teaches us what are the relations and connexions that ſubſiſt between the ſupreme Being and men, and what are the duties which reſult from theſe relations.

9 This diviſion uſeleſs and improper. We have briefly mentioned theſe diviſions of the ſcience, becauſe they were once prevalent in the ſchools. The greater part of them, however, appears to us to be not only ſuperfluous, but ſuch as can ſerve no other purpoſe than to perplex the mind. The only beings of which we know any thing are mind and body; and we have no reaſon to think that there are any other beings in the univerſe. Of bodies indeed there are various kinds, endowed with different properties: and it is extremely probable, that of minds endowed with different powers, the variety may be equally great. Our own minds we know to be united in one ſyſtem with bodies by which they perform all their operations; and we can demonſtrate that there is another Mind, which is independent of all body, and is the cauſe of all things. Between theſe there may be numberleſs orders of minds; but their energies are wholly unknown to us, and therefore they can never become the objects of ſcience.

Mind and body therefore, *i. e.* the minds and bodies which we know to exiſt, together with their powers and properties, eſſential and accidental, can alone be the ſubjects of rational inquiry. We may inquire into the eſſence of mind and the eſſence of body, and endeavour to aſcertain in what reſpects they differ. We may examine the nature of different bodies, in order to diſcover whether all bodies, however modified, have not ſomething in common; and we may conſider the properties, relations, and adjuncts of bodies, and endeavour to diſtinguiſh thoſe which are accidental from ſuch as appear to be ſo neceſſary that without them body itſelf could not exiſt. Of minds we cannot make the ſame compariſon. In this part of the ſcience we have not ſufficient data for an accurate and complete induction: we can only examine the powers of our own mind; and by probable analogy make ſome eſtimate of the powers of ſuperior minds, as obſervation will help us to gueſs at the powers of thoſe which are placed beneath us in the ſcale of exiſtence.

If this be ſo, Coſmology, as diſtinguiſhed from Ontology, cannot properly be a branch of Metaphyſics. For if mind and body, with their ſeveral powers, properties, and adjuncts, compoſe the univerſe, it is obvious, that when we have aſcertained, as well as we are able, the eſſence of mind and the eſſence of body, together with the powers and properties of each, and have traced them all to the firſt cauſe, we have done every thing in the ſcience of the univerſe, if we may uſe the expreſſion, which belongs to the province of the metaphyſician. The particular laws of motion on the earth and in the planetary ſyſtem belong to the natural philoſopher and aſtronomer.

In like manner, Anthropoſophy, Pſychology, Pneumatology, if they be not words expreſſive of diſtinctions where there is no difference, ſeem to be at leaſt very needleſsly disjoined from each other. Of the nature of ſpirits we can know nothing but from contemplating the powers of our own minds; and the body of man is in the province, not of the metaphyſician, but of the anatomiſt and phyſiologiſt. Anthropoſophy, pſychology, and pneumatology, if they be uſed to denote our knowledge of all minds except the Supreme, are words of the ſame import; for of no created minds except our own can we acquire ſuch knowledge as deſerves the name of ſcience.

Ontology has ſometimes been defined the ſcience of *being in the abſtract*; but in the courſe of our inquiries it will be ſeen, that *being in the abſtract* is a phraſe without meaning. Conſidered as the ſcience of *real beings* and their *properties*, Ontology is a very ſignificant word, of the ſame import with Metaphyſics, comprehending in itſelf the knowledge of the nature of all things exiſting. Or if it be thought proper to make a diſtinction between ontology and theology, the former branch of the ſcience will teach the knowledge of body and created minds, whilſt it is the province of the latter to demonſtrate the exiſtence and attributes of that mind which is uncreated.

10 Another propoſed.

Body and mind, therefore, with their properties, adjuncts, and powers, comprehend the whole ſubject of the ſcience of metaphyſics: and as we are earlier acquainted with body than with mind, the natural order of conducting our inquiries ſeems to be, to begin with the former, and thence proceed to the latter. It is obvious, however that if we would purſue theſe inquiries with any hopes of ſucceſs, we muſt firſt trace human knowledge from its ſource, aſcertain the nature of truth, and ſhow what kind of evidence on each topic to be treated ought to enforce conviction. In this view of the ſcience, metaphyſics appears to be divided into three parts; the firſt treating *of human underſtanding*; the ſecond, *of body with its adjuncts*; and the third, *of mind with its powers*.

11 Idea and notion explained.

Previous to the entering upon ſuch inquiries, ſome philoſophers of great merit have thought it expedient to explain the terms which they might have occaſion to uſe. Their conduct is judicious and worthy of imitation; for the objects of metaphyſics being, for the moſt part, ſuch as fall not under the cognizance of the ſenſes, are liable to be differently apprehended by different men, if the meanings of the words by which they are expreſſed be not aſcertained with the utmoſt preciſion. We intend, however, to uſe very few words but in the common acceptation; and we therefore hope, that as terms of ſcience are explained under different words in the Dictionary, to which references are made, we have little or no occaſion for ſwelling the article by previous definitions. There are indeed two words which have given riſe to much uſeleſs diſputation, which yet cannot be baniſhed from ſpeculative philoſophy, and which it will therefore be proper here to define. The words to which we allude are *idea* and *notion*. Theſe are very generally conſidered as ſynonymous; but we think that much logomachy might have been avoided by aſſigning to each a determinate ſignification. We know not any philoſopher who made much uſe of the word *idea* before Plato; but with his myſterious doctrine concerning ideas we have here nothing to do: our preſent buſineſs is to aſcertain the preciſe meaning of the word, which is evidently derived from ειδω to *ſee*, as the word *notion* is from "noſco, novi, *notum*," and that from γινωσκω to *know* or *underſtand*. In the original ſenſe of the two words, therefore, *notion* is more comprehenſive than *idea*, becauſe we *know* many things which cannot be *ſeen*. We have not a doubt, but that at firſt the word *idea* was employed to denote only thoſe forms of external objects which men contemplate in their imaginations, and which are originally received through the ſenſe of *ſight*. Its ſignification was afterwards extended to the relicts of every ſenſation, of touch, taſte, ſound, and ſmell, as well as of ſight; and at laſt it was confounded with *notion*, which denotes the mental apprehenſion of whatever may be known. In our uſe of the word *idea*, except when we quote from others, we ſhall employ it only to denote that appearance which abſent objects of ſenſe make in the memory or imagination (B); and by the word *notion* we ſhall denote our apprehenſion or knowledge of ſpirits, and all ſuch things as, though they be the objects of ſcience, cannot be perceived by the external ſenſes. Having ſaid this, we proceed to our inquiries, beginning with that into human underſtanding.

PART I. OF HUMAN UNDERSTANDING.

Preliminary Obſervations on the Origin *of our* Ideas *and* Notions.

12 No innate ideas or notions in the human mind.

THAT the mind of man has no innate ideas or notions, but comes into the world ignorant of every thing, is a truth which ſince the days of Locke has been very little diſputed. In the firſt book of his Eſſay on the Human Underſtanding, that acute philoſopher has demonſtrated, that the rudiments or firſt principles of all our knowledge are communicated to us by ſenſation; and he has compared the mind, previous to the operation of external objects upon the ſenſes, to a *tabula raſa* or ſheet of white paper. To repeat his arguments would ſwell the article to no purpoſe. There is not a man capable of attending to his own ideas, who

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(B) In thus reſtricting the meaning of the word *idea*, we have the honour to agree with the great Engliſh Lexicographer.—"He was particularly indignant againſt the almoſt univerſal uſe of the word *idea* in the ſenſe of *notion* or *opinion*, when it is clear that *idea* can only ſignify ſomething of which an image may be formed in the mind. We may have an *idea* or *image* of a mountain, a tree, or a building; but we cannot ſurely have an *idea* or *image* of an *argument* or *propoſition*. Yet we hear the ſages of the law delivering their *ideas* upon the queſtion under conſideration; and the firſt ſpeakers in Parliament entirely coinciding in the *idea*, which has been ſo ably ſtated by an honourable member; or repreſenting an *idea* as unconſtitutional, and fraught with the moſt dangerous conſequences to a great and free country. This Johnſon called *modern cant*." *Boſwell's Life of Johnſon.*

who can entertain a doubt in what manner he received them. Without the ſenſe of ſight, we could never have known colours; nor ſound, without hearing; nor hardneſs, ſoftneſs, ſmoothneſs, pain, or bodily pleaſure, without touch; nor odours, without ſmell, &c.

Self-evident as theſe facts are, objections have been ſtarted to the inferences drawn from them; and Locke has been accuſed of advancing principles ſubverſive of all diſtinction between truth and falſehood, and favourable of courſe to univerſal ſcepticiſm.—"The firſt book of his Eſſay, which with ſubmiſſion (ſays Dr Beattie*) I think the worſt, tends to eſtabliſh this dangerous doctrine, that the human mind, previous to education and habit, is as ſuſceptible of one impreſſion as of another: a doctrine which, if true, would go near to prove that truth and virtue are no better than human contrivances; or at leaſt that they have nothing permanent in their nature, but may be as changeable as the inclinations and capacities of men; and that there is no ſuch thing as common ſenſe in the world. Surely this is not the doctrine which Mr Locke meant to eſtabliſh." We are ſo thoroughly ſatisfied that it is not, that we cannot help wondering how ſuch inferences could, by a man of learning, genius, and candour, be drawn from any thing which is to be found in the Eſſay on the Human Underſtanding.

But the Doctor thinks Mr Locke's "ſimile of the mind to white paper one of the moſt unlucky alluſions that could have been choſen; becauſe the human ſoul, when it begins to think, is not extended, nor of a white colour, nor incapable of energy, nor wholly unfurniſhed with ideas, nor as ſuſceptible of one impreſſion or character as of any other:" and it has been obſerved by another objector†, that "on a ſheet of white paper you may write that ſugar is bitter; wormwood ſweet; fire and froſt in every degree pleaſing and ſufferable: that compaſſion and gratitude are baſe; treachery, falſehood, and envy, noble; and that contempt is indifferent to us."

13 Objections anſwered.

All this is true; but we apprehend it is not to the purpoſe. Mr Locke has no where expreſſed himſelf in ſuch a manner as to lead us to ſuppoſe that he believed the ſoul to be extended or coloured; or, when it begins to think, incapable of energy, and wholly unfurniſhed with ideas: but he certainly did believe, that it begins not to think the firſt inſtant of its exiſtence, and that it *acquires* all the ideas of which it is ever poſſeſſed. We may undoubtedly write upon a piece of white paper that ſugar is bitter, and that wormwood is ſweet; but how the capacity of paper to receive the ſymbols of falſe propoſitions ſhould make Mr Locke's compariſon improper or dangerous, we cannot comprehend. Mr Uſher indeed ſays, that it is improper on this account, "that no human art or induſtry is able to make thoſe impreſſions upon the mind: in reſpect of them, the mind diſcovers not a paſſive capacity, but reſiſts them with the force of fate." Does it indeed? does the mind reject the idea of ſugar or of bitterneſs, of contempt or of indifference? May not any man have the *idea* of ſugar and at the ſame time the *idea* of bitterneſs, and compare the one with the other in his mind, as well as the word *ſugar* may be written beſide the word *bitter*, and connected with it on the ſame piece of paper? In all this we perceive nothing that is impoſſible or even difficult. The mind cannot indeed be made to feel that ſugar has the ſame taſte with wormwood; but who ever thought that it could? Not Mr Locke, we ſhall be bold to ſay; nor does his ſimile give the ſmalleſt countenance to ſuch an abſurdity. The author of the Eſſay on the Human Underſtanding underſtood his ſubject too well to imagine that either truth or falſehood could be communicated to paper, or that paper is capable of comparing ideas. Paper is capable of receiving nothing but lines or figures; and it paſſively receives whatever lines or figures we may chooſe to inſcribe on it: yet if a pen be carried over it in a circular direction, the figure impreſſed will not be a ſquare; juſt as, to the mind of one eating ſugar, the taſte communicated is not that of wormwood.

On a piece of paper a circle may be deſcribed, and cloſe beſide it a ſquare: in like manner an agreeable ſenſation may be communicated to the mind, and immediately afterwards a ſenſation that is diſagreeable. Theſe two ſenſations, or the ideas which they leave behind them, may be compared together; and it is certainly true that no art or induſtry can make them appear ſimilar in the mind: but is it not equally true, that no art or induſtry can make the circle and the ſquare ſimilar on the paper? The paper is ſuſceptible of any ſort of plain figures, and the mind is equally ſuſceptible of any ſort of ideas or ſenſations; but figures diſſimilar cannot be made to coincide, neither can diſcordant ideas be made to agree. Again, one may write upon paper, that "a circle *is* a ſquare," and likewiſe that "a circle *is not* a ſquare;" and both theſe propoſitions may be communicated to the mind by the organs of ſight or of hearing. The paper receives the *words* expreſſive of the falſe as well as thoſe expreſſive of the true propoſition; and the mind receives the *ideas* and *relations* ſignified by the one cluſter of words as well as thoſe ſignified by the other: but in the mind the *idea* of a ſquare is *different* from that of a circle, and on the paper the *figure* of a ſquare is *different* from the *figure* of a circle. The great difference between the mind and the paper is, that *the former* is *conſcious* of its ideas, and *perceives* their agreement or diſagreement; whereas the paper is *not* conſcious of the figures drawn upon it, nor perceives any thing about them. But ſtill thoſe figures are what they are; they either agree or diſagree on the paper, as well as the ideas either agree or diſagree in the mind. It is not in the power of the mind to alter the *ideas* of the ſquare and the circle, not in the power of the paper to alter the *forms* of theſe figures.

It appears then, that the principles of Mr Locke, and the compariſon by which he illuſtrates them, have no more tendency to ſubvert the difference between truth and falſehood, right and wrong, than the paſſiveneſs of paper has to ſubvert the difference between a ſtraight line and a crooked, a circle and a ſquare: and with a view to eſtabliſh the doctrine of innate ideas and inſtinctive principles of knowledge, we might with as much propriety aſk, Whether it be poſſible to imagine that any mode of manufacture could make paper of ſuch a nature, as that a pen drawn over it in a circular direction would leave the figure of a ſquare? as that, "Whether it be poſſible to imagine, that any courſe of education could ever bring a rational creature to believe that two and two are equal to three."

The

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* *Eſſay on the Nature and Immutability of Truth.*

† *J. Uſher, author of* Clio. See *a vol. of Fugitive Pieces printed for J. Davies, London,* 1774.

Origin of Ideas and Notions.

The mind being thus, as we may ſay, originally white paper, void of all characters, without ideas or notions of any kind, the firſt queſtion which we have to conſider is, Whence and in what manner it derives the materials of all its knowledge? To this queſtion the only anſwer which can be given is, That it derives them from obſervation and experience; from obſervation, either employed upon external objects of ſenſe, or turned inwardly upon its own operations. Our ſenſes, converſant about particular external objects, convey into the mind ſeveral diſtinct perceptions; ſuch as thoſe of *colour*, *figure*, *heat*, *cold*, *bitterneſs*, *ſweetneſs*, and all thoſe things which are uſually called *ſenſible qualities*. The notions, ideas, or whatever elſe they may be called, which are acquired in this manner, may be called *ſenſible knowledge*; and the ſource of that knowledge is termed *ſenſation*.

14
But all derived from ſenſation and reflection.

The other fountain from which experience furniſhes the underſtanding with knowledge, is that attention which we are capable of giving to the operations of our own minds when employed about thoſe ideas which were originally ſuggeſted by objects of ſenſe. Theſe operations, when the ſoul comes to reflect on them, furniſh us with a ſet of notions entirely different from the ideas of ſenſe; ſuch as the notions of *perception*, *thinking*, *doubting*, *believing*, *reaſoning*, *knowing*, *willing*, and all the different energies and paſſions of our own minds. Of theſe operations we are always conſcious when we are awake: but it requires, as ſhall be ſhown afterwards, no inconſiderable effort to ſet them, as it were, at a diſtance, to reflect on them and conſider what they are; but when we have made this effort, we acquire notions as diſtinct, and perhaps more important, than thoſe ideas which we receive through the medium of the ſenſes.

Senſation and reflection then furniſh mankind with the firſt materials of all their knowledge. The mind ſeems not to have ideas or notions of any kind which it did not receive by one or other of theſe ways. By means of the ſenſes it perceives external objects; and by that power which it has of turning its attention upon itſelf, it diſcovers the nature and manner of its own operations.

Although the knowledge which we acquire from *reflection* be of equal importance, and perhaps of greater certainty than that which we receive through the medium of the ſenſes, it comes into the mind at a much later period; both becauſe it is impoſſible that the faculties of the mind ſhould operate without materials, and becauſe it is much more difficult to attend to theſe operations even while they are going on, than to the objects of ſenſe which ſolicit our attention. It is for this reaſon pretty late before children have any notions whatever of the operations of their own minds; and of the greater part of theſe operations the bulk of mankind have no clear or accurate notions during their whole lives. On the other hand, every human being is ſo ſurrounded with bodies, which perpetually and variouſly affect his ſenſes, that a variety of ſenſible ideas force an entrance even into the minds of children. In order therefore to trace the procedure of the underſtanding, and to aſcertain the extent and limits of human knowledge, it ſhould ſeem that we muſt begin with conſidering the external ſenſes, that we may diſcover the manner in which we receive knowledge by means of them, the objects of that knowledge, and its certainty. It is to be obſerved, however, that though we conſider the mind as poſſeſſed of many powers or faculties, and inquire firſt into the nature of that faculty which we conceive to be firſt exerted, this is done merely for the ſake of proceeding in our ſubject with method and perſpicuity. The mind is one ſimple and undivided being; and in every mental energy it is the whole mind, and not any part or portion of it, that is energetic. On this account, it is impoſſible to explain even the nature of ſenſation and perception to him who knows not what is meant by *will* and *underſtanding*; but to every one who is acquainted with the common import of theſe words, and who has read the ſhort ſyſtem of LOGIC inſerted in this Work, we hope that our theory of perception will be intelligible and convincing.

Of Senſation.

CHAP. I. *Of* SENSATION *and* PERCEPTION.

SECT. I. *Of Senſation.*

15
Senſation by five organs.

THE Supreme Being, who made us and placed us in this world, has given us ſuch powers of mind as he ſaw to be ſuited to our ſtate and rank in his creation. He has given us the power of perceiving many objects around us; but that power is limited in various ways; and particularly in this, that without the organs of the ſeveral ſenſes we perceive no external object. The ſenſes, as every one knows, are five in number, and each communicates its proper ſenſation. It is by the eyes alone that we ſee, by the ears that we hear, by the noſe that we ſmell, and by the tongue and palate that we taſte; the ſenſe of feeling or touch is ſpread over the whole body, for we feel equally by our hands and by our feet, &c. To the powers of perception by the ſenſes it is neceſſary not only that we have all the organs enumerated, but that we have them alſo in a ſound and natural ſtate. There are many diſorders of the eye which cauſe total blindneſs, as well as others which impair without deſtroying the power of viſion. The ſame thing is true of the organs of all the other ſenſes.

All this is ſo well known from experience, that it needs no proof; but it may be worth while to obſerve, that it is known from experience only*. For any thing that we know to the contrary, our Creator might have endowed us with the power of perception by a thouſand organs of ſenſe, all different from thoſe which we poſſeſs; and it is certain that he himſelf perceives every thing more perfectly than we do without bodily organs. For it is to be obſerved, that the organs of ſenſe are different from the being which is ſentient.—It is not the eye which ſees, nor the ear which hears; theſe are only the organs by which we ſee and hear. A man cannot ſee the ſatellites of Jupiter but by means of a teleſcope, nor hear a low voice but by means of an ear trumpet. Does he from this conclude that it is the teleſcope which ſees thoſe ſatellites, or the trumpet which hears that voice? Such a concluſion would be evidently abſurd. It is no leſs abſurd to conclude that it is the eye which ſees, or the ear which hears. The teleſcope and the trumpet are artificial organs of ſight and of hearing, of which the eye and the ear are natural organs; but the natural organs ſee and hear as little as the artificial.

16
Theſe organs themſelves not ſentient, but

17
Inſtruments of ſenſation.

That this is the caſe with reſpect to the eye and the ear, is ſo obvious, that, as far as we know, it has never been denied. But with reſpect to the ſenſes of touch, taſte, and ſmell, the truth at firſt view appears not ſo evident. A celebrated writer has obſerved *, that "after the utmoſt efforts, we find it beyond our power to conceive the flavour of a roſe to exiſt in the mind: we are neceſſarily led to conceive that pleaſure as exiſting in the noſtrils, along with the impreſſion made by the roſe upon that organ (c); and the ſame will be the reſult of experiments with reſpect to every feeling of taſte, touch, and ſmell. Touch (he ſays), affords the moſt ſatisfactory evidence, and philoſophy detects the deluſion." To detect this deluſion requires, indeed, no great depth in philoſophy; for it is ſo far from being true that we are neceſſarily led otherwiſe than by aſſociation, of which the laws ſhall be explained afterwards, to conceive the pleaſure or pain of touch as exiſting at that part of our body upon which the impreſſion is made, that, as every man muſt have obſerved, children previous to experience cannot diſtinguiſh the preciſe place of their bodies which is affected by the touch of any external object. Nay, we believe it will be found upon trial, that if a full grown man, with all the experience of age to guide him, he pricked with a pin on any part of his body which he has ſeldom handled, and never ſeen, he will not readily nor at firſt put his finger upon the wound, nor even come very *near* to the wound. This, however, he would certainly and infallibly do were the ſenſe of touch neceſſarily conceived as exiſting at the organ. To theſe obſervations objections may perhaps be made, which we cannot ſtay to obviate; but the following, we think, will admit of none. We appeal to every man who has experienced that particular ſenſation of touch which Scaliger dignified with the name of a ſixth ſenſe, whether, whilſt thoſe ſenſations were new to him, he was neceſſarily led to conceive them as exiſting at any particular organ. If he was not, it follows undeniably that the organs of ſenſation are different from the being which is ſentient; that it is not the eye which ſees, the ear which hears, the noſtrils which ſmell, the tongue which taſtes, nor any part of the body which feels; and that it is by experience that we learn to aſſociate our ſeveral ſenſations with thoſe organs upon which the impreſſions are made.

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* *Reid's Eſſays on the Intellectual Powers of Man.*

It is, however, certain that we receive no ſenſation from external objects, unleſs when ſome impreſſion is made upon the organ of ſenſe, either by the immediate application of the object itſelf, or by ſome medium which paſſes between the object and the organ †. In two of our ſenſes, viz. *touch* and *taſte*, there muſt be an immediate application of the object to the organ. In the other three the ſenſation is occaſioned by the impreſſion of ſome medium paſſing from the object to the organ. The effluvia of bodies drawn into the noſtrils with the breath are the medium of ſmell; the undulations of the air are the medium of hearing; and the rays of light paſſing from viſible objects to the eye are the medium of ſight. Theſe are facts known from experience to hold univerſally both in men and in brutes.

18
The brain and nerves neceſſary to ſenſation.

It is likewiſe a law of our nature perfectly known to all who know any thing of anatomy, that in order to actual ſenſation the impreſſions made upon the external organs muſt be communicated to the nerves, and from them to the brain. Firſt, The object, either immediately, or by ſome medium, makes an impreſſion upon the organ; the organ ſerves only as a medium, by which the impreſſion is communicated to the nerves; and the nerves ſerve as a medium to carry it on to the brain. Here the corporeal part ends; at leaſt we can trace it no farther. The reſt is all intellectual.

The proof of theſe impreſſions upon the nerves and brain in ſenſation is this, that from many obſervations and experiments it is found, that when the organ of any ſenſe is perfectly ſound, and has the impreſſion made upon it by the object ever ſo ſtrongly, yet if the nerve which ſerves that organ be cut or tied hard, there is no ſenſation; and it is well known that diſorders in the brain deprive us of ſenſation, while both the organ and its nerve are ſound.

19
Proceſs of nature in ſenſation.

There is ſufficient reaſon, therefore, to conclude, that in ſenſation the object produces ſome change in the organ; that from the organ the change proceeds to the nerve, and from the nerve to the brain. Hence it is that we have poſitive ſenſations, from negative objects, or mere nonentities, ſuch as *darkneſs*, *blackneſs*, and *vacuity*. For, ſenſation reſulting from changes in the brain, whatever produces any change muſt of courſe occaſion a new ſenſation: but it is obvious, that the mere abſence of any impreſſion, by the removal of the object which produced it, muſt as neceſſarily cauſe a change in the organ, nerves, and brain, as the preſence of a new impreſſion from a new object. To theſe changes, or that which *immediately* produces them, we give the name of *impreſſions*; becauſe we know not how, in a general manner, to expreſs more properly any change produced by an external cauſe without ſpecifying the nature of that cauſe. Whether it be preſſure, or attraction, or repulſion, or vibration, or ſomething unknown, for which we have no name, ſtill it may be called an impreſſion.

Sir Iſaac Newton was perhaps the firſt who ſuppoſed that the rays of light falling upon the bottom of the eye excite vibrations in the *tunica retina*; and that thoſe vibrations being propagated along the ſolid fibres of the optic nerves into the brain, cauſe the actual ſenſation of ſeeing. This hypotheſis was adopted by Dr Hartley, applied to the other ſenſes, and ſhown to be

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* *Elements of Criticiſm.*

† *Reid's Eſſays on the Intellectual Powers of Man*, and *Hartley's Obſervations on Man.*

(c) Another eminent writer thinks on this ſubject very differently, and in our opinion much more juſtly.—"Suppoſe (ſays Dr Reid) a perſon who never had this ſenſe (viz. *ſmell*) before, to receive it all at once, and to ſmell a roſe; can he perceive any ſimilitude or agreement between the ſmell and the roſe? or indeed between it and any other object whatever? Certainly he cannot. He finds himſelf affected in a new way, he knows not why, or from what cauſe. He is conſcious that he is not the cauſe of it himſelf; but he cannot from the nature of the thing determine whether it be cauſed by body or ſpirit; by ſomething near, or by ſomething at a diſtance. He cannot give it a *place* any more than he can give a place to melancholy or joy; nor can he conceive it to have any exiſtence but when it is ſmelled." *Inquiry into the Human Mind*, ch. 2. ſect. 2.

20 In ſenſation the mind is partly active.

be at leaſt as probable as any which has yet been invented to account for the perception of external objects by means of the organs of ſenſe. Be this as it may, experience informs us, that whatever be the nature of thoſe impreſſions and changes which are made by external objects upon the ſenſes, nerves, and brain, we have without them no actual ſenſation, and of courſe perceive nothing *ab extra*. Hence it has been ſuppoſed, that the mind is wholly paſſive in ſenſation, and that ſenſation is *neceſſarily* produced by thoſe impreſſions. But this we believe to be a miſtake. Every man who has been attentive to his own thoughts and actions, muſt know inſtances of impreſſions having been certainly made upon his organs of ſenſe without producing any ſenſation, or ſuggeſting to his mind the perception of the particular objects by which the impreſſions were cauſed. He whoſe mind is intenſely employed in any particular purſuit, may have his eyes open upon an object which he does not ſee; or he may not hear the ſound of a clock ſtriking within two yards of him: Nay, we will venture to affirm, that there is hardly one reader of this article to whom ſuch abſences of ſenſation have not often occurred. Now, as there is no reaſon to ſuppoſe, that in the one caſe the undulations of the air, cauſed by the ſtriking of the clock, did not reach his ears, or that in the other the rays of light, reflected from the object, did not fall upon his eyes, which were open to receive them; the only reaſon which can be aſſigned for his not having, in theſe inſtances, had audible and viſible ſenſations, is, that his mind was ſo engaged in ſomething elſe as not to pay to the vibrations in his brain that attention, if we may ſo ſay, without which impreſſions *ab extra* can produce no ſenſation. There are, indeed, ſome impreſſions on the organs of ſenſe ſo violent and ſo ſudden, as to force themſelves upon the mind however employed. Such are thoſe made on the ear by thunder, and on the eye by ſtrong light. In theſe caſes, ſenſation is involuntary and unavoidable; whence we conclude, not that in ſuch inſtances the mind is paſſive or deſtitute of energy, but that by the violent agitation given to the brain, it is rouſed from its reverie, and compelled to give attention. It appears, therefore, that in ſenſation the mind exerts ſome kind of energy; for in nothing but in the ſentient being itſelf can we ſeek for the cauſe why, when all external circumſtances are the ſame, organical impreſſions ſometimes produce ſenſations and ſometimes not; and that cauſe can only be the energy of the mind; what kind of energy, we pretend not to ſay.

SECT. II. *Of Perception by the Senſes.*

21 Difficult to account for the perception of objects.

How the correſpondence is carried on between the thinking principle within us and the material world without us, has always, as Dr Reid obſerves, been found a very difficult problem to thoſe philoſophers who conſider themſelves as obliged to account for every phenomenon in nature. It is, indeed, a problem of which we expect not to ſee a complete ſolution. A few ſteps beyond the vulgar we may certainly go; but the nature of that connexion by which the mind and body are united, will probably remain for ever unknown. One queſtion, however, which has employed much of the attention of philoſophers, both ancient and modern, appears to be not wholly unanſwerable. It is, Whether by means of our ſenſes we perceive external objects mediately or immediately; or in other words, Whether ſenſation and perception be one and the ſame thing, or two things ſucceeding each other? On this ſubject, till of late, there appears to have been in the main a great uniformity in the ſentiments of philoſophers, notwithſtanding their variations reſpecting particular points. Of ſome of the moſt eminent of them, we ſhall give the opinions as we find them collected by one * who is well acquainted with their writings, who is thoroughly qualified to eſtimate their reſpective merits, and who cannot be ſuſpected of partiality to that theory which we feel ourſelves compelled to adopt.

22 The hypotheſis of Plato;

“ Plato illuſtrates our manner of perceiving external objects thus: He ſuppoſes a dark ſubterraneous cave, in which men lie bound in ſuch a manner as that they can direct their eyes only to one part of the cave. Far behind there is a light, of which ſome rays come over a wall to that part of the cave which is before the eyes of our priſoners. A number of men variouſly employed paſs between them and the light, whoſe ſhadows are ſeen by the priſoners, but not their perſons themſelves. In this manner did that philoſopher conceive that by our ſenſes we perceive not things themſelves, but only the ſhadows of things; and he ſeems to have borrowed his notions on this ſubject from the diſciples of Pythagoras.

23 Of Ariſtotle.

“ If we make due allowance for Plato's allegorical genius, his ſentiments with reſpect to ſenſation and perception correſpond very well with thoſe of the Peripatetics. Ariſtotle, the founder of that ſchool, ſeems to have thought, that the ſoul conſiſts of two or three parts, or rather that we have three ſouls—the vegetable, the animal, and the rational. The animal ſoul he held to be a certain *form* of the body, which is inſeparable from it, and periſhes at death. To this ſoul the ſenſes belong; and he defines a ſenſe to be that which is capable of receiving the ſenſible forms, or ſpecies of objects, without any of the matter of them; as wax receives the form of the ſeal without any of its matter. Of this doctrine it ſeems to be a neceſſary conſequence, that bodies are conſtantly ſending forth, in all directions, as many different kinds of forms without matter as they have different ſenſible qualities. This was accordingly maintained by the followers of Ariſtotle, though not, as far as we know, taught by himſelf. They diſputed concerning the nature of theſe forms or ſpecies, whether they were real beings or nonentities: but of matter and form we ſhall have occaſion to ſpeak afterwards.

24 Of Des Cartes;

“ After Ariſtotle had kept poſſeſſion of the ſchools for more than a thouſand years, his authority, which had often ſupplied the place of argument, was called in queſtion by Lord Bacon and others. Des Cartes, however, was the firſt philoſopher who, convinced of the defects of the prevailing ſyſtem, attempted to form another entirely new: but on the nature of perception by means of the ſenſes he differs little or nothing from thoſe who had preceded him in that department of ſcience. He denies, indeed, and refutes by ſolid reaſoning, the doctrine which maintains that *images*, *ſpecies*, or *forms* of external objects, come from the objects themſelves, and enter into the mind by the

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* Dr Reid in his *Eſſays on the Intellectual Powers of Man*.

Of Perception.

avenues of the ſenſes. But he takes it for granted, as all the old philoſophers had done, that what we immediately perceive muſt be either in the mind itſelf, or in the brain, in which the mind is immediately preſent. The impreſſions made upon our organs, nerves, and brain, can be nothing, according to his philoſophy, but various modifications of extenſion, figure, and motion. There can be nothing in the brain like *ſound* or *colour*, *taſte* or *ſmell*, *heat* or *cold*. Theſe are ſenſations in the mind, which, by the laws of the union of the ſoul and body, are raiſed on occaſion of certain traces in the brain; and although he ſometimes gives the name of ideas to theſe traces, he does not think it neceſſary that they ſhould be perfectly like the things which they repreſent, any more than that words and ſigns ſhould reſemble the things which they ſignify.

“ According to this ſyſtem it would appear, that we perceive not external objects *directly* by means of our ſenſes; but that theſe objects, operating either mediately or immediately upon the organs of ſenſe, and they again upon our nerves and brain, excite in the mind certain ſenſations; whence we *infer* the exiſtence of external objects from our ſenſations of which they are the cauſe. Perception of external objects, therefore, according to Des Cartes, is not one ſimple original act of the mind, but may be reſolved into a proceſs of reaſoning from effects to cauſes.”

25 Of Malebranche;

The doctrines of Malebranche, Locke, and Hartley, reſpecting perception, differ not eſſentially from that of Des Cartes. Malebranche, indeed, ſuppoſes, that external objects are not themſelves the cauſes of perception; but that the Deity, being always preſent to our minds more intimately than any other being, does, upon occaſion of the impreſſions made upon our organs of ſenſe, diſcover to us, as far as he thinks proper, and according to fixed laws, his own ideas of the object: and thus, according to him, we ſee all things in God, or in the divine ideas. He agrees, however, with Des Cartes and the ancient philoſophers, in conſidering it as a truth which it is impoſſible to refute, that we perceive not the objects without us, the ſun, moon, and ſtars, &c. becauſe it is not likely that the ſoul ſallies out of the body, and takes a walk, as it were, through the heavens to contemplate theſe objects. She ſees them not therefore by themſelves; and the immediate object of the mind, when it ſees the ſun, is not the ſun itſelf, but ſomething which is intimately united to the mind, and is that which he calls an *idea*.

26 Of Locke.

Locke, ſpeaking of the reality of our knowledge, ſays: “ It is evident the mind knows not things immediately, but only by the intervention of the *ideas* it has of them. Our knowledge, therefore, according to him, is real only ſo far as there is a conformity between our ideas and the things which they repreſent.” The manner of our perceiving external objects he illuſtrates by the following ſimilitude: “ Methinks the underſtanding is not much unlike a cloſet wholly ſhut from light, with only ſome little opening left, to let in external viſible reſemblances or ideas of things without. Would the pictures coming into ſuch a dark room but ſtay there, and lie ſo orderly as to be found upon occaſion, it would very much reſemble the underſtanding of a man in reference to all objects of ſight, and the ideas of them *.” He has elſewhere † defined an *idea* thus: “ Whatſoever the mind perceives in itſelf, or is the immediate object of perception, thought, or underſtanding, that I call an *idea*; and the power to produce any idea in our mind, I call *quality* of the ſubject wherein the power is.” He likewiſe thinks it “ eaſy to draw this obſervation, that the ideas of what he calls primary qualities of bodies, viz. *extenſion*, *ſolidity*, *figure*, *mobility*, &c. are reſemblances of theſe qualities as they really exiſt in the bodies themſelves.”

This unguarded expreſſion, which affirms that ideas in the mind are the reſemblances of external things, has brought upon Mr Locke much undeſerved ridicule. That on this and other occaſions he uſes the word *idea* with too great latitude, and that he often confounds ideas with ſenſations, and even with the cauſes of ſenſation, muſt be admitted by his warmeſt admirers: but we believe, that by an attentive reader, who peruſes his whole work, and compares ſuch paſſages as are obſcure with thoſe which are clearer, his meaning may always be diſcovered, and with reſpect to ſenſation and perception will generally be found juſt. That by calling the ideas of primary qualities reſemblances of the qualities themſelves, he meant nothing more than that bodies in all poſſible ſtates impreſs the ſenſes, nerves, and brain, in ſuch a manner as to produce in the mind certain ſenſations, between which and thoſe impreſſions there is an inſeparable, though unknown, connection, is evident from the account which he gives of the manner of perception. “ Our ſenſes (ſays he), converſant about particular ſenſible objects, do convey into the mind ſeveral diſtinct perceptions of things, according to thoſe various ways in which theſe objects affect them: and thus we come by thoſe ideas we have of *yellow*, *white*, *heat*, *cold*, *ſoft*, *hard*, *bitter*, *ſweet*, and all thoſe which we call ſenſible qualities; which when I ſay the ſenſes convey into the mind, I mean, they from external objects convey into the mind what produces thoſe perceptions.” And as bodies can act only by impulſe, he adds, that “ thoſe perceptions can be produced only by an impreſſion made upon the ſenſes, and ſome motion thence continued by our nerves to the brain or ſeat of perception.”

27 Of Hartley.

Dr Hartley was the pupil of Locke and Newton; and has, in a more ſatisfactory manner than all who had preceded or have ſince followed him, explained the material part of the proceſs of perception. His principles we ſhall have occaſion, during the courſe of the article, to develope pretty fully. For our preſent purpoſe it is ſufficient to ſay, that all his obſervations and arguments evidently ſuppoſe, that nothing diſtant from the mind can be perceived in the immediate act of ſenſation; but that the apparently immediate perception of external objects is an inſtance of early and deep-rooted aſſociation.

28 Of Hume.

In this ſentiment Mr Hume agrees with his predeceſſors; but he obſcures his philoſophy, and miſleads his reader, by confounding ſenſations with the impreſſions from which they proceed. “ Every one (ſays he*) will allow, that there is a conſiderable difference between the perceptions of the mind, when a man feels the pain of exceſſive heat, or the pleaſure of moderate warmth, and when he afterwards recals to his memory this ſenſation, or anticipates it by his imagination.”

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* *Eſſay on the Underſtanding*, book ii. chap 11.

† Book ii. chap. 8.

* *Inquiry concerning Human Underſtanding*, ſect. ii.

tion." The leſs forcible and lively of theſe perceptions he with great propriety calls *ideas;* but it is either through wilful perverſeneſs, or confuſion of intellect, that he chooſes to call the others *impreſſions*. Senſation and perception are cauſed by *impreſſions;* but they are no more impreſſions themſelves, than the pain occaſioned by the ſtroke of a bludgeon is the ſtroke itſelf, or the bludgeon with which it was ſtruck. But more of this afterwards.

29
Agreement of philoſophers, and the reaſon of it.

Thus far, then, that we perceive not external objects *directly*, but infer their exiſtence from certain ſenſations excited in our minds by the operation of theſe objects upon our *ſenſes*, *nerves* and *brain*, ſeems to have been the opinion of every philoſopher from Pythagoras † to Mr Hume. For an opinion ſo univerſal, and at the ſame time ſo contrary to the perſuaſion of the multitude, ſome cogent reaſon muſt have been aſſigned. That reaſon has been given by many philoſophers, but by none with greater perſpicuity than Dr Porterfield, in his Eſſay concerning the Motion of the Eyes. "How body acts upon the mind, or mind upon body (ſays he), I know not; but this I am very certain of, that nothing can act, or be acted upon, where it is not: and therefore, our mind can never perceive any thing but its own proper modifications, and the various ſtates of the ſenſorium to which it is preſent. So that it is not the external ſun and moon, which are in the heavens, that our mind perceives, but only their image or repreſentation impreſſed on the ſenſorium. How the ſoul of a ſeeing man ſees thoſe images, or how it receives thoſe ideas from ſuch agitations in the ſenſorium, I know not; but I am ſure it can never perceive the external bodies themſelves to which it is not preſent."

This reaſoning appears to have force; and, perhaps, the unanimous agreement of thinking men in all ages has ſtill greater force; yet the doctrine which prevailed ſo long, and which to Locke appeared ſo evident as to need no proof, has been ſince called in queſtion by ſome eminent philoſophers of our own country; who, though they allow that we cannot perceive external objects but by means of the ſenſes, yet affirm that they are the objects themſelves which we perceive directly; and that in perception there is no aſſociation which can be reſolved into a proceſs of reaſoning from ſenſations the effects, to external objects the cauſes. Dr Reid, who was perhaps the firſt, and is unqueſtionably the ableſt of this claſs of philoſophers, had expreſſed himſelf on the ſubject as follows:

"If we attend to the ACT of our mind, which we call the perception of an external object of ſenſe, we ſhall find in it theſe three things: *Firſt*, Some conception or notion of the object perceived. *Secondly*, A ſtrong and irreſiſtible conviction and belief of its preſent exiſtence. And, *Thirdly*, That this conviction and belief are immediate, and not the effect of reaſoning ‡." To the firſt and ſecond of theſe propoſitions, we are perſuaded that Des Cartes and Locke would readily have aſſented; nor do we imagine that they would have denied the third, had the author allowed that this ſtrong and irreſiſtible conviction is the conſequence of an early and deep-rooted aſſociation reſolvable into a proceſs of reaſoning. This, however, the learned profeſſor does not allow; for he repeatedly affirms, that it is inſtinctive and original, and that "the conſtitution of our power of perception determines us to hold the exiſtence of what we diſtinctly perceive as a firſt principle, from which other truths may be deduced, but it is deduced from none." With this view of the matter, he could with no propriety attempt to ſupport his own opinion by argument; but to the reaſonings of Dr Porterfield and others in defence of the Carteſian theory, he replies in the following words: "That nothing can act immediately where it is not, I think muſt be admitted (D); for I agree with Sir Iſaac Newton, that power without ſubſtance is inconceiveable. It is a conſequence of this, that nothing can be acted upon immediately where the agent is not preſent; let this, therefore, be granted. To make the reaſoning concluſive, it is farther neceſſary, that when we perceive objects, either they act upon us, or we act upon them. This does not appear ſelf-evident, nor have I ever met with any proof of it †."

Of the profundity of Dr Reid's underſtanding, we have the moſt firm conviction; nor is there any metaphyſician, ancient or modern, from whom we differ with greater reluctance: but we cannot help thinking this a very raſh aſſertion, as his own works appear to us to afford complete proof, that, in perception, the mind both acts and is acted upon. Let us attend, however, to the reaſons which, on this occaſion, induced

† See *Moſheim's edition of Cudworth's Intellectual Syſtem*, where the opinions of the philoſophers of antiquity are more faithfully collected than in any other work with which we are acquainted.

‡ *Eſſays on the Intellectual Powers of Man*, Eſſay ii. ch. 5.

† *Eſſays on the Intellectual Powers of Man*, Eſſay ii. chap. 14.

(D) One of the moſt celebrated of Dr Reid's followers thinks otherwiſe. "That no diſtant ſubject can act upon the mind, is a propoſition (ſays Lord Kames) which undoubtedly requires evidence; for it is not inſtinctively certain: And, therefore, till the propoſition be demonſtrated, every man may without ſcruple rely upon the conviction of his ſenſes, that he hears and ſees things at a diſtance." But his Lordſhip ought to have known, that Locke and Berkeley, the two philoſophers whom he was combating, have no where called in queſtion the conviction of their ſenſes. They do not, indeed, admit, that the external organs are themſelves percipient, or that by means of them the mind can *immediately* perceive diſtant objects; but they have no where denied, that through the *medium* of them the mind comes to the knowledge of external exiſtence. And the reaſons which they aſſign for this twofold opinion are, that in perception they experience action or the effects of action, which is not their own; and that it is an intuitive truth, that nothing can act where it is not preſent. "But admitting (ſays his Lordſhip) that no being can act but where it is, is there any thing more ſimple or more common, than the acting upon ſubjects at a diſtance by intermediate means? This holds in fact with reſpect both to ſeeing and hearing." It certainly does, and with reſpect to the other ſenſes likewiſe; but it is the very thing for which Locke and Berkeley would have contended, had any man in their days preſumed to call it in queſtion. It is the very foundation of their ſyſtem; and if it be granted, nothing can be more evident, than that external exiſtence is not the *immediate* object of perception. See *Appendix to Elements of Criticiſm.*

ced him to think, that in perception there is no action either of the object on the mind or of the mind on the object.

“ When we ſay, that one being acts upon another, we mean, that ſome power or force is exerted by the agent, which produces, or has a tendency to produce, a change in the thing acted upon. If this be the meaning of the phraſe, as I conceive it is, there appears no reaſon for aſſerting, that in perception, either the object acts upon the mind or the mind upon the object. An object, in being perceived, does not act at all. I perceive the walls of the room where I ſit; but they are perfectly inactive, and therefore act not upon the mind. To be perceived, is what logicians call an external denomination, which implies neither action nor quality in the object perceived.”

30 We think unſucceſsfully; and

This laſt ſentence we pretend not to underſtand. Subſtance without qualities is to us inconceivable, and certainly is no object of perception; for Dr Reid himſelf has told us, and told us truly, that “ the objects of perception are the various qualities of bodies.” That an object in being perceived does not act at all, is directly contrary to what the ingenious author has taught us, both in his *Inquiry* and in his *Eſſays*, viz. that “ it is a law of our nature that we perceive not external objects, unleſs certain impreſſions be made by the object upon the organ, and by means of the organ upon the nerve and brain;” for if the external object in being perceived make impreſſions, it is certainly not true that it acts not at all. It is indeed readily acknowledged, that when one perceives the walls of the room where he ſits, theſe walls do not act immediately upon the organs of ſight; but it does not, therefore, follow, that they are perfectly inactive; for it is known to all mankind, that from every point of the wall which is ſeen, rays of light are reflected to the eye; that thoſe rays make upon the *retina tunica* an impreſſion, which is conveyed by the optic nerve to the brain; and that this impreſſion on the brain is one of the immediate cauſes of viſion. In what *particular manner* it cauſes viſion, we ſhall never be able to diſcover, till we know more of the laws which unite mind and body, and by which one of theſe is qualified to act upon the other; but becauſe we know not the *manner* of this operation, to affirm that there is no operation at all ſeems to be as abſurd as it would be to affirm, becauſe we perceive no neceſſary connexion between a ſtroke and the ſenſation of ſound, that the ſound of a muſical ſtring is not cauſed by the ſtroke of a plectrum. That God might have given us powers of perception of a different kind from thoſe which we poſſeſs, there can be no doubt; but with what we might have been, we have no concern. As we are, we know perfectly that the eye is an inſtrument of viſion, becauſe without it nothing can be ſeen: we know alſo, that the retina and optic nerves are equally neceſſary; becauſe if they be diſordered, viſion is ſtill wanting; we know likewiſe, that the brain is neceſſary to all perception; becauſe, when it is diſordered, thinking either entirely ceaſes, or is proportionably diſturbed. And, laſtly, We are not more certain of our own exiſtence, than that *actual perception* takes not place but when the object makes an impreſſion upon ſome organ of ſenſe: for when no rays of light fall upon the eye, we ſee nothing; when no ſapid body is applied to the tongue and palate, we taſte nothing; and if we could be removed from every thing ſolid, we would feel nothing. Theſe are concluſions which cannot be controverted. They are admitted equally by the philoſopher and by the plain unlettered man of common ſenſe; nor are they rendered one whit leſs certain by our not being able to go a ſtep farther, ſo as to diſcover in what *manner* the brain or the affections of it can be the immediate inſtrument of ſenſation and perception. For (as Dr Reid, in the ſpirit of true philoſophy, obſerves ‡), “ in the operations of mind, as well as in thoſe of bodies, we muſt often be ſatisfied with knowing that certain things are connected and invariably follow one another, without being able to diſcover the chain that goes between them. It is to ſuch connexions that we give the name of *laws of nature;* and when we ſay that one thing produces another by a law of nature, this ſignifies no more than that one thing which we call in popular language *the cauſe*, is conſtantly and invariably followed by another which we call *the effect;* and that we know not *how* they are connected.

In the preceding ſection we have obſerved, that in ſenſation the mind exerts ſome energy; and therefore, as on every hypotheſis perception is a conſequence of ſenſation, it follows, that in perception the mind cannot be wholly inactive. Dr Reid, in his Eſſays on the Intellectual Powers of Man, ſeems to affirm that it is. “ I ſee no reaſon (ſays he) to believe, that in perception the mind acts upon the object. To perceive an object is one thing, to act upon it is another: Nor is the laſt at all included in the firſt. To ſay that I act upon the wall, by looking at it, is an abuſe of language, and has no meaning.” This is indeed true; it would be a great abuſe of language to ſay, that by looking at the wall a man acts upon it; but we do not believe that any man ever ſaid or ſuppoſed ſuch a thing. The philoſophers, whoſe opinion he is combating, might argue in this manner. We are conſcious that in perception the mind is active; nothing can act immediately where it is not; the mind cannot act immediately upon external exiſtence: external exiſtence, therefore, is not the immediate object of that energy which is exerted in perception. As Dr Reid affirms that external exiſtence is the immediate object of perception, he muſt deny the firſt propoſition in this argument; for *if it* be granted, as we have juſt ſeen that in his reply to Dr Porterfield he admits the ſecond, the laws of reaſoning will compel him to admit the third. To ſay, that in perception the mind acts not upon *external* objects, is a truth in which all mankind are agreed; and it is the very principle from which his antagoniſts infer, that the conviction of the preſent exiſtence of external objects is not an original and inſtinctive conſequence of ſenſation, but an early and deep rooted aſſociation which may be reſolved into a proceſs of reaſoning. His meaning, therefore, muſt be, that in perception the mind *acts not at all:* but this is directly contrary to his definition of perception, which he calls an ACT of the mind: it is likewiſe contrary to his theory of perception, as it is detailed in *the Inquiry into the Human Mind on the principles of Common Senſe*. We are there taught, with equal elegance and perſpicuity, “ that an impreſſion made by an external object upon the organ, nerves, and brain, is

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‡ *Inquiry into the Human Mind*, 4th edit. p. 258.

Of Perception.

is followed by a *ſenſation*, and that this ſenſation is followed by the perception of the object." We are likewiſe taught, that "although the Peripatetics had no good reaſon to ſuppoſe an active and paſſive intellect, they yet came nearer the truth, in holding the mind to be, in ſenſation, partly paſſive and partly active, than the moderns in affirming it to be purely paſſive. Senſation, imagination, memory, and judgement, have by the vulgar, in all ages, been conſidered as acts of the mind. The manner in which they are expreſſed in all languages ſhows this: for when the mind is much employed in them, we ſay, it is very active; whereas, if they were impreſſions only, we ought to ſay that the mind is very paſſive." All this is undeniable; but if ſenſation neceſſarily precede perception, and if in ſenſation the mind be active, what becomes of the aſſertion, that in perception it acts not at all? Indeed we may appeal to the common ſenſe of mankind, whether any thing can be perceived without ſome mental energy of the percipient. For when the impreſſions made on the external ſenſes are faint, in order to be conſcious of them an evident exertion is requiſite, not of the organ only, but alſo of the mind, as in perceiving very remote objects and ſounds; but when the impreſſions are ſtronger, the perception is involuntary and unavoidable, as has been already explained in the preceding ſection.

31
Therefore the old theory of perception to be preferred to his.

It being thus certain that in perception the mind both acts and is acted upon, and it being univerſally acknowledged that nothing can act where it is not, we feel ourſelves compelled to admit with the Carteſians, that in perception the conviction of the preſent exiſtence of external objects is not original and inſtinctive, but the conſequence of an early and unavoidable aſſociation of certain ſenſations with the cauſes which produce them. In this opinion we are ſtill more confirmed by the well-known fact, that particular preſſures upon the organ, nerves, and brain, excite not only ſenſations, but even perceptions of objects apparently external, when no ſuch objects are within the reach of our ſenſes. Thus §, if a man in the dark preſs either corner of his eye with his finger, he will ſee a circle of colours like thoſe in the feather of a peacock's tail, though no ſuch external object be before him, and though the room be ſo dark that nothing external could poſſibly be ſeen. Again, If a burning coal be nimbly moved round in a circle, with gyrations continually repeated, the whole circumference of the circle will at once appear on fire, though it is certain that there can be really no fire but one portion of that circumference, equal in length to the diameter of the coal. Theſe are facts known to all mankind; and they are perfectly irreconcileable with the ſuppoſition, that the perception of external objects by the ſenſe of ſight is original and inſtinctive; but they are at once accounted for, if it be true that rays of light falling from external objects upon the *retina tunica* agitate the optic nerves and brain, and that ſuch agitations excite ſenſations in the mind which experience has taught us to refer to external objects, as, under God, their ultimate cauſe.

§ *Hartley's Obſervations on Man.*

But though we have declared ourſelves to be in this inſtance Carteſians, we do not admit all the abſurdities which have ſometimes been imputed to that ſyſtem of perception. We do not believe that external objects are perceived by means of images of them in the mind or the brain; nor do we think that Des Cartes or Locke has anywhere affirmed that they are, otherwiſe than by an expreſſion obviouſly figurative, denoting, not that the actual ſhapes of things are delineated in the brain or upon the mind, but only that impreſſions of ſome kind or other are conveyed to the brain by means of the organs of ſenſe and their correſponding nerves; and that between theſe impreſſions and the ſenſations excited in the mind, there is a real, and in our preſent ſtate a neceſſary, though unknown, connexion.

32
That theory fairly ſtated, and

Upon the whole, we think that there is good evidence for believing, that in perception the proceſs of nature is as follows: *Firſt*, If the object be not in contact with the organ of ſenſe, there muſt be ſome medium which paſſes between them; as, in viſion, the rays of light; in hearing, the vibrations of elaſtic air; and in ſmelling, the effluvia of the body ſmelled; otherwiſe we have neither ſenſation nor perception. *Secondly*, There muſt be ſome action or impreſſion upon the organ of ſenſe, either by the immediate application of the object, as in the two ſenſes of touch and taſte; or by the medium that goes between them, as in the other three ſenſes. *Thirdly*, The nerves which go from the brain to the organ, muſt receive ſome impreſſion by means of that which was made upon the organ; and by means of theſe nerves that impreſſion muſt be carried to the brain. *Fourthly*, The impreſſion made upon the organ, nerves, and brain, rouſes the dormant energy of the mind; and this double action of the mind and the object produces a ſenſation And, *laſtly*, As we know by experience that the mind alone cannot, by any exertion of its own, produce one ſenſation, and are intuitively certain that nothing can begin to exiſt without a cauſe, we infer from the exiſtence of any new ſenſation the exiſtence of ſome other cauſe than the internal energy of the mind, from which that ſenſation proceeds; and this cauſe experience teaches us to be the external object. This proceſs is carried on ſo rapidly, and the ſeveral parts of it, by being continually repeated, are ſo cloſely aſſociated, that except by a reflex act of the mind we diſtinguiſh them not from one another, and therefore we denominate the whole *perception*.

33
Shown to differ little from Dr Reid's.

It is with extreme diffidence that we advance a doctrine which Dr Reid has controverted; but he differs from us only in the laſt ſtage § of the proceſs, where he ſuppoſes ſenſation and perception to be two ſimple and independent acts of the mind. Yet he ſometimes expreſſes himſelf, as if he thought, as we do, that in perception the belief of the preſent exiſtence of external objects is rather the reſult of experience than an inſtinctive perſuaſion. Thus, ſpeaking of the perception which we have in ſmelling a roſe, he ſays §, "Perception has always an external object, and the object of my perception in this caſe is that quality in the roſe which I diſcern by the ſenſe of ſmell. Obſerving that the agreeable ſenſation is raiſed when the roſe is near, and ceaſes when it is removed, I am led by my nature [we think *by experience* would have been more proper] to conclude ſome quality to be in the roſe, which is the cauſe of this ſenſation. This quality in the roſe is the object perceived; and that act of my mind, by which I have the conviction and belief

§ See *Inquiry into the Human Mind*, 4th edit. p. 383.

§ *Eſſays on the Intellectual Powers of Man*, Eſſay ii. chap. 15. and 21.

lief of this quality, is what in this caſe I call perception. Again (he ſays) that " three of our ſenſes, viz. ſmell, taſte, and hearing, originally give us only certain ſenſations, and a conviction that theſe ſenſations are occaſioned by ſome external object. We give a name to that quality of the object by which it is fitted to produce ſuch a ſenſation, and connect that quality with the object and with its other qualities. Thus we learn, that a certain ſenſation of ſmell is produced by a roſe; and that quality in the roſe by which it is fitted to produce this ſenſation we call the *ſmell of the roſe*. Here it is evident that the ſenſation is original. The perception that the roſe has that quality which we call its *ſmell*, is acquired."

To this doctrine no Carteſian could poſſibly object; for it is the very account which Des Cartes himſelf would have given of perception by the organ of ſmell, as it reſolves ſuch a perception into an early aſſociation between a certain ſenſation and that external quality from which we know by experience that the ſenſation proceeds. Indeed this excellent author repeatedly affirms, that every different perception is conjoined with a ſenſation which is proper to it; and that the one is the ſign, and the other the thing ſignified. He likewiſe doubts *, whether children, from the time that they begin to uſe their ſenſes, make a diſtinction between things which are only conceived or imagined, and things which really exiſt. But if the conviction of the preſent exiſtence of external objects were in perception *inſtinctive*, we cannot ſee how there could be room for ſuch a doubt; for the mere ſenſes of children are as perfect as thoſe of full grown men; and they know well the difference between actually ſucking their nurſes and only thinking of that operation, though they be not capable of expreſſing that difference in language.

34 Both theories afford intuitive evidence that ſomething exiſts beſides the perception and the ſenſation.

But if in perception our conviction of the preſent exiſtence of external objects be not inſtinctive, what, it may be aſked, is the evidence that ſuch objects really exiſt? This queſtion we ſhall partly anſwer in the following ſection, and more completely when we come to examine Berkeley's theory of the non-exiſtence of matter: but from what has been ſaid already, it is ſufficiently evident, that every ſenſation compels us to believe in the preſent exiſtence of ſomething different from ourſelves, as well as from our ſenſations.

Sect. III. *Of the Objects of each Senſe reſpectively.*

35 Touch, the ſenſe by which we perceive heat and cold, &c.

Hitherto we have conſidered ſenſation and perception in general, and ſhown that it is not by inſtinct that we perceive the exiſtence of external objects. This will appear more clearly, if we can aſcertain the preciſe nature of that information which each ſenſe affords us: and in order to this, we ſhall begin with the ſenſe of *touch*, not only becauſe it is that which is certainly firſt exerciſed, but alſo becauſe there is a meaning in which all the others may be reſolved into it.

36 The nature of heat and cold, which are perceived immediately.

By means of touch we perceive many things, of which the chief are, heat and cold, hardneſs and ſoftneſs, roughneſs and ſmoothneſs, extenſion, figure, ſolidity, and motion. Of theſe perceptions, ſome are immediate; and others, as we are perſuaded, early aſſociations, which may be reſolved into a proceſs of reaſoning. The perceptions of heat and cold are immediate. When a perſon for the firſt time in his life approaches the fire, he feels heat; and when he is firſt expoſed to the froſt, he feels cold. What are heat and cold, and where do they reſide? They are obviouſly the reverſe of each other; but are they external objects, or mere ſenſations in the mind? They are undoubtedly ſenſations which have no exiſtence but when they are felt. To every man not altogether a ſtranger to theſe ſpeculations, this propoſition is ſelf evident; but to the bulk of the people it appears an extravagant paradox. To make it plain, however, to the meaneſt capacity, it is ſufficient to obſerve, that at a certain diſtance the fire has no perceptible influence upon any perſon; if that diſtance be leſſened, we feel an agreeable warmth; approach a little nearer, and the warmth becomes diſagreeable; and ſtill nearer, it will riſe to pain. No man ſuppoſes the pain inflicted by a ſword to exiſt in the ſword, or anywhere elſe but in a ſentient being. It is equally abſurd to ſuppoſe pain to exiſt in fire, or anywhere elſe but in a ſentient being. But that which at one diſtance is pain, at another is only agreeable warmth; and ſince warmth and pain are only different degrees of the ſame feeling, it is equally abſurd to ſuppoſe the one as the other in the fire. What then is the object of ſenſe when we feel heat? There is obviouſly no object beyond the preſent ſenſation.

37 Their external cauſes.

But has the ſenſation of heat no cauſe independent of us? Undoubtedly it has, and experience teaches us that the cauſe is in the fire. We know that we cannot produce the ſenſation of heat in ourſelves by any mental energy of our own; and we are intuitively certain, that nothing can begin to exiſt without ſome cauſe. A man on the top of a mountain covered with ſnow, may imagine or remember what he felt when in the neighbourhood of fire, and thus have in his mind what is called an *idea* of heat; but that idea will not warm him (E) like the actual ſenſation, which no exertion of his own can in ſuch circumſtances produce. When he leaves the mountain, however, and approaches the fire, he feels the ſenſation actually produced, and produced as often as he makes the experiment. He is, therefore, under the neceſſity of inferring, that in the fire there is ſome power or quality which, acting either mediately or immediately upon his ſenſe of touch, excites the feeling which is called *heat*. What that power is, we ſhall perhaps never be able to diſcover; but it is ſelf-evident, that it is neither heat nor the reſemblance of

* *Eſſays on the Intellectual Powers of Man.*

(L) ——Who can hold a fire in his hand,
By thinking on the froſty Caucaſus?
Or cloy the hungry edge of appetite,
By bare imagination of a feaſt?
Or wallow naked in December's ſnow,
By thinking on fantaſtic ſummer's heat?
Oh no! the apprehenſion of the good
Gives but the greater feeling to the worſe.
K. Richard II.

Objects of the reſpective Senſes.

of heat, though in vulgar language it is known by that name.

The ſame reaſoning holds goods with reſpect to cold. There is at certain times, and in certain countries, ſome power in the air which congeals water and cauſes cold; but that power is as different from the ſenſation of cold, as the power of fire is different from the ſenſation of heat, or the point of a ſword from a fleſh wound.

38 The perceptions of extenſion and figure, &c. not immediate.

By the ſenſe of touch we perceive extenſion, figure, ſolidity, &c. but we do not perceive them *immediately* as we perceive heat and cold; for extenſion, figure, and ſolidity, are not ſenſations. Thoſe perceptions then muſt be acquired; and more clearly to aſcertain the manner in which we acquire them, let us ſuppoſe a man from his birth deſtitute of the ſenſe of ſight and the power of local motion, but poſſeſſed of intellect and every other faculty which we enjoy.—Such a perſon, it is obvious, would be capable of every ſenſation and perception which is *original* to us, except the perception of colours; but we doubt whether it would be poſſible to give him perceptions of extenſion, figure, and ſolidity. Let us try; and as he cannot move a ſingle limb or member of himſelf, let us ſuppoſe a ſolid ſubſtance of ſmall dimenſions to be gently preſſed againſt any part of his body; what would ſuch preſſure communicate to him? We think it could communicate nothing but a new ſenſation, to which, as it is neither pleaſing nor painful, no name has hitherto been given, except the general one of *feeling*. This ſenſation he would not know whether to refer to an external or internal cauſe; or rather he could have no notion whatever of an external cauſe, though he would at the ſame time be conſcious that the new ſenſation was not excited by any energy of his own will. Were the preſſure to be gradually increaſed till it roſe to pain, our blind man would ſtill be conſcious of nothing but a ſenſation, which could not lead him to the notion of extenſion, figure, or ſolidity, becauſe mere ſenſations cannot be conceived as either ſolid or extended. Let us next ſuppoſe the preſſure to be applied ſucceſſively to different parts of his body; he would now indeed be conſcious of ſucceſſive ſenſations, but he could not aſſign to them either extenſion or *place*: for it has been already ſhown that the external parts of the body are not themſelves ſentient; and it ſhall be ſhown afterwards, that to a man who has never perceived motion, place is abſolutely inconceivable. Laſtly, Let us ſuppoſe the dimenſions of the preſſing ſubſtance to be greatly enlarged: what would then follow? nothing, we apprehend, but an increaſe of pain: for though his whole body were preſſed *ab extra*, the preſſure could affect the individual being which is ſentient, not more extenſively, but only more violently. It appears, therefore, that a man blind from his birth, and deſtitute of the power of local motion, could never be made to perceive extenſion, figure, or ſolidity.

39 How they are acquired.

Let us now ſuppoſe this man to receive by a miracle the uſe of his limbs, and to be ſuddenly prompted, by ſome inſtinctive impulſe, to ariſe and walk. So long as he met with no obſtacle in his way, he would not, we apprehend, acquire by this exerciſe any correct notions of extenſion or figure; but were a ſtone or log of wood of conſiderable dimenſions to be laid acroſs his uſual walk, the caſe would ſoon be altered. He would feel himſelf interrupted in his courſe, and he would at the ſame inſtant recognize his wonted ſenſations of touch. After being twice or thrice thus interrupted, he would learn from experience that the interruption or reſiſtance proceeded from the ſame cauſe which in this inſtance communicated to him the ſenſation of feeling; and were he to run his hand along the ſurface of the log or ſtone, he would perceive the reſiſtance and the ſenſation continued. As every effect muſt have an adequate cauſe, this continued reſiſtance would compel him to believe the continuity of ſomething external in every direction in which he felt his hand reſiſted; but ſuch continuity of being is all that is meant by the word extenſion. At the very ſame time, and by the very ſame means, he would gradually acquire the perception of figure; for by running his hand in every direction over the ſurface of the obſtacle which oppoſed him, he would ſoon perceive it on all ſides limited; but the limits of extenſion is a phraſe of preciſely the ſame import with figure. It appears, therefore, that without the power of local motion, men could never, by the ſenſe of touch, acquire the notions of extenſion and figure; and the ſame will be found to be the caſe with reſpect to hardneſs and ſoftneſs.

40 Hardneſs and ſoftneſs, how perceived.

When we preſs our hand gently againſt a ſtock or a ſtone, we feel a ſenſation which is neither painful nor pleaſing. When we preſs it more violently, the ſenſation becomes painful, and we experience in the object a reſiſtance which we have not power to overcome. When we preſs butter or pomatum very gently, we have a ſenſation in all reſpects ſimilar to that which we felt when we gently touched the ſtock or the ſtone. But when we preſs the butter with violence, we feel no pain, and experience little reſiſtance; for the parts of which it is compoſed give way before the hand, though the parts of the ſtock or the ſtone remained fixed and immoveable. That the parts of one body ſhould thus reſiſt a preſſure to which the parts of another ſo readily yield, muſt proceed from ſome difference in the texture of the two bodies: for by the ſenſe of touch we perceive the effects to be different; and are therefore certain that they muſt proceed either from different cauſes, or from the ſame cauſe operating with different degrees of force. That particular texture which makes the parts of a ſtone reſiſt the preſſure of touch, we call hardneſs; and the texture which makes the parts of butter or pomatum give way to touch, we call ſoftneſs. But what hardneſs and ſoftneſs are in themſelves, touch cannot inform us; for they are neither ſenſations, nor ſimilar to ſenſations. We acquire, however, by experience, ſo complete notions of hardneſs and ſoftneſs, that every one who underſtands the Engliſh language perfectly knows the meaning of theſe words as ſoon as he hears them; and when he is told that one body is hard and another ſoft, he knows with abſolute certainty that the meaning of the aſſertion is, that the parts of the body which is ſaid to be hard are held together by ſome unknown cauſe operating forcibly, and that the parts of the other are held together by the ſame or a ſimilar cauſe operating with leſs force.

41 Roughneſs and ſmoothneſs.

We acquire the notions of roughneſs and ſmoothneſs in the very ſame way and by the very ſame means that we acquire ideas of extenſion and figure. To deſcribe the proceſs at large would certainly be ſuperfluous; for if what we have ſaid concerning our perceptions of extenſion and figure be juſt and intelligible, every one will, without farther aſſiſtance, diſcover for himſelf how he perceives roughneſs and ſmoothneſs. *Motion* ſhall be conſidered among the adjuncts of body; but in order to underſtand what body itſelf is, it will be neceſſary, before we diſmiſs the ſenſe of touch, to inquire how we come by the notion of ſolidity.

42 Solidity, what; and how perceived.

Solidity is one of thoſe notions, or, in the language of Locke, one of thoſe ideas, which are commonly ſaid to be acquired by the ſenſe of touch. That touch gives the firſt hint towards our notion of ſolidity, is certainly true; but that hint muſt be afterwards improved by the intellect, or we never could have an adequate knowledge of what is meant when any thing is ſaid to be abſolutely ſolid. We know by experience, that we can at pleaſure open and ſhut our empty hand without meeting with any reſiſtance. We know likewiſe, that when we graſp an ivory ball of three or four inches diameter, no force which we can exert will bring together the ſeveral parts of the hand, which were eaſily brought together when we graſped nothing. In this way do we acquire our firſt notion of ſolidity; for that word denotes nothing more in this inſtance than the power or property of the ball, by which our fingers are excluded from the place which it occupies. Solidity differs from hardneſs in this reſpect, that hardneſs reſults from the ſtrong coheſion of the parts of a hard body, which renders it difficult to change the places of thoſe parts, as they reſpect one another; whereas ſolidity reſpects the whole maſs, and is as eſſential a quality of water as of adamant. A drop of water, indeed, placed between two plane ſurfaces of marble, will not like adamant preclude their contact; becauſe the parts of a drop of water, cohering but looſely to one another, give way to the preſſure, and eſcape in every lateral direction. But if a drop of water be confined on all ſides, as in a globe of gold, we know from experiment that no force will bring the ſides of the globe together without forcing the water through the pores of the metal; and hence we infer ſolidity to be eſſential to every corporeal ſubſtance.

Thus then it appears, that of the objects perceived by touch not one is *immediately* perceived except heat, cold, and other ſenſations. The ſenſations, as they are not excited by any internal energy of our own, lead us indeed to ſomething external as their cauſe; and by comparing the different ſenſations with each other, and obſerving what effects their external cauſes have upon our own motions, we are naturally led to conceive theſe cauſes as extended, figured, ſolid, hard or ſoft, rough or ſmooth, &c.; but it is obvious that this conception is the reſult of experience, and a proceſs of mental reaſoning.

43 Nothing but mere ſenſations the object of ſmell,

On the ſenſes of taſte, ſmell, and hearing, it is needleſs to ſay much. The immediate objects of theſe are confeſſedly ſenſations which have no exiſtence but when they are perceived; though experience teaches us to refer them all to external objects as their reſpective cauſes. With reſpect to ſmell, this has been made ſufficiently evident in the preceding ſection, and it is not leſs evident with reſpect to taſte and hearing.

44 Taſte, and

Certain bodies applied to the tongue and palate, and moiſtened with the ſaliva, excite certain ſenſations which we call taſtes. Theſe ſenſations, however, are not in the bodies; nor can they have any exiſtence but in a ſentient being. They are produced in conſequence of impulſes on the nerves of the tongue and palate, exciting certain agitations in the brain; but the ſenſation itſelf is neither impulſe nor agitation. Some ſubſtances excite taſtes which are agreeable, and others ſuch as are diſagreeable; and there are not a few which excite no taſte at all. Bodies, which applied to the tongue and palate of one man produce taſtes that are agreeable, applied to the ſame organs of another man give him taſtes which are diſagreeable; and we have all experienced, that the ſame ſubſtance, which, when the organs are ſound, excites a ſweet or pleaſant taſte, has, when the organs were diſordered, excited a taſte which was bitter or unpleaſant. Theſe facts, which cannot be controverted, afford the fulleſt evidence, if evidence were wanted, that taſte, as we feel it, is no quality of bodies, nor has any exiſtence out of the mind.

45 Hearing.

The organ of hearing is the *ear*, and its object is ſound. It is well known, that ſound is produced by certain vibrations of the air ſtriking the tympanum of the ear, and that theſe vibrations are cauſed by the ſonorous body. Sound, however, is not vibration, nor the idea of ſound the idea of vibration. Sound conſidered by itſelf is a mere ſenſation, which can have no exiſtence but in a ſentient being. We know by experience, that it is cauſed by ſomething external; but we know likewiſe that the effect has no reſemblance to the cauſe. Previous to experience we could not refer ſound to any external cauſe; far leſs could we diſcern whether it proceeded from an object above us or below us, on our right hand or on our left. It appears to us ſelf-evident, that if a man born deaf were ſuddenly made to hear, he would conſider his firſt ſenſation of ſound as originating wholly within himſelf. Between that ſenſation and the ſenſations of touch, taſte, ſmell, and ſight, there is no reſemblance; nor are there any relations among them, which, previous to experience, could induce him to trace them all to external objects as their ſeveral cauſes. Our deaf man might have learned to refer all his other ſenſations to their true cauſes, in ſome ſuch way as we have deſcribed under the ſenſe of touch; but ſound would be ſomething ſo new to him, and ſo totally different from touch, taſte, and ſmell, that he could attribute it to nothing external.

46 It is by experience that we diſtinguiſh different ſonorous bodies by their reſpective ſounds.

Experience, however, would ſoon teach him, that the ear is its organ, and the ſonorous body its cauſe; and he would in time learn to diſtinguiſh one ſound, that of a trumpet for inſtance, from another, ſuppoſe the ſound of a bell; and to attribute each to its proper cauſe, even when neither the trumpet nor the bell was perceived by his other ſenſes. With reſpect to ſounds which we have been accuſtomed to hear, this is done ſo inſtantaneouſly, that ſome philoſophers have imagined it to be the effect of an inſtinctive principle in our nature, totally different from experience, and independent of reaſon. But the fact is not ſo. Long before we are capable of making ſenſation and perception objects of reflection, we have heard the ſound produced by the ringing of a bell, and ſeen the object which produced the ſound ſo often, that, when we hear a ſimilar

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ſound again, we inſtantly refer it to a *bell*, though we ſee not the bell from which it proceeds: but this is the effect of habit, and not of inſtinct. Had we never perceived a bell while ringing by either of our ſenſes of ſight or touch, we could not by the ſenſe of hearing acquire any notion of the figure or texture of the body from which the cauſe of the ſound proceeds, though we had heard that ſound every day of our lives. It is, indeed, by experience only that we learn to diſtinguiſh by the ear whether a ſonorous body be before or behind us, on our right hand or on our left; for we find it always difficult to ſay from what preciſe quarter a ſtrange ſound proceeds; and this difficulty would be heightened to impoſſibility, had not all ſounds ſomething in common. Dr Sparrman relates, that when he firſt heard the roaring of a lion, he did not know on what ſide of him to apprehend danger, as the ſound ſeemed to proceed from the ground, and to encloſe a circle of which he and his companions ſtood in the centre. The ſame thing has happened to every man, when the ſound was ſuch as he had never heard before; even though it was neither ſo loud nor ſo terrific as the roaring of a lion in a deſert wilderneſs: but with reſpect to ſounds which we are daily hearing on each ſide of us, we ſoon learn to diſtinguiſh with tolerable accuracy whether they be before or behind us, above or below, on our right hand or on our left. All this, however, is the effect, not of inſtinct, but of experience improved into habit.

47

Sight originally perceives nothing but colours, which are mere ſenſations.

Sight is juſtly conſidered as the nobleſt and moſt comprehenſive of all our ſenſes. The reaſon is obvious: for when a full grown man opens his eyes, he perceives houſes, trees, rivers, the earth, ſun, and moon, &c. and to each of theſe objects belong figure, extenſion, colour, &c. which are all perceived inſtantly by means of this ſenſe. Yet it is certain, that the ſenſe of ſight does not originally communicate to us ſo many perceptions; and there is abundant evidence, that an infant cannot at firſt, or for ſome weeks after its birth, diſtinguiſh by viſion one object from another. *Colour* is the proper object of ſight, and for ſome time its only object; but colour as perceived by us is a mere ſenſation, which can have no exiſtence but in a ſentient being. If this propoſition ſtood in need of proof, we might obſerve that there are men, and even whole families, who poſſeſs the ſenſe of ſight in a degree of perfection ſufficient for all the purpoſes of life, and yet cannot diſtinguiſh certain colours from each other; blue, for inſtance, from green, or perhaps from red: and there is no man who can diſtinguiſh between ſome particular ſhades of blue and green by the feeble light of a candle. Were colours the real qualities of body, this miſtake of one for another could never be experienced. No man who poſſeſſes the ſenſe of touch ever confounded hardneſs with ſoftneſs, a ſphere with a cube, or an ell with an inch. The reaſon is, that hardneſs and ſoftneſs, figure, and extenſion, are the qualities of things external; whereas colour being a mere ſenſation, is nothing but an affection or modification of the ſentient being. But it is obvious, that ſentient beings, according as they differ from one another, may be differently affected by the ſame external cauſe; ſo that one man may perceive that to be green which all other men perceive to be blue. The immediate external cauſe of the ſenſation of colour, is the rays of light reflected from the body, which in common language is ſaid to be coloured. Theſe rays falling upon the pupil of the eye, are refracted differently, according as their incidence is more or leſs oblique into points on the retina, where they form a picture of the external object; and from the picture, by means of the optic nerve, is communicated to the brain ſome impulſe or agitation, which produces viſion or the perception of colour. As rays of light are corporeal ſubſtances, it is obvious that they can act upon body only by impulſe; but between impulſe and the various ſenſations of *red*, *green*, *blue*, &c. there is no reſemblance. For the laws of reflection and refraction, and for the ſtructure of the eye, ſee OPTICS and ANATOMY. That which we have to inquire into at preſent is, how we learn, by means of the ſenſe of ſight, to perceive the figure, magnitude, motion, and diſtance of external objects, or indeed to diſtinguiſh one object from another.

A ray of light proceeding, as all rays do, in a ſtraight line, muſt, however great its length, affect the eye, retina, and optic nerve, as if it were a ſingle point. From this obvious and undeniable fact, Biſhop Berkeley predicted *, that a man born blind, who ſhould be ſuddenly made to ſee, would at firſt perceive nothing without him, would diſtinguiſh neither the diſtance, ſize, figure, nor ſituation, of external objects; that he would only ſee in his eyes themſelves, or, to ſpeak more properly, would only experience new modifications in his mind, until joining *touch* to *ſight*, he formed thus a communication with the external world, and learned, by the ſimultaneous exerciſe of the two ſenſes, that natural language in which the *viſible* is the ſign of the *tangible*. This truth, which was diſcovered by the biſhop merely by contemplating in his own mind the nature of ſenſation and the known laws of optics, after having been laughed at for more than 20 years as one of the many dreams of a viſionary genius, was completely confirmed by the caſe of the famous patient whom Cheſelden cured of a cataract; and that too, though the cataract does not produce total blindneſs: which makes it evident, that the firſt viſual perceptions of the patient after his recovery could not be wholly new and unmixed. It may indeed be confirmed at any time by a ſimple experiment made upon an infant. For ſeveral weeks after birth, a child ſhuts not its eyes upon the ſudden approach of an object to them, nor ſhows the leaſt ſymptom of diſtinguiſhing one diſtance from another; and it is eaſy by a little attention to obſerve, how it gradually learns to diſtinguiſh objects at greater and greater diſtances. Indeed colour, or the immediate object of ſight, being a mere ſenſation or affection of the mind, can have no natural relation whatever to any thing external.

48

Perception of diſtance by ſight, how acquired.

It is plain, therefore, that diſtance is in its own nature imperceptible to the eye, and yet it is often perceived by ſight. How is this done? We think, in the following manner. Diſtance is one mode of extenſion, which, we have already ſeen, is perceived by means of touch. Of ſhort diſtances, our firſt ideas are doubtleſs acquired by the ſtretching out and drawing back of our arms; and thoſe ideas are ſoon ſo connected with certain ſenſations which we have in actual viſion, that the latter inſtantly ſuggeſts the former.

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* *Eſſay towards a new Theory of Viſion.*

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Thus, it is a fact known by experience, that when we look at a near object with both eyes, according as it approaches or recedes from us, we alter the diſpoſition of our eyes, by leſſening or widening the interval between the pupils. This diſpoſition, or turn of the eyes, is attended with a ſenſation of which every man is conſcious at the time of viſion; and this ſenſation ſeems to us to be that which in this caſe ſuggeſts the idea of greater or leſs diſtance to the mind. Not that there is any natural or *neceſſary* connexion between the ſenſation of which we are conſcious, and greater or leſs diſtance; for the ſenſation is wholly internal, and the diſtance is external. But becauſe the mind has, by conſtant *experience*, found the different ſenſations occaſioned by different diſpoſitions of the eyes to correſpond to different degrees of diſtance in the object, there has grown a habitual or cuſtomary connexion between thoſe ſenſations and the notions of greater or leſs diſtance. So that the mind no ſooner perceives the ſenſation ariſing from the different turn it gives the eyes in order to bring the *pupils* nearer or farther aſunder, than it is inſtantly impreſſed with a certain notion of the diſtance which was wont to be connected with that ſenſation. Again, An object placed at a certain diſtance from the eye, to which the breadth of the pupil bears a ſenſible proportion, being made to approach nearer, is ſeen more confuſedly; and the nearer it is brought, the confuſion is always the greater. The reaſon of all this is known to every optician: but it being conſtantly experienced by thoſe who never dipt into optics, there ariſes in the mind of every man a habitual connexion between the ſeveral degrees of confuſion and diſtance; the greater confuſion ſtill implying the leſs diſtance, and the leſs confuſion the greater diſtance. It is of no avail to ſay, that between confuſed viſion and diſtance, great or ſmall, there is no neceſſary connexion: for there is as little connexion between a bluſh in the face and the mental feeling of ſhame; and yet no ſooner does a man of obſervation perceive that particular colour in the face of another, than it ſuggeſts to him the notion of that feeling or paſſion with which he has conſtantly obſerved it accompanied.

In theſe ways, however, we perceive only ſmall diſtances. Of diſtances more remote our judgement is formed from other data; and happily theſe data are not far to ſeek. It is a fact known to every man who is not totally ignorant of the ſcience of optics, that a greater number of rays fall upon the eye when reflected from a body near at hand, than can fall from the ſame body at a diſtance; and as thoſe rays operate by impulſe, it is ſelf-evident that the impreſſion muſt be ſtronger, and of courſe the ſenſation or colour more vivid, when the body is near than when it is diſtant. Now having acquired the notion of the true diſtance of objects by motion and the ſenſe of touch, and finding by uniform experience, that as they are near or far off, the ſenſation or colour which they excite in the mind through the organ of viſion is more or leſs vivid, thoſe degrees of ſenſation come to be ſo cloſely aſſociated with the reſpective diſtances of the object, that the one inſtantly ſuggeſts the other.

49 How figure perceived by ſight.

It is juſt ſo that we perceive figure by ſight. Having experienced by the ſenſe of touch that one ſurface is a ſquare and another a circle, that one body is a cube and another a ſphere; and finding our ſenſe of ſight differently affected by the ſquare and the circle, by the cube and the ſphere; theſe different affections come to be ſo cloſely connected in our minds with the figures of the reſpective bodies, that long before we are capable of reaſoning on the ſubject the one is never preſent to us without ſuggeſting the other. Nay, ſo complete in this caſe is the connexion or aſſociation, that we cannot even in idea abſtract the colour from the figure; though it is certain that colour is a mere ſenſation, and figure an external quality; that colour alone is immediately perceivable by the eye, and the notion of figure ſuggeſted by the colour. We are aware that it has been affirmed, and affirmed with great vehemence, that figures of two dimenſions are immediately perceived by the eye, and perceived with greater accuracy than by the ſenſe of touch. But they who inſiſt upon this doctrine affirm likewiſe, contrary to experience and the cleareſt reaſoning, that the immediate objects of ſight are external, and that colour is a quality of bodies. In the arguments too by which they ſupport their hypotheſis, they ſeem to confound ſight as an affection of the mind, with the picture on the bottom of the eye, as if the retina were the ſentient being; whereas the retina and picture are no more than inſtruments of ſenſation. It is indeed a fact, that the picture has the ſame figure nearly with the plane of the object which is preſented to the eye; as when the object is a ſphere, the picture is a circle variouſly ſhaded in colour. It is likewiſe a fact, that the picture is enlarged in proportion as the object is brought near, and diminiſhed as it is carried to a diſtance. But theſe facts are known only to perſons ſkilled in optics; and therefore it is evident, that though calculations may be raiſed from them by mathematicians to determine the diſtance and figure of external objects, they cannot poſſibly be the data from which diſtance and figure are inferred by the vulgar, who knew not that ſuch pictures on the retina exiſt. Beſides all this, it is univerſally known, that a painter, by laying on his colours properly, can make a plain ſquare ſurface appear to the eye in certain poſitions as an oblong or as a cube, and a plain circular ſurface as a concave or a convex hemiſphere. But not one of theſe things could poſſibly be done, were figure, or indeed any thing elſe than colour, the immediate object of viſion.

50 Magnitude.

As we ſee diſtance and figure, ſo we ſee magnitude; and we ſee both in the ſame way that we ſee ſhame or anger in the looks of a man. The impreſſion made upon the bottom of the eye by rays reflected from a large magnitude, muſt neceſſarily be different from the impreſſion made by rays reflected from a magnitude that is leſs. This is ſelf-evident; and ſince the impreſſion *ab extra* is in ſome way or other the cauſe of that ſenſation, which is all of which we are originally conſcious in viſion, it is obvious that the ſenſation, like every other effect, muſt correſpond to the cauſe from which it proceeds. Being therefore conſcious of different ſenſations; and having, at an earlier period than we diſtinctly remember, learned by experience to refer them to different magnitudes; no ſooner is each ſenſation excited than it ſuggeſts the notion, or, if you pleaſe, the perception, of that magnitude with which it is connected. So completely is this aſſociation fixed in the mind, that when we look at a known object, its

real

Objects of the reſpective Senſes.

real magnitude appears to be as inſtantly obſerved as its colour, whilſt we hardly attend at all to the particularity of the ſenſation by which the magnitude is ſuggeſted. It is indeed cuſtomary with writers on optics to diſtinguiſh between tangible and viſible magnitude, as if any kind of magnitude were the immediate object of viſion: but this is not ſo: for magnitude is ſomething external, whereas the immediate object of viſion is a mere ſenſation. What has introduced into ſcience this mode of ſpeaking is the following fact, that as we approach a diſtant object it appears to the eye larger and larger every ſtep, and leſs and leſs as we recede from it; whereas the tangible magnitude of an object is always the ſame. The reaſon of this apparent change of magnitude to the eye, according to the diſtance at which any particular object is viewed, is, that from a near object rays of light fall in greater numbers and more diverging than from the ſame object viewed at a diſtance. This of courſe alters the nature of the viſible ſenſation: each common ſenſation is in the mind cloſely linked with a particular notion of magnitude; and by the exerciſe of ſight and touch we have learned from experience, that the particular ſenſation cauſed by diverging rays muſt be referred to a larger magnitude than that which is cauſed by parallel rays proceeding from the ſame diſtance.

51
Viſible ſenſations a kind of natural language.

Upon the whole, then, we think ourſelves entitled to conclude, that the proper and original objects of viſion conſtitute an univerſal language of the Author of Nature, by which we are inſtructed how to regulate our actions, in order to attain thoſe things that are neceſſary to the preſervation and well-being of our bodies, as alſo to avoid whatever may be hurtful or deſtructive to them. It is principally by the information of this language that we are guided in all the tranſactions and concerns of life: And the manner in which it ſignifies and marks to us the objects which are at a diſtance, is ſimilar to that of languages and ſigns of human appointment, which do not ſuggeſt the things ſignified by any likeneſs or identity of nature, but only by a habitual connexion, which experience has made us to obſerve, between them. This language of the eye, like the language of the tongue, ſuggeſts by one ſenſation what may be reſolved into a variety of perceptions. A tree is compoſed of a trunk, branches, leaves; it has colour, figure, ſize; and all theſe things are at once ſuggeſted to the mind by the two words *ſpreading oak*. Juſt ſo it is with reſpect to viſion: the ſenſation received by the eye ſuggeſts at once the *trunk*, *branches*, *leaves*, *colour*, *figure*, and *ſize* of the oak, and ſuggeſts them all as the qualities of one object.

CHAP. II. *Of* RETENTION *and* IDEAS.

52
Senſations and perceptions remain for a very ſhort time after the removal of their objects.

FROM the experiment with the burning coal mentioned in N° 31. it is apparent, that ſenſations excited through the eye, together with their correſponding perceptions, remain in the mind for a ſhort time after the external exciting cauſe is removed. The ſame thing appears from another experiment which was firſt made by Sir Iſaac Newton, and which every man may repeat for his own ſatisfaction. It is univerſally known*, that a proper mixture of the ſeven original colours, *red*, *yellow*, *green*, *blue*, &c. conſtitutes that uniform appearance which we call *white*. But when theſe colours are made to paſs in a rapid conſecution before the eye, they excite the very ſame perception as when they are properly mixed, which is a ſatisfactory proof that the impreſſion made by each ſeparate colour remains in the brain until a revolution of all the colours be completed; for nothing but the impreſſion of all the colours at *once* can produce the ſenſation and perception of *white*. Indeed no perſon capable of paying the proper attention to theſe things, can keep his eye fixed upon a luminous object, and afterwards ſhut it, without experiencing that the ſenſation and perception remain for ſome time after the external object is ſhut out, and that they go off gradually till they leave behind them the mental appearance, which is properly called an *idea* of the object.

Retention and Ideas.

The ſame continuance of the ſenſation after the removal of its cauſe is equally obſervable in the ſenſe of hearing; for every ſound which we hear is reflected by the neighbouring bodies; and therefore conſiſts in reality of a variety of ſounds ſucceeding each other at different diſtances of time, according to the diſtances of the ſeveral reflecting bodies. Yet this cauſes no confuſion or apparent complexity of ſound, unleſs when the diſtance of the reflecting bodies is very conſiderable, as in ſpacious buildings.

With reſpect to the continuance of the ſenſation of touch, doubts have been ſtarted; but for theſe there is as little room as for doubting the continuance of the ſenſations of ſeeing and hearing. The continuance of heat after the heating body is removed, and of the ſmart of a wound after the inſtant of infliction, are proofs that every ſenſation of touch does not vaniſh with its cauſe. A man unuſed to the motion of a ſhip or a coach, after having been a day at ſea or on the road, feels or imagines he feels the rolling of the ſhip or the jolting of the coach after he is in bed and actually at reſt. Of theſe facts we know not what other account can be given, than that the agitation in the brain, which is the immediate cauſe of the ſenſation of touch, remains for ſome time after the external cauſe of the agitation is removed.

As to the ſenſes of taſte and ſmell, Dr Hartley ſeems to think that there is no clear and direct evidence for the continuance of their ſenſations after their proper objects are removed: but in this inſtance the ingenious author does not do juſtice to his own theory. Let any man eat onions, garlic, or any other thing of a very pungent taſte, and immediately waſh his mouth with freſh water, ſo that he may be ſure no part of the ſapid body remains on his tongue or palate. According to this doctrine, the taſte of the onion or garlic ſhould inſtantly vaniſh with its object; but the fact is otherwiſe. Whoever ſhall make the experiment, will find the ſenſation to remain a conſiderable time; not indeed in its original force, but weakened no more than what it muſt neceſſarily be by the introduction of a new ſenſation excited by the water. It is more difficult to aſcertain the permanency of ſmell: but analogy inclines us to believe, that in this particular it reſembles the other ſenſes, though we know not how to direct the reader to an experiment which will give him abſolute conviction.

Whether the cauſe of theſe continued ſenſations, after the removal of their objects, be in the brain alone, in

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* *Hartley on Man.*

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Hence we have that power or faculty called *memory.*

in the mind alone conſidered as an immaterial being, or in both together, is of very little importance; becauſe, taking the mind and its internal organs as one *metaphyſical whole**, it matters not to our preſent inquiry, where this retentive power reſides, as long as it can be proved to exiſt within us: for it ſeems evident, that what has the faculty of retaining a ſenſation when no longer acted upon by the object which excited it, muſt alſo have a power to preſerve the veſtiges of that ſenſation even after the ſenſation itſelf ſhall be entirely obliterated. This is in fact the caſe with the mind. When an object which we have once perceived is moſt remote from our thoughts, we are certain that there is within us a capacity, diſpoſition, tendency, or power, by which a repreſentation of that object may be at any time revived and preſented to the intellect. Thus the ſame inherent power of the mind and its internal organs, which retains a ſenſation and perception in the abſence of the object by which they were excited, can alſo reproduce that perception, or bring into the view of the intellect ſomething exactly ſimilar to it. The reproduction will not indeed be ſo lively as the original perception when accompanied with its correſponding ſenſation, becauſe ſenſation and actual perception are affected by a double cauſe, the action of the external object upon the organ, nerves, and brain, and the correſponding energy of the mind or ſentient principle; whereas, in the reproduction, the mind ſeems to act ſolely by its own power, and certainly without the aſſiſtance of external objects. This reproductive power is commonly called *memory.* By many of the ancient philoſophers, and by *M. Schwab*, with one or two others among the moderns, it is called *imagination.* We do not chooſe either to revive antiquated modes of expreſſion, or to introduce innovations of our own; but as we cannot diſapprove of the ancient phraſeology, after the definitions which the reader will by and by find of *imagination. memory*, and *recollection*, as given by Mr Harris, we have prefixed to this chapter the general title of *retention*, which comprehends them all.

54
The opinions of philoſophers reſpecting memory.

When one recalls an object of ſight by the power of memory, it appears to him preciſely the ſame as in the original ſurvey, only leſs diſtinct, and with a conviction (which is perhaps the reſult of experience) that the real object is not immediately before him. How is an object recalled by the power of memory? Does the man endeavour to form in his mind a picture or repreſentative image of the object? Let us liſten to the anſwers given by different philoſophers to this queſtion.

55
The Peripatetics and Platoniſts

The ſentiments of the Peripatetics, as expreſſed by *Alexander Aphrodiſienſis*, one of the earlieſt commentators on *Ariſtotle*, are thus tranſlated by Mr Harris in his Hermes.—"Now, what fancy or imagination is, we may explain as follows: We may conceive to be formed within us, from the operation of the ſenſes about ſenſible ſubjects, ſome impreſſion (as it were), or picture in our original ſenſorium, being a relict of that motion cauſed within us by the external object; a relict which, when the external object is no longer preſent, remains, and is ſtill preſerved, being as it were its image; and which, by being thus preſerved, becomes the cauſe of our having memory. Now ſuch a ſort of relict, (and as it were) impreſſion, they call *fancy* or *imagination* (E)." A paſſage from ALCINOUS *of the doctrines of Plato*, as rendered into Engliſh by Dr Reid †, ſhows, that in this theory, as in that of perception, the Platoniſts agreed with the Peripatetics. "When the form or type of things is imprinted on the mind by the organs of the ſenſes, and ſo imprinted as not to be deleted by time, but preſerved firm and laſting, its preſervation is called *memory.*"

Mr Harris, who was deeply read in the ancient philoſophy, and who conſidered the authority of Ariſtotle and Plato as ſuperſeding all reaſoning and all inquiry, after juſtly obſerving, that if the ſoul had no other faculties than the ſenſes, it could never acquire the leaſt idea of *time*, thus expreſſes himſelf on the ſubject before us:—"But happily for us we are not deſerted here. We have, in the firſt place, a faculty called *imagination* or *fancy*; which, however as to its *energies* it may be ſubſequent to ſenſe, yet is truly prior to it both in *dignity* and *uſe.* This it is which *retains the fleeting forms of things*, when things themſelves are gone, and *all ſenſation* is at an end. That this faculty, however connected with ſenſe, is ſtill perfectly different, may be ſeen from hence. We have an *imagination* of things that are gone and extinct; but no ſuch things can be made objects of *ſenſation.* We have an eaſy command over the objects of our *imagination*, and can call them forth in almoſt what manner we pleaſe; but our *ſenſations* are neceſſary when their objects are preſent, nor can we controul them but by removing either the objects or ourſelves. As wax would not be adequate to its buſineſs of ſignature, had it not a power to retain, as well as receive; the ſame holds of the SOUL, with reſpect to *ſenſe* and *imagination.* SENSE is its *receptive* power: IMAGINATION its *retentive.* Had it ſenſe without imagination, it would not be as wax but as water; where, though all impreſſions may be inſtantly made, yet as ſoon as made they are entirely loſt. Thus then, from a view of the two powers taken together, we may call SENSE (if [illegible] pleaſe), *a kind of tranſient imagination*; and IMAGINATION, on the contrary, *a kind of permanent ſenſe.*"

56
diſtinguiſh properly between imagination and memory, &c.

Great part of the office which is here given to imagination, is in common Engliſh attributed to memory; but between theſe two faculties, as well as between them and recollection, the author accurately diſtinguiſhes thus:—"When we view ſome *relict* of ſenſation repoſed within us, *without thinking of its riſe*, or *referring it to any ſenſible object*, this is FANCY or IMAGINATION. When we view ſome ſuch *relict*, and *refer it withal to that ſenſible object which in time paſt was its*

* See *An Eſſay on the Reduction of the Faculties of the Mind, by M. Schwab.*

† *Eſſays on the Intellectual Powers of Man.*

(E) The original is as follows: Τι τοινυν εϛιν ἡ φαντασια ωδε αν γνωρισαιμεν δει νοειν εν ημιν απο των ενεργειων των περι τα αισθητα, οιον τυπον τινα αναζωγραφημα εν τω πρωτω αισθητηριω, εγκαταλειμμα τι της υπο του αισθητου γινομενης κινησεως, ὁ και μηκετι του αισθητου παροντος, υπομενει τε και σωζεται, ον ὡσπερ εικων τις αυτου. ο και της μνημης ημιν σωζομενον αιτιον γινεται το τοιουτον εγκαταλειμμα, και τον τοιουτον ὡσπερ τυπον, φαντασιαν καλουσιν. *Alex. Aphrod. de Anima*, p. 135. *Edit. Ald.*

its cauſe and original, this is MEMORY. Laſtly, The *road which leads to memory through a ſeries of ideas however connected, whether rationally or caſually*, this is recollection."

57 Objections to their theory.

Of this theory we ſhall only remark, that if we could underſtand the words *picture* and *form* in a metaphorical ſenſe, as candour obliges us to underſtand Locke's *images* in the mind, the doctrine of *Alexander Aphrodiſienſis* would be very little wide of the truth. Experience teaches us that memory as well as perception depends upon the ſtate of the brain; and as it is undeniable, that when a man to-day contemplates an object which he perceived yeſterday, or at any former period, he has a view of it in all reſpects ſimilar to the original perception, only fainter and leſs diſtinct, it is extremely probable, that an impreſſion *ab extra*, which produces a ſenſation and perception, leaves behind it ſome *tendency* in the brain, to vibrate as in the actual ſenſation, and that this *tendency* is carried into *effect* by the internal energy of the mind itſelf. But in the Peripatetic philoſophy, *pictures* and *forms* in the *ſenſorium* were conſidered as real things, and by no means as metaphorical expreſſions. This is evident from their being conſtantly compared to the impreſſion of a ſeal upon wax, and from their converting the *materia prima* from ſomething, which can neither be ſeen nor felt, into viſible and tangible body, of which we ſhall treat afterwards. Now it being certain that on a being immaterial, no corporeal *form* can be impreſſed, and repeated diſſections having ſhown that no ſuch forms are in fact impreſſed on the brain, this whole theory is at once overturned.

58 Locke's doctrine concerning memory

Modern philoſophers having denied that there are real *images* or *forms* in the mind during the immediate act of perception, cannot confidently with themſelves admit ſuch images in the act of retention, or when thoſe things which were formerly objects of perception are recalled to the mind by the power of memory. Mr Locke's doctrine is, "that the mind retains theſe ſimple ideas which it firſt received from ſenſation or reflection, two ways: firſt, by keeping the idea, which is brought into it, for ſome time actually in view, which is called CONTEMPLATION: and ſecondly, by the power which we have to revive again in our minds thoſe ideas, which, after imprinting, have diſappeared, or have been, as it were, laid out of ſight; as when we conceive heat or light, yellow or ſweet, the object being removed. This (he ſays) is MEMORY; which is, as it were, the ſtorehouſe of our ideas †.

To explain this more fully, he immediately adds the following obſervation:—" But our ideas being nothing but actual perceptions in the mind, which ceaſe to be any thing when there is no perception of them, this laying up of our ideas in the repoſitory of the memory, ſignifies no more than this, that the mind has a power, in many caſes, to revive perceptions which it has once had, with this additional perception annexed to them, that it has had them before. And in this ſenſe it is, that our ideas are ſaid to be in our memories, when indeed they are actually nowhere; but only there is an ability, in the mind, when it will, to revive them again, and, as it were, paint them anew on itſelf, though ſome with more ſome with leſs difficulty, ſome more lively and others more obſcurely. And thus it is, by the aſſiſtance of this faculty, that we are ſaid to have all thoſe ideas in our underſtandings, which, though we do not actually contemplate them, yet we can bring in ſight, and make appear again, and be the objects of our thoughts, without the help of thoſe ſenſible qualities which firſt imprinted them there."

† *Eſſay*, book ii. chap. 10.

To attempt a defence of the accuracy of this language would be vain; but as the author's meaning is ſufficiently obvious, his expreſſions may be eaſily and certainly corrected. Had Locke ſaid—" But our ideas being nothing but ſcenes or appearances in the mind, which ceaſe to be any thing when there is no perception of them, this laying up of our ideas in the repoſitory of the memory ſignifies no more but this, that the mind has a power, in many caſes, to revive ſcenes which it has once viewed, with this additional perception annexed to them, that it has viewed them before," there would have been no room for the many petulant remarks which have been made upon the paſſage.

59 objected to.

But againſt this account of memory, a much heavier charge has been brought than that which regards the propriety of the language. It has been ſaid, that the additional perception, which, according to Locke, attends the revival of our ideas by the power of memory, " would be a fallacious perception, if it led us to believe that we had them before, ſince they cannot have two beginnings of exiſtence: nor can we believe them to have two beginnings of exiſtence; we can only believe that we had formerly ideas or perceptions very like to them, though not identically the ſame." Let us examine this queſtion ſomewhat narrowly: for if it be really true, that in the ſenſe in which the word *ſame* is here uſed, we cannot twice contemplate the ſame idea, all confidence in memory would ſeem to be at an end.

60 The objection obviated.

Suppoſe a man to ſtand on ſome of the riſing grounds about Edinburgh, the Caltonhill for inſtance, and from that eminence to view the glorious proſpect of the coaſt of Fife, the ocean, the frith of Forth, and the little iſlands ſcattered in the frith. Let him go away, and return next day to the ſame place, and look the ſame way: we would aſk whether he has the ſame *view* or *perception* which he had the day before? The man muſt ſurely be very captious who would ſay that he has not: and yet it is certain that the energy of mind by which he perceives on one day cannot be identically the ſame with that by which he perceived on another; nor are the rays of light which fall upon his eyes on the ſecond day, identically the ſame with thoſe which fell upon his eyes and occaſioned viſion on the firſt day. Let the ſame man now ſhut his eyes, and contemplate the various objects at which he had been juſt looking. They will appear to him in all reſpects the ſame as when viewed by means of his organs of ſight, only fainter and leſs diſtinct, with this additional conviction, that the immediate objects of his preſent contemplation are not real external things, but *ideas* or *mental repreſentations* of thoſe things which had ſo lately been the objects of his ſight. Let him think no more about the matter for ſome days, and then exert his powers of memory. We have no heſitation to ſay, that in the ſenſe of the word *ſame*, as uſed by Mr Locke, the very ſame ideas will recur and be preſent to his intellect which were preſent to it at the former contemplation. The ſecond energy of memory or imagination, or whatever it may be called, is not indeed identically the ſame with the firſt; nor is that agitation or motion, or whatever other affection of the brain is neceſſary to memory, identically the ſame at the ſecond time as at the firſt: but the mind exerting itſelf in the very ſame manner at the one time as at the other, produces the ſame kind of agitation in the brain, and is itſelf affected in the very ſame way at the ſecond as at the firſt exertion. Whence it follows, that the ſecond *ideal ſcene* will be as much the ſame with the firſt, as the ſecond *actual perception* is the ſame with the firſt; and the two ideal ſcenes, and the two actual perceptions, are reſpectively ſaid to be the ſame with each other, only becauſe they impreſs the mind with a conviction that they were occaſioned by the ſame external objects.

But though we think Locke's doctrine, with reſpect to memory, may be thus eaſily vindicated from the charge of fallaciouſneſs, we muſt acknowledge that to us it appears not to be of much value. It teaches nothing, but that the mind has a power to retain ideas of thoſe objects which it formerly perceived, and in many inſtances to recal them as occaſion may require. But theſe are truths known to all mankind, to the clown as well as to the philoſopher.

61 The opinion of Hume.

Philoſophers in general have paid leſs regard to the retentive faculties of the mind than to its original powers of perception. Perhaps they imagined, that as memory depends upon perception, and in ſome reſpects appears to reſemble it, a competent knowledge of the nature of the former faculty would lead to that of the ſecond. Be this as it may, Mr Hume, who was at ſome pains to detail his notions of perception, has in his Philoſophical Eſſays only dropt concerning memory and imagination a few hints, ſo looſely thrown together, that, if he had not elſewhere expreſſed himſelf with more preciſion, it would have been difficult to diſcover his real meaning. According to him, that which is commonly called the *perception of an external object*, is nothing but a ſtrong impreſſion upon the mind; and that which is called the *remembrance of a paſt object*, is nothing but a preſent impreſſion or idea weaker than the former. Imagination is an idea weaker than the idea or impreſſion which he calls *memory*. This ſeems to be a wonderful abuſe of language. Impreſſions are not perceptions; and, if poſſible, they can ſtill leſs be called *ideas*, which are but ſecondary perceptions. It is likewiſe far from being true, that an idea of imagination has neceſſarily leſs vivacity than an idea of memory. We have ſeen Mr Hume, and have at the preſent moment an idea of his form and dreſs: we can likewiſe imagine to ourſelves a centaur; and though a centaur was never ſeen, and therefore cannot be *an impreſſion repeated by memory*, our idea of the monſter is much more lively and diſtinct than that of the philoſopher.

62 Of Dr Reid.

Dr Reid having obſerved of memory *, that it is by it we have an immediate knowledge of things paſt; that it muſt have an object; that in this reſpect it agrees with perception, but differs from ſenſation, which has no object but the feeling itſelf; and that every man can diſtinguiſh the thing remembered from the remembrance of it—proceeds to inquire what memory is. And, "Firſt (ſays he), I think it appears that memory is an original faculty given us by the Author of our being, of which we can give no account but that we are ſo made. The knowledge (continues he) which I have of things paſt by my memory, ſeems to me as unaccountable as an immediate knowledge would be of things to come (F); and I can give no reaſon why I ſhould have the one and not the other, but that ſuch is the will of my Maker. I find in my mind a diſtinct conception and a firm belief of a ſeries of paſt events; but how this is produced I know not. I call it *memory*; but this is only giving a name to it; it is not an account of its cauſe. I believe moſt firmly what I diſtinctly remember; but I can give no reaſon of this belief. It is the inſpiration of the Almighty which gives me this underſtanding. When I believe the truth of a mathematical axiom or of a mathematical propoſition, I ſee that it muſt be ſo: every man who has the ſame conception of it ſees the ſame. There is a neceſſary and an evident connexion between the ſubject and the predicate of the propoſition; and I have all the evidence to ſupport my belief which I can poſſibly conceive. When I believe that I waſhed my hands and face this morning, there appears no neceſſity in the truth of the propoſition. It might be or it might not be. A man may diſtinctly conceive it without believing it at all. How then do I come to believe it? I remember it diſtinctly. This is all I can ſay. This remembrance is an act of my mind. Is it impoſſible that this act ſhould be, if the event had not happened? I confeſs I do not ſee any neceſſary connexion between the one and the other. If any man can ſhow ſuch a neceſſary connexion, then I think that belief which we have of what we remember will be fairly accounted for: but if this cannot be done, that belief is unaccountable; and we can ſay no more but that it is the reſult of our conſtitution. Our original faculties are all unaccountable: Of theſe memory is one. He only who made them comprehends fully how they are made, and how they produce in us not only a conception, but a firm belief and aſſurance, of things which it concerns us to know."

On this account of memory we ſhall make no remarks. There is a certain ſenſe of the words, in which every thing which the author has ſaid on the ſubject is undoubtedly juſt; and it would be very uncandid to take his words in any other ſenſe. But though memory, as it is the reſult of that conſtitution which was given us by God, and not the offspring of habit or human contrivance, is unqueſtionably an original faculty; and though it is therefore impoſſible to account for it ſo fully as to ſilence every inquiry which may be made, yet we could wiſh that Dr Reid had beſtowed a little more pains upon it, in order to diſcover if poſſible in what reſpects it reſembles or differs from perception. He has well obſerved, that there are laws of nature by which the operations of the mind are regulated, as well as laws of nature which govern the material ſyſtem. As the latter are the ultimate concluſions which the human faculties can reach in the philoſophy of bodies, ſo the former are the ultimate concluſions which we can reach in the philoſophy of minds. The more general that theſe laws are in both caſes, the more uſeful they are and the more ſatisfactory: for as they are themſelves inexplicable, the fewer they are in number, and the more comprehenſive each, the fewer will thoſe phenomena be for which we can give no account. Thus, as we know not what makes the planets tend to the centre of the ſun, or heavy bodies tend to the centre of the earth, we can give no other account of theſe phenomena, but that, as they appear to be of the ſame kind, it is reaſonable to conclude that they proceed from ſimilar cauſes. What the cauſe is of this tendency of bodies towards each other, we know not. We call it *gravitation*, and employ it to account for all phenomena of the ſame kind. In like manner it is univerſally allowed, that as we know not how mind and matter operate upon each other, there is ſomething in perception wholly unaccountable. That perception follows ſenſation; and that there is no ſenſation which is not occaſioned by ſome affection of the brain, proceeding from ſome impreſſion *ab extra;* we have the evidence of experience: but how a particular affection of the brain ſhould excite a ſenſation in the mind, we know not; though we may here, as in the corporeal ſyſtem, attribute ſimilar effects to the ſame or ſimilar cauſes. Thus, if when we exert an act of memory we have the ſame appearance of things as in the original act of perception, the rules of philoſophizing authorize us to refer both phenomena to the ſame general law; juſt as they authorize us to refer the motion of the planets and of projectiles to the ſame general law. On the other hand, if we perceive no ſimilarity between memory and perception, we have made no progreſs in the philoſophy of mind; for in that caſe we have diſcovered two phenomena proceeding from two cauſes totally different from each other, and both inexplicable. Although we ſcarcely hope to throw any light upon a ſubject which Dr Reid has not attempted to illuſtrate, we ſhall ſtate a few facts reſpecting the memory, and ſubmit to the reader the concluſions to which we think theſe facts lead.

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* Eſſays on the Intellectual Powers of Man.

(F) If memory depends upon the ſtate of the brain as it has been affected in paſt perceptions, this appears to us a ſtrange poſition. Perhaps the excellent author means nothing more, than that it is as unaccountable to us, that impreſſions on the brain ſhould cauſe perception, and the veſtiges of thoſe impreſſions ſhould cauſe remembrance, as how the mind might not perceive things to come without the intervention of impreſſions on the brain. If this be his meaning, no man will controvert it: for it is impoſſible to diſcover the nature of that relation which ſubſiſts between an impreſſion and perception; but that there is ſuch a relation, we know from experience.

63
The appearance of ſenſible objects when recalled by the power of memory.

1. Objects once perceived by the ſenſes, when recalled to the mind by the power of memory, appear preciſely the ſame as in the original perception, only leſs diſtinct *. For example, having ſeen yeſterday a ſpreading oak growing on the bank of a river, and having heard a ſhepherd play, and handled a ſquare ſtone, we endeavour to recal to our mind theſe objects which are now abſent. How is this operation performed? Do we endeavour to form in our minds pictures of them or repreſentative images? or, does our intellect ſurvey the types or forms which, according to Ariſtotle, thoſe objects left in the imagination when originally perceived? Neither of theſe things is done. We conceive ourſelves as ſtanding in the ſame place where we ſtood yeſterday; upon which we have perceptions of the objects ſimilar in all reſpects to the perceptions which we had when we employed our eyes, our ears, and our hands. The tree appears, as it were, before us; faint indeed, but attended with all the objects which we obſerved around it yeſterday: we ſeem to hear the ſound of the pipe confuſedly, and at a diſtance; to move our hands over the ſtone, and to feel the ſame ſurfaces and the ſame angles which we felt in the original perception. In this recollection we are not conſcious of pictures or images more than in the original ſurvey. The perceptions ſeem to be of the tree and river themſelves, of the ſound itſelf, and of the ſtone itſelf, exactly as at the firſt; and yet we are ſatisfied that in the act of remembrance we perceive no ſuch object as a *real* tree, pipe, or ſtone. That theſe are facts, every man muſt be convinced who attends to the energies of his own mind when exerting the powers of retention: and therefore it is, in our opinion, with no impropriety that Mr Harris ſays, we may call SENSE, if we pleaſe, *a kind of tranſient imagination;* and IMAGINATION, on the contrary, *a kind of permanent ſenſe;* for if theſe two faculties, as far as the mind or intellect is concerned, be not the ſame, they ſeem to reſemble each other much.

* *Appendix to Elements of Criticiſm.*

64
What ideas remain longeſt in the memory.

2. The *primary* perception of a *viſible* object is more complete, lively, and diſtinct, and remains longer in the *ſenſorium*, than that of any other object. We know likewiſe by experience, that an *idea* or *ſecondary* perception of a viſible object is as much more complete, lively, and diſtinct, than the idea of any other object, as was the *primary* perception; and that we remember things which we have ſeen for a longer time than ſounds which we have heard, or than tangible objects which we have only handled. Yet there ſeems to be a conſtant decay of all our ideas, even of thoſe which are ſtruck (G) deepeſt and in minds the moſt retentive; ſo that if they be not frequently renewed by repeated exerciſe of the ſenſes, or by reflection on thoſe objects which at firſt occaſioned them, the print (G) wears out,

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(G) Theſe expreſſions, which mention ideas as things which are *deep ſtruck*, and as *prints which wear out*, are the expreſſions of Locke. We hope it is needleſs to warn our readers, that they are uſed by us, as they were by him, in a metaphorical ſenſe. On theſe ſubjects it is impoſſible to write without metaphor; which, while the meaning is obvious, no man will condemn, who reflects that the words of language were not invented by metaphyſicians, and are for the moſt part *literally* ſignificant only of ſenſible objects.

out, and at laſt there remains nothing to be ſeen. Concerning ideas, it is eaſy to remark, that thoſe remain longeſt and cleareſt in the memory which are derived from two or more ſenſes, eſpecially if the ſenſe of ſight be one of the number, or which are ofteneſt refreſhed by a return of the objects which produced them. Hence a man has a longer and more diſtinct remembrance of what he has ſeen than of what he has only heard, of what he has both ſeen and felt than of what he has only ſeen; and the ideas which we have of heat and cold, of hunger and thirſt, and of all thoſe things which moſt frequently affect our ſenſes, are extremely clear, and are never quite loſt whilſt the mind retains any ideas at all.

65
Memory a kind of habit.

3. Memory appears to be a kind of habit, which is not always in exerciſe with regard to things we remember, but is ready to ſuggeſt them when there is occaſion. The moſt perfect degree of this habit is, when the thing preſents itſelf to our remembrance ſpontaneouſly, and without labour, as often as there is occaſion. A ſecond degree is, when the thing is forgotten for a longer or ſhorter time, even when there is occaſion to remember it, and yet at laſt ſome incident, ſuch as a violent paſſion [*], which agitates the whole mind and ſenſorium, tumbles the idea, as it were, out of its dark corner, and brings it into view without any ſearch. A third degree is, when we caſt about and ſearch for what we would remember, and after ſome labour find it out. This ſearching faculty of the ſoul is by Ariſtotle called *αναμνησις*, by Dr Reid and others *reminiſcence*, and by Mr Harris *recollection*. Should it be ſaid, that what we *will* to remember we muſt already conceive, as we can will nothing of which we have not a conception; and that, therefore, a *will* to remember a thing, ſeems to imply that we remember it already—we anſwer, with Dr Reid, that when we will to remember a thing, we muſt indeed remember ſomething relating to it; but we may have no poſitive idea or conception of the thing itſelf, but only of the relation which it bears to that other thing which we do remember. Thus, one remembers that a friend charged him with a commiſſion to be executed at ſuch a place, but he has forgotten what the commiſſion was. He applies himſelf to diſcover it; and *recollects* that it was given by *ſuch a perſon*, upon *ſuch an occaſion*, in conſequence of ſuch a *converſation*: and thus by a train of thought he is led to the very thing which he had forgotten and wiſhed to remember. To this operation it is not always neceſſary that the relations between the various ideas which the mind turns over be very cloſe, or have their foundation in nature; for a caſual connexion is often ſufficient. Thus, from ſeeing a garment, we think of its owner; thence of his habitation; thence of woods; thence of timber; thence of ſhips; thence of admirals; thence of cannons, iron, furnaces, and forges," &c.

66
In recollection one idea ſuggeſts another, and why.

That, in the proceſs of recollection, one idea ſhould ſuggeſt another, may be eaſily accounted for. When, in perception, our minds are expoſed to the influence of external objects, all the parts and properties, and even the accidental variable adjuncts of theſe objects, are perceived by full-grown men at the ſame time; ſo that the whole group makes but one impreſſion upon our organs of ſenſe, and conſequently upon the mind. By theſe means all the parts of the ſimultaneous impreſſion [†], and conſequently of the perception occaſioned by that impreſſion, are ſo intimately aſſociated or linked together, that the idea of any one of them recurring at any future period, generally introduces the ideas of all the reſt. But as the neceſſary parts and properties of any thing are more cloſely linked together, and occur more frequently than any particular variable adjuncts, it is obvious, that by the idea of any one of theſe properties, the idea of the reſt, and of the object itſelf, will be more readily introduced than by the idea of any variable adjunct. It ſeems, however, to be certain, that we have no power of calling up any idea at pleaſure, but only ſuch as have a connexion, either in nature or by means of former aſſociations, with thoſe that are at any time preſent to the mind. Thus the ſight, or the idea, of any particular perſon, generally enables us to recollect his name, becauſe his name and his perſon have been conſtantly aſſociated together. If that fail to introduce the name, we are at a loſs and cannot recollect it at all till ſome other aſſociated circumſtance help us. In naming a number of words in a ſentence, or lines in a poem, the end of each preceding word or line being connected with the beginning of the word or line which ſucceeds it, we can eaſily repeat them in that order; but we are not able to repeat them backwards with any eaſe, nor at all till after many fruitleſs efforts. By frequent trials, however, we acquire at laſt a facility in doing it, as may be found by making the experiment on the names of number from one to twenty. It is, indeed, probable, that in the wildeſt flights of *fancy*, no ſingle idea occurs to us but ſuch as had a connexion with ſome other idea, perception, or notion, previouſly exiſting in the mind, as ſhall be ſhown more fully in a ſubſequent chapter.

67
Memory depends on the ſtate of the brain.

4. "Memory appears to depend entirely or chiefly upon the ſtate of the brain [*]. For diſeaſes, concuſſions of the brain, ſpirituous liquors, and ſome poiſons, impair or deſtroy it; and it generally returns again with the return of health, from the uſe of proper medicines and methods. It is obſervable, too, that in recovering from concuſſions and other diſorders of the brain, it is uſual for the perſon to recover the power of remembering the then preſent common incidents for minutes, hours, and days, by degrees; alſo the power of recalling the events of his life preceding his illneſs. At length he recovers this laſt power perfectly; and at the ſame time forgets almoſt all that paſt in his illneſs, even thoſe things which at firſt he remembered for a day or two. Now the reaſon of this ſeems to be, that upon a perfect recovery the brain recovers its natural ſtate, and all its former affections and tendencies; but that ſuch affections or tendencies as took place during the preternatural ſtate, i. e. during the patient's illneſs, are obliterated by the return of the natural ſtate." All this we are induced to believe; becauſe, though it is a fact incontrovertible, that in certain diſeaſes the memory is impaired, and recovers its vigour with the return of health, it is not conceivable that the mind itſelf ſhould ſuffer any change by diſeaſes, concuſſions, or ſpirituous liquors, &c.

From theſe facts we are ſtrongly inclined to conclude,

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[*] *Reid's Eſſays on the Intellectual Powers of Man, Locke's Eſſay*, &c. and *Harris's Hermes*.

[†] *Hartley on Man.*

[*] *Hartley on Man.*

68
External objects operating on the ſenſes leave ſome permanent effect in the brain.

clude, that the power of the *mind*, or *immaterial* (H) *principle*, by which it remembers paſt events, differs not from that by which it perceives preſent objects. In perception, impreſſions are made upon the organs of ſenſe, which are communicated to the brain; and, by ſome unknown means, occaſion ſenſations which are followed by the perception of the external object. When by the power of memory we recal paſt objects of ſenſe, the mind has the ſame view of them as in the original perception, except that they appear fainter, leſs diſtinct, and generally more diſtant. We have, therefore, reaſon to conclude, that in the act of remembrance the brain is affected in the ſame way, though not ſo forcibly, as in perception. That memory depends as much as perception upon the ſtate of the brain, is confirmed by daily experience; and therefore there cannot be a doubt but that external objects, operating upon the ſenſes, nerves, and brain, leave ſome permanent effect behind them. What that effect preciſely is we cannot know, and we need not deſire to know; but that they leave *ſome* effect we have as good evidence as that the planets are moved round the ſun by forces of the ſame kind with thoſe by which projectiles are moved on the earth. Could we ſuppoſe that they leave real *prints* or *impreſſions* behind them, which we confeſs to be very little probable, memory would ſeem to be nothing but the perceptive power of the mind turned to thoſe impreſſions. If the permanent effect of impreſſions by external objects be, as Dr Hartley ſuppoſes, only a tendency in the brain to vibrate as in the original perception, remembrance will reſult from the mind's operating upon the brain as in actual perception; and the reaſon that ideas of memory are fainter than perceptions of ſenſe, is, that the former are produced by a ſingle, and the latter by a double, operation.

69
Why the memory advances to perfection, and then gradually decays.

This theory appears to be greatly confirmed by the following well known facts, that children ſoon commit to their memory any thing which they underſtand, and as ſoon forget it; that the powers of memory gradually advance to perfection, and then gradually decay; and that old men remember more diſtinctly what they perceived in their youth, than what they perceived a year ago. For if the memory belonged wholly to the pure intellect, and had no dependence upon the brain, it is not eaſy to conceive how it ſhould advance towards a ſtate of perfection and afterwards decay. A being which is unextended and indiviſible, can ſuffer no change either in its eſſence or in its faculties: the ideas which it had once retained, it would retain for ever. But if memory be occaſioned by ſome relict of ſenſe left in the brain, it is eaſy to ſee how all thoſe changes ſhould take place: and therefore, though we have the weight of Dr Reid's authority againſt us, we cannot help thinking that Ariſtotle was in the right, when he imputed the ſhortneſs of memory in children to this cauſe, that their brain is too moiſt and ſoft to retain impreſſions made upon it; and that he was likewiſe in the right, when he imputed the defect of memory in old men to the hardneſs and rigidity of the brain, which hinders it from receiving any durable impreſſion.

Another argument to prove, that in remembrance the mind acts upon ſomething left in the brain by the impreſſions of ſenſe, is this, that nothing can act but where it is preſent. The truth of this axiom is acknowledged by Dr Reid, and we believe by all mankind except Dr Prieſtley and one or two others, whoſe paradoxes we ſhall conſider afterwards. Now it is confeſſed, that in recollection at leaſt the mind is active; and therefore it muſt act, *not* upon an object which has now perhaps no exiſtence, and certainly no immediate exiſtence, *but* upon ſomething left by that object in the brain or ſenſorium, to which the mind is intimately preſent.

70
By what means we never confound memory with perception.

But if this be ſo, we may be aſked how it comes to paſs that men never confound memory with perception, nor fancy that they perceive things which they only remember? If perception be an inference drawn from certain ſenſations excited by an impreſſion on the brain, and if remembrance reſult from the mind's operating upon relicts of thoſe impreſſions, one would think it natural to ſuppoſe, that in both caſes we have actual perceptions, though in the one caſe the perception muſt be more vivid and diſtinct than in the other. To this we anſwer, That previous to all experience, perception and memory are very probably confounded; and that we believe a man brought into the world with all his faculties in their full *natural* perfection, would not inſtantly be able to diſtinguiſh what he remembered from what he perceived. This we know to be the caſe with reſpect to imagination, a faculty which ſtrongly reſembles memory; for in dreams, and ſometimes even in waking reveries, we fancy that we actually perceive things which it is certain we can only imagine. A very ſhort experience, however, would enable this newly created man to make the proper diſtinction between remembrance and perception. For let us ſuppoſe him to be brought into a dark room, and ſoon afterwards a candle to be introduced. The candle would give him a viſible ſenſation, though not at firſt the perception of an external object. Let the candle after ſome time be carried out: the man would retain a viſible *idea*, which he might confound with the actual ſenſation. But if, whilſt this idea remained in his mind, the candle were brought back, he would inſtantly feel a difference between the real ſenſation and the idea, when both were together preſent to his mind. And having, in ſome ſuch manner as we have already deſcribed, acquired the power of perceiving external objects by means of his ſenſes, he would ſoon diſcover, without any effort of his own, the difference between actual perceptions and the ideas treaſured up in his memory.

(H) Through the whole of this and the preceding chapters, we have taken it for granted, that the ſentient principle in man is not material. This is the *common*, and, as ſhall be ſhown afterwards, the moſt *probable* opinion; but whether it be abſolutely certain or not, makes no difference on the theories of ſenſation and perception. Theſe are obviouſly neither figure nor motion, and therefore not ſubject to the laws which govern the material world.

71 The order of ſucceſſion in which objects recur to the memory.

The only remaining difficulty which ſeems to encumber this theory of remembrance, is, to account for the order of ſucceſſion in which objects recur to the memory, and to which we give the name of *time*.—But this difficulty will vaniſh when we have aſcertained what *time* is. At preſent it is ſufficient to obſerve, that our perceptions of external objects remain a certain ſpace of time in the mind; that this time is different, according to the ſtrength and other circumſtances of the impreſſion which occaſioned the perception; and that traces of thoſe perceptions, i. e. *ideas*, may be recalled after the intervention of other trains of ideas, and at very different intervals. If one look upon a houſe, and then ſhut his eyes, the impreſſion which it made upon his mind will not inſtantly vaniſh: he can contemplate the houſe almoſt as long as he pleaſes; and, by the help of various aſſociated circumſtances, he may recal the idea ſeveral years afterwards, and refer it to the original perception.

72 Brutes have memory, and

Before we diſmiſs the ſubject of retention, it may not be improper to take notice of the retentive powers of inferior animals. Ariſtotle, Locke, Dr Reid, and almoſt every philoſopher of eminence both among the ancients and moderns, have maintained, that inferior animals have memory as well as men; and indeed we do not perceive how the fact can be denied of the more perfect animals, and thoſe with whoſe operations we are beſt acquainted. A dog knows his maſter again after a long abſence; a horſe will trace back a road which he has but once travelled, often with more accuracy than his rider; and it is well known that many ſpecies of ſinging birds have a capacity to learn tunes from the human voice, and that they repeat the notes again and again, approaching nearer and nearer to perfection, till at laſt they ſing the tune correctly. Theſe phenomena can be accounted for only by ſuppoſing, that in the brains of the ſeveral animals traces are left by perception, of the ſame kind with thoſe which perception leaves in the brain of man, and which are the cauſe or occaſion of his remembrance. With reſpect to this point, the learned author of *Ancient Metaphyſics* differs from his maſter Ariſtotle. He allows that brutes have imagination, but denies that they have memory: for (ſays he) "memory neceſſarily implies a ſenſe of *time*, and what is *firſt* and *laſt*; but brutes have no idea of time, or of firſt and laſt; and it is certain that they have not conſciouſneſs or reflection, by which only they could review their own operations. At the ſame time he admits, that imagination in the brute ſerves the purpoſe of memory in us; for whenever he ſees the object that is painted on his *phantaſia*, he knows it again, but without any perception of the time when he firſt ſaw it." But that a brute, when he ſees the object which is painted on his phantaſia, ſhould know it *again* without referring it to a former perception, is plainly impoſſible. The recogniſance of any thing conſiſts in a conſciouſneſs of its having been perceived before; and nothing more than ſuch recogniſance is eſſential to memory. The author's miſtake ſeems to lie in ſuppoſing that memory neceſſarily implies a ſenſe of ſome determinate portion of paſt time; but we ſurely remember many things of which we can only ſay that we have formerly perceived them, without being able to aſcertain the preciſe period at which we had ſuch perceptions. A child has the uſe of memory ſooner than he acquires the faculty of ſpeech; but he muſt have ſpoken and even reaſoned before he can have an accurate notion of time, which, as ſhall be ſhown afterwards, ariſes from comparing the fleeting ſucceſſion of our own ideas with the permanence of ourſelves and other objects. The author's diſtinction between memory and imagination ſeems to be on all accounts improper. Ariſtotle has ſaid, and ſaid truly, that there is memory of *ideas* as well as of ſenſible objects; meaning by ideas general conceptions or propoſitions: but this reviver of his philoſophy is inclined to ſay, "that *memory* is only of *ideas*, conſequently belongs only to man; and that *imagination* is only of ſenſible objects, and conſequently belongs both to man and brute."—But ſurely man *remembers* what he has *ſeen* and *felt* as well as what he has *conceived* or *thought*; and if imagination and memory be properly diſtinguiſhed by Mr Harris, the reverſe of this writer's doctrine muſt be true, viz. that imagination belongs only to *man*, and memory of ſenſible objects both to *man* and *brute*.—We can contemplate in imagination the idea of a *centaur* or a *golden mountain*; but we cannot be ſaid to remember them, for they were never perceived. That a dog can contemplate in his imagination the idea of a *centaur* or of a *golden mountain*, we have not the leaſt reaſon to ſuppoſe; but were he not capable of viewing relicts of ſenſe repoſed with him, and referring them to their original cauſes, he could not poſſibly recogniſe his maſter after a day's abſence.

73 the power of recollection.

Dr Reid and the ſame author agree with Ariſtotle, in thinking it probable that brutes have not reminiſcence, or the power of recollection; but there are many well-atteſted facts which ſeem to prove the contrary. We ſhall mention one which fell under our own obſervation. One of the perſons concerned in this work was, when a young man, abſent for five months from the houſe of his father. Upon his return, a dog of that ſpecies which is commonly called the *ſhepherd's cur*, and which had been in the poſſeſſion of his father only a few months before his departure, gazed at him for a few minutes as at any other ſtranger. The animal then began to walk round him with looks which ſoon attracted his notice. This made him call the dog by the name which he bore in the family, and ſtretch out his hand to careſs him, when the creature inſtantly leaped upon him with all that appearance of attachment which theſe animals ſo commonly exhibit upon the return of their maſter after a few days abſence. If this was not recollection, we ſhould be glad to know what it was, for we cannot diſtinguiſh it from recollection in men. Indeed, if dogs and ſome other animals poſſeſs, as Ariſtotle, Locke, and others, allow them to poſſeſs, the power of memory, and ſomething of ratiocination; and if, as Dr Reid expreſly ſays *, "they expect events in the ſame order and ſucceſſion in which they happened before;" it is not conceivable that they can be wholly deſtitute of reminiſcence, or the power of recollection.

74 Memory capable of improvement.

That memory is a faculty of the firſt importance, cannot be denied; ſince it is obvious, that, without the power of retaining the ideas and notions which we receive by the ſenſes and other faculties, we never could make any progreſs in the acquiſition of knowledge, but ſhould begin every day, nay every hour, in the ſame ſtate of ignorance in which we are born. That it is a faculty capable of improvement by exerciſe, and that there are ſome methods of exerciſe better adapted for this purpoſe than others, has been ſhown elſewhere. See MEMORY.

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* *Eſſays on the Intellectual Powers of Man.*

CHAP. III. *Of* SIMPLE APPREHENSION *and* CONCEPTION.

75 Ideas of ſenſation the firſt materials of human knowledge.

THE ideas received into the mind by the ſenſes, and treaſured up in the memory and imagination, are the original materials of human knowledge. It is by comparing thoſe ideas with one another, or by analyzing them into their firſt principles, that we acquire all our knowledge in mathematics and philoſophy, and indeed all the knowledge which regulates our conduct through life. It muſt, therefore, be of importance to trace the progreſs of the mind in her various operations upon theſe materials; beginning, as ſhe certainly begins, with that which is moſt ſimple, and proceeding regularly to thoſe which are more complex and difficult.

76 Simple apprehenſion of ideas

Now the firſt operation of the mind about her ideas appears plainly to be that which logicians term *ſimple apprehenſion*. Having yeſterday obſerved a *tree* or any other object, if we contemplate the idea of that tree to-day as it remains in the imagination, without comparing it with any other idea, or referring it to any external object, we perform the operation which is called *ſimple apprehenſion*. We conſider ſimple apprehenſion as an *operation*, becauſe the mind in the apprehenſion of her own ideas is certainly active; ſhe turns them, as it were, round and round, and views them on every ſide.

77 different from conception.

Simple apprehenſion is a phraſe which is commonly taken to be of the ſame import with the word *conception*; and in the ordinary affairs of life no confuſion can ariſe from an indiſcriminate uſe of the two words: but in this article we think it expedient to employ the phraſe *ſimple apprehenſion*, to denote the view or contemplation of thoſe ideas only which the mind by ſenſation has actually received from external objects; and the word *conception* to denote the view, not only of thoſe ideas, but alſo of ſuch as the mind fabricates to herſelf. Thus, a man may *conceive* a centaur, but we would not chooſe to ſay that he may *apprehend* a centaur: not that there is any impropriety, perhaps, in this laſt expreſſion; but as there is certainly a difference between *apprehending* the idea of what has been ſeen or felt, and *conceiving* that which never exiſted, perſpicuity requires that theſe different operations be expreſſed by different names.

78 In what ſenſe it is true that we can conceive objects which never exiſted.

We have ſaid that the mind may conceive what never exiſted: and every man may eaſily ſatiſfy himſelf that what we have ſaid is true: but though this has been frequently called the creative power of the mind, it has in fact no reſemblance to *creation*. The materials of all our moſt complex and fantaſtic conceptions are furniſhed to our hands by ſenſation and reflection; nor can we form one ſimple idea which was not originally received by ſome of our ſenſes from external objects, or, as ſhall be ſhown afterwards, one intellectual notion which was not acquired by reflecting on the operations of our own minds. To explain the proceſs of fantaſtic conception, it is to be obſerved, that in every ſenſible object we perceive at once ſeveral things, ſuch as *colour*, *figure*, *extenſion* and *motion* or *reſt*, &c. Theſe are the objects of different ſenſes: but they are not, at leaſt by full-grown men, perceived in ſucceſſion, but all at once; whence it comes to paſs that the memory, or the imagination, retains not ſeveral diſtinct and diſjointed ideas, but the idea of *one coloured*, *figured*, and *extended object*. But when we compare various objects, or the ideas of various objects, together, we find that in ſome reſpects they agree and in others diſagree; i. e. that ſeveral objects affect ſome of our ſenſes in the ſame way, and other ſenſes differently. Thus one globe is black, and another white; one black ſubſtance is circular and hard, and another ſquare and ſoft. In the firſt inſtance, the two globes affect our ſenſe of touch in the ſame way, and our ſenſe of ſeeing differently; in the ſecond, the two black ſubſtances affect our ſenſe of ſight in the ſame way, and our ſenſe of touch differently.

From obſerving this difference among objects by means of the different ſenſations received from them, the mind learns to analyze its original ideas, which are copies of thoſe ſenſations, into their firſt principles, and to combine thoſe principles in ſuch a manner as to form complex ideas of objects which were never actually perceived by the ſenſes. Of the ſimple and unmixed principles which compoſe thoſe complex ideas, there is not indeed one which was not originally received by ſome ſenſe; ſo that the whole difference between complex ideas fabricated by the mind, and thoſe which are the relicts of ſenſation, conſiſts in the order in which the conſtituent ſimple ideas of each are put together. Thus, no man ever ſaw a mountain of pure gold; and therefore the idea of ſuch a mountain can be in no human mind as a relict of ſenſation; but we have all ſeen pieces of gold of different ſizes, and we have all ſeen mountains; and nothing is more eaſy than to *conceive* a piece of gold extended on all ſides to the ſize of a mountain, and riſing out of the earth. Again, Though no perſon ever ſaw a centaur, yet it is eaſy to *conceive* the upper parts of a man joined to the breaſt and ſhoulders of a horſe. In theſe inſtances, the complex conceptions are of things which it is in the higheſt degree probable never had a real exiſtence, and which it is certain we never *perceived* as exiſting: but the ſimple ideas of which they are compoſed are the relicts of actual ſenſations; for every one has perceived as really exiſting the body of a horſe and the upper parts of a man, and when conceiving a centaur he only perceives them to exiſt united. That we have not in the imagination one ſimple and unmixed idea which was not left there as a relict of ſenſe, every man will be convinced who ſhall try to conceive a ſimple colour or taſte which is totally different from all the colours and taſtes, and all the ſhades and varieties of them, which he has received by ſenſation; but his ſimple ideas, though all received from without, he may put together in numberleſs manners, differing from any order in which he has ever actually perceived the qualities of external objects exiſting.

79 This power of conception limited to poſſible exiſtence.

Yet even this power of the mind is limited. It is impoſſible to put together a number of *contrary* and *inconſiſtent* ideas, in ſuch a manner as to form of them one complex conception. No man, for inſtance, can conceive a thing to be at once white and black, round and ſquare, hard and ſoft, in motion and at reſt.—Hence it is a maxim among philoſophers almoſt univerſally received, that though we can conceive many things which never *actually* exiſted, yet we can form no ideas but of ſuch things as *might poſſibly exiſt*. A centaur never exiſted, but it may be conceived; for it is by no means impoſſible that the head of a man might be joined to the body of a horſe: but black ſnow cannot be *conceived;* for in the complex idea denoted by the word *ſnow* whiteneſs is an eſſential part, and nothing can be conceived to be both black and white at the ſame time. From this undoubted fact, that we cannot conceive impoſſible exiſtence, the power of conception has by ſome writers in certain inſtances been made a teſt of truth. "In every idea is implied (ſays Dr Price*) the poſſibility of the exiſtence of its object; nothing being clearer, than that there can be no idea of an impoſſibility, or conception of what cannot exiſt." "It is an eſtabliſhed maxim in metaphyſics (ſays Hume), that whatever the mind conceives, includes the idea of poſſible exiſtence; or, in other words, that nothing we imagine is abſolutely impoſſible †." In a word, it has been admitted by all philoſophers, from Pythagoras to Dr Reid, to be an axiom as evident and undeniable as any in Euclid, that whatever we can diſtinctly conceive is poſſible, though many things may be poſſible, nay, may really exiſt, of which we can form no conception.

80 The ſingular opinion of Dr Reid reſpecting our power of conception

This axiom has been denied by the author of the Eſſays on the Intellectual Powers of Man; who affirms, that "any two ſides of a triangle may be conceived to be equal to the third," as diſtinctly as "any two ſides of a triangle may be conceived to be greater than the third." This aſſertion from ſuch a man ſurpriſed us as much as any paradox which we ever read: for nothing is more certain, than that *we* ourſelves can form no conception of a triangle of which two of the ſides are only equal to the third. We can, indeed, reſolve the propoſition into its different parts, and form the diſtinct and independent ideas of a *triangle*, *two ſides*, and *one ſide;* and we can likewiſe form the general notion of *equality:* but to combine theſe ideas and this notion into one individual complex conception, we find to be abſolutely impoſſible. A man who knows nothing of triangles, if ſuch a man there be, might *believe* Dr Reid that it is a figure of which one of its ſides is equal to the other two; but ſuch a perſon would have no *conception* of the *figure itſelf*, but only a confidence in the doctor's veracity.

81 Controverted.

What is it to *conceive* a corporeal thing to exiſt? Is it not to fancy that we view it on all ſides, as what may be ſeen, or felt, or ſmelt, or taſted? The doctor, indeed, repeatedly reprobates as the ſource of much error the notion of ideas as images in the mind; and if ideas be taken as real material figures, he is certainly in the right: But we appeal to the common ſenſe of mankind, whether every perſon who diſtinctly *conceives a triangle*, is not at the time conſcious that his mind is affected in a manner ſimilar, though not ſo forcibly, as when he actually views a triangle with his eyes? What other men may feel, they know beſt; but we are as certain that this is the caſe with reſpect to ourſelves, as we are certain of our own exiſtence. That this affection of the mind is occaſioned by ſome agitation in the brain, of the ſame kind with that which occaſions actual perception, is highly probable; but whatever be the cauſe, the fact is undeniable.

The doctor's words, indeed, taken by themſelves, would lead one to think, that by *conception* he means in this caſe nothing more than the underſtanding of the terms of a propoſition: but if that be his meaning, there was no room for controverſy; as the great philoſophers *Cudworth*, *Clarke*, *Price*, and *Hume*, whoſe opinion he is combating, would have been as ready as himſelf to allow, that when a man is thoroughly maſter of any language, he will find no difficulty in underſtanding the meaning of any particular words in that language, however abſurdly theſe words may be put together. When Dr Price ſays, that "in every idea is implied the poſſibility of the exiſtence of its object, nothing being clearer than that there can be no idea of impoſſibility or conception of what cannot exiſt," his meaning evidently is, that we cannot mentally contemplate or fancy ourſelves viewing any thing corporeal, which we might not actually view with our eyes, or perceive by ſome other ſenſe (K). This is the true meaning of *conception*, which is ſomething very different from underſtanding the ſeparate meaning of each word in a propoſition.

The learned profeſſor, however, appeals to the practice of mathematicians for the truth of his opinion: and if they be on his ſide, we muſt give up the cauſe; for in no ſcience have we ſuch clear ideas, or ſuch abſolute certainty, as in mathematical reaſonings. But it is to be obſerved, that the word *conception* is

with

[*] *Review of the principal Queſtion and Difficulties in Morals.*

[†] *Eſſays.*

(K) Dr Price may be thought by ſome to have contradicted in this paſſage what he had aſſerted in a former. He is a ſtrenuous advocate for abſtract and general ideas even of material objects; but thoſe among the moderns who contend the moſt zealouſly for theſe, contend for them only as conceptions of the mind which can have no poſſible exiſtence out of it. Were this likewiſe the opinion of Dr Price, he would certainly have fallen into a direct contradiction; but this is not his opinion. His notion of abſtract ideas ſeems to be the ſame with that of Plato, who conſiders ideas not only as the poſſibilities of exiſtence, but as things actually exiſting from eternity, uncreated and independent even of the Supreme Mind. That Dr Price carries the matter thus far, we are unwilling to believe; but he certainly conſiders general ideas as real exiſtences independent of *our* minds, though the immediate objects of our underſtanding. That in this notion he is miſtaken, we ſhall endeavour to prove in the next chapter. It is enough for our preſent purpoſe to have ſhown that he does not contradict himſelf; and that he might with great propriety affirm on his own principles, as well as upon the principles of thoſe who admit not of univerſal ideas, that in every idea is implied the poſſibility of its object.

with no propriety applied to *abſtract truth*, but to *real* or *poſſible* exiſtence; nor can we be ſaid to conceive diſtinctly a *real* or *poſſible* object, unleſs we be able to turn it round and round, and view it on all ſides.—The faculties which are converſant about *abſtract truth* are the judgement and the reaſon; and truth itſelf conſiſts in the agreement, as falſehood does in the diſagreement, of two or more ideas or terms compared together. If thoſe ideas about which the judgement is to be made can be immediately brought together, without the intervention of a third idea, it is impoſſible that we ſhould *judge*, or, if Dr Reid will have it ſo, *conceive* that to be *true* which is *really falſe*. If the two ideas cannot be immediately brought together, it is impoſſible that we ſhould form any *judgement* or *conception* at all about their *agreement* or *diſagreement*: but we may *ſuppoſe* or *admit*, for the ſake of argument, that they agree or diſagree; and if that ſuppoſition conduct to a manifeſt abſurdity, we then *know* that the ſuppoſition was falſe. It is, therefore, perfectly agreeable to the maxim of Price and Hume, that mathematicians ſhould in many caſes prove ſome things to be poſſible and others impoſſible, which without demonſtration would not have been believed; becauſe if the ideas compared cannot be immediately brought together, no *judgement* previous to the demonſtration can be formed of the truth or falſehood of the propoſition; and if it concern not real or poſſible exiſtence, it is a propoſition with which *conception* has nothing to do.

"But (ſays Dr Reid) it is eaſy to *conceive*, that, in the infinite ſeries of numbers and intermediate fractions, ſome one number, integral or fractional, may bear the ſame ratio to another as the ſide of a ſquare bears to its diagonal." We are ſo far from thinking this an eaſy matter, that if the word *conceive* be taken in the ſenſe in which it is uſed by the philoſophers whoſe opinion he is combating, we muſt confeſs that we can form no adequate conception at all of an infinite ſeries. When we make the trial, we can only bring ourſelves to *conceive* the real numerical figures 1, 2, 3, &c. or the fractional parts $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, &c.; and even here our *conception* reaches but a ſmall way. We have reaſon to believe, that minds of a larger graſp can conceive at once more of the ſeries than we can; and that the Supreme Mind conceives the whole of it, if the whole of a mathematical infinity be not a contradiction in terms: but ſurely no man will ſay that he can conceive an infinite ſeries as he conceives a centaur, and have an adequate and diſtinct view of it at once. If, by conceiving that in an infinite ſeries ſome one number may bear the ſame ratio to another that the ſide of a ſquare bears to its diagonal, the doctor only means that ſuch a *ſuppoſition* may be made, his obſervation is not to the purpoſe for which it is brought; for the queſtion is not about our power to make ſuppoſitions of this kind, but about our power to raiſe in our imaginations an adequate and diſtinct mental view of poſſible or impoſſible exiſtence. "To ſuppoſe (ſays Johnſon), is to advance by way of argument or illuſtration, without maintaining the truth of the poſition." In this ſenſe a man may *ſuppoſe* that in an infinite ſeries there may be ſome one number which bears the ſame ratio to another that the ſide of a ſquare bears to its diagonal: but ſuch a ſuppoſition contains in it nothing that is *poſitive*, which conception always does; it is only admitting, for the ſake of argument, a poſition, of the truth or falſehood of which the perſon who makes the ſuppoſition knows nothing.—He is only talking of ratios as a blind man may talk of colours. A man born blind may be made to comprehend many of the laws of optics, and may make ſuppoſitions about colours, and reaſon from ſuch ſuppoſitions to a certain extent. as clearly and juſtly as one who ſees; but will any perſon ſay that a man blind from his birth can conceive *red* or *green*? It is much the ſame with reſpect to an infinite ſeries. We can follow ſuch a ſeries ſo far, and may know the ratio by which it increaſes or decreaſes, and reaſon from what we know with the utmoſt certainty: but no man ever *conceived the whole of an infinite ſeries* as he conceives an individual object; nor can any reaſonings upon the nature of it be applied to the queſtion of conceiving impoſſible exiſtence.

But "mathematicians often require us (ſays Dr Reid) to conceive things that are impoſſible, in order to prove them to be ſo. This is the caſe in all their demonſtrations *ad abſurdum*. Conceive (ſays Euclid) a right line drawn from one point of the circumference of a circle to another, to fall without the circle. I conceive this, I reaſon from it, until I come to a conſequence that is manifeſtly abſurd, and from thence conclude that the thing which I conceived is impoſſible." If it be indeed true, that Euclid deſires his readers to conceive a mathematical circle with a line drawn from one point of its circumference to another, and that line lying without the circle—if he really deſires them to form ſuch a complex conception as this, we have no heſitation to affirm, that he requires them to do what is manifeſtly impoſſible. The writer of this article has not in his cuſtody any copy of the Elements in the original Greek, and therefore cannot ſay with certainty what are Euclid's words, nor is it of much importance what they be; for on a queſtion which every man may decide for himſelf, by looking into his own mind, the authority of Euclid is nothing.—The propoſition to which the doctor refers, is the ſecond of the third book; and, in the edition of Simpſon, is expreſſed thus: "If any two points be taken in the circumference of a circle, the ſtraight line which joins them ſhall fall within the circle." Every mathematician who can form an adequate conception of a circle and a ſtraight line, perceives the truth of this propoſition inſtantly, for it reſults neceſſarily from his conception; but he who has not an adequate conception of a circle, *may* ſtand in need of a demonſtration to ſhow him the truth: for it is to be obſerved, that demonſtration does not *make truth*; it only points it out to thoſe who cannot perceive it intuitively, juſt as a microſcope does not make the hairs on a mite's back, but only brings them within the field of viſion.

Were a man who never examined a mite through a microſcope, and who has no adequate ideas of the inſect kingdom, to be aſked whether there be hairs on a mite's back? he would probably anſwer that he did not know, but he could *conceive* no ſuch hairs. In like manner, were a man who has no adequate conception of a mathematical circle, to be aſked whether a ſtraight line, which joins any two contiguous points in the circumference, could lie *without* the circle? he would probably anſwer that he did not know. Now it is to be remembered, that the reader of the Elements can have no very adequate conception of a circle when he comes to the ſecond propoſition of the third book. The definition of a circle was indeed given him in the introduction to the firſt book; but of that definition he has hitherto had occaſion to make very little uſe, ſo that his idea of a circle will be little more accurate than that of an illiterate clown, who has no other idea of the figure than what he takes from a halfpenny or a ſhilling. Dr Reid himſelf has elſewhere * well obſerved, that "when a youth of moderate parts begins to ſtudy Euclid, every thing at firſt is new to him. His apprehenſion is unſteady; his judgement is feeble, and reſts partly upon the evidence of the thing, and partly upon the authority of his teacher: but every time he goes over the definitions, the axioms, the elementary propoſitions, more light breaks in upon him; the language becomes familiar, and conveys clear and ſteady conceptions." In this ſtate he certainly is when he reads for the firſt time the ſecond propoſition of the third book: his conception of a circle can then be neither clear nor ſteady. Our young geometrician, however, muſt allow, that the propoſition is either true or falſe; and if he has read the preceding books with any advantage, he muſt have clear and ſteady conceptions of angles and triangles, and be able to demonſtate many of their properties. "Well (ſays Euclid), though you have no adequate conception of a circle, you are well acquainted with plane angles and triangles, and many of their properties: let us ſuppoſe, if that be poſſible, that my propoſition is falſe, and I will ſhow you that the ſuppoſition is abſolutely inconſiſtent with what you know to be demonſtrable or ſelf-evident truth." This is all which Euclid can be ſuppoſed to require, when, in the words of his excellent tranſlator, he ſays, "If it (viz. the ſtraight line) do not fall within (the circle), let it fall, if poſſible, without." He could not poſſibly deſire a man who has an adequate idea of a circle, to form the poſitive and complex conception of that figure, with a ſtraight line touching two points of the circumference, and yet lying on the outſide of the circumference; becauſe all his figures and lines are mere conceptions, and not real material things; and ſuch a requeſt would have been the ſame thing as if he had ſaid, Conceive what cannot be conceived (L).

* See *Lord Kames's Sketches of the Hiſtory of Man*; Appendix to the firſt Sketch on the Sciences.

We have inſiſted the longer on this point, becauſe we think it of the higheſt importance: for were it indeed true, that we could conceive impoſſible exiſtence, the conſequences would be very melancholy. Theſe conſequences it is needleſs to enumerate. Our readers will perceive, that if we could put together inconſiſtent ideas of ſenſible objects, and view them ſo united as one conſiſtent whole, nothing is clearer than that our faculties would be contrived to deceive us, and we would be doomed to cheerleſs and univerſal ſcepticiſm.

CHAP. IV. *Of* ABSTRACTION *and* GENERAL IDEAS.

82 Every ſenſible object and every idea are individual.

EVERY ſenſible object is an individual, and differs in many reſpects from every other object. As ſuch it is perceived by the ſenſes; and ideas being nothing more than relicts of ſenſation preſerved in the imagination or memory, every idea muſt of courſe be an individual, as much as the object to which it refers. But all ſcience, whether mathematical, moral, or metaphyſical, is converſant about general truths; and if truth conſiſt, as we have already obſerved, and ſhall more fully evince afterwards, in the agreement or coincidence of ideas, how, it may be aſked, can general truth reſult from the compariſon of particular ideas? To get rid of this difficulty, many philoſophers, both ancient and modern, pretend that the mind is furniſhed with *general ideas*, from a compariſon of which reſult general propoſitions applicable to many individuals. Philoſophers, indeed, have differed in opinion reſpecting the ſource of thoſe ideas, ſome of the ancients deriving them immediately from the Supreme Mind to the human, whilſt almoſt all the moderns ſays that they are framed by abſtraction, and therefore call them *abſtract ideas.*

83 The doctrine of abſtract ideas ſtated, and

The doctrine of *abſtract* ideas has been ſo fairly ſtated, and, in our opinion, ſo completely overturned, by Biſhop Berkeley, that we ſhall content ourſelves with abridging what he has ſaid on the ſubject, and obviating

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(L) Principal Campbell, treating of the commonly received doctrine of abſtraction, and having ſhown, that though Locke has in one paſſage of his immortal work expreſſed himſelf on the ſubject in terms unintelligible, his ſentiments on the whole differed little from thoſe of Berkeley and Hume, adds, "Some of the greateſt admirers of that eminent philoſopher ſeem to have overlooked entirely the preceding account of his ſentiments on this ſubject; and, through I know not what paſſion for the paradoxical (I ſhould rather ſay the impoſſible and unintelligible), have ſhown an amazing zeal for defending the propriety of the haſty expreſſions which appear in the paſſages formerly referred to. Has not the mind of man (ſay they) an unlimited power in moulding and combining its ideas? The mind, it muſt be owned, hath an unlimited power in moulding and combining its ideas. It often produces wonderful forms of its own out of the materials originally ſupplied by ſenſe; forms indeed of which there is no exemplar to be found in nature:—centaurs and griffins,

Gorgons and hydras, and chimeras dire.

But ſtill it muſt not attempt abſolute impoſſibilities, by giving to its creature contradictory qualities. It muſt not attempt to conceive the ſame thing to be black and white at the ſame time; to be no more than three inches long, and yet not leſs than three thouſand; to conceive two or more lines to be both equal and unequal; the ſame angle to be at once acute, obtuſe, and right;" or, we may add, the two ſides of a triangle to be not greater than the third. See *Philoſophy of Rhetoric*, vol. ii. p. 108, &c.

obviating ſome cavils which have lately been urged againſt his reaſoning. "It is agreed on all hands (ſays that learned and ingenious prelate †), that the qualities or modes of things do never really exiſt each of them apart by itſelf and ſeparated from all others; but are mixed, as it were, and blended together, ſeveral in the ſame object. But, we are told, the mind being able to conſider each quality ſingly, or abſtracted from thoſe other qualities with which it is united, does by that means frame to itſelf abſtract ideas. For example: There is perceived by ſight an object extended, coloured, and moved: this mixed or compound idea, the mind reſolving into its ſimple conſtituent parts, and viewing each by itſelf excluſive of the reſt, does frame the abſtract ideas of extenſion, colour, and motion. Not that it is poſſible for colour or motion to exiſt without extenſion; but only that the mind can frame to itſelf by *abſtraction* the idea of colour excluſive of extenſion, and of motion excluſive of both colour and extenſion. Again, The mind having obſerved, that in the particular extenſions perceived by ſenſe, there is ſomething common and alike in all, and ſome other things peculiar, as this or that figure or magnitude, which diſtinguiſh them from one another; it conſiders apart, or ſingles out by itſelf, that which is common, making thereof a moſt abſtract idea of extenſion, which is neither line, ſurface, nor ſolid, nor has any figure or magnitude, but is an idea entirely preſcinded from all theſe. So likewiſe the mind, by leaving out of the particular colours perceived by ſenſe that which diſtinguiſhes them one from another, and retaining that only which is common to all, makes an idea of colour in abſtract, which is neither red, nor blue, nor white, nor any other determinate colour. And as the mind frames to itſelf abſtract ideas of qualities or modes, ſo does it by the ſame preciſion or mental ſeparation attain abſtract ideas of the more compounded beings, which include ſeveral coexiſtent qualities. For example: The mind having obſerved that *Peter*, *James*, and *John*, reſemble each other in certain common agreements of ſhape and other qualities, leaves out of the complex or compounded idea it has of *Peter*, *James*, and any other particular man, that which is peculiar to each, retaining only what is common to all, and ſo makes an abſtract idea wherein all the particulars equally partake, abſtracting entirely from and cutting off all thoſe circumſtances and differences which might determine it to any particular exiſtence. After this manner, it is ſaid, we come by the abſtract idea of *man*, or, if you pleaſe, humanity or human nature, in which, it is true, there is included colour, becauſe there is no man but has ſome colour; but then it can be neither *black*, nor *white*, nor any *particular* colour, becauſe there is no one particular colour wherein all men partake. So likewiſe there is included ſtature; but then it is neither tall ſtature, nor low ſtature, nor middle ſtature, but ſomething abſtracted from all theſe; and ſo of the reſt. Moreover, there being a great variety of other creatures that partake in ſome parts, but not all, of the complex idea of *man;* the mind, leaving out thoſe parts which are peculiar to man, and retaining thoſe only which are common to all the living creatures, frameth the idea of *animal;* which abſtracts not only from all particular men, but alſo from all birds, beaſts, fiſhes, and inſects. The conſtituent parts of that abſtract idea of animal, are body, life, ſenſe, and ſpontaneous motion. By *body*, is meant body without any particular ſhape or figure, there being no one ſhape or figure common to all animals, without covering either of hair or feathers or ſcales, &c. and yet not naked; hair, feathers, ſcales, and nakedneſs, being the diſtinguiſhing properties of particular animals, and for that reaſon left out of the *abſtract idea.* Upon the ſame account, the ſpontaneous motion muſt be neither walking, nor flying, nor creeping: it is nevertheleſs motion; but what that motion is, it is not eaſy to conceive.

84 controverted; and

"Whether others have this wonderful faculty of *abſtracting their ideas* (continues the biſhop), they beſt can tell; for myſelf, I find indeed that I have a faculty of imagining or repreſenting to myſelf the ideas of thoſe particular things which I have perceived, and of variouſly compounding and dividing them. I can imagine a man with two heads, or the upper parts of a man joined to the body of a horſe. I can conſider the hand, the eye, the noſe, each by itſelf abſtracted or ſeparated from the reſt of the body. But then, whatever hand or eye I imagine, it muſt have ſome particular ſhape, and ſome particular colour.—Likewiſe the idea of man that I frame to myſelf, muſt be either of a white, or a black, or a tawney, a ſtraight or a crooked, a tall or a low, or a middleſized man. I cannot by any effort of thought conceive the abſtract idea above deſcribed. To be plain, I own myſelf able to abſtract in one ſenſe, as when I conſider ſome particular parts or qualities ſeparated from others with which, though they are united in ſome objects, yet it is poſſible they may really exiſt without them. But I deny that I can abſtract one from another, or conceive ſeparately thoſe qualities which it is impoſſible ſhould exiſt ſo ſeparated; or that I can frame a general notion by abſtracting from particulars in the manner aforeſaid; and there are grounds to think moſt men will acknowledge themſelves to be in my caſe."

85 ſhown to be abſurd.

To think this, there are indeed ſuch good grounds, that it is probable ſome of our readers, little converſant with the writings of modern metaphyſicians, are by this time diſpoſed to ſuſpect, that the biſhop in his zeal may have miſrepreſented the doctrine of *abſtraction;* as no man in his ſenſes, who is not perverted by ſome darling hypotheſis, can ſuppoſe himſelf capable of tagging together ſuch monſtrous inconſiſtencies, as magnitude which is neither large nor ſmall, and colour which is neither white, red, green, nor black, &c. But that the ingenious prelate, in his account of this proceſs of *lopping* and *pruning*, as Mr Harris contemptuouſly, but moſt properly, terms it, has not exaggerated in the ſmalleſt degree, is apparent from the following account of *abſtraction* given by Mr Locke. "*Abſtract ideas* (ſays that writer) are not ſo obvious or eaſy to children, or the yet unexerciſed mind, as particular ones. If they ſeem ſo to grown men, it is only becauſe by conſtant and familiar uſe they are made ſo: for when we nicely reflect upon them, we ſhall find that general ideas are fictions and contrivances of the mind that carry difficulty with them, and do not ſo eaſily offer themſelves as we are apt to imagine. For example, does it not require ſome pains and ſkill to form the general idea of a

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† *Introduction to the Principles of Human Knowledge.*

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triangle (which is yet none of the moſt abſtract, comprehenſive, and difficult)? for it muſt be neither oblique nor rectangle, neither equilateral, equicrural, nor ſcalenon, but *all and none of theſe at once*. In effect, it is ſomething imperfect that cannot exiſt, an idea wherein ſome parts of ſeveral different and *inconſiſtent* ideas are put together." "Surely (to uſe the words of Principal Campbell *) the bare *mention* of this hypotheſis is equivalent to a confutation of it, ſince it really confutes itſelf." But if any man has the faculty of framing in his mind ſuch an idea of a triangle as is here deſcribed, it would be vain in us to diſpute with him; for we are poſſeſſed of no ſuch faculty, and therefore would fight on unequal terms. All we have to deſire is, that the reader would fully and certainly inform himſelf whether he has ſuch an idea or not; and this can be no hard taſk to perform. What is more eaſy for any one than to look a little into his own thoughts, and there try whether he has, or can attain to have, an idea of *colour* ſeparated from all *extenſion*; of *extenſion*, which is neither *great* nor *ſmall*; of *taſte*, which is neither *ſweet* nor *bitter*, nor *acid*, nor *agreeable*, nor *diſagreeable*; or the general idea of a triangle, which is neither *oblique* nor *rectangle*, *equicrural*, *equilateral*, nor *ſcalenon*, *but all and none of theſe at once* (M)?

* *Philoſophy of Rhetoric.*

56
Abſtract conceptions the ſame with abſtract ideas.

Dr Reid having denied that there are or can be in the mind any *ideas* of ſenſible objects, rejects of courſe the doctrine of *abſtract general ideas*, whilſt he maintains in fact the ſame thing, only ſubſtituting the word *conception* for the word *idea*. "What hinders me (ſays he) from attending to the whiteneſs of the paper before me, without applying that colour to any other object?" We know nothing indeed which can hinder any man from performing this operation, which is daily and hourly performed by infants; but will the doctor ſay, that he can attend to colour, or conceive it, abſtracted from the paper and every other ſurface? We are perſuaded he will not, though he immediately adds, "the whiteneſs of this individual object is an *abſtract conception*." Now we ſhould rather have thought, that, conſiſtent with his own notions of colour, he would have called the whiteneſs of the paper a *concrete quality*, and his own conception of it a *particular* and *concrete conception*. If he conceives the whiteneſs as ſeparated from the paper, it is no longer the whiteneſs of that individual object: and he muſt either conceive it as abſtracted from *all* objects, which is plainly impoſſible: or he muſt conceive it as inhering in ſome other object; and then neither the quality of whiteneſs, nor his conception of it, is abſtract in general, but concrete and particular. He affirms, however, "that in abſtraction, ſtrictly ſo called, he can perceive nothing that is difficult either to be underſtood or practiſed." This is going much farther into the doctrine than Mr Locke went; for he owned that there was much difficulty in it. Let us ſee how it becomes ſo eaſy to Dr Reid. "What can be more eaſy (ſays he) than to diſtinguiſh the different attributes which we know to belong to a ſubject? In a man, for inſtance, to diſtinguiſh his ſize, his complexion, his age, his fortune, his birth, his profeſſion, and twenty other things that belong to him." All this indeed, and much more, we can do with the utmoſt eaſe; but this is not abſtraction, ſtrictly ſo called, nor any thing like abſtraction. We diſtinguiſh the ſize, the complexion, the age, &c. of the man, from *one another*: but ſtill we conceive them all as *his* qualities; nor is it poſſible, at leaſt for us, *to abſtract them from him*, without conceiving them as the qualities of ſome *other* man; ſo that *our* conceptions are all concrete and particular. "It ought likewiſe to be obſerved (ſays the Profeſſor), that attributes may with perfect eaſe be diſtinguiſhed and *disjoined* in our conception, which cannot be *actually ſeparated* in the ſubject." They may be ſo in his conception, but certainly not in ours; for *we* can conceive nothing which may not actually exiſt. "Thus (continues he) I can in a body diſtinguiſh its ſolidity from its extenſion, and its weight from both. In extenſion, I can diſtinguiſh length, breadth, and thickneſs; yet none of theſe can be ſeparated from the body, or from one another. It is therefore *certain*, that attributes, which in their nature are abſolutely inſeparable from their ſubject and from one another, may be disjoined in our conception; one *cannot exiſt* without the other, but one *can be conceived* without the other." So far is this from being a matter of *certainty*, that in every poſſible ſenſe in which we can underſtand the word *conception*, it appears to us as evidently *falſe*, as that *three* and *two* are equal to *nine*. It is indeed not difficult to diſtinguiſh *in* a body its ſolidity from its extenſion, and its weight from both: but can we diſtinguiſh them *out* of the body? or, to ſpeak in plain language, can we conceive *ſolidity* as ſeparated from *all extenſion* and *all weight*? Unleſs this can be done, and by *us* it cannot be done, there is no *abſtraction ſtrictly ſo called*. It is indeed eaſy to conceive *ſolidity* or *extenſion* abſtracted from *any one* individual object: but how is it done? Why, by transferring your attention to ſome other *individual object*. Thus, we can eaſily conceive *ſolidity* or *extenſion* ſeparated from a guinea, for inſtance; but it is only by transferring our thoughts to another body, *a piece of ſilver*, or a *ball of lead*, &c. and our conceptions in both caſes are *particular* and *concrete*.

As we think this opinion of Dr Reid's reſpecting ABSTRACTION both ill-founded and of dangerous conſequences, we have expreſſed our diſſent from it in ſtrong terms; and in doing ſo we have only followed the example ſet us by himſelf when diſſenting from the theories of Hume and Berkeley. But we are ſo thoroughly

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(M) "If ſuch an extraordinary faculty (abſtraction) were poſſible, I cannot for my part conceive what purpoſe it could ſerve. An idea hath been defined by ſome logicians, the form or reſemblance of a thing in the mind; and the whole of its power and uſe in thinking is ſuppoſed to ariſe from an exact conformity to its archetype. What then is the uſe or power of that idea, to which there neither is nor can be any archetype in nature, which is merely a creature of the brain, a monſter that bears not the likeneſs of any in the univerſe?" *Philoſophy of Rhetoric*, vol. ii. p. 110.

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roughly convinced that the doctor's acuteneſs is ſuperior to our own (M), that we are not without our fears that we may have miſtaken his meaning. We are conſcious that we have not wilfully miſrepreſented it; and to enable our readers to judge for themſelves between him and us, we ſhall lay before them his definition of *general conceptions* in his own words.

87 Terms, how they are

That there are in every language *general terms*, is known to all mankind; for ſuch are all ſubſtantives, proper names excepted; and all adjectives. But "it is impoſſible (ſays the doctor*) that words can have a general ſignification, unleſs there be conceptions in the mind of the ſpeaker and of the hearer, of *things* (N) that are *general*. It is to ſuch that I give the name of *general conceptions*: and it ought to be obſerved, that they take this denomination, not from the act of the mind in conceiving, which is an individual act; but from the object or thing conceived, which is general." Now, whatever is conceived, muſt be either *external* to the mind, or *preſent* with it. But the doctor himſelf acknowledges, "That all the objects we perceive are individuals. Every object of ſenſe, of memory, or of *conſciouſneſs*, is an individual object. All the good things we enjoy or deſire, and all the evils we feel or fear, muſt come from individuals; and I think I may venture to ſay, that every creature which God has made in the heavens above, or in the earth beneath, or in the waters under the earth, is an individual." If this be ſo, and no man can call it in queſtion, it is obvious that we can have no *general* conception of any thing *external*. The *act* of conceiving is *an individual act*; and therefore the only thing which can be *general*, muſt be ſomething preſent with the mind, and different from the *mere act of conceiving*: But what can this be, if not what Berkeley and others call an *idea*? and how can we have an *idea* of which we are not *conſcious*? yet every thing of which we are conſcious Dr Reid himſelf acknowledges to be an *individual*.

88 of general ſignification.

But if the doctrine generally received reſpecting abſtract ideas be ſo very abſurd as it has appeared in our repreſentation, how comes it to be ſo prevalent among the acuteſt philoſophers? To this we anſwer, that thoſe philoſophers have certainly in this inſtance been impoſed upon by the ſtructure of language. Every adjective and every ſubſtantive, proper names excepted, are words of general ſignification; and all ſcience is converſant about general truth; but as words are ſaid to be ſignificant, not of things, but of ideas; and as truth reſults from the agreement or coincidence of ideas; it has been haſtily ſuppoſed, that without general ideas there could have been neither general terms nor general truth. This is plauſible, but it is not ſolid. Every object which affects our ſenſes is an individual object; but we perceive that two or more objects which affect ſome of our ſenſes very differently, affect others of them in preciſely the ſame way. Thus, the paper upon which one writes, the ſnow which he perceives from his window, and the milk which he may uſe at breakfaſt, affect his ſenſes of touch and taſte very differently, but they preſent the ſame appearances to his eye. This diverſity in the one caſe he believes to proceed from different powers or qualities in the ſeveral objects; and the ſameneſs of appearance in the other, from ſimilar qualities in theſe objects. To the ſimilar qualities, though he can frame no idea of them abſtracted from every individual object, he gives one common name; and calls every object which preſents the ſame appearance to his eye that ſnow does, a *white* object; where the word *white* does not ſtand for an abſtract idea, but for a quality inherent in one or more objects. Hence the origin of adjectives in language, which denote more than can be expreſſed by any claſs of ſubſtantives; for every adjective, beſides the power of a name, includes in itſelf the force of a conjunction. See GRAMMAR.

The other claſs of general terms comprehends ſubſtantives; of which the origin is as follows: The objects about which we have occaſion to ſpeak or write are ſo numerous and ſo fluctuating, that if every individual had a proper name, a complete language could never be formed. But as there are not perhaps in nature two objects that appear to us ſimilar in all reſpects, ſo are there not in nature two objects which affect *all* our ſenſes differently. The mind, therefore, either actually perceiving two or more objects at once, or contemplating the *ideas* left by two or more objects in the memory, perceives, by its intellective power, in what reſpects they agree and in what they diſagree. If the agreement be ſtriking, and in more qualities than one, it combines the ſeveral individuals into one claſs or ſpecies, giving to the whole a common name, which equally denotes the ſpecies and every individual belonging to it. Thus, obſerving that Peter, James, and John, agree in having the ſame erect form, in walking on two legs, in having hands, &c. and in being endowed with reaſon, we combine theſe three, and all other individuals which we perceive to agree in the ſame ſtriking and important qualities, into one ſpecies, to which we give the name of *man*—a word which equally denotes the whole ſpecies and every individual of it. Again, Contemplating ſeveral figures, which all agree in the circumſtance of being bounded by three ſtraight lines meeting one another ſo as to form three angles, we call the whole claſs of figures and each individual by the name of *triangle*—though it may be impoſſible to contemplate any number of triangles without perceiving that all the angles of one are acute; that one angle of another is a right angle; and that in the third there is one angle obtuſe; but the word *triangle*, unleſs it is limited in its ſignification by the addition of an adjective, is equally expreſſive of an acute-angled triangle, a right-angled triangle, and an obtuſe-angled triangle. By thus arranging individuals according to their moſt conſpicuous qualities, we may combine all the objects exiſting into ſo many claſſes or ſpecies, which ſhall be afterwards known by as many names; but of each ſpecies we neither have, nor can have,

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* *Eſſay on the Intellectual Powers of Man.*

(M) Notwithſtanding this declaration, which is made with the greateſt ſincerity, we do not apprehend that we are guilty of preſumption when we examine the doctor's opinions. Berkeley and Hume were certainly as acute as any metaphyſician who has ſucceeded them; yet their opinions have been canvaſſed without ceremony, and to much advantage. *Aliquando bonus dormitat Homerus.*

(N) He tells us ſoon afterwards, that there are *no things general*. How is the one paſſage to be reconciled with the other?

have, any other idea than that of a multitude of ſimilar individuals.

As our acquaintance with nature enlarges, we diſcover reſemblances, ſtriking and important between one ſpecies and another, which naturally begets the notion of a higher claſs called a *genus*. From comparing man with beaſts, birds, fiſhes, and reptiles, we perceive that they are all alike poſſeſſed of life, or a principle of ſenſation and action, and of an organized body: hence we rank them all under a higher claſs or genus, to which we give the name of *animal;* which equally denotes the whole *genus*, each ſpecies comprehended under the *genus*, and every *individual* of every *ſpecies*. Thus, *animal*, is a *genus; man*, *beaſt*, *bird*, are ſo many *ſpecies* comprehended under that *genus;* and *Peter*, *James*, and *John*, are *individuals* of the ſpecies *man*. *Peter*, *James*, and *John*, are proper names, denoting each an *individual; man*, *beaſt*, *bird*, are *ſpecific* terms, denoting each a *whole ſpecies* compriſing many *individuals;* and *animal* is a *general term*, becauſe it denotes a *whole genus*, comprehending under it *ſeveral ſpecies*, of which each conſiſts of *many individuals;* and the general term denotes either the whole *genus*, all the *ſpecies*, or any *individual* of all the ſpecies. This is the whole myſtery of *abſtraction:* they are merely *terms*, that in ſtrictneſs of ſpeech are *general* and *abſtract;* and even thoſe are general only as *ſigns*, of which the full ſignification cannot always be repreſented by any conceivable *idea*.

89 Names and ideas often uſed as mere ſigns,

"It is a received opinion (ſays Biſhop Berkeley), that language has no other end but the communicating of our ideas, and that every ſignificant name ſtands for an idea. This being ſo; and it being withal certain, that names, which yet are not thought altogether inſignificant, do not always mark out particular conceivable ideas; it is ſtraightway concluded that they ſtand for abſtract notions. That there are many names in uſe amongſt ſpeculative men, which do not always ſuggeſt to others determinate particular ideas, is what nobody will deny: and a little attention will diſcover, that it is not neceſſary, even in the ſtricteſt reaſonings, that ſignificant names, which ſtand for ideas, ſhould every time they are uſed excite in the underſtanding the ideas they are made to ſtand for. In reading and diſcourſing, names are for the moſt part uſed as letters in algebra; in which, though a particular quantity be marked by each letter, yet to proceed right, it is not requiſite that in every ſtep each letter ſuggeſt to our thoughts that particular quantity it was appointed to ſtand for." The ſame thing is true of ideas, which as well as names are often uſed merely as ſigns repreſenting a whole claſs; and on that account they may be called *general*, though every idea is in itſelf ſtrictly particular. Thus, "An idea, which conſidered in itſelf is particular, becomes general by being made to repreſent or ſtand for all other particular ideas of the ſame ſort. To make this plain by an example, ſuppoſe a geometrician is demonſtrating the method of cutting a line in two equal parts: He draws, for inſtance, a black line of an inch in length: this, which in itſelf is a particular line, is nevertheleſs, with regard to its ſignification, general; ſince, as it is there uſed, it repreſents all particular lines whatſoever: ſo that what is demonſtrated of it is demonſtrated of all lines, or, in other words, of a line in general. And as that particular line becomes general by being made a ſign, ſo the *name* line, and the *idea* of a line in the imagination, either of which taken abſolutely is particular, by being ſigns are made general likewiſe. And as the former owes its generality, not to its being the ſign of an abſtract or general line, but of all particular right lines that may poſſibly exiſt; ſo the latter, the name and the idea, muſt be thought to derive their generality from the ſame cauſe, namely, the various particular lines which each of them indifferently denotes." Again, When one demonſtrates any propoſition concerning triangles, it is to be ſuppoſed that he has in view to demonſtrate an univerſal truth; yet the particular triangle which he conſiders muſt be either equilateral, iſoſceles, or ſcalenon; for a plain triangle, which is none of theſe, can neither exiſt nor be conceived. But whether it be of this or that ſort is of no importance, as any of them may equally ſtand for and repreſent all rectilineal triangles, and on that account be denominated *univerſal*.

This doctrine reſpecting names and ideas being uſed merely as *ſigns*, has been adopted by almoſt every ſubſequent philoſopher; and by Principal Campbell it has been illuſtrated with perſpicuity and acuteneſs every way worthy of the author of the Diſſertation on Miracles. "In confirmation of this doctrine (ſays he *), it may be obſerved, that we really think by *ſigns*, as well as ſpeak by them. All the truths which conſtitute ſcience, which give exerciſe to reaſon, and are diſcovered by philoſophy, are general; all our ideas, in the ſtricteſt ſenſe of the word, are particular. All the particular truths about which we are converſant are properly hiſtorical, and compoſe the furniture of memory. Nor do I include under the term *hiſtorical* the truths which belong to natural hiſtory; for even theſe too are general. Now, beyond particular truth or hiſtorical facts, firſt perceived and then remembered, we ſhould never be able to proceed one ſingle ſtep in thinking any more than in converſing, without the uſe of ſigns.

"When it is affirmed that *the whole is equal to all its parts*, there cannot be an affirmation which is more perfectly intelligible, or which commands a fuller aſſent. If, in order to comprehend this, I recur to ideas, all that I can do is to form a notion of ſome individual whole, divided into a certain number of parts of which it is conſtituted; ſuppoſe of the year, divided into the four ſeaſons. Now all that I can be ſaid to diſcern here is the relation of equality between this particular whole and its component parts. If I recur to another example, I only perceive another particular truth. The ſame holds of a third and of a fourth. But ſo far am I, after the perception of ten thouſand particular ſimilar inſtances, from the diſcovery of the univerſal truth, that if the mind had not the power of conſidering things as ſigns, or particular ideas as repreſenting an infinity of others, reſembling in one circumſtance though totally diſſimilar in every other, I could not ſo much as conceive the meaning of an univerſal truth. Hence it is that *ſome ideas*, to adopt the expreſſion of Berkeley, *are particular in their nature, but general in their repreſentation*."

90 which, though particular in themſelves, ſerve to demonſtrate general truths; becauſe

But if in univerſal propoſitions, ideas particular in themſelves be uſed only as the ſigns of others, it may be demanded, how we can know any propoſition to be true of all the ideas which are repreſented by the ſign?

* Philoſophy of Rhetoric.

ſign? For example, having demonſtrated that the three angles of an iſoſceles rectangular triangle are equal to two right ones, how can we conclude that this affection therefore agrees to all other triangles which have neither a right angle nor two equal ſides? To this queſtion Biſhop Berkeley and Principal Campbell give the following anſwer: Though the idea we have in view whilſt we make the demonſtration be that of an iſoſceles rectangular triangle, whoſe ſides are of a determinate length, we may yet be certain that the demonſtration extends to all other rectilineal triangles of what ſort or bigneſs ſoever; for this plain reaſon, that neither the equality nor determinate length of the ſides, nor the right angle, are at all concerned in the demonſtration. It is true, the idea or diagram we have in view includes all theſe particulars; but then there is not the leaſt mention made of them in the proof of the propoſition. It is not ſaid the three angles are equal to two right angles, *becauſe* one of them is a *right angle*, or becauſe the ſides comprehending it are of equal length; which ſufficiently ſhows that the right angle might have been oblique and the ſides unequal; and for all that the demonſtration have held good. In every one of Euclid's theorems, a particular triangle, and a particular parallelogram, and a particular circle, are employed as ſigns to denote all triangles, all parallelograms, and all circles. When a geometrician makes a diagram with chalk upon a board, and from it demonſtrates the property of a ſtraight-lined figure, no ſpectator ever imagines that he is demonſtrating a property of nothing elſe but that individual white figure, five inches long, which is before him.—Every one is ſatisfied that he is demonſtrating a property of all of that order, whether more or leſs extenſive, of which it is both an example and a ſign; all the order being underſtood to agree with it in certain characters, however different in other reſpects. Nay, what is more, the mind with the utmoſt facility extends or contracts the repreſentative power of the ſign as the particular occaſion requires. Thus the ſame equilateral triangle will with equal propriety ſerve for the demonſtration, not only of a property of all equilateral triangles, but of a property of all iſoſceles triangles, or even of a property of all triangles whatever. Nay, ſo perfectly is this matter underſtood, that if the demonſtrator in any part ſhould recur to ſome property belonging to the particular figure he hath conſtructed, but not eſſential to the kind mentioned in the propoſition, and which the particular figure is ſolely intended to repreſent, every intelligent obſerver would inſtantly detect the fallacy: So entirely for all the purpoſes of ſcience doth a particular ſerve for a whole ſpecies or genus. Now, why one *viſible* individual ſhould in our reaſonings ſerve without the ſmalleſt inconvenience as a ſign for an infinite number, and yet one *conceivable* individual, or a particular idea of imagination, ſhould not be adapted to anſwer the ſame end, it will, we imagine, be utterly impoſſible to ſay (N).

It muſt, however, be confeſſed, that there is a conſiderable difference in kind, between *ideas* uſed as ſigns and the *general* terms of any language. Amongſt all the individuals of a ſpecies, or even of the higheſt genus, there is ſtill a natural connexion, as they agree in the ſpecific or generic character; and when the mind makes uſe of any poſitive idea as the ſign of the ſpecies or genus, that idea appears in the imagination as an exact reſemblance of ſome one individual. But the connexion which ſubſiſts between words and things, or even between words and ideas, is in its origin arbitrary; and yet its effect upon the mind is much the ſame with that of the natural connexion between ideas and things. For having often had occaſion to obſerve particular words uſed as ſigns of particular things, and ſpecific terms uſed as ſigns of a whole ſpecies, we contract a habit of aſſociating the ſign with the thing ſignified, inſomuch that either being preſented to the mind neceſſarily introduces or occaſions the apprehenſion of the other. Cuſtom in this inſtance operates preciſely in the ſame manner as natural reſemblance in the other; ſo that certain ſounds, and the ideas of things to which they are not naturally related, come to be as thoroughly linked in our conceptions as the ideas of things and things themſelves. Nay, ſo completely are they linked together, that we often uſe, through long chains of reaſoning, certain ſounds or words, without attending at all to the ideas or notions of which they are ſigns. "I believe (ſays the author of *A Treatiſe on Human Nature*), that every one who examines the ſituation of his mind in reaſoning will agree with me, that we do not annex diſtinct and complete ideas to every term we make uſe of; and that in talking of *government*, *church*, *negotiation*, *conqueſt*, we ſeldom ſpread out in our minds all the ſimple ideas of which the compound notions ſignified by theſe terms are compoſed. It is, however, obſervable, that notwithſtanding this imperfection, we may avoid talking nonſenſe on theſe ſubjects, and may perceive any repugnance among the ideas as well as if we had a full comprehenſion of them." This remark generally holds true; but then it is to be obſerved, that all the words uſed as ſigns, and which yet do not denote any one conceivable determinate *idea*, muſt be capable of definition. Thus, in matters that are perfectly familiar, in ſimple narration, or in moral obſervations on the occurrences of life, a man of common underſtanding may be deceived by ſpecious falſehood, but is hardly to be gulled by downright nonſenſe or a repug-

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(N) Were it poſſible to frame an *abſtract general idea* of a triangle, which is neither equilateral, iſoſceles, nor ſcalenon, even *that idea* muſt be uſed merely as a ſign as much as any particular triangle whatever; and the queſtion might ſtill be aſked, How we can know any propoſition to be true of all the triangles repreſented by the ſign? For example: having demonſtrated that the three angles of an ideal triangle, which is neither equilateral, iſoſceles, nor ſcalenon, are equal to two right angles, how can we conclude that this affection agrees to triangles which are equilateral, &c.? To this queſtion it is not eaſy to conceive what anſwer could be given other than that of Berkeley and Campbell, in the caſe of uſing particular and conceivable triangles as ſigns.

nance of ideas. Almoſt all the poſſible applications of the terms (in other words, all the acquired relations of the ſigns) have become cuſtomary to him. The conſequence is, that an unuſual application of any of them is inſtantly detected: this detection breeds doubt, and this doubt occaſions an immediate recourſe to *definition;* which, proceeding through ſpecies and genera, reſolves complex terms into others leſs complex, till it ends at laſt in ſimple ideas and relations, which can neither be defined nor miſunderſtood (o). See Logic.

91 It is not the *matter* but the *power* of the ſign that is regarded by the mind.

Thus then we ſee, that though there are no ideas, properly ſpeaking, general and abſtract, a man may, by *terms* and *particular* ideas, uſed as *ſigns*, arrive at the knowledge of general truth. In neither caſe is it the *matter*, if we may be allowed the expreſſion, but the *power* of the ſign that is regarded by the mind. We find, that even in demonſtrative reaſonings, ſigns the moſt arbitrary, or mere ſymbols, may be uſed with as little danger of error as ideas or natural ſigns. The operations both of the algebraiſt and arithmetician are ſtrictly of the nature of demonſtration. The one employs as *ſigns* the letters of the alphabet, the other certain numerical characters. In neither of theſe arts is it neceſſary to form ideas of the quantities and ſums ſignified; in ſome inſtances it is even impoſſible without reſolving the quantity or ſum into parts, in a manner analogous to definition; and then the mind comprehends not the whole quantity or number at once, but the ſeveral parts of which it is compoſed, which it connects (p) by the relation of junction or addition. Yet without this reſolution, the equations and calculations carried on by means of the letters and figures ſignificant of the whole quantity or the whole ſum, are not the leſs accurate or convincing. And ſo much for *abſtraction*, *generalization*, and the power of *ſigns*, whether *natural* or artificial.

CHAP. V. *Of the* ASSOCIATION *of* IDEAS.

92 A continued train of thought in the mind.

EVERY man whilſt awake is conſcious of a continued train of thought ſpontaneouſly ariſing in his mind and paſſing through it; nor could a ſingle now or inſtant be pitched upon in which ſome idea is not preſent in his memory or imagination. No one idea, however, unleſs detained by a voluntary exertion of the mind, or unleſs productive of intenſe pleaſure or pain, remains long in the imagination; but each haſtens off the ſtage to make way for another, which takes its turn and is ſucceeded by a third, &c. We are not to imagine that this train of thought is altogether fortuitous and incoherent. "It is evident (ſays Mr Hume *), that there is a principle of connexion between different thoughts or ideas of the mind; and that, in their appearance to the memory or imagination, they introduce each other with a certain degree of method and regularity. In our more ſerious thinking or diſcourſe this is ſo obſervable, that any particular thought which breaks in upon the regular track or chain of ideas is immediately remarked and rejected. Even in our wildeſt and moſt wandering reveries, nay, in our very dreams, we ſhall find, if we reflect, that the imagination ran not altogether at adventures, but that there was ſtill a connexion upheld among the different ideas which ſucceeded each other. Were the looſeſt and freeſt converſation to be tranſcribed, there would immediately be obſerved ſomething which connected it in all its tranſitions: Or, where this is wanting, the perſon who broke the thread of diſcourſe might ſtill inform you, that there had ſecretly revolved in his mind a ſucceſſion of thoughts, which had gradually led him from the ſubject of converſation. Among different languages, even where we cannot ſuſpect the leaſt connexion or communication, it is found, that words expreſſive of ideas the moſt compounded, do yet nearly correſpond to each other; a certain proof that the ſimple ideas comprehended in the compound ones, were bound together by ſome univerſal principle, which had an equal influence on all mankind."

93 Principles of aſſociation.

That theſe obſervations are well founded, every man may be ſatisfied by looking attentively into his own thoughts; but when the author reduces the principles of this aſſociation of ideas to *three*, viz. *reſemblance*, *contiguity* in time and place, and *cauſe* or *effect*, he certainly contracts them within too narrow a compaſs. That theſe principles often ſerve to connect ideas, will not indeed be denied. A picture leads our thoughts to the original: the mention of one apartment in a building introduces an inquiry or diſcourſe concerning the others: and if we think of a wound, we can hardly forbear reflecting on the pain which follows it. But ſurely ideas ſometimes ſucceed each other without *reſemblance*, without *contiguity* in time or in place, and without being connected by the relation of a *cauſe* to its *effect*. Beſides all this, there are other aſſociations than of *ideas*. Ideas are aſſociated with paſſions and emotions, and paſſions and emotions are aſſociated together. A particular idea is aſſociated with a proper name, and often with the general name of the ſpecies. General conceptions, ſuch as thoſe which Mr Locke calls mixed modes (ſee MODE), are aſſociated with ſigns both audible and viſible, and ſigns are aſſociated with each other. Surely virtue, as it conſiſts in action and intention, does not reſemble the *ſound* virtue, is not *contiguous* to it in time or in place, and is neither its *cauſe* nor its *effect;* nor is it conceivable, that the arbitrary ſigns of different things ſhould have any natural relation to one another.

But were the enumeration complete, the bare mention of theſe principles does not account for the phenomena:

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* *Eſſays.*

(o) For a farther view of this ſubject, ſee ſome excellent obſervations on the common doctrine concerning abſtraction by Profeſſor Dugald Stewart of Edinburgh. *Elements of the Philoſophy of the Human Mind.*

(p) No man, we think, will pretend that he can perceive at one view a million of individual men, or that he can imagine or conceive at once a million of ideal men: yet he may divide the million into parts, which, in the one caſe may be eaſily viewed, and in the other may be eaſily conceived, in ſucceſſion. Thus, 100+100+100, &c.

nomena: For, granting the fact, it may ſtill be aſked, Why does a picture lead our thoughts to the original; or the mention of one apartment in a building introduce an inquiry concerning the others? To theſe queſtions our author has given no anſwer; nor are we acquainted with any writer who can be ſaid to have attempted it, except Dr Hartley and his ingenious editor. There may be ſome of our readers whom the names of theſe men will prejudice againſt their theory; but, doubtleſs, the greater part are willing to adopt truth, or to examine an ingenious ſpeculation, from whatever quarter it comes. To ſuch as feel themſelves otherwiſe diſpoſed, we beg leave to ſay, that if they allow the name of *Prieſtley* to diſguſt them at what follows, they will furniſh him with a new proof of the truth of the doctrine which they reject.

94 How they operate. That *ideas* ſhould be aſſociated together, ſeems to be inevitable from the manner in which the mind acquires them. All our ideas, properly ſpeaking, are of ſenſible objects, and by far the greater part of them of *viſible* objects. But every ſenſible object conveys at once various ſenſations and perceptions to the mind, which appear not only united in fact, but inſeparable in imagination. Thus, when a man looks at any particular object, a tree for inſtance, he perceives the *trunk*, *branches*, *leaves*, *ſize*, *ſhape*, and *colour*, &c. of the whole at *once:* he does not firſt perceive the *figure* of the trunk, then its *ſize*, then its *colour*, then the *branches*, &c. all in ſucceſſion; but a perception of the *whole* is conveyed to the mind by one ſimultaneous impreſſion (Q). We have already ſeen, that the ſenſes, in fact, convey nothing to the mind but their reſpective ſenſations; and that the perception of the external object inſtantly follows the ſenſation. We have likewiſe ſeen, that ſenſation is occaſioned by ſome impreſſion, concuſſion, or vibration, given to the nerves and brain, and by them communicated to the mind or percipient being. We have likewiſe ſeen, that memory depends as much upon the brain as original ſenſation, and is always attended or occaſioned by ſimilar concuſſions or vibrations, &c. Theſe are facts proved by univerſal experience, and which, we believe, no thinking man has ever called in queſtion. It follows, therefore, that every actual ſenſation muſt leave ſome effect in the brain, either an actual print, which ſeems to be impoſſible, or a tendency to vibrate or be agitated in the ſame way as when the original impreſſion was made. This being the caſe, it is natural to conclude, that when any part of the original perception is revived in the memory, the whole perception ſhould be revived at once, ſo as that we cannot have an idea of the trunk of a tree without perceiving the ideas of the branches aſſociated with it. This is indeed not merely natural, but the contrary ſeems to be impoſſible; for as the original agitation or vibration was occaſioned by the whole tree, it is evident, that whatever effect or tendency that agitation or vibration left behind it, muſt be left by the whole vibration, and therefore be equally related to the whole tree.

But no object ſtands ſingle in nature. When we view a tree, or any thing elſe, we always notice, however tranſiently, the field where it grows and the objects around it. Theſe too leave effects in the brain at the ſame time that the tree does ſo; and therefore make their appearance with it in the memory or imagination: but if the tree was the object to which we principally attended during the actual ſenſation, the idea of it will be much more vivid than the idea of its adjuncts, and remain much longer in the imagination or memory; becauſe the original ſenſation by which it was perceived, was ſtruck much deeper than the ſenſations by which its adjuncts were perceived. All this muſt be intelligible to every one who attends to what we have already ſaid of ſenſation, perception, and memory.

Thus we ſee why a picture leads our thoughts to the original, and why the mention of one apartment in a building introduces an inquiry concerning the others. It is not merely becauſe the picture *reſembles* the original, and becauſe the apartments of a building are *contiguous*. Between a plain ſurface, variouſly coloured and ſhaded, and the contour of the human face, there is certainly very little real reſemblance, as any man may be convinced who places his eye within ſix inches of a good picture. But the painter, having by his ſkill in perſpective, contrived to lay his colours on the plain canvas in ſuch a manner as that they reflect the ſame rays of light with the original, provided the ſpectator ſtand at the proper diſtance; theſe rays proceeding from the picture fall upon the eye in the ſame direction, and therefore give to the nerves and brain the very ſame impulſe which was given by the original. When one apartment of a building is mentioned, we inquire concerning the others from the very ſame cauſe that, when we think of the trunk of a tree which we have ſeen, we cannot avoid thinking likewiſe of its branches.

95 Aſſociation gives meaning to the words of language; But the principle of aſſociation takes place among things not naturally connected, as the apartments of

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(Q) This is certainly the caſe with adults, but it may be doubted whether it be ſo with very young children. It has been ſhown already, that the ſenſation communicated by the eye from any viſible object, has not the leaſt reſemblance to that object; and that in looking at a tree or any thing elſe, a full-grown man pays not the leaſt attention to the appearance which the tree really makes to his eye; nay, that he is not even conſcious of that appearance farther than as it conſiſts in colour. It is by the ſenſe of touch only that we acquire ideas of figure, even of plain figure; and we imagine that we perceive them by the eye only becauſe different figures, as diſtinguiſhable by touch, are ſo cloſely aſſociated with their correſponding viſible ſenſations, that long before we are capable of inquiry, theſe two things are inſeparable in the imagination. It is otherwiſe with children, who, when they firſt begin to diſtinguiſh objects by the ſenſe of ſight, appear to do it, with great deliberation, as if they firſt felt the proper ſenſation of light and colour ſo or ſo modified, and afterwards acquired, by ſomething like a mental inference, a notion of the figure at which they are looking.

a building and a ſubſtance and its attributes and adjuncts. It is aſſociation which is the original ſource of all the general or complex conceptions which we have, and which even gives meaning to the words of every language. Between ſounds conſidered in themſelves, and things, or the ideas of things, every one knows that there is no natural connexion; yet the idea of every known object is in the mind of every man ſo ſtrictly aſſociated with the name that it bears in its native tongue, that the preſence of the one always ſuggeſts the other. It cannot indeed be otherwiſe, if we attend to the manner in which a child learns to affix a meaning to the words which he hears. —A child knows his mother and nurſe, and indeed almoſt every viſible object in the family, long before he acquires the power of articulation. The impreſſions made by theſe objects, and repeated daily and hourly on his brain, every one of which excites a ſenſation, muſt ſoon become ſo deep as not to be eaſily effaced. Numbers of them too are aſſociated together, ſo that the preſence of one introduces the other. It has been already obſerved, that ideas of ſight are the moſt vivid and the moſt laſting; but the child hearing the ſame ſound often repeated, even that ſound comes in time to leave in his memory a permanent idea. He then hears the ſound *nurſe*, for inſtance, uttered at the time when he is looking earneſtly at the perſon of the nurſe, with whom he is well acquainted, and to whom he is ſtrongly attached; and having the two ideas repeatedly excited together, they ſoon become ſo aſſociated, that the one neceſſarily excites the other: the *word nurſe* calls into view the *idea* of the *woman* treaſured up in his imagination.

But we need not have recourſe to children for the proof of our aſſertion. It is obvious that the name of every ſimple and uncompounded idea can be ſignificant only by aſſociation. Of a complex conception the name may be made intelligible by a definition; but ſimple ideas cannot be defined, and between ideas and ſounds there is no natural connexion, ſo as that the one previous to aſſociation ſhould ſuggeſt the other. Even of complex conceptions and mixed modes, the meaning of the names is generally acquired by aſſociation; for though it is certainly true, that all ſuch names are capable of definition, they are yet uſed with ſufficient propriety by thouſands who know not what a definition is. Were a plain unlettered man aſked to define virtue, it is not probable that he could do it ſo as to make himſelf underſtood; yet having ideas of the *practice of juſtice*, *charity*, *fortitude*, &c. ſtrictly aſſociated in his mind with the *word virtue*, he may know the general meaning of that word as well as the moſt acute grammarian or the moſt profound philoſopher.

An *alms* is a donation to a poor man; but a child who never heard of this definition knows perfectly what an *alms* is, from having often ſeen his parents give money to a beggar, and call what they were doing by the name *alms*. The ſound of the word, after having ſeen the firſt alms given, will excite in his mind an idea of the *individual* object who received it, and of the *action* of him by whom it was given; but after having ſeen ſeveral poor men relieved, he comes to aſſociate with the word *alms* any thing given to any perſon who needs it or appears to be in want.

So completely does this aſſociation take place between ideas or cluſters of ideas, and the words by which they are expreſſed, that even men of letters hear and underſtand perfectly many words without reviewing in their minds all the ideas and relations of which they are the ſigns. It has been already obſerved, that in talking of *government*, *church*, *negotiation*, *conqueſt*, we ſeldom ſpread out in our minds all the ſimple ideas of which the compound notions ſignified by theſe terms are compoſed; and we now add, that the terms may be uſed with ſufficient propriety, and be perfectly underſtood by thoſe who never attempted to analyze the notions of which they are ſignificant into their primary and conſtituent parts. Every man has read numberleſs details of the tranſactions of one court with another; he has heard ſuch tranſactions univerſally called by the term *negotiation*. The term and the tranſactions ſignified by it are ſo cloſely aſſociated in his mind, that they are in a manner inſeparable; and by this aſſociation he knows the meaning of the term better than he could have done by the moſt complete definition; which, perhaps, he would find it difficult to give, or even to comprehend.

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and is the ſource of our firſt notions of virtue.

We have ſaid that the *meaning* of the word *virtue* is acquired by aſſociation, by having often heard that ſound applied to certain *actions*; but it is extremely probable, that the very *notion* of virtue, ſimple and uncompounded as it appears to be, is acquired in the very ſame manner. The *firſt* rudiments of the notions of *right* and *wrong* and *obligation* ſeem to be acquired by a child when he finds himſelf checked and controuled by ſuperior power. At firſt he feels nothing but mere *force*, and conſequently has no notion of any kind of reſtraint but that of neceſſity. He finds he cannot have his will, and therefore he ſubmits. Afterwards he attends to many circumſtances which diſtinguiſh the commands of a *father*, or of a *maſter*, from thoſe of any other perſon. Notions of *reverence*, *love*, *eſteem*, and *dependence*, are connected with the idea of him who gives thoſe commands; and by degrees the child experiences the peculiar *advantages* of filial ſubjection. He ſees alſo that all his companions, who are noticed and admired by others, obey their parents; and that thoſe who are of a refractory diſpoſition are univerſally diſliked. Theſe and other circumſtances now begin to alter and modify the notion of mere neceſſity, till by degrees he conſiders the commands of a parent as ſomething that *muſt not* be reſiſted or diſputed, even though he has a power of doing it; and all theſe ideas coaleſcing, form the notions of *moral right* and *moral obligation*, which are eaſily transferred from the commands of a parent to thoſe of a magiſtrate, of God, and of conſcience. This opinion of the gradual formation of the ideas of moral right and wrong, from a great variety of elements aſſociated together, perfectly accounts for that prodigious diverſity in the ſentiments of mankind reſpecting the objects of moral obligation; nor do we ſee that any other hypotheſis can account for the facts. If the notion of moral obligation were a ſimple uncompounded idea, ariſing from the view of certain actions or ſentiments; or were it acquired, as it certainly might be, by a chain of reaſoning from the nature of God and the nature of man; why ſhould it not in the one caſe be as invariable as the perception of colours or ſounds, and in the other as our judgements of mathematical or phyſical truths? But though the ſhape and colour of a flower appear the ſame to every human eye; though every man of common underſtanding knows, that if a billiard ball be ſtruck by another, it will move from its place with a velocity proportioned to the force of the impulſe; and though all mankind who have but dipt into mathematics, perceive that any two ſides of a triangle muſt be greater than the third ſide; yet one man practiſes as a moral duty what another looks upon with abhorrence, and reflects on with remorſe. Now a thing that varies with education and inſtruction, as moral ſentiments are known to do, certainly has the appearance of being generated by a ſeries of different impreſſions and aſſociations in ſome ſuch manner as we have endeavoured to deſcribe. Let not any man imagine that this account of the origin of moral ſentiments endangers the cauſe of virtue; for whether thoſe ſentiments be inſtinctive or acquired, their operation is the very ſame, and in either caſe their rectitude muſt often be tried by the teſt of reaſon, ſo that the intereſts of virtue are equally ſafe on this as on any other ſcheme. See *Moral Philoſophy*.

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It ought, therefore, to be attended to in the education of youth.

This principle of aſſociation has ſo great an influence over all our actions, paſſions, reaſonings, and judgements, that there is not perhaps any one thing which deſerves more to be looked after in the education of youth. Some of our ideas—ſuch as thoſe of a ſubſtance and its attributes, a genus and the ſpecies contained under it, a ſpecies and its ſeveral individuals, have a real connexion with each other in nature. Theſe it is the office of our reaſon to trace out and to hold together in that union and order in which nature preſents them to the view of the mind; for ſuch aſſociations conſtitute perhaps the greateſt part of neceſſary and of uſeful truths. But there are others formed by cuſtom and caprice, which are too often the ſources of error, ſuperſtition, vice, and miſery—of errors the more dangerous, and of vice the more deplorable; that if the aſſociations have been long formed without an attempt to diſſolve them, they generally become at laſt too ſtrong to be broken by the moſt vigorous effort of the beſt-diſpoſed mind. Thus, let a fooliſh maid * amuſe or rather frighten children with ſtories of ghoſts appearing in the dark, let her repeat theſe fictions till they have made a deep impreſſion on the young minds, and the notion of ghoſts will in time become ſo cloſely aſſociated with the idea of darkneſs, that the one ſhall always introduce the other; and it may not be in the power of the children, after they have become men, and are convinced in their judgements of the falſehood and abſurdity of the tales which originally frightened them, to ſeparate entirely the notion of ghoſts from the idea of darkneſs, or with perfect eaſe to remain alone in a dark room. Again, Let the idea of *infallibility* be annexed to any perſon or ſociety, and let theſe two inſeparably united conſtantly poſſeſs the mind; and then one body in ten thouſand places at once ſhall, unexamined, be ſwallowed for an incontrovertible fact, whenever that infallible perſon or ſociety dictates or demands aſſent without inquiry.

Some ſuch wrong and unnatural combinations of ideas will be found to eſtabliſh the irreconcilable oppoſition that we find between different ſects in philoſophy and religion; for we cannot imagine every individual of any ſect to impoſe wilfully on himſelf, and knowingly to reject truth offered by plain reaſon. That which leads men of ſincerity and good ſenſe blindfold, will be found, when inquired into, to be ſome early and wrong aſſociation. Ideas independent and of no alliance to one another, are by education, cuſtom, and the conſtant din of their party, ſo linked together in their minds, that they can no more be ſeparated from each other than if they were but one idea; and they operate upon the judgement as if they really were but one. This gives ſenſe to jargon, the force of demonſtration to abſurdities, and conſiſtency to nonſenſe: it is the foundation of the greateſt and moſt dangerous errors in the world; for as far as it obtains, it hinders men from ſeeing and examining.

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The principle of aſſociation operates in our perception of external objects;

Before we diſmiſs the ſubject of aſſociation, it may be proper to inquire, how far it is agreeable to the account which we have given of the manner in which external objects are perceived by means of the ſenſes, and the ideas of ſuch objects retained in the memory.—It has been proved, we think, by arguments unanſwerable, that by the organs of ſenſe nothing is conveyed immediately to the mind but ſenſations which can have no reſemblance to external objects, and that the perception of an object may be reſolved into a proceſs of reaſoning from effects to cauſes.—But children, it will be ſaid, do not reaſon from effects to cauſes, and yet they ſoon acquire the faculty of perceiving and diſtinguiſhing the objects with which they are ſurrounded. This is an undoubted truth, and it can be accounted for only by the principle of aſſociation. A child has as much the uſe of his ſenſes as a full-grown man. By his eye he has the ſenſation of colour; by his noſe, that of ſmell; by his ear he has the ſenſation of ſound; and by his hand he feels heat and cold, reſiſtance and bounded reſiſtance. Every object which is preſented to him, impreſſes his mind with various ſenſations: and theſe ſenſations combined together are probably all that he perceives for ſome years; for there is no reaſon to imagine that a boy of one or two years old has the ſlighteſt notion of what we mean by ſolidity, hardneſs, ſoftneſs, or indeed of that which is termed *ſubſtance*. Yet when two or more objects are preſent, he may eaſily diſtinguiſh the one from the other, becauſe the ſenſations excited by the one muſt differ from thoſe excited by the other, as much as the real qualities of the one are different from the real qualities of the other; and by diſtinguiſhing between his own ſenſations, he in effect diſtinguiſhes between the objects which produce theſe ſenſations. His ſenſations too being frequently excited, leave behind them ideas in his memory or imagination; and thoſe ideas, from having been imprinted together and never ſeparated, become in time ſo cloſely aſſociated, that whenever one of them is called into view, the others neceſſarily make their appearance with it. Thus a child has a ſet of combined ſenſations excited in his mind by the preſence of his nurſe; he has a different cluſter excited, ſuppoſe, by the preſence of his mother. Theſe are often repeated, and leave deep traces behind them; ſo that when the mother or the nurſe makes her appearance, ſhe is immediately recogniſed as a known object; or, to ſpeak more correctly, the child feels the very ſame ſenſa-

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* Locke's *Eſſay*, and his *Conduct of the Underſtanding*.

tions which he has felt before, from which he has experienced pleaſure, and of which he has the ideas treaſured up in his memory or imagination. A ſtranger, on the other hand, muſt affect him with a ſet of new ſenſations, and of courſe will be diſtinguiſhed from a known object as accurately as if the child were poſſeſſed of the notions of ſolidity, ſubſtance, qualities, and diſtance. A man born blind, who knew not that ſuch things as fire and ſnow had ever exiſted, would yet diſtinguiſh the one from the other the moment that he ſhould be brought within their influence. He could not indeed apply their names properly, nor ſay which is the fire and which the ſnow, nor would he at firſt have any notion of either of them as a real, external, and diſtant object; but he would certainly diſtinguiſh his own ſenſations, the ſenſation of heat from that of cold. It is juſt ſo with a child: At firſt he perceives nothing but different ſenſations. Theſe he can diſtinguiſh; and as they are cauſed by different objects, in diſtinguiſhing between the ſenſations he will appear to diſtinguiſh between the objects themſelves. In a ſhort time, however, he acquires, by the following proceſs, ſome inaccurate notions of diſtance. He looks, for inſtance, earneſtly in his nurſe's face, and at the ſame time touches her cheek perhaps by accident. He repeats this operation frequently, till the ſenſation communicated by his eye comes to be aſſociated with that of his touch, and with the extending of his arm; and being all treaſured up as aſſociated ideas in the memory, the ſight of his nurſe makes him ever afterwards ſtretch out his hands with a deſire to touch her. All this while there is not the ſlighteſt probability that the child has any notion of *ſubſtance* or *qualities*, or of any thing beyond his own *ſenſations*, and the means by which he has experienced, that ſenſations which are pleaſant may be obtained, and that ſuch as are painful may be avoided. The preciſe time at which a child begins to think of external things we cannot pretend to aſcertain; but we are perſuaded that it is later than many perſons imagine, and certainly not till he has made conſiderable progreſs in the exerciſe of reaſon. Prior to that period the things which men know to be bodies, are known to children only as ſenſations and ideas ſtrongly bound together by the tie of aſſociation.

99 and ſeems to diſtinguiſh memory from imagination;

But if aſſociation be of ſuch importance in the act of ſenſation, it is of ſtill greater in that of retention; for it ſeems to conſtitute the whole difference that there is between imagination and memory. By many of the ancients, as well as by ſome modern philoſophers, theſe two faculties ſeem to have been confounded with each other; but between them there is certainly a great difference, though they likewiſe reſemble each other in ſome reſpects. An idea of memory, conſidered by itſelf, makes the very ſame appearance to the intellect as an idea of imagination. We contemplate both as if they were actual, though faint and diſtant perceptions: but the one is attended with the conviction, that it is the idea of an object which has really been perceived at ſome period of paſt time; whilſt the other is attended with no conviction, except that the idea itſelf is actually preſent to the mind. Mr Hume has ſaid, that ideas of memory differ from thoſe of imagination only in being more vivid and diſtinct; but certainly this is not always the caſe. An idea of imagination has ſometimes been taken for a real perception, which an idea of memory can never be. The difference between theſe two kinds of ideas, we are perſuaded, ariſes chiefly, if not wholly, from aſſociation. Every idea of memory is aſſociated with many others, and thoſe again with others down to the very moment of the energy of remembrance; whereas ideas of imagination are either the voluntary creatures of the fancy at the moment of their appearance, in which caſe we ſhould call them conceptions; or they are ideas which we have actually received from ſenſation, but which, on account of ſome link being broken in the vaſt chain of aſſociation, we cannot refer to any real objects. What gives probability to this conjecture is, that ideas often appear in the mind which we know not whether to refer to the memory or imagination, nothing being more common than to hear a perſon ſay, I have in my head the idea of ſuch or ſuch an object; but whether I remember or only imagine the object, I am very uncertain. Afterwards, however, by turning the idea over and over in the mind, he finds other ideas make their appearance, till at laſt cluſters of them come into view, and aſſociate ſo cloſely with the principal idea, which was the object of doubt, as to convince the judgement that it is an idea of memory.

100 and to be the ground of our belief of what we remember.

It has been aſked, Why we believe what we diſtinctly remember? and to that queſtion it has been ſuppoſed that no anſwer can be given. But it appears to us, that aſſociation is the ground of belief in this as it will be found to be in other inſtances; and that a man believes he waſhed his hands and face in the morning, becauſe the idea of that operation is ſo ſtrongly linked in his mind to the whole train of ideas which have ariſen in it through the day, that he cannot ſeparate the firſt from the laſt, that which was a ſenſation in the morning from the ſenſations which are preſent at the inſtant of remembrance. As thoſe ideas are aſſociated by nature, each muſt paſs in review in its proper order; ſo that in ſo ſhort a ſpace of time there is no danger, and hardly a poſſibility, of taking the firſt for the laſt, or the laſt for the firſt. Nay more, we will venture to hazard an opinion, that every paſt event of a man's life, which he diſtinctly remembers, is tied by the chain of aſſociation to his preſent perceptions. That this is poſſible is certain, ſince it is not difficult to conceive how it may be done. The principal events of a ſingle day may ſurely be ſo linked together as to be all diſtinctly reviewed in a cluſter of ideas on the morrow. Of theſe events ſome one or other muſt be the moſt important, which will therefore make its appearance as an idea more frequently than the reſt, and be more cloſely aſſociated with the events of next day. Some event of that day will, for the ſame reaſon, be more cloſely aſſociated with it than the others; and theſe two, dropping perhaps all the reſt of their original companions, will paſs on together to the third day, and ſo on through weeks, and months, and years. In the compaſs of a year, ſeveral things muſt occur to make deep impreſſions on the mind. Theſe will at firſt be aſſociated together by events of little importance, like the occurrences of a ſingle day. Whilſt theſe feeble chains, however, continue unbroken, they will be ſufficient to link the one important event to the other, and to bring them both into view at the ſame time, till at laſt theſe two, from appearing ſo often together, will in time unite of themſelves, and the intermediate ideas be completely effaced. Thus may two or three important events of one year be aſſociated with ſuch a number of ſimilar events of another year, ſo that the ideas of the one ſhall always introduce to the mind the ideas of the other; and this chain of aſſociation may paſs from the earlieſt event which we diſtinctly remember through all the intermediate years of our lives down to the inſtant when memory is exerted.

To this account of memory it may perhaps be objected, that it gives us no diſtinct notion of time. Every thing that is remembered is neceſſarily believed to have been preſent in ſome portion of paſt time; but aſſociation brings into view nothing but a ſeries of events. This objection will be ſeen to have no weight when we have inquired into the nature of time, and aſcertained what kind of a thing it is. It will then perhaps appear, that duration itſelf, as apprehended by us, is not diſtinguiſhable from a ſeries of events; and that if there were no train of thought paſſing through our minds, nor any motion among the objects around us, time could have no exiſtence. Meanwhile, whatever become of this opinion, we beg leave to obſerve, that our theory of remembrance is perfectly conſiſtent with the commonly received notions reſpecting time; and indeed, that it is the only theory which can account for numberleſs phenomena reſpecting paſt duration. It is univerſally allowed, that if motion or a ſucceſſion of events, do not conſtitute time, it is the only thing by which time can be meaſured. Now it is a fact which no man will deny, that the diſtance of time from the preſent *now* or inſtant to the earlieſt period which he diſtinctly remembers, appears to his view extremely ſhort, much ſhorter than it is ſaid to be in reality; and that one year, when he looks forward, appears longer than two, perhaps longer than ten, when he looks backward. Upon our principles this fact is eaſily accounted for. We remember nothing which is not linked by a chain of aſſociations with the perceptions of the preſent moment; and as none but a few of the moſt important events of our lives can be linked together in this manner, it hence follows, that events which, in the order of ſucceſſion, were far *diſtant* from each other, muſt thus be brought *together* in the memory, and the whole chain be contracted within very ſhort limits. But when we figure to ourſelves a ſeries of future events, we employ the active power of fancy inſtead of the paſſive capacity of retention; and can therefore bring within the compaſs of one periodical revolution of the ſun a longer ſeries of imaginary events ſucceeding each other, than is preſerved of real events in our memory from the earlieſt period of our exiſtence: So perfectly does our theory accord with this well-known fact. On the other hand, if memory be an original faculty of the mind totally independent of aſſociation, and of which no other account is to be given than that it neceſſarily commands our belief, why is it a faculty which, with regard to duration, thus uniformly deceives us? and how comes it to paſs, that to a man whoſe memory is tenacious, who has read much, ſeen many countries, and been engaged in various occurrences, any determinate portion of paſt time always appears longer than to another man whoſe memory is feeble, and whoſe life has been waſted in eaſe and idleneſs? To theſe queſtions we know not what anſwer can be given upon any other principle than that which makes the evidence of memory depend upon aſſociation. But if we remember nothing but what is linked to the perception or idea which is preſent with us at the time of remembrance, and if duration be meaſured by the ſucceſſion of events, it is obvious that any portion of paſt time muſt neceſſarily appear longer to him who has many ideas aſſociated in his mind than to him who has but few.

101
The importance of aſſociation in the philoſophy of the human mind.

There is not perhaps a ſingle fact of greater importance in the philoſophy of the human mind than the *aſſociation of ideas;* which, when thoroughly underſtood, accounts for many of thoſe phenomena which ſome late writers of name have, with injury to ſcience and with danger to morality, attributed to a number of diſtinct and independent inſtincts. It is for this reaſon that we have conſidered it ſo minutely, and dwelt upon it ſo long; and in addition to what we have ſaid on the ſubject, we beg leave to recommend to our more philoſophical readers the diligent ſtudy of Hartley's Obſervations on Man (R). In that work we think ſeveral things are taken for granted which require proof; and ſome which, we are perſuaded, have no foundation in nature: but, with all its defects, it has more merit than any other treatiſe on the ſenſitive part of human nature with which we are acquainted.

CHAP. VI. *Of* CONSCIOUSNESS *and* REFLECTION.

102
Conſciouſneſs, what it is, and what are its objects.

SENSATION, remembrance, ſimple apprehenſion, and conception, with every other actual energy or paſſion of the mind, is accompanied with an inward feeling or perception of that energy or paſſion; and that feeling or perception is termed *conſciouſneſs*. *Conſciouſneſs* is the perception of what paſſes in a man's own mind at the *inſtant* of its paſſing there; nor can we *ſee*, *hear*, *taſte*, *ſmell*, *remember*, *apprehend*, *conceive*, employ our faculties in any manner, enjoy any pleaſure, or ſuffer any pain, without being *conſcious* of what we are doing, enjoying, or ſuffering. *Conſciouſneſs* is only of things *preſent* *; and to apply it to things *paſt*, is to confound *conſciouſneſs* with memory or *reflection*. One cannot ſay that he is conſcious of what he has ſeen or heard and now remembers: he is only conſcious of the act of remembrance; which, though it reſpects a paſt event, is itſelf a preſent energy. It is likewiſe to be obſerved, that conſciouſneſs is only of things in the mind or conſcious being, and not of things external. It is improper in any perſon to ſay that he is *conſcious* of

* *Reid's Eſſays on the Intellectual Powers of Man.*

(R) Since this was written Mr Stewart's *Elements of the Philoſophy of the Human Mind* have been publiſhed; in which the reader will find many excellent remarks on the nature and influence of the aſſociating principle.

of the table before him: he perceives it, he *ſees* it, and he may with great propriety ſay that he is *conſcious* he perceives or ſees it; but he cannot ſay that he is conſcious of the table itſelf, for it is only his immediate energy of perception that can be the object of conſciouſneſs. All the operations of our minds are attended with conſciouſneſs; which is the only evidence that we have or can have of their exiſtence. Should a man take it into his head to think or to ſay that his conſciouſneſs may deceive him, and to require a proof that it cannot, we know of no proof that can be given him: he muſt be left to himſelf as a man that denies firſt principles, without which there can be no reaſoning. Every attempt to prove this point, or to ſet it in a clearer light, would only ſerve to render it more dark and unintelligible. I *think*, I *feel*, I *exiſt*, are firſt truths, and the baſis of all human knowledge.

103
Des Cartes's argument from conſciouſneſs for his own exiſtence.

This has given riſe to the queſtion, whether Des Cartes did not fall into an abſurdity when, inferring his own exiſtence from his actual thought, he ſaid, *Cogito, ergo ſum.* This argument has been called a pitiful ſophiſm, and a *petitio principii;* becauſe, before a man take it for granted that he thinks, he muſt alſo, it is ſaid, take it for granted that he exiſts, ſince there cannot be thought where there is no exiſtence. Now it muſt be confeſſed, that if Des Cartes pretended by this argument to give us a freſh conviction of our own exiſtence, his endeavours were uſeleſs and puerile; becauſe a man capable of being convinced by the arguments of another, muſt have a previous conviction of his own exiſtence: but the argument itſelf is certainly neither a ſophiſm nor a *petitio principii.* Thoſe * who defend Des Cartes aſſert, and there is no reaſon to doubt the truth of their aſſertion, that his only view in urging ſuch an argument was not to prove the truth of our exiſtence, but to exhibit the order of that proceſs by which we arrive at the knowledge of the fact; and this he has very clearly done by analyzing the truth into its firſt principles. A ſtone exiſts as well as the human mind; but has the ſtone any knowledge of its own exiſtence? No man will ſay that it has; neither ſhould we have any knowledge of ours, did we think as little as the ſtone. We certainly *might* exiſt without thinking, as it is probable we do in very ſound ſleep; and in that ſtate our exiſtence might be known to other beings, but it could not poſſibly be known to ourſelves: for the only things of which the mind is conſcious, or has immediate knowledge, are its own operations. I *exiſt* is therefore a legitimate inference from the propoſition I *think;* and the obſervation that it is ſo may be uſeful to ſhow us the procedure of the mind in the acquiſition of knowledge; but it has little merit as an argument, and ſtill leſs as a diſcovery, though, being ſtrictly true and juſt, it ſhould never have been expoſed to ridicule.

104
Reflection, what it is, and how different from conſciouſneſs.

It is to be obſerved, that we are conſcious of many things to which we give very little attention. We can hardly attend to ſeveral things at the ſame time; and our attention is commonly employed about that which is the *object* of our thought, and rarely about the thought itſelf. It is in our power, however, when we come to the years of underſtanding, to give attention to our own thoughts and paſſions, and the various operations of our minds. And when we make theſe the objects of our attention, either while they are preſent, or when they are recent and freſh in our memory, we perform an act of the mind which is properly called *reflection.* This *reflection* ought to be diſtinguiſhed from *conſciouſneſs* *; with which it is confounded ſometimes by Locke, and often by the learned author of Ancient Metaphyſics. All men are *conſcious* of the operations of their own minds at all times while they are awake, nor does it appear that brutes can be wholly deſtitute of conſciouſneſs; but there are few men who *reflect* upon the operations of their minds, or make them the objects of thought; and it is not probable that any ſpecies of brutes do ſo.

From infancy, till we come to the years of underſtanding, we are employed ſolely about ſenſible objects. And although the mind is conſcious of its operations, it does not attend to them; its attention is turned ſolely to the objects about which theſe operations are employed. Thus, when a man is angry, he is *conſcious* of his paſſion; but his *attention* is turned to the *perſon* who offended him and the *circumſtances* of the *offence,* while the *paſſion of anger* is not in the leaſt the object of his attention. The difference between *conſciouſneſs* and *reflection,* is like the difference between a ſuperficial view of an object which preſents itſelf to the eye, while we are engaged about ſomething elſe, and that attentive examination which we give to an object when we are wholly employed in ſurveying it. It is by conſciouſneſs that we immediately acquire all the knowledge which we have of mental operations; but attentive reflection is neceſſary to make that knowledge accurate and diſtinct. *Attention* is a voluntary act; it requires ſome exertion to begin and continue it; and by great exertion it may be continued for a conſiderable time; but *conſciouſneſs* is involuntary, and of no continuance, changing with every thought. The power of reflection upon the operations of their own minds does not at all appear in children. Men muſt have come to ſome ripeneſs of underſtanding before they are capable of it. Of all the powers of the human mind it ſeems to be the laſt that unfolds itſelf. Moſt men ſeem incapable of acquiring it in any conſiderable degree; and many circumſtances conſpire to make it to all men an exerciſe of difficulty. The difficulty, however, muſt be conquered, or no progreſs can be made in the ſcience of our own or of other minds.

105
All our notions of mental energies got by reflection.

All the notions which we have of mind and of its operations are got by reflection; and theſe notions are by Mr Locke called *ideas of reflection.* This term we think extremely ill choſen; and we believe it has been the ſource of much error and confuſion among Locke's followers. A man, by attending to the operations of his own mind, may have as diſtinct *notions* of remembrance, of judgement, of will, of deſire, as of any object whatever: but if the ſecondary perception of a ſenſible object, that appearance which it has to the mind when viewed in the memory or imagination, be properly called an *idea,* it is certain that of the operations of the mind itſelf there can be no ideas; for theſe operations, when reflected on, make no appearance without their objects either in the memory or in the imagination. Nothing is more evident, in fact, than that we have no *ideas,* in the original and proper meaning of the word, but of ſenſible objects upon which the mind exerts its firſt operations. Of theſe operations we have indeed a

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* See *Buffier's Firſt Truth.*

* *Reid's Eſſays on the Intellectual Powers of Man.*

conſciouſneſs; but abſtracted from their objects we cannot frame of them any idea or reſemblance. We are *conſcious* to ourſelves of *thinking*, *willing*, *remembering*, *diſcerning*, *reaſoning*, *judging*, &c. but let any one look into himſelf, and try whether he can there find any *idea* of *thinking* or *willing*, &c. entirely ſeparate and abſtracted from the *object* of thought or will. Every man who has ſeen a tree or houſe, will find in his mind ideas of theſe objects, which he can contemplate by themſelves, independent of every thing elſe; but no man can contemplate the *idea* of thinking or deſiring without taking into view the thing thought on or deſired. It is plain, therefore, that the energies of *thinking*, *willing*, and *deſiring*, with all their various modifications, are not themſelves *ideas*, or capable of *communicating* ideas to be apprehended, as the ideas of bodies are apprehended by the pure intellect. They are the *actions* and *workings* of the *intellect itſelf* upon ideas which we receive from the objects of ſenſe, and which are treaſured up in the memory or imagination for the very purpoſe of furniſhing the intellect with materials to work upon. Between *ideas* and the *energies of thinking* there is as great and as obvious a difference as there is between a *ſtone* and the *energies* of him by whom it is caſt. Ideas are the paſſive ſubjects; the energies of thinking are the operations of the agents. Ideas are relicts of ſenſation, and have a neceſſary relation to things external; the energies of thinking are relicts of nothing, and they are wholly and originally internal.

106
Our knowledge of the operations of intellect immediate, and not by the intervention of *ideas*.

That we can in no ſenſe of the word be ſaid to have *ideas* of the operation of the intellect, will be ſtill more evident, if we conſider by what means we acquire the knowledge which we have of thoſe operations. It has been already obſerved, that when our thoughts are employed upon any ſubject, though we are conſcious of thinking, yet our *attention* is commonly employed upon the *object* of our thought, and not upon the *thought* itſelf; and that if we would give attention to our thoughts and paſſions, we muſt do it by a reflex act of the mind, whilſt the act of thinking is ſtill recent and freſh in our memory. Thus, if a man wiſhes to know what perception is, it is not the time to make the inquiry while he is looking at ſome rare or beautiful object; for though he is *conſcious* of the energy of perceiving, the *object* of perception employs all his *attention*. But the time to make this inquiry is either when the object has become familiar to him, or preſently after it is removed from his ſight. In the former caſe, he can look upon it without emotion, pay attention to every ſtep in the proceſs of perception, and be immediately conſcious what perception is. In the latter caſe, by turning his attention inwards, and reflecting on what he did or felt when the object was before him, he will find clear and vivid ideas of every thing which he perceived by his ſenſe of ſight; but he will find no *idea* of the act of *ſeeing* or *perceiving*. On the contrary, if he be capable of ſufficient attention, he will obſerve that his intellect is employed in the very ſame manner upon the *ideas* that it was upon the original *ſenſations*; and of that employment, and the manner of it, he will be equally conſcious as he was of the original energy exerted in ſenſation. There is indeed this difference between the two, without which reflection could make no diſcoveries, that the moſt vivid ideas being ſtill faint when compared with actual ſenſations, the intellect is not ſo wholly engroſſed by them, as it was by the original objects, nor is it ſo rapidly carried from idea to idea as it was from ſenſation to ſenſation. It is thus at leiſure to attend to its own operations, and to know what they are; though to form *ideas* of them as ſeparate from their objects, is abſolutely impoſſible. Every man capable of paying attention to what paſſes within himſelf when he ſees, hears, and feels, &c. may have very accurate *notions* of *ſeeing*, *hearing*, and *feeling*, &c. but he cannot have *ideas* of them as he has of the *objects* of *ſight*, *hearing*, and *touch*.

The ſame is the caſe with reſpect to the exertion of our reaſoning faculties. A man muſt have diſtinct and clear *ideas* to reaſon upon, but he can have no *idea* of reaſoning itſelf, though he muſt be conſcious of it, and by attention may know what it is. When a man ſits down to ſtudy for the *firſt time* a propoſition in the Elements of Euclid, he certainly employs his reaſoning faculty, and is conſcious that he is doing ſo; but his attention is wholly turned to the diagram before him, and to the ſeveral ideas which the diagram ſuggeſts. Afterwards, when he has maſtered the propoſition, he may go over it again, with a view to diſcover what reaſoning is; but he will not find he has any *idea* of reaſoning as he has of the diagram. He will only exert that faculty a ſecond time, and perceive one trunk linked to and depending upon another in ſuch a manner that the whole taken together forms a complete demonſtration. In a word, the operations of our own minds, when attention is paid to them, are known immediately by conſciouſneſs; and it is as impoſſible that we ſhould have ideas of them, as that a living man ſhould be a picture upon canvas. He who attends to what paſſes in his own mind when he perceives, remembers, reaſons, or wills, muſt know by conſciouſneſs what theſe operations are, and be capable of forming very accurate notions of them, as connected with their objects; and he who does not attend to what paſſes in his own mind will never acquire any notions of them, though he were to read all that has been written on the ſubject from the days of Pythagoras to thoſe of Dr Reid.

107
There are things which we know partly by ſenſation and partly by reflection, &c.

As we acquire ideas of external objects by means of our ſenſes; and notions of perceiving, remembering, reaſoning, and willing, &c. by reflecting on the operations of our own minds; ſo there are other things of which we acquire notions, partly by ſenſation, partly by reflection, and partly by means of that faculty of which it is the more peculiar office to compare ideas and to perceive truth. Such are *ſubſtance*, *body*, *mind*, with their ſeveral qualities, adjuncts, and relations; the knowledge of which, as has been already obſerved, conſtitutes what in ſtrictneſs of ſpeech is termed the ſcience of *metaphyſics*. Theſe ſhall be conſidered in order, after we have inveſtigated the nature of truth, and inquired into the ſeveral ſources of evidence; but there is one notion, about the origin and reality of which there have been ſo many diſputes, which in itſelf is of ſo great importance, and which will be ſo intimately connected with all our ſubſequent inquiries, that it may not be improper to conſider it here.—The notion to which we allude is of POWER.

108
Our notion of power how acquired.

Among the objects around us we perceive frequent changes, and one event regularly ſucceeding another.

Gold thrown into the fire is changed from a ſolid to a fluid body. Water expoſed to a certain degree of cold is changed from a fluid to a ſolid body. Night ſucceeds to day, and ſummer ſucceeds to winter. We are conſcious of new ſenſations in ourſelves every hour. We are likewiſe conſcious of reaſoning, willing, and deſiring; and we know that by an exertion of will we can riſe or ſit, ſtand ſtill or walk, call one idea into view, and diſmiſs others from our contemplation. Experience teaches us, that it is not occaſionally, but always, that gold is changed into a fluid by being thrown into the fire, and water into a ſolid body by being expoſed to a certain degree of cold; that night ſucceeds to day, and ſummer to winter. Theſe changes have regularly taken place ſince the creation of the world; and it has never once been obſerved that water was made ſolid by fire, or gold rendered liquid by cold. Were we not aſſured by experience that our own voluntary motions are produced by exertions of our minds, of which we are conſcious, and that without ſuch exertions thoſe motions would never have taken place, we ſhould probably have conſidered the liquefaction of gold as an event equally independent of fire, though uniformly conjoined with it, as night is independent of day, and day of night. But having experienced that we can move or not move our bodies as we pleaſe; that when it is our will to ſit, we never get up to walk; and that when we wiſh to walk, we always do it except prevented by external violence: having likewiſe experienced, that by a thought, by ſome internal and inexplicable exertion of our minds, we can call up in our memory or imagination one idea and diſmiſs others from our mental view; we are led to believe with the fulleſt conviction, that all thoſe motions of our bodies which in common language are termed *voluntary*, and that ſucceſſion of ideas which follows a conſcious exertion of the mind, depend upon ourſelves. In other words, we are neceſſitated to believe that we have a *power* to move or not move our bodies in many caſes, and a *power* to turn our attention to one idea in preference to others.

It is thus that we acquire the notion of *power* in ourſelves, which we eaſily transfer to other objects. Knowing that the various motions of our bodies thus effected proceed from power, we are naturally led to inquire whether the changes which we perceive in other bodies may not proceed from *power* likewiſe, i. e. from ſomething analogous to that power, of the exertions of which we are conſcious in ourſelves. Now uniform experience teaching us that gold is liquefied by being thrown into the fire, and that water is made ſolid by being expoſed to cold; we infer with the utmoſt certainty that there are *powers* in fire and cold to produce theſe changes, and that without the exertion of ſuch *powers* theſe changes would not be produced. We cannot indeed ſay of external powers, as we can of our own, in what ſubſtance they inhere. We know with the utmoſt certainty that the voluntary motions of our hands, &c. are produced by a power not inherent in the hands but in the mind, for of the exertion of that power we are conſcious; but we do not know whether the power which liquefies gold be inherent in that ſenſible object which we call *fire*, or in ſomething elſe to which fire is only an inſtrument. We learn by obſervation, that the minute particles of fire or heat inſinuate themſelves between the particles of gold, and, if we may uſe the expreſſion, tear them aſunder; but whether they do this in conſequence of a *power* inherent in themſelves, or only as inſtruments impelled by another *power*, is a queſtion which *obſervation* cannot enable us to anſwer.

Were we not conſcious of the exertion of our own powers, it ſeems not conceivable that we could ever have acquired any notion of power at all; for power is not an object of ſenſe, nor, independent of its operations, is it indeed an object of conſciouſneſs. In external operations, all that we perceive is *one thing*, in which we ſuppoſe the *power* to reſide, followed by another, which is either the *change* or that on which the change is *produced;* but the exertion of the power itſelf we do not perceive. Thus we perceive gold, after it has been ſome time in the fire, converted from a ſolid to a fluid body; but we perceive not by our ſenſes either the power or the energy of the power which operates to this converſion. In the exerciſe of our own powers, the caſe is otherwiſe. When a man puts his hand to his head, and afterwards thruſts it into his boſom, he not only perceives by his ſenſes the change of poſition, but is alſo conſcious of the energy or exertion by which the change was produced.

“ Suppoſe (ſays Mr Hume *) a perſon, though endowed with the ſtrongeſt faculties of reaſon and reflection, to be brought on a ſudden into this world; he would indeed immediately obſerve a continual ſucceſſion of objects, and one event following another, but he would not be able to diſcover any thing farther. He would not at firſt by any reaſoning be able to reach the idea of cauſe and effect; ſince the particular powers by which all natural operations are performed never appear to the ſenſes. The impulſe of one billiard ball is attended with motion in the ſecond. This is the whole that appears to the *outward* ſenſes. The mind feels no ſentiment or *inward* impreſſion from this ſucceſſion of objects; conſequently there is not, in any ſingle particular inſtance of cauſe and effect, any thing which can ſuggeſt the idea of power or neceſſary connexion. From the firſt appearance of an object, we never can conjecture what effect will reſult from it; but, were the power or energy of any cauſe diſcoverable by the mind, we could foreſee the effect even without experience; and might at firſt pronounce with certainty concerning it by the mere dint of thought and reaſoning. It is impoſſible, therefore, that the idea of power can be derived from the contemplation of bodies in ſingle inſtances of their operations; becauſe no bodies ever diſcover any power which can be the original of this idea.”

There is a ſenſe in which this reaſoning is unqueſtionably juſt. A man who had never been conſcious of exerting power in himſelf, would certainly not acquire the notion of power from obſerving a continual ſucceſſion of external objects. The impulſe of one billiard ball being followed by the motion of another, would no more lead him to the notion of power in the former, than the ſucceſſion of night to day would lead him to the notion of a power in light to produce darkneſs. When Mr Hume ſays, “ that from the *firſt* appearance of an object *we* can never conjecture what ef-

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* Eſſays.

fect will reſult from it," he uſes language that is ambiguous, and utters an aſſertion which is either true or falſe according to the ſenſe in which it is underſtood. If it be meant, that after having reflected on the operations of our own minds, and learned by experience that motion is communicated by impulſe from one ball of ivory to another, we could not conjecture whether a ſimilar effect would be produced by the impulſe of balls made of other hard bodies which we had never before ſeen, the aſſertion is manifeſtly falſe. A man who had but once ſeen motion communicated in this manner from one *ivory* ball to another, would certainly conjecture that it might be communicated from one *wooden* ball to another; and if he had ſeen it repeatedly communicated from one ball to another of different ſubſtances, he would infer, with the utmoſt confidence, that it might be communicated from ball to ball of whatever ſubſtance compoſed, provided that ſubſtance be hard, or of a ſimilar texture with the balls to the impulſe of which he had formerly paid attention. If by this ambiguous phraſe the author only means, as is probably the caſe, that from the firſt appearance of an object to which we had never before obſerved any thing in any reſpect ſimilar, we could not conjecture what effect would reſult from it; or if his meaning be, that a man ſuddenly brought into the world, who had never acquired ſuch a notion of power as may be had from attention to the energies and operations of our own minds, would not, by obſerving an effect to reſult from one body, conjecture from the firſt appearance of another ſimilar body what effect would reſult from it; in either of theſe caſes his aſſertion is certainly true, and tends to prove, that without the conſciouſneſs of the operations of our own minds we could never acquire a notion of power from the changes perceived by our ſenſes in external objects.

109 Mr Hume attempts to prove that we can have no notion whatever of power,

But Mr Hume, not contented with denying, which he might juſtly do, that we could ever have derived the idea of power merely from obſerving the continual ſucceſſion of external objects, labours hard to prove that we have no notion of power at all, and that when we uſe the word *power*, we do nothing more than utter an inſignificant ſound. To pave the way for the arguments by which ſo extravagant a paradox is to be ſupported, he lays it down as a "propoſition which will not admit of much diſpute, that all our ideas are nothing but copies of our impreſſions; or, in other words, that it is impoſſible for us to *think* of any thing that we have not antecedently *felt* either by our external or internal ſenſes." As this propoſition, however, will admit, it ſeems, of *ſome* diſpute, he takes care, before he applies it to the purpoſe of demoliſhing all power, to ſupport it by two arguments. "Firſt (ſays he), when we analyze our thoughts or ideas, however compounded or ſublime, we always find that they reſolve themſelves into ſuch ſimple ideas as were copied from a precedent feeling or ſentiment. Thoſe who would aſſert, that this poſition is not univerſally true nor without exception, have only one, and that an eaſy, method of refuting it; by producing that idea, which, in their opinion, is not derived from this ſource. Secondly, If it happen, from a defect of the organ, that a man is not ſuſceptible of any ſpecies of ſenſation, we always find that he is as little ſuſceptible of the correſpondent ideas. A blind man can form no notion of colours, a deaf man of ſounds. And though there are few or no inſtances of a like deficiency in the mind, where a perſon has never felt, or is wholly incapable of a ſentiment or paſſion that belongs to his ſpecies; yet we find the ſame obſervation to take place in a leſs degree. A man of mild manners can form no idea of inveterate revenge or cruelty; nor can a ſelfiſh heart eaſily conceive the heights of friendſhip and generoſity."

110 His reaſoning ſophiſtical.

As theſe propoſitions are the engines by which all power is baniſhed from the world, it may not be improper, before we proceed to inquire by what means they perform ſo arduous a taſk, to conſider their own inherent ſtrength; for if they be weak in themſelves, their work, however dexterouſly they may be employed, can have no ſtability. We have already noticed the perverſeneſs of this writer's language, when it confounds *ſenſations* with *impreſſions*; but here it is ſtill more perverſe, for paſſions, ſentiments, and even *conſciouſneſs*, are ſtyled *impreſſions*. When ſenſations are confounded with impreſſions, the effect is only miſtaken for the cauſe, it being univerſally known that ſenſations proceed from impreſſions made upon the organs of ſenſe. When conſciouſneſs is confounded with an impreſſion, one thing is miſtaken for another, to which it is univerſally known to have neither reſemblance nor relation. But, not to waſte time upon theſe fallacies, which, though dangerous if admitted, are yet too palpable to impoſe upon a reader capable of the ſlighteſt attention, let us examine the propoſitions themſelves. The moſt important, and that for the ſake of which alone the others are brought forward, is, that it is impoſſible for us to *think* of any thing that we have not immediately *felt*, either by our external or internal ſenſes." Did Mr Hume then never *think* of a mathematical *point*, or a mathematical *line*? Neither of theſe things is capable of being *felt* either by making an impreſſion upon the organs of ſenſe or as an object of conſciouſneſs; and therefore it is impoſſible that he ſhould ever have had ideas of them ſuch as he doubtleſs had of ſenſible objects; yet in the moſt proper ſenſe of the word *think* (s), he certainly thought of both points and lines; for he appears to have made conſiderable progreſs in the ſcience of geometry, in which he could not have proceeded a ſingle ſtep without a perfect knowledge of theſe things, on which the whole ſcience is built. It is not therefore true, that our thoughts or ideas, when analyzed, always reſolve themſelves into ſuch ſimple ideas as were copied from a precedent feeling or ſentiment; for every mathematical figure of which we can think reſolves itſelf into a point and motion; and a point having no parts and no magnitude, cannot poſſibly be the object of feeling to any of our ſenſes. If, therefore, ideas alone be the objects of thought, we have refuted Mr Hume's poſition by the very method which he himſelf lays down; for we have produced an idea which is not derived either from a precedent feeling or a precedent ſentiment. By ſentiment, we ſuppoſe to be here meant that which by other philoſophers is denominated conſciouſneſs; and of conſciouſneſs it is undeniable that nothing is the object but the actual energies of our own minds.

(s) *Thinking*, in the propriety of the Engliſh tongue, ſignifies that ſort of operation of the mind about its ideas wherein the mind is active; where it, with ſome degree of voluntary attention, conſiders any thing.—*Locke.*

111 Things of which we can have no *ideas* may themſelves be the objects of thought.

But ideas are not the only objects of thought. We have already given our reaſons for reſtricting the word *idea* to that appearance which an object of ſenſe, when reflected on, makes either in the memory or imagination. Such was undoubtedly its original ſignification; and had it never been uſed to denote other and very different objects, much error and perplexity would have been avoided, which now diſgrace the ſcience of metaphyſics. Things may *themſelves* be the objects of thought; and when that is the caſe, to think of their *ideas*, were it poſſible to do ſo, would be worſe than uſeleſs; for we may certainly know a man better by looking at himſelf than by looking at his picture. Of things which are *themſelves* the objects of thought, we have either a *direct* or a *relative* knowledge. We know directly the actual operations of our own minds by the moſt complete of all evidence, that of conſciouſneſs; and we have a *relative* notion of mathematical points and lines: but neither of mental energies nor of theſe external things (T) can we poſſibly have any *idea*.

112 We have only relative notions of ſome things,

It is well obſerved by Dr Reid*, that our notions both of body and mind are nothing more than relative. "What is body? It is, ſay philoſophers, that which is extended, ſolid, and diviſible. Says the queriſt, I do not aſk what the properties of body are, but what is the thing itſelf? let me firſt know directly what body is, and then conſider its properties. To this demand I am afraid the queriſt will meet with no ſatisfactory anſwer; becauſe our notion of body is not direct, but relative to its qualties. We know that it is ſomething extended, ſolid, and diviſible, and we know no more. Again, If it ſhould be aſked, what is mind? It is that which thinks. I aſk not what it does, or what its properties are, but what it is? To this I can find no anſwer; our notion of mind being not direct, but relative to its operations, as our notion of body is relative to its qualities (U)."

113 about which, however, we can reaſon with the utmoſt preciſion:

Our notion of a mathematical point is of the very ſame kind. What is a point? It is, ſays Euclid, that which hath no parts and no magnitude. Replies the queriſt, I aſk not either what it has or what it has not, let me firſt know what it is? To this ſecond queſtion, it might perhaps be anſwered, that a mathematical point is that which by motion generates a line. But, rejoins the queriſt, I am not inquiring what it generates; give me a direct idea of the point itſelf? or, if that cannot be done, as ſurely it cannot, tell me what its offspring a line is? A line, ſays Euclid, is length without breadth. I have no idea, replies the queriſt, of length without breadth. I never felt an *impreſſion* from a ſenſible object which did not ſuggeſt length, breadth, and thickneſs, as inſeparably united; and I can have no idea which is not the *copy* of a *former impreſſion*. To aſſiſt the queriſt's conception, it may be ſaid that lines are the boundaries of a ſuperficies, and that ſuperficies are the boundaries of a ſolid body; but of a ſolid body every man has a clear and direct idea, in the moſt proper ſenſe of the word. Here then are ſeveral things, viz. points, lines, and ſuperficies, of not one of which is it poſſible to form a direct notion; and yet we know them ſo thoroughly, from the relation which they bear to other ſubjects, that we can reaſon about them with a preciſion and certainty which only the mathematical ſciences admit.

114 And ſuch is power:

The great advantage of theſe ſciences above the moral, Mr Hume himſelf expreſsly admits: but he attributes it to a wrong cauſe, when he ſays it conſiſts in this, that the "ideas of the former being *ſenſible* are always clear and determinate;" for we ſee that the notion of a point or of a line is merely relative, and cannot poſſibly be the copy of a ſenſation, or, in his language, of a ſenſible impreſſion. If then we have clear and determinate notions of points and lines, and may reaſon about them without ambiguity, as he acknowledges we may, what is there to hinder us from having an equally clear and determinate notion of power, or from reaſoning about it with as little ambiguity (V); Why ſays he, we are not conſcious of power. And to prove this poſition, which needs no proof,

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* *Eſſay on the Active Powers of Man.*

(T) By calling mathematical points and lines external things, we do not mean to attribute to them any corporeal exiſtence. We know well that they are merely creatures of the mind, and that if there were no mind, they could have no exiſtence. But twenty men may at the ſame inſtant have a notion of the ſame lines and the ſame points; and therefore theſe lines and points have an exiſtence independent of, and external to, any *one* mind, at leaſt to any one *human* mind. The objects, however, of which a man is conſcious, are in no ſenſe whatever external, for they are preſent to no human mind but his own.

(U) The opinions of philoſophers concerning corporeal and ſpiritual ſubſtances ſhall be conſidered more fully hereafter. In quoting from Dr Reid on another ſubject, we have been obliged to anticipate his opinion, which will be found to be not more modeſt than juſt.

(V) "There are ſome things of which we can have both a direct and relative conception. I can directly conceive ten thouſand men, or ten thouſand pounds, becauſe both are objects of ſenſe, and may be ſeen. But whether I ſee ſuch an object, or directly conceive it, my notion of it is indiſtinct; it is only that of a great multitude of men, or of a great heap of money; and a ſmall addition or diminution makes no perceptible change in the notion I form in this way. But I can form a relative notion of the ſame number of men or of pounds by attending to the relations which this number has to other numbers greater or leſs. Then I perceive that the relative notion is diſtinct and ſcientific; for the addition of a ſingle man, or a ſingle pound, or even

Of Conſciouſneſs and Reflection.

proof, he makes many obſervations that, however juſt, might certainly have been ſpared. Of theſe one is, that "a man ſuddenly ſtruck with a palſy in the leg or arm, or who had now loſt theſe members, frequently endeavours at firſt to move them, and employ them in their uſual offices. Here he is as much conſcious of power to command ſuch limbs, as a man in perfect health is conſcious of power to actuate any member which remains in its natural ſtate and condition. But conſciouſneſs never deceives. Conſequently, neither in the one caſe nor in the other are we ever conſcious of any power." This is true; we never are conſcious of any power; but we are frequently conſcious of actual energies: and the man who, after being ſuddenly ſtruck with a palſy, endeavours in vain to move his leg or arm, is as conſcious of energy as he who in health makes the attempt with ſucceſs. Nor let it be imagined that his conſciouſneſs deceives him; for, as Mr Hume juſtly obſerves, conſciouſneſs never deceives. He is certain of the *energy*, but finds by experience that the *inſtrument* of this energy has ſuddenly become diſordered and unfit for its uſual office. In this and this alone conſiſts the difference between the paralytic and the man whoſe limbs are ſound. The one may be as conſcious of energy as the other, and his conſciouſneſs may be equally infallible. What then is this energy? Mr Hume will not ſay that it is an *idea*, for it is not the copy of any antecedent impreſſion; beſides, he has ſomewhere allowed that ideas are never active. Is it then a ſubſtance? Impoſſible! for it is not permanent: and we believe no man will venture to affirm, or even to ſuppoſe, that the ſame ſubſtance can be repeatedly annihilated, and as often created. Is it then the occaſional exertion of ſome ſubſtance? This muſt be the truth; for no other ſuppoſition remains to be made. If ſo, that ſubſtance muſt be poſſeſſed of *power*; for a capacity of exerting actual energy is all that is meant by the word *power*. —"Wherever there is a *capability* of energy or exertion, there muſt be *power*; for though there can be no exertion without power, there may be power that is not exerted *. Thus a man may have *power* to ſpeak when he is ſilent; he may have power to riſe and walk when he ſits ſtill. But though it be one thing to *ſpeak* and another to have the *power* of ſpeaking, we always conceive of the power as ſomething which has a certain relation to the effect; and of every power we form our notion by the effect which it is able to produce. Nor is it only in ſpeaking and moving his limbs that a man is conſcious of energy. There is as much energy, though of a different kind, in *thinking* as in *acting*. Hence the powers of the human mind have been divided into active and ſpeculative. By the former we move the body; and by the latter we ſee, hear, remember, diſtinguiſh, judge, reaſon, and perform upon our notions and ideas every other operation which is comprehended under the general word *to think*."

*Reid's Eſſays on the Active Powers of Man.

Of Conſciouſneſs and Reflection.

115
Locke's paſſive power an improper expreſſion.

Mr Locke † has introduced into his theory of power another diſtinction than that which we have made between active and ſpeculative powers. Obſerving by our ſenſes, under which on this occaſion memory is certainly included, various changes in objects, we collect, ſays he, a poſſibility in one object to be changed, and in another a poſſibility of making that change, and ſo come by that idea which we call power. Thus we ſay that fire has a power to melt gold, and that gold has a power to be melted. The firſt he calls *active*, the ſecond *paſſive*, power. But to ſay that the *poſſibility* of being changed is *power*, ſeems to be a very improper mode of ſpeaking, and ſuch as may lead to conſequences which the excellent author certainly held in abhorrence. It tends to make unwary readers imagine that the paſſive ſubject is as neceſſary to the exiſtence of power, as the active being of which power is an attribute; but if the univerſe had a beginning, and if its Creator be immutable, two propoſitions which Mr Locke firmly believed, there certainly was power when there was no change, nor any thing exiſting which was capable of change. He owns, indeed, that active power is more properly called power than the other; but we ſee no propriety at all in paſſive power. "It is (in the language of Dr Reid) a powerleſs power, and a contradiction in terms."

† Eſſay, book ii. chap 21.

116
Juſt obſervations of the ſame author reſpecting power as belonging to body or mind.

But though Locke here uſes improper terms, he has other obſervations with which we have the honour fully to agree, and which lead to conſequences the reverſe of that impiety which ſeems to follow from the notion of *paſſive* power. He obſerves, that "we have from body no idea at all of thinking, nor any idea of the beginning of motion. A body at reſt affords us no idea of any active power to move; and when it is ſet in motion itſelf, that motion is rather a paſſion than an action in it. For when the ball obeys the ſtroke of a billiard ſtick, it is not any action of the ball, but a paſſion: alſo, when by impulſe it ſets another ball in motion that lay in its way, it only communicates the motion it had received from another, and loſes in itſelf ſo much as the other received; which gives us but a very obſcure idea of an active power of moving in body, whilſt we obſerve it only to transfer, but not to produce any motion. So that it ſeems to me, we have from the obſervation of the operation of bodies by our ſenſes but a very imperfect obſcure idea of

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of a penny, is eaſily perceived. In like manner, I can form a direct notion of a polygon of a thouſand equal ſides and equal angles. This direct notion cannot be more diſtinct when conceived in the mind, than that which I get by ſight when the object is before me; and I find it ſo indiſtinct that it has the ſame appearance to my eye, or to my *direct* conception, as a polygon of a thouſand and one, or of nine hundred and ninety nine ſides. But when I form a *relative* conception of it, by attending to the relation it bears to polygons of a greater or leſs number of ſides, my notion of it becomes diſtinct and ſcientific, and I can demonſtrate the properties by which it is diſtinguiſhed from all other polygons. From theſe inſtances it appears, that our relative conceptions of things are not always leſs diſtinct, nor leſs fit materials for accurate reaſoning, than thoſe that are direct; and that the contrary may happen in a remarkable degree."

Reid's Eſſays on the active Powers of Man.

of active power, ſince they afford us not any idea in themſelves of the power to begin any action either of motion or thought." He thinks it evident, however, "that we find in ourſelves a power to begin or forbear, continue or end, ſeveral actions of our minds and motions of our bodies, barely by a thought or preference of the mind ordering, or, as it were, commanding, the doing or not doing ſuch or ſuch a particular action. This power which the mind has thus to order the conſideration of any idea, or the forbearing to conſider it, or to prefer the motion of any part of the body to its reſt, and *vice verſa* in any particular inſtance, is that which we call *will*. The actual exerciſe of that power, by directing any particular action, or its forbearance, is that which we call *volition* or *willing*."

117
Whence it follows, that only ſuch beings as have will and underſtanding can poſſeſs real power.

According to Mr Locke, therefore, the only clear notion or idea we have of power, is taken from the power which we find in ourſelves to give certain motions to our bodies, or certain directions to our thoughts; and this power in ourſelves can be brought into action only by willing or volition. This is exactly our doctrine; where we have endeavoured to prove, that without the conſciouſneſs of actual energy in ourſelves, we never could have acquired any notion at all of power from obſerving the changes which take place among external objects. But if this be ſo, if the *power*, of which alone we know any thing, can be brought into action only by willing or volition, and if will neceſſarily implies ſome degree of underſtanding, as in us it certainly does, it comes to be a queſtion of the firſt importance, whether any being which poſſeſſes not will and underſtanding can be poſſeſſed of real power, or be the efficient cauſe of any action. This queſtion we feel ourſelves compelled to anſwer in the negative. If *we* had not will, and that degree of underſtanding which will neceſſarily implies, it is evident that we could exert no power, and conſequently could have none: for power that cannot be exerted is no power. It follows alſo, that the power, of which alone we can have any diſtinct notion, can be only in beings that have underſtanding and will. Power to produce any effect, implies power not to produce it; and we can conceive no way in which power may be determined to one of theſe rather than the other in a being that has not will. We grow from infancy to manhood; we digeſt our food, our blood circulates, our heart and arteries beat; we are ſometimes ſick and ſometimes in health: all theſe things muſt be done by the power of ſome agent, but they are not done by our power. And if it be aſked how we know this? the anſwer is, becauſe they are not ſubject to our will. This is the infallible criterion by which we diſtinguiſh what is our doing from what is not; what is in our power from what is not. Human power can be exerted only by will: and we are unable to conceive any active power to be exerted without will. If, therefore, any man affirms that a being may be the efficient cauſe of an action which that being can neither conceive nor will, he ſpeaks a language which we do not underſtand. If he has a meaning, he muſt take the words *power* and *efficiency* in a ſenſe very different from ours; for the only diſtinct notion, indeed the only notion which we can form, of real efficiency, is a relation between the cauſe and the effect ſimilar to that between us and our voluntary actions. It ſeems therefore moſt probable, that ſuch beings only as have ſome degree of underſtanding and will can poſſeſs active power, and that inanimate beings muſt be merely paſſive. Nothing which we perceive without us affords any good ground for aſcribing active power to any inanimate being; and we can as little conceive ſuch a being poſſeſſed of power as we can conceive it capable of feeling pain. On the other hand, every thing which we diſcover in our own conſtitution, leads us to think that active power cannot be exerted without will and intelligence: and to affirm that it can, is to affirm what to us at leaſt is a contradiction in terms.

118
An objection obviated.

To this reaſoning, which is Dr Reid's *, and which to us appears unanſwerable, we have heard it objected, that a man born blind has the ſame evidence for the non-exiſtence of colour that is here urged for the impoſſibility of power being exerted without will and underſtanding. If the objection had not been made by a very acute man, we ſhould have deemed it altogether unworthy of notice; for between the two caſes ſuppoſed to be ſimilar there is hardly any analogy. A man born blind has no notion whatever of colour. If you deſcribe it to him in the beſt manner you can, and refer it to any of the ſenſes which he poſſeſſes; if you ſay that it is the object of feeling, and that by feeling it one may perceive things at the diſtance of many miles; the blind man has reaſon to ſay that you are uttering a propoſition which he knows with the utmoſt certainty cannot poſſibly be true. But if you tell him that colour is the object of the ſenſe of ſight, a ſenſe which he poſſeſſes not; that it has not the leaſt reſemblance to the objects of the other ſenſes; and that perſons endowed with the ſenſe of ſight perceive coloured objects at the diſtance of many miles; the blind man cannot know whether what you ſay be true or falſe, becauſe he has no idea or conception of the things of which you ſpeak. This is not the caſe with reſpect to power; for every man who has reflected on the operations of his own mind has a very diſtinct notion of power, and knows perfectly, that to the actual exertion of the only power which he can conceive, will and underſtanding are neceſſary. Should it be ſaid that there may be power altogether different from that of which we have a diſtinct conception, we think it ſufficient to reply, that of a thing which cannot be conceived nothing can be either affirmed or denied: that activity exerted without will and underſtanding ought not to be called an exertion of *power*, becauſe power is the name already appropriated to the attribute of a being by which he can do certain things if he wills; that as we can form no notion of a real efficient cauſe which has not will and underſtanding, ſo we have no reaſon to believe that ſuch a cauſe any-where exiſts; and to ſay that power, ſuch as we can conceive, may be exerted without will and underſtanding, is as great an abſurdity as to ſay that there may be velocity without ſpace.

But if active power, in its proper meaning, requires a ſubject endowed with will and intelligence, what ſhall we ſay of thoſe active powers which philoſophers teach us to aſcribe to matter, the powers of corpuſcular attraction, magnetiſm, electricity, gravitation, and others? Theſe powers, as they are called, ſhall be conſidered when we treat of the nature and ſource of corporeal motion. In the mean time, it is ſufficient to obſerve, that whatever the agents may be in the operations of nature, whatever the manner of their agency or the extent of their power, they depend upon the Firſt Cauſe, and are all under his controul.

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* See *Eſſays on the Active Powers of Man.*

CHAP. VII. *Of* TRUTH, *and the different* SOURCES *of* EVIDENCE.

SECT. I. *Of Truth.*

BY purſuing theſe inquiries in the order which to us appears moſt natural, we are now led to the contemplation of thoſe faculties of the human mind of which *truth* is properly the object. But what is *truth?* This was a famous queſtion among the Greek ſophiſts; which had been ſo often agitated, and to which ſo many abſurd anſwers had been given, that it came at laſt to be doubted by men of the world whether a ſatisfactory anſwer could be given, or indeed whether the matter was worthy of inveſtigation. It is well known, that among the ancient philoſophers there was a ſect called from their principles *Sceptics*, and from their founder *Pyrrhonians*, who openly avowed their opinion that *truth*, like virtue, is nothing but a name; that all things are equally true, or rather equally doubtful; and that it is in vain for man to hope for certainty in any inquiry in which he can be engaged. Such ſcepticiſm as this no modern philoſopher has profeſſed; but many have had enough of it to make ſober men heſitate about defining truth, and even inſinuate that of truth no definition can be given. This ſurely is a miſtake. If truth cannot be defined, it ſtill wanders at large and in diſguiſe, and vain muſt be the purſuit of every man who endeavours to obtain it; he is purſuing he knows not what.

119 Truth defined.

So obvious and ſo ſolid is this reflection, that almoſt every philoſopher of merit who has lately written on the nature of evidence has begun his work, if not with a formal definition, with ſomething at leaſt equivalent to a definition of the object of his purſuit. To repeat all theſe definitions could ſerve no other purpoſe than to ſwell this article to a diſproportioned bulk, and to perplex perhaps the mind of the reader. We ſhall therefore content ourſelves with that which is given by Mr Wollaſton. "Thoſe propoſitions (ſays he) are true which repreſent things as they are: or, truth is the conformity of thoſe words or ſigns by which things are expreſſed to the things themſelves." Notwithſtanding the objections of a very learned and acute writer (w), this is the beſt definition of *truth* which we have met with in any language. It is conciſe

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(w) Dr Tatham having aſked, with a contemptuous air, How imperfect and illogical is the definition of truth given by Wollaſton? proceeds, though not to define, to deſcribe or characterize it himſelf. "Truth (ſays he) is of the nature and eſſence of God, like him *incomprehenſible* in the whole, and *ineffable* in its ſublimer parts. For theſe and other reaſons it cannot admit of an *adequate definition.* And who, in the beginning of his reſearches, ſhould preſume to define that which, after all his longeſt and beſt conducted labours, he can only hope partially, and often imperfectly, to comprehend; and of which an important part can neither be *directly* expreſſed nor *directly* underſtood? We may indeed eſteem ourſelves highly favoured by the Author and Finiſher of all truth, if, at the end of our reſearches, we ſhall be able any way to underſtand, to define, and to apply, a few particular portions and detachments of it, and to guard them from ERROR and corruption. When upon a ſolemn occaſion the queſtion was put to our Lord by a Roman governor, *What is* TRUTH*?* though it was what he fully and perfectly knew, and what he came purpoſely and profeſſedly to teach, he did not define it. He knew that definition was never the beſt method of inſtruction; and that in its common uſe and application it was ſeldom the friend of truth. Philoſophically viewed, words do not conſtitute truth; they are only the vocal inſtruments by which it is communicated, or the written ſigns by which it is recorded. By an inquirer, therefore, things are to be examined rather than words defined. By a teacher, things are to be conveyed by words in ſome form or other, which are doubtleſs to be explained to the underſtanding, if not ſufficiently underſtood before. But *explanation* is one thing, and *definition* quite another. Explanation is the *firſt* office of a teacher: Definition, if it be good, is the *laſt* of the inquirer, after the truth be found; and is then the moſt *advantageouſly* employed by the teacher, when his previous inſtructions have prepared him for it. GOD is a mind, and TRUTH is conſequently an *attribute* of MIND. To the SUN, declaring at his riſing a marvellous inſtrument, He, by whom all things were made, hath delegated the power of enlightening the *material* ſyſtem; whilſt he hath reſerved to HIMSELF the office which is more ſuitable to his nature, of giving light and knowledge, by his eternal TRUTH to the *mind* of man. But whether he acts through the inſtrumentality of his creatures, or more *immediately* from himſelf, he is uniform and conſiſtent in his operations; ſo that one part of his divine economy is always illuſtrative of another. As the SUN ſheds his *light* over the material creation to be apprehended by the eye, TRUTH is the *light* ſhed down from heaven to be apprehended by the intellect, given to illumine every ſubject, natural and moral, corporeal and ſpiritual, ſo far as they are qualified by their different natures to convey it to the human mind, or rather perhaps ſo far as the human mind is qualified to receive it from them." *The Chart and Scale of Truth*, vol. i.

This paſſage, of which ſome parts are certainly not remarkable for perſpicuity, ſeems to be deſcriptive, not of *truth* in the common acceptation of the word, but of *all knowledge* human and divine, of which indeed no adequate definition can be given. *Truth*, as here uſed, ſeems to be oppoſed to *ignorance;* as uſed by Mr Wollaſton and others, it is oppoſite to *falſehood.* In this laſt ſenſe it may certainly be *explained*, if not defined; and if the learned lecturer will allow that Mr Wollaſton has given a good *explanation* of the word *truth* as oppoſed to *falſehood*, we ſhall not quarrel with him or any man about the propriety of an expreſſion. We have called it a *definition* of truth; becauſe it was ſo called by the author from whom it is taken.

ciſe and perſpicuous. It comprehends all kinds of truth, as well that which is merely mental, the ſubject of ſilent contemplation, as that which is communicated either by written language or by the living voice: and it makes truth itſelf immutable, as depending not upon the arbitrary conſtitution of this or that individual, or even of the whole human race (x), but upon the nature of things as eſtabliſhed by their Almighty Creator.

120
Every propoſition either true or falſe.

According to this definition, every propoſition which can be expreſſed or apprehended is neceſſarily either true or falſe, whether its truth or falſehood be perceived or not either by him who hears or by him who utters it. All propoſitions are either affirmative or negative; but before any thing can with certainty be affirmed or denied of another, we muſt know thoſe things as they are in themſelves, as well as the eſtabliſhed uſe of the ſigns by which they are expreſſed. He who affirms or denies without this knowledge, ſpeaks at random, and has no diſtinct meaning.

121
Every human faculty concerned in the acquiſition of truth.

Every faculty which we poſſeſs is in ſome way or other an inſtrument of knowledge; for we know by our ſenſes, by our memory, and by our intellect. Every one of our faculties, therefore, is concerned in the acquiſition of truth, and furniſhes the mind with the materials of propoſitions. Theſe propoſitions are indeed of various kinds; but they are all certainly true or certainly falſe, though the *certainty* of the truth or falſehood of every one it is not always in our power to perceive.

122
Diverſity of belief affects not the truth of what is believed.

When a man affirms that red is a quality inherent in a ſoldier's coat, he utters a propoſition which every one of the vulgar firmly believes to be true, but which every philoſopher knows to be falſe. This diverſity of belief, however, affects not the truth of the propoſition itſelf. All mankind know that it is either true or falſe, independent of them or their perceptions; and it is eaſy, by a few optical experiments and by an explanation of terms, to convince them all, that what they have agreed to call *red* is no quality inherent in external objects, but only a ſenſation cauſed by the impulſe of certain rays of light reflected from certain objects to the eye of the percipient. The contrariety therefore in this caſe of vulgar to philoſophical belief, does not reſult from any ambiguity in the nature of truth itſelf, but from the different means of perception which the clown and the philoſopher poſſeſs.

Again, Were a man looking at a red and a green object, to affirm that they are both of the ſame colour, he would affirm what in one ſenſe may be true, what in another is undoubtedly falſe, and what in a third may be either true or falſe. If it be his meaning that the two objects give to him the ſame ſenſation, he may know with the utmoſt certainty that what he ſays is true; if he mean that they affect all mankind preciſely as they affect him, he utters what all mankind with the moſt abſolute certainty know to be falſe; if he mean that the texture of the two bodies (that particular diſpoſition of parts on their ſurfaces which makes them reflect certain rays of light and abſorb others) is exactly ſimilar, ſo as that the one muſt reflect the very ſame kind of rays with the other, he utters what all mankind muſt *believe* to be falſe, though ſtill it is *poſſible* that what he affirms may be true. This diverſity of belief affects not the truth itſelf. The two objects are what they are by whomſoever perceived, or whether perceived or not; the rays of light reflected by each are what they are, whether they fall upon this, upon that, or upon any eye; and the ſenſation communicated to this ſingular man is certainly what he is conſcious it is, as thoſe of the reſt of mankind are with equal certainty what they are conſcious of. This being the caſe, it is obvious and undeniable, that the organs of ſight in this individual of the human race are ſomehow differently formed from thoſe of other men: and the only queſtion which can occaſion a doubt in the mind of the ſceptic is, whether his or their eyes be ſo formed as to repreſent things falſely? for that by the one or the other things are falſely repreſented, is as evident as that two contradictory propoſitions cannot both be true. Now, though, for any thing we know it is certainly poſſible, as to us it appears not to imply any contradiction, that the eyes of but one man are formed in a manner ſuitable to their objects, whilſt the eyes of all other men are formed to deceive them; yet the contrary is ſo highly probable, that no man really doubts of it any more than he doubts whether three and two be equal to five.

123
Why ſome truths are ſaid to be abſolutely and others morally certain.

This laſt propoſition is indeed ſaid to expreſs a truth abſolutely certain, whilſt the former expreſſes a truth which is called morally certain: not that there is any difference or degrees of certainty in the nature of truths themſelves; the only difference is in our power of perceiving them. That three and two are equal to five, is ſaid to be an abſolute truth; becauſe we perceive the whole of it as it is in itſelf, and are convinced that every intelligence from the higheſt to the loweſt who underſtands the terms in which it is expreſſed perceives it as we do: whereas of *moral* or *phyſical* truths, as they are called, we only perceive a part, and may therefore miſtake for want of evidence. Thus, in the caſe of the two objects exhibiting the ſame colour to one man, whilſt they exhibit different colours to all other men, could we ſee into the objects themſelves, and comprehend them immediately with our intellect as we comprehend our own ideas, it might, and no doubt would, appear as palpable a contradiction to ſay that the particular diſpoſition of the parts on their ſurfaces, which reflect the rays of light, are the ſame in both, as it is now to affirm that three and two are not equal to five. Between truth and falſehood there is no medium. All truths are in *themſelves* equally certain; and to the Supreme Being, who knows the nature of every thing more fully and intimately than we know our own ideas, they all *appear* equally certain: but yet we may without abſurdity ſpeak of *probable* truth as well as of *certain* truth, provided always that we make the difference to reſult, not from the nature of things, but from the power of our underſtanding, which comprehends the one kind of truth wholly and the other only partially.

(x) Dr Beattie, in his elegant eſſay, has given a definition of truth very different from this, though it is poſſible that his meaning may be the ſame with Mr Wollaſton's. "I account that to be *truth* (ſays he) which the conſtitution of our nature determines us to believe; and that to be *falſehood* which the conſtitution of our nature determines us to diſbelieve." But if truth be really *immutable*, as he teaches or wiſhes to teach, it muſt depend upon the nature of things, and not upon the inſtinctive impulſe of any particular conſtitution. It is always difficult, often impoſſible, to diſtinguiſh between the conſtitution of our nature, as it came from the hand of God, and the ſame conſtitution as it is moulded by arbitrary and capricious aſſociations of our own. A ſincere member of the church of Rome certainly believes the doctrine of tranſubſtantiation. How he may do ſo we have already ſhown. Were all mankind ſincere members of that church, it would be ſaid and thought, "that the conſtitution of human nature determines men to believe tranſubſtantiation:" a doctrine which, though it is rejected by millions, Pere Buffier has laboured hard to reconcile with common ſenſe. Yet it is certain that the ſame body cannot be in different places at the ſame time; and that therefore tranſubſtantiation muſt be falſe, though believed by all mankind. Our *believing* any thing does not make it true, nor our *diſbelieving* any thing make it falſe. We muſt, indeed, *act* according to our belief; but in every inſtance truth and falſehood would have been what they are, though we had never exiſted.

124
Why ſome truths are ſaid to be eternal and neceſſary, whilſt others are conſidered as temporary and contingent.

There is another diviſion made of truth into that which is eternal and neceſſary, and that which is temporary and contingent. Though we do not approve of applying the epithets *temporary* and *eternal* to any thing but real exiſtences, yet as this manner of ſpeaking has been uſed by all philoſophers, we ſhall give inſtances of each kind of truth, and endeavour to aſcertain in what the diſtinction conſiſts. "The three angles of a plain triangle are equal to two right angles," is a propoſition expreſſive of a neceſſary and eternal truth. "The world exiſts," is a contingent and temporary truth. Here it is obvious, that if both theſe propoſitions be true, there is no diſtinction between them, ſo far as mere *truth* is concerned; for truth admits not of degrees of compariſon. It is however ſaid, that the firſt propoſition depends not upon time, or will, or any thing elſe; and that the Supreme Being himſelf could not make it falſe: whereas it is certainly poſſible, that he who created the world could annihilate it, and thus reduce what is now a truth to an abſolute falſehood. This difference between the two propoſitions is thought a ſufficient ground for calling the former a *neceſſary* and *eternal* truth, and the latter a *temporary* and *contingent* truth. But is the difference itſelf real? In the preſent inſtance we cannot think that it is: for if the right angles and triangles, which conſtitute the materials of the former propoſition, be real corporeal things, they may be annihilated as well as the reſt of the world; and then the truth of the propoſition will ceaſe, for there can be neither equality nor inequality between nonentities. If the angles and triangles be merely ideas in the mind of a rational being, it is not to be denied that the propoſition muſt be true, independent of all *will*, whenever thoſe ideas exiſt, i. e. whenever right angles and triangles are *thought upon*; but if all reaſonable creatures were to be annihilated, and the Supreme Being never to think of triangles, the propoſition would unqueſtionably ceaſe to be either true or falſe. The world may indeed be annihilated; but it certainly is not annihilated whilſt any one creature exiſts to contemplate even that which is called *neceſſary* and *eternal* truth: and therefore whilſt any truth exiſts in a mind not divine, it muſt be neceſſarily true that the world exiſts; for the individual being by which truth is perceived would then conſtitute the whole world.

But if in a ſomewhat different manner we compare the former of theſe propoſitions with this, "The ſolar ſyſtem conſiſts of the ſun and at leaſt ſeven primary planets," we ſhall at once perceive the difference between neceſſary and contingent truths. Both propoſitions we know to be true at this moment: but there is this difference between them, that a plain triangle can neither actually exiſt at any period of duration, nor be conceived by any one mind divine or human, of which the three internal angles are not preciſely equal to two right angles; whereas the ſolar ſyſtem may eaſily be conceived, and might certainly have been formed, with a ſmaller number of primary planets rolling round the central fire. This needs no proof; as it is well known, that till very lately we conceived the ſyſtem to conſiſt of the ſun and only ſix primary planets; and it has been already ſhown, that whatever we can poſitively conceive may poſſibly exiſt. Thus, then, every propoſition, of which the contrary is clearly and diſtinctly perceived to be impoſſible, is a *neceſſary* truth; and it may likewiſe be ſaid to be *eternal*, becauſe at every period of duration it muſt of neceſſity when thought upon be perceived to be true: On the other hand, every propoſition of which the contrary may be clearly and diſtinctly conceived, is, if true, only a *contingent* truth, becauſe its contrary might have exiſted; and it may likewiſe be called *temporary*, becauſe what might have been falſe in time paſt may yet be falſe in time future.

125
Truth perceived by our rational faculties, which are commonly ſaid to be two, *reaſon* and *judgement*.

Though all our faculties (our ſenſes, our memory, and our intellect), furniſh materials for propoſitions, and are therefore all ſubſervient to the inveſtigation of truth; yet the perception of truth, as it is in itſelf, is commonly aſcribed to our rational faculties; and theſe have by Locke and others been reduced to two—reaſon and judgement. The former is ſaid to be converſant about certain truths, the latter chiefly about probabilities.

126
To which ſome philoſophers have added a third faculty, viz. *common ſenſe*.

Some late philoſophers of great merit, diſſatisfied with this analyſis of the intellect, have added to reaſon and judgement a third faculty, to which they have given the name of *common ſenſe*, and of which the proper object is ſuch truths as neither admit nor ſtand in need of evidence. By *common ſenſe* they mean, "that degree of judgement which is common to men with whom we can converſe and tranſact buſineſs." Whether the introduction of ſuch a term into metaphyſics was proper or improper, we do not think it of importance to inquire. According to this definition of it, which is Dr Reid's, it differs not from the *reaſon* (Y) and *judgement* of Locke; agreeing with the former when its

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(Y) This is expreſsly acknowledged by Dr Reid. "It is abſurd (ſays that able and candid writer) to conceive its object is certain truth, and with the latter when it is converſant about probabilities. Nothing indeed is more evident, than that in the aſſent of the mind to every propoſition, ſome energy of the judgement is exerted; and upon every propoſition not ſelf-evident, reaſoning of ſome kind or other muſt be employed to procure that aſſent. Inſtead therefore of perplexing ourſelves and our readers with various analyſes of the human underſtanding, or rather with various names to what after all is perhaps but one individual power, it will ſurely be of more importance to the cauſe of truth to examine the different ſources of evidence by which the aſſent of the reaſon, or judgement, or common ſenſe, is determined.

Under the article LOGIC it was obſerved, that *intuition*, *experience*, and *teſtimony*, are each a ſufficient *ground of judgement;* but they are not the only grounds. *Conſciouſneſs* is certainly one ſource of evidence, perhaps the moſt complete of any; and, in a low degree, *analogy* is another. Of *conſciouſneſs* we have already treated, but of *analogy* we have yet ſaid nothing: and though we might (for an account of *intuition*, *experience*, and *teſtimony*) refer our readers to the article LOGIC, where they are accurately though conciſely explained, we ſhall, without repeating what has been already ſaid, add a few words on each, as well to complete the preſent article as to ſupply the deficiencies of the former.

SECT. II. *Of Intuitive Evidence and Demonſtration.*

127 Intuitive evidence, what.

INTUITIVE evidence is that which ariſes from the compariſon of two or more ideas or notions when their agreement or diſagreement is perceived immediately, without the intervention of any third idea or notion. Of this kind is the evidence of theſe propoſitions: One and four make five *; things equal to "the ſame thing are equal to one another; the whole is greater than any of its parts;" and in a word, all the axioms in arithmetic and geometry. All theſe are in reality propoſitions in which the ſubject and predicate appear upon compariſon to be nothing more than the ſame thing taken in different views or expreſſed by different terms. In fact, they are all in ſome reſpect reducible to this axiom, "Whatever is, is." We do not ſay that they are deduced from it; for they have in themſelves that original and intrinſic evidence which makes them, as ſoon as the terms are underſtood, to be perceived intuitively. And if they be not thus perceived, no deduction of reaſon will ever confer on them any additional evidence. But though not deduced from the general axiom, they may be conſidered as particular exemplifications of it; inaſmuch as they are all implied in this, that the properties and relations of our clear and adequate ideas can be no other than what the mind clearly perceives them to be.

128 Every demonſtration a ſeries of propoſitions intuitively evident.

It may perhaps be thought, that if axioms were propoſitions perfectly identical, it would be impoſſible by their means to advance a ſingle ſtep beyond the ſimple ideas firſt perceived by the mind. And it would indeed be true, that if the predicate of the propoſition were nothing but a repetition of the ſubject under the ſame aſpect, and in the ſame or ſynonymous terms, no conceivable advantage could be made of it for the furtherance of knowledge. Of ſuch propoſitions as theſe, for inſtance, "ſeven are ſeven, eight are eight, the three angles of a triangle are the three angles of a triangle, two right angles are two right angles," it is manifeſt that we could never avail ourſelves for the improvement of ſcience: But when the thing, though in effect coinciding, is conſidered under a different aſpect; when that which is ſingle in the ſubject is divided in the predicate, and converſely; or when what is a whole in the one is regarded as a part of ſomething elſe in the other; ſuch propoſitions lead to the diſcovery

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* Campbell's Philoſophy of Rhetoric.

conceive that there can be any oppoſition between reaſon and common ſenſe. It is indeed the firſt-born of reaſon; and as they are commonly joined together in ſpeech and in writing, *they are inſeparable in their nature.* We aſcribe to reaſon two offices or two degrees: the firſt is to judge of things ſelf-evident; the ſecond to draw concluſions that are not ſelf-evident from thoſe that are. The firſt of theſe is the province, and the ſole province of common ſenſe; and therefore it *coincides with reaſon in its whole extent*, and is only *another name* for one branch or one degree of reaſon." Pere Buffier talks nearly the ſame language; but Dr Beattie expreſſes himſelf very differently. "That there is a real and eſſential difference between theſe two faculties; that common ſenſe cannot be accounted for by being called the *perfection of reaſon*, nor reaſon by being reſolved into *common ſenſe;* will appear (he thinks) from the following remarks: 1. We are conſcious, from internal feeling, that the energy of underſtanding, which perceives intuitive truth, is different from that other energy which unites a concluſion with a firſt principle by a gradual chain of intermediate relations. 2. We cannot diſcern any neceſſary connexion between reaſon and common ſenſe." Nay, he ſays, "That we often find men endued with the one who are deſtitute of the other:" and he inſtances dreams and certain kinds of madneſs where this is the caſe; adding, that a man who believes himſelf made of glaſs, ſhall yet reaſon very juſtly concerning the means of preſerving his ſuppoſed brittleneſs from flaws and fractures." Surely theſe are ſtrange remarks. Dreams and madneſs have hitherto been ſuppoſed to originate in the imagination, or, as it was denominated by the ancient philoſophers, the *phantaſia:* and when the ideas or forms which are there treaſured up are diſarranged or abſurdly compounded, a dreaming ſane man or a waking madman, if he reaſon at all, muſt reaſon from abſurd principles: not, however, through any defect of common ſenſe, but from a diſorder in that region of the brain, upon which the phantaſia more immediately depends. Of his firſt remark, we can only ſay, that to us it appears to be the reverſe of truth. In every propoſition which admits of demonſtration, *we* are conſcious that the concluſion is united with the firſt principle by a repetition of the very ſame energy of the underſtanding which perceives intuitive truth. That this is the caſe in every one of Euclid's demonſtrations, we appeal to every mathematical reader; and why it muſt be ſo, we ſhall by and by endeavour to evince.

Of Intuitive Evidence and Demonſtration

diſcovery of innumerable and apparently remote relations. It is by the aid of ſuch ſimple and elementary principles that the arithmetician and the algebraiſt proceed to the moſt aſtoniſhing diſcoveries. Nor are the operations of the geometrician eſſentially different: for to this claſs belong all propoſitions relating to number and quantity; that is, all which admit of mathematical demonſtration. If the truth of a mathematical propoſition be not ſelf-evident; in other words, if the ſubject and predicate do not appear at firſt ſight to be different names for the ſame thing, another term muſt be found that ſhall be ſynonymous to them both. Thus, to prove that the three internal angles of a right-lined triangle are equal to two right angles, I produce the baſe of the triangle; and by a very ſhort proceſs I diſcover that the exterior angle ſo formed is equal to the two interior and oppoſite angles. By a proceſs equally plain and ſhort, I perceive that the exterior angle and the interior adjacent angle are equal to two right angles: But I have already ſeen, that the exterior angle is neither more nor leſs than the two interior and oppoſite angles under a different aſpect; whence it appears that the three internal angles of the triangle are nothing elſe than two right angles under a different aſpect. In a word, all demonſtration is founded on firſt principles or primary truths, which neither admit nor ſtand in need of proof, and to which the mind is compelled to give its aſſent by a bare intuition of the ideas or terms of which theſe primary truths are compoſed. Nothing is ſuſceptible of demonſtration, in the rigid ſenſe of the word, but general, neceſſary, and eternal truths; and every demonſtration is built upon intuition, and conſiſts in a ſeries of axioms or propoſitions of the very ſame kind with the firſt principle or truth from which the reaſoning proceeds. That propoſitions formerly demonſtrated are taken into the ſeries, doth not in the leaſt invalidate this account; inaſmuch as theſe propoſitions are all reſolvable into axioms, and are admitted as links in the chain; not becauſe neceſſary, but merely to avoid the uſeleſs prolixity which frequent and tedious repetitions of proofs formerly given would occaſion. But it is obvious that ſuch truths only as reſult from the compariſon of ideas and notions are neceſſary; and of courſe that ſuch truths only are capable of ſtrict demonſtration. The truths which relate to real exiſtences are all contingent, except that which affirms the exiſtence of the Supreme Being, the Parent of all truth.

The mathematical ſciences, categorical logic, and that part of metaphyſics which demonſtrates the being of God, are therefore the only branches of human knowledge which admit of ſtrict demonſtration. The longeſt demonſtration in the mathematical ſciences may be traced to this general and neceſſary truth, "Whatever is, is," or to ſome particular exemplification of it: the longeſt train of categorical ſyllogiſms terminates in this general principle, "What is affirmed or denied of a whole *genus*, may be affirmed or denied of all the *ſpecies* and all the *individuals* belonging to that genus:" and the metaphyſical demonſtration of the being of God reſts upon this foundation, "Whatever had a beginning, had a cauſe." That theſe are truths abſolutely certain, which can neither be proved nor called in queſtion, every man may be ſatisfied, merely by attending to the ideas or notions which the terms of each propoſition expreſs. The two firſt are merely identical propoſitions, of the truth of which no man has ever pretended to doubt; and though the laſt is not identical, it is a neceſſary and ſelf-evident truth, as its contrary implies, that in the ſame thing there is power and no power, change and no change, action and inaction, at the ſame inſtant.

Of Experience and Analogy.

129 It is by intuition that we acquire all our notions of relation.

Before we diſmiſs the ſubject of intuition, it may not be improper to obſerve, that it is by this faculty or power of the mind contemplating its ideas, and comparing one idea with another, that we acquire all our notions of relation; ſuch as *identity* and *diverſity*, *reſemblance*, *coexiſtence*, relations of *ſpace* and *time*, relations of *quantity* and *number*, of a *cauſe* to its *effect*, and many more which it would be uſeleſs as well as tedious to enumerate.

SECT. III. *Of Experience and Analogy.*

130 Experience, the reſult of repeated obſervations.

It has been juſt obſerved, that intuition and demonſtration are applicable only to general and neceſſary propoſitions, of which the contrary are not only falſe, but abſurd and impoſſible. The great buſineſs of life, however, is with facts and contingent truths, which admit not of demonſtration, but reſt upon other evidence. The ſenſes, external and internal, are the inlets to all our knowledge of facts; and the memory is the ſtorehouſe where that knowledge is preſerved. Of what a man ſees or feels, he can at the inſtant of ſeeing or feeling entertain no doubt; and whilſt the ideas of what he has ſeen or felt, with all their aſſociated circumſtances, remained vivid and diſtinct in his memory, he is conſcious that he poſſeſſes ſo much real knowledge. But all our knowledge, as it is derived from the ſenſes, is of particular facts or particular truths; and the man who has in certain circumſtances obſerved one particular phenomenon, for the exiſtence of which he perceives no *neceſſity*, has not ſufficient ground to conclude, that in ſimilar circumſtances ſimilar phenomena will always occur. Milton, who ſurpaſſed the greater part of his cotemporaries in philoſophical ſcience almoſt as far as he has ſurpaſſed all ſucceeding poets in the ſublimity of his genius, repreſents Adam, when firſt falling aſleep, as under apprehenſions that he was about to ſink into his original ſtate of inſenſibility:

> ———————" Gentle ſleep
> " Firſt found me, and with ſoft oppreſſion ſeiz'd
> " My drouſed ſenſe, untroubled; though I thought
> " I then was paſſing to my former ſtate
> " Inſenſible, and forthwith to diſſolve."

Apprehenſions ſimilar to theſe would take place in his mind when he firſt perceived that darkneſs had overſpread the earth. In his circumſtances, he could have no ground to expect that the ſun when once ſet would riſe again to relume the world, as he had not then experienced the alternate ſucceſſion of light and darkneſs, and probably knew not whence light proceeds. After ſome time, however, having obſerved day and night regularly to ſucceed each other, theſe two appearances, or the ideas of them, would be ſo aſſociated in his mind, that each ſetting ſun would ſuggeſt the idea of next ſunriſing, and lead him to expect that glorious event with the utmoſt confidence. He would then conſider the alternate ſucceſſion of day and night as a law of nature, which might be affirmed in a propoſition expreſſive of a certain truth.

131 Is the only evidence that we have for all the general truths in phyſics, even thoſe which we think intuitively certain.

This continued obſervation of the ſame event happening in the ſame or ſimilar circumſtances, is what we call *experience*; and it is the only evidence which we have for all the general truths in phyſics, even for thoſe which we are apt to think intuitively certain *. Thus, that *milk* is white, and that *gold* is yellow, are ſuppoſed to be univerſal and neceſſary truths: but for any thing that we know, they may be particular truths; and they are certainly contingent, as the contrary to either of them may be ſuppoſed without abſurdity. We have indeed always obſerved the milk of animals of every ſpecies *white*; and therefore the idea of *white* becomes a neceſſary part of our *idea* of the ſubſtance milk, of which we call whiteneſs an eſſential property. This, however, reſpects only the milk of thoſe animals with which we are acquainted. But ſince the milk of all the animals with which we are acquainted, or of which we have heard, is white, we can have no reaſon to ſuſpect that the milk of any new and ſtrange animal is of any other colour. Alſo, ſince, wherever there has been the ſpecific gravity, ductility, and other properties of *gold*, the colour has always been *yellow*; we conclude that theſe circumſtances are neceſſarily united, though by ſome unknown bond of union, and that they will always go together.

* *Campbell's Philoſophy of Rhetoric*; and *Prieſtley's Remarks on the Drs Reid*, &c.

132 Difference between experience and analogy.

The proper proof, therefore, of ſuch univerſal propoſitions as "that milk is white," "that gold is yellow," or, "that a certain degree of cold will freeze water," conſiſts in what is called an induction of *particular facts* of preciſely the ſame nature. Having found, by much and various experience, that the ſame events never fail to take place in the ſame circumſtances, the *expectation* of the ſame conſequences from the ſame previous circumſtances is neceſſarily generated in our minds; and we can have no more ſuſpicion of a different event than we can ſeparate the *idea* of *whiteneſs* from that of the other properties of *milk*. When the previous circumſtances are preciſely the ſame, we call the proceſs of proof by the name of *induction*, and expect the event from *experience*: but if they be not preciſely the ſame, but only bear a conſiderable reſemblance to the circumſtances from which any particular appearance has been found to reſult, we call the argument *analogy*; and it is ſtronger in proportion to the degree of reſemblance in the previous circumſtances. Thus the milk of all the cows that we have ſeen, or upon which we have made the experiment, having been found nouriſhing, we confidently expect that the milk of all other cows will prove nouriſhing likewiſe; and this confidence of expectation is the reſult of uniform experience. But if, from having found the milk of all the animals with which we are acquainted to be nouriſhing, however different the nature of theſe animals; we infer that the milk of any ſtrange animal will likewiſe be nouriſhing; the inference is drawn by analogy, and by no means carries with it the conviction of experience. A proof from *real* experience can leave no doubt in the mind (z); an argument from analogy always muſt. In the one caſe, we only infer that two events of preciſely the ſame nature, and in preciſely the ſame circumſtances, have been produced by the ſame kind of cauſe; in the other, we infer that two events ſimilar in moſt reſpects, though for any thing that we know diſſimilar in others, have been produced by the ſame kind of cauſe; and it is obvious that between theſe caſes the difference is great.

133 The evidence of analogy inferior to that of experience.

Thus, after having obſerved that all the projectiles to which we have paid any attention—a ſtone thrown from the hand, a ball from a gun, and an arrow from a bow—deſcribe a certain curve, and are impelled in that curve by two powers acting in different lines of direction which form with each other a certain angle, we infer that all projectiles which on the ſurface of the earth deſcribe the ſame curve are impelled by the ſame or ſimilar powers acting in the ſame or ſimilar lines of direction. This inference is the reſult of experience, and carries with it the fulleſt conviction to the mind. But when, from having obſerved that the curves deſcribed by the planets are of the ſame kind with thoſe deſcribed by projectiles on the earth, Sir Iſaac Newton inferred that theſe vaſt bodies are impelled in their orbits by forces of the very ſame kind, and acting in the ſame manner with the forces which impel a ball from a cannon or an arrow from a bow, his argument was founded only on analogy; and even that analogy is very remote. We know by experience that all projectiles which fall under our immediate cognizance are of the very ſame kind and in the very ſame circumſtances; that every one of them has a tendency, from whatever cauſe, to the centre of the earth, and is preſerved from falling by the force of projection; we know likewiſe that they are all moved through the medium of the atmoſphere, which at the ſurface of the earth is conſiderably denſe, and that a denſe medium muſt occaſion much reſiſtance: But we do not *know* that the planets have a tendency to the centre of the ſun, that they are preſerved from falling into that luminary by a projectile force, or whether they move through a *medium* or *in vacuo*; ſo that we are not *certain* that the motion of the planets is perfectly ſimilar to that of terreſtrial projectiles in any other circumſtance than the form of the curve which they all deſcribe; and from this ſingle caſe of coincidence no inference can be drawn which carries to the mind abſolute conviction.

(z) We ſay from *real* experience; becauſe what is often taken for *experience*, and to human eyes has that appearance, is in fact nothing more than *analogy*. Thus a phyſician may have preſcribed to ninety nine patients labouring under the ſame diſeaſe the ſame remedy, and always with the ſame ſucceſs. If ſo, he will think that he has experience of its utility, and will preſcribe it again with the fulleſt confidence. Yet in this caſe he may be diſappointed; for though the medicine be the ſame and the diſeaſe the ſame, there may be ſomething in the conſtitution of the hundredth patient ſo different from that of the ninety-nine, that what was ſalutary to them may be pernicious to him. This does not detract from the evidence of experience; it only ſhows, that the circumſtances of the caſe in which the medicine failed were different from thoſe in which it ſucceeded. In ſuch concluſions as are founded on a complete induction and uniform experience, every man expects the event with the laſt degree of aſſurance, and regards his paſt experience as a full *proof* of the future exiſtence of that event: In other caſes, where experience has been variable—or apparently variable—he knows that the induction has been incomplete, and therefore proceeds with caution. He weighs the oppoſite experiments; takes as complete a view as he can of the circumſtances in which they were made; conſiders which ſide is ſupported by the greater number of experiments, and inclines to that ſide with doubt and heſitation. And when at laſt he fixes his judgement, the evidence exceeds not what is called *probability*. All probability, then, ſuppoſes an oppoſition of experiments and obſervations, where the one ſide is found to overbalance the other, and to produce a degree of evidence proportioned to the ſuperiority.

When a man reaſons from *experience*, he infers, that what has uniformly happened hitherto, will happen always in the very ſame circumſtances; or that what is known to be the cauſe of *various phenomena of the ſame kind* is the cauſe of every other phenomenon in *all reſpects* ſimilar to theſe. Such an inference is founded on the united and complete evidence of ſenſe, memory, and reaſon. When a man reaſons from *analogy* he infers, that what has *generally* happened hitherto, will happen again in circumſtances *nearly ſimilar*; or that what is known to be the cauſe of various phenomena of the ſame kind, is the cauſe of other phenomena in *ſome reſpects* ſimilar to theſe. This inference is likewiſe founded on the united evidence of ſenſe, memory, and reaſon: but here the evidence of ſenſe is not complete, and it can be ſtrengthened only by finding more facts of the ſame or of a ſimilar nature.

Sect. IV. *Of Teſtimony.*

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Mankind ready to believe the teſtimony of each other.

The laſt ſource of evidence which we propoſed to conſider is *teſtimony*, or the report of men concerning events which have fallen under the obſervation of their ſenſes. That we are all ready to believe the information which we receive from the teſtimony of our fellow creatures is undeniable; and indeed without ſuch belief every man's knowledge of facts and events would be confined to thoſe only of which he himſelf had been a perſonal witneſs. In that caſe, no man who had not travelled would believe that there are ſuch cities as Rome and Conſtantinople; and no man whatever could now believe that ſuch heroes as Hannibal and Cæſar had ever exiſted.

Between words and things there is no natural connexion; and though we are all accuſtomed to give to things the names by which they are known in the language that we ſpeak, and to expreſs their mutual relations by the words appropriated for that purpoſe; yet it is obviouſly impoſſible to denote one thing by the name of another, and to expreſs by words relations that have no exiſtence. This being the caſe, it may be aſked upon what principle we give credit to human teſtimony? To this queſtion various anſwers have been given, which have produced much controverſy on one of the moſt important ſubjects which can employ the mind of man.

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The reaſon aſſigned by Hume for this propenſity.

"We may obſerve (ſays Mr Hume *), that there is no ſpecies of reaſoning more common, more uſeful, and even neceſſary to human life, than that which is derived from the teſtimony of men and the reports of eye-witneſſes and ſpectators. This ſpecies of reaſoning perhaps one may deny to be founded on the relation of cauſe and effect. I ſhall not diſpute about a word. It will be ſufficient to obſerve, that our aſſurance in any argument of this kind is derived from no other principle than our obſervation of the veracity of human teſtimony, and of the uſual conformity of facts to the reports of witneſſes. It being a general maxim that no (A) objects have any diſcoverable connexion together, and that all the inferences which we can draw from one to another are founded merely on our experience of their conſtant and regular conjunction; it is evident that we ought not to make an exception to this maxim in favour of human teſtimony, whoſe connexion with any event ſeems in itſelf as little neceſſary as any other. Were not the memory tenacious to a certain degree; had not men commonly an inclination to truth, and a principle of probity; were they not ſenſible to ſhame when detected in falſehood: Were not theſe, I ſay, diſcovered by *experience* to be qualities inherent in human nature, we ſhould never repoſe the leaſt confidence in human teſtimony. And as the evidence derived from witneſſes and human teſtimony is founded on paſt experience, ſo it varies with the experience, and is regarded either as *a proof* or *probability*, according as the conjunction between any particular kind of report and any kind of object has been found to be conſtant or variable. There are a number of circumſtances to be taken into conſideration in all judgements of this kind; and the ultimate ſtandard by which we determine all diſputes that may ariſe concerning them, is always derived from experience and obſervation. The reaſon why we place any credit in witneſſes and hiſtorians, is not derived from any *connexion* which we perceive *à priori* between teſtimony and reality, but becauſe we are accuſtomed to find a conformity between them. But when the fact atteſted is ſuch a one as has ſeldom fallen under our obſervation, here is a conteſt of two oppoſite experiences; of which the one deſtroys the other as far as it goes, and the ſuperior can only operate on the mind by the force which remains. The very ſame principle of experience which gives us a certain degree of aſſurance in the teſtimony of witneſſes, gives us alſo, in this caſe, another degree of aſſurance againſt the fact which they endeavour to eſtabliſh; from which contradiction there neceſſarily ariſes a counterpoiſe, and mutual deſtruction of belief and authority."

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confuted, and

This account of the origin of faith in teſtimony has been controverted with much ſucceſs by the Doctors Campbell and Reid. "That the evidence of teſtimony is derived ſolely from experience (ſays the former of theſe writers *), is at leaſt not ſo inconteſtable a truth as Mr Hume ſuppoſes it; that, on the contrary, teſtimony hath a natural and original influence on belief antecedent to experience, will, I imagine, eaſily be conceived. For this purpoſe, let it be remarked, that the earlieſt aſſent which is given to teſtimony by children, and which is previous to all experience, is, in fact, the moſt unlimited; that by a gradual experience of mankind, it is gradually contracted, and reduced to narrower bounds. To ſay, therefore, that our diffidence in teſtimony is the reſult of experience, is more philoſophical, becauſe more conſonant to truth, than to ſay that our faith in teſtimony has this foundation. Accordingly, youth, which is unexperienced, is credulous; age, on the contrary, is diſtruſtful. Exactly the reverſe would be the caſe were this author's doctrine juſt." This is a complete confutation of the reaſoning of Mr Hume: but in order to prevent all cavilling, it is to be wiſhed that the very acute author had explained more fully what he means by ſaying, that teſtimony hath a *natural* and *original* influence on belief; for theſe words may be taken in different ſenſes, in one of which what he affirms is true, and in another falſe.

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* *Eſſay on Miracles.*

(A) Is there then no diſcoverable connexion between a tree and the field in which it grows; between a man and his clothes; between an author and his work; between a ſceptic and paradoxes? Surely all theſe are correlates, and neceſſarily ſuggeſt the ideas of each other.

Dr Campbell's omiſſion is amply ſupplied by Dr Reid, who gives † the following account of teſtimony, and of the credit which it obtains. "The wiſe and beneficent Author of nature, who intended that we ſhould be ſocial creatures, and that we ſhould receive the greateſt and moſt important part of our knowledge by the information of others, hath, for theſe purpoſes, implanted in our nature two principles that tally with each other. The firſt of theſe principles is a propenſity to ſpeak truth, and to uſe the ſigns of language ſo as to convey our real ſentiments. This principle has a powerful operation even in the greateſt liars; for where they lie once, they ſpeak truth a hundred times. Truth is always uppermoſt, and is the natural iſſue of the mind. It requires no art or training, no inducement or temptation, but only that we yield to a natural impulſe. Lying, on the contrary, is doing violence to our nature, and is never practiſed even by the worſt men without ſome temptation. Speaking truth is like uſing our natural food, which we would do from appetite, although it anſwered no end; but lying is like taking phyſic, which is nauſeous to the taſte, and which no man takes but for ſome end which he cannot otherwiſe attain.—When we are influenced by any motive, we muſt be conſcious of that influence, and capable of perceiving it upon reflection. Now, when I reflect upon my actions moſt attentively, I am not conſcious that in ſpeaking truth I am influenced on ordinary occaſions by any motive moral or political. I find that truth is always at the door of my lips, and goes forth ſpontaneouſly if not held back. It requires neither good nor bad intention to bring it forth, but only that I be artleſs and undeſigning. There may indeed be temptations to falſehood, which would be too ſtrong for the natural principle of veracity, unaided by principles of honour or virtue; but where there is no ſuch temptation, we ſpeak truth by *inſtinct*. By this inſtinct, a real connexion is formed between our words and our thoughts; and thereby the former become fit to be ſigns of the latter, which they could not otherwiſe be."

Such is the account which Dr Reid gives of the truth of human teſtimony: and he adds, that there is another original principle implanted in us by the Supreme Being, to tally with it, viz. a diſpoſition to confide in the veracity of others, and to believe what they tell us. "This (he ſays) is the counterpart to the former; and as that may be called the *principle of veracity*, we ſhall, for the want of a more proper name, call this the *principle of credulity*. It is unlimited in children, until they meet with inſtances of deceit and falſehood; and retains a very conſiderable degree of ſtrength through life."

It is ever with extreme reluctance that we controvert the opinions of this able writer; and that reluctance cannot be leſſened in the preſent inſtance, when we are conſcious that great part of what he ſays is unanſwerable. That truth is always at the door of the lips; that it requires no effort to bring it forth; that in ordinary caſes men ſpeak truth uninfluenced by any motive moral or political; that the greateſt liars ſpeak truth a hundred times where they lie once; and that lying is never practiſed by the worſt men without ſome temptation, are poſitions which daily experience renders it impoſſible to queſtion: But notwithſtanding this, we do not think that truth is ſpoken by an *inſtinctive* principle; becauſe it is inconceivable that inſtinct ſhould teach the uſe of arbitrary and artificial ſigns, ſuch as the words of every language undoubtedly are; or that between ſuch ſigns and ideas any *inſtinctive* connexion ſhould ever be formed. "Truth (as we have defined it) is the conformity of thoſe words or ſigns by which things are expreſſed to the things themſelves;" and things themſelves are what they are, independent of us, our inſtincts, and perceptions. When we have preciſe and adequate ideas of objects, and when thoſe ideas are related to one another as the objects themſelves are related, we are in poſſeſſion of mental truth; and in this caſe there is a *real* and *natural* connexion between the ſigns and the things ſignified: for we cannot frame original and ſimple ideas which have no archetype in nature; nor can *one* object, diſtinctly perceived, generate in our minds the ideas that are generated by *other* objects. Here external things are the objects, and ideas are the ſigns, which, when they are in conformity to the things ſignified by them, conſtitute truth.

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The true reaſon aſſigned.

But in human teſtimony, the ideas in the mind of the ſpeaker are the things ſignified, and the words of language are ſigns by which they are expreſſed; and when theſe things and ſigns are in conformity to each other, the words uttered expreſs ſo much truth.—Now, though in this caſe there is no *natural* connexion between the ſign and the thing ſignified, yet it is obvious, that without a violent effort of the ſpeaker to the contrary they muſt always be in conformity with each other; becauſe, in every language, there are words appropriated for the purpoſe of denoting every idea and relation which can be expreſſed; and in the mind of every man theſe ideas, relations, and *words*, have been conſtantly aſſociated from the time that he learned to ſpeak. So intimate is this aſſociation, and ſo impoſſible to be broken, that whoever will pay ſufficient attention to the operations of his own mind, will find that he *thinks* as well as *ſpeaks* in ſome language; and that in cogitation he ſuppoſes and runs over, ſilently and habitually, thoſe ſounds which in ſpeaking he actually utters (B). If this be ſo, it is impoſſible that a man without ſome effort ſhould ever ſpeak any thing but truth: for the *ideas* of what he has ſeen or heard, &c. are not of his manufacture; they are generated by external objects; and till they be effaced from the memory, they muſt always, by the law of aſſociation, make their appearance there with all their mutual relations, and in their proper dreſs. In the very act of learning to ſpeak, we neceſſarily learn to ſpeak the *truth:* for were we not to employ words exactly as they are employed by thoſe with whom we converſe, our language (if language it might be called) would be unintelligible; and we could neither declare our wants nor aſk relief with any hopes of ſucceſs. *Children* beginning to ſpeak, may indeed utter untruths without any motive, and merely from miſtake; becauſe the ideas and words of children have neither been long nor cloſely aſſociated: but it is impoſſible that a *man*, however wicked, ſhould habitually and without motives lie on ordinary occaſions, unleſs the fundamental principles of his nature have been totally altered; unleſs his brain has been diſordered by diſeaſe; unleſs his ideas have been diſarranged, and all his original aſſociations broken.

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* *Diſſertation on Miracles*, and *The Philoſophy of Rhetoric*.

† *Inquiry into the Human Mind*, &c.

We know indeed by woful experience, that immoral men occaſionally utter falſehoods with a view to deceive. But on theſe occaſions they are influenced by ſome motive either of hope or terror: the falſehood is always uttered with an effort: and ſo ſtrong is the aſſociation between words and ideas, that the truth will at times break out in ſpite of all their endeavours to ſuppreſs it; ſo that the end or middle of a falſe narrative, if it be of any length, is commonly inconſiſtent with the beginning. We entertain a ſuſpicion concerning any matter of fact, when thoſe who relate it contradict each other—when they are but few in number, or of doubtful character—when they have an intereſt in what they affirm—when they deliver their teſtimony with heſitation—or, on the contrary, with too violent aſſeverations; becauſe theſe are circumſtances which we have generally experienced to accompany falſe witneſs. It is likewiſe with reluctance that we admit a narrative of events entirely different from every thing which hitherto we have ſeen or heard; becauſe we may not be certain that the narrator is not under ſome influence to deceive us in matters concerning which we have nothing but his teſtimony on which to ground our judgement. But in every caſe where the fact recorded is in itſelf poſſible, and attributed to an adequate cauſe; where a competent (C) number of witneſſes had ſufficient means of information, and are certainly under no inducement to deceive; teſtimony is complete evidence, however extraordinary the fact may be; becauſe no fact which is known to have an adequate cauſe can be ſo incredible, as that a number of men of ſound underſtandings ſhould act contrary to the fundamental principles of human nature, or be able, if ſo diſpoſed, to diſſolve aſſociations which had been formed in the mind of each from his infancy, and form new ones, all agreeing exactly with one another, but all contrary to truth.

PART II. OF BODY WITH ITS ADJUNCTS.

CHAP. I. *Of the* COMPOSITION *of* BODIES; *or, of* MATTER *and* FORM.

HITHERTO we have contemplated only the powers of our minds by which we acquire a ſtock of ideas, and the various operations of the intellect upon thoſe ideas, as treaſured up in the memory or imagination. In the courſe of the inquiry we have found, that every idea and notion which we have was ſuggeſted by ſomething independent of us; and in order to diſcover what thoſe things are, we have inveſtigated the nature of each ſenſe, as it is by the ſenſes only that we have any communication with the external world. By touch we perceive heat and cold, hardneſs and ſoftneſs, figure, ſolidity, motion, and extenſion; by the organ of ſmell, we perceive odours; by the tongue and palate, taſtes; by the ear, ſounds; and by the ſight, colours. We have likewiſe ſeen, that heat and cold, odours, taſtes, ſounds, and colours, are mere ſenſations which have no exiſtence but while they are perceived. On the other hand, hardneſs and ſoftneſs, figure and ſolidity, motion and extenſion, are neither ſenſations, nor like ſenſations; but are conceived to be ſomething ex-

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(B) This ſeems to have been *Plato's* opinion; for he calls *thinking* λογον ον αυτη προς αυτην ἡ ψυχη δι εξερχεται περι ων αν σκοπη, "the language by which the ſoul explains itſelf to itſelf when it conſiders any thing." And *Plotinus* ſays, Ὁ εν φωνη λογος μιμημα του εν ψυχη, "the vocal words are an imitation of thoſe of the ſoul." To ſay that vocal words are an imitation of thoſe of the ſoul, is to ſpeak inaccurately, and to reverſe the proceſs of aſſociation; but it affords ſufficient evidence, that in the opinion of Plotinus men think as well as ſpeak in words.

(C) Should it be aſked what number we call competent, we beg leave to ſay, that it will be greater or leſs according to circumſtances. In caſes where they are not liable to the deceptions of ſenſe, two men of integrity and intelligence deſerve equal credit with two thouſand; but where there is particular occaſion for good organs, whether of ſight, hearing, or touch, the greater the number the greater is our ſecurity. To this muſt be added, that as one man is influenced by that which to another would be no motive, a great number of witneſſes concurring in the ſame teſtimony is always an additional ſecurity that they are not under the influence of any latent bias.

ternal and independent of our faculties, which may operate in a deſert wilderneſs as well as in a populous city, though, for want of ſentient beings to operate upon, it cannot in the wilderneſs produce the ſame effects as in the city.

138 Of things perceived by the ſenſes the greater part always united.

Of things perceived by the ſenſes we find the greater part always united; for when a man perceives a piece of ſealing wax, if he makes uſe of all his ſenſes, he perceives at once cold, taſte, colour, hardneſs, roughneſs or ſmoothneſs, figure, ſolidity, motion or reſt, and extenſion. That the powers or qualities, which in this inſtance produce the ſenſations of heat or cold, taſte, odour, and colour, are ſo united to the hardneſs, figure, ſolidity, and extenſion of the wax, as that they cannot exiſt alone, is evident; becauſe it is impoſſible to remove any one of theſe things, or to conceive it removed, without removing with it all the reſt. What then is the bond of this union? Do theſe things neceſſarily accompany one another, ſo as that one of them cannot exiſt without bringing all the reſt along with it? No; there is no neceſſary connexion among them; for by the operation of fire the wax may be rendered liquid, when the *hardneſs* and *cold* are gone, though every thing elſe remains the ſame, or nearly the ſame, as it was before. By a ſtill farther operation of fire the appearance may be entirely changed; and that which was formerly a piece of hard red wax, may be reduced to ſmoke and aſhes, in which there is neither hardneſs, colour, odour, nor figure; at leaſt there is not in the ſmoke and aſhes *ſuch* hardneſs, colour, odour, or figure, as was in the wax. The ſolidity and extenſion, however, remain; for we perceive aſhes and ſmoke to be extended and ſolid as much as wax or an adamant: nor is it poſſible to do any thing with the wax, or with any other ſenſible object, which ſhall deprive it of extenſion or ſolidity.

139 Some of theſe things termed *accidents*, and why.

Thus, then, extenſion and ſolidity may exiſt and be perceived when ſeparated from hardneſs, colour, and odour; but none of theſe can exiſt, or be conceived to exiſt, independent of extenſion and ſolidity. Hardneſs, colour, odour, taſte, and figure, or the things which ſuggeſt theſe notions to us, have with great propriety been termed accidents or qualities; becauſe they cannot exiſt or be conceived to exiſt by themſelves, but require for their ſupport one common ſubject. Extenſion and ſolidity can exiſt independent of them, but they cannot exiſt independent of ſolidity and extenſion.

140 Things perceived by the ſenſes, qualities, which inhere in a ſubject called *matter*.

Is then ſolidity the baſis of theſe qualities, ſo that they neceſſarily reſult from it? No; there are many things ſolid and extended which are neither hard, nor coloured, nor odorous, nor ſapid; which could not be if theſe qualities were the neceſſary effect of ſolidity. Beſides, all mankind conceive of ſolidity and extenſion as qualities of ſomething elſe; for we never ſay that ſolidity is extended or coloured, or hard or odorous, but that ſomething ſolid has theſe qualities: whence it is evident that we conſider ſolidity as a quality itſelf. In what then does ſolidity and all the other ſenſible qualities inhere, ſince they cannot exiſt ſeparately, and do not ſupport each other? This is a queſtion which modern philoſophers pretend not to anſwer: bot ſome of the ancients were not ſo modeſt. Ariſtotle and his followers reſolved every bodily ſubſtance into *matter* and *form*, making matter the baſis or *ſubſtratum*, and under form comprehending all ſenſible qualities.

As attempts have been lately made to revive this philoſophy, it may not be improper to give a ſhort view of the doctrine of *matter* and *form*, if it were only to diſcover whether the ſpeculations of Ariſtotle and his adherents on this ſubject deſerve to be preferred to thoſe of Newton and Locke.

The moſt perſpicuous, and by far the moſt elegant writer among the moderns who has adopted the ancient philoſophy, is Mr Harris; and leſt we ſhould be accuſed by others of doing injuſtice to a ſubject above the reach of ordinary comprehenſion, we ſhall tranſcribe ſo much of what he has ſaid of *matter* and *form* in his Philoſophical Arrangements as ſeems neceſſary to make our readers underſtand his meaning as far as it is intelligible.

141 The Peripatetic doctrine concerning matter;

"Matter (ſays this writer) is that elementary conſtituent in compoſite ſubſtances which appertains in *common* to them all, without diſtinguiſhing them from one another. Every thing generated or made, whether by nature or art, is generated or made out of ſomething elſe; and this ſomething elſe is called its ſubject or matter. Such is iron to the ſaw; ſuch is timber to the boat. Now this *ſubject* or *matter* of a thing being *neceſſarily previous* to that thing's exiſtence, is *neceſſarily different* from it, and *not the ſame*. Thus iron, as iron, is not a ſaw; and timber, as timber, is not a boat. Hence, then, one character of every *ſubject* or *matter*, that is, the character of *negation* or *privation*. [He means *negation* or privation of what is to be made out of it.]

142 which is deſcribed as deſtitute of every attribute or quality,

"Again, Though the *ſubject* or *matter* of a thing be not that thing, *yet*, were it incapable of becoming ſo, it could not be called its ſubject or matter. Thus iron is the *ſubject* or *matter* of a ſaw; becauſe, though *not* a ſaw, it may ſtill *become* a ſaw. On the contrary, timber is *not* the ſubject or matter of a ſaw; becauſe it not only (as timber) is no ſaw, but can never be made one from its very nature and properties. Hence, then, beſides *privation*, another character of every *ſubject* or *matter*, and that is the character of *aptitude* or *capacity*. [He means aptitude or capacity to be that which is made oot of it.]

"Again, When one thing is the *ſubject* or *matter* of *many* things, it implies a *privation* of them *all*, and a *capacity* to them *all*. Thus iron being the ſubject or matter of the ſaw, the axe, and the chiſſel, implies *privation* and *capacity* with reſpect to *all three*. Again, We can change a ſaw into a chiſſel, but not into a boat; we can change a boat into a box, but not into a ſaw. The reaſon is, there can be no change or mutation of one thing into another where the two changing beings do not participate the ſame matter (D). But even here, were the boat to moulder and turn to earth,

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(D) In a note he ſays: This reaſoning has reference to what the ancients called *υλη προσεχης*, *the immediate matter*, in oppoſition to *υλη πρωτη*, *the remote* or *primary matter*.

Of the Compoſition of Bodies.

Of the Compoſition of Bodies.

earth, and that earth by natural proceſs to metallize and become iron; through ſuch progreſſion as this we might ſuppoſe even the boat to become a ſaw. Hence therefore it is, that *all change* is by immediate or mediate participation of the *ſame matter*. Having advanced thus far, we muſt be careful to remember, firſt, that every *ſubject* or *matter* implies, as ſuch, *privation* and *capacity;* and next, that *all change* or *mutation* of beings into one another is *by means of their participating the ſame common matter*. This we have choſen to illuſtrate from works of art, as falling more eaſily under human cognizance and obſervation. It is, however, no leſs certain as to the productions of nature, though the ſuperior ſubtlety in theſe renders examples more difficult. The queſtion then is, whether in the world which we inhabit, it be not admitted from experience, as well as from the confeſſion of all philoſophers, that ſubſtances of every kind (E), whether natural or artificial, either immediately or mediately, paſs into one another: and whether, in that caſe, there muſt not be ſome one *primary matter* common to *all things*. I ſay ſome *one primary matter*, and that common to *all things*, ſince without ſome *ſuch* matter, *ſuch mutation* would be wholly impoſſible. But if there be ſome *one primary matter*, and that *common to all things*, this *matter* muſt imply, not (as particular and ſubordinate matters do) a *particular* privation and a *particular* capacity, but, on the contrary, *univerſal* privation and *univerſal* capacity. If the notion of ſuch a being appear ſtrange and incomprehenſible, we may farther prove the *neceſſity* of its exiſtence from the following conſiderations: Either there is no ſuch general change as here ſpoken of; which is contrary to fact, and would deſtroy the ſympathy and congeniality of things: Or, if there be, there muſt be a matter of the character *here* eſtabliſhed; becauſe without it (as we have ſaid) ſuch change would be *impoſſible*. Add to this, however hard *univerſal* privation may appear, yet had the *primary matter*, in its proper nature, any one particular attribute, ſo as to prevent its *privation* from being unlimited and univerſal, ſuch *attribute would run through all things*, and be conſpicuous in all. If it were white, all things would be white; if circular, they would be circular; and ſo as to other attributes; which is contrary to fact. Add to this, that the *oppoſite* to ſuch attribute could *never* have exiſtence, unleſs it were poſſible for the ſame thing to be at *once* and in the ſame inſtance both white and black, circular and rectilineal, &c. ſince this inſeparable attribute would neceſſarily be *every where;* becauſe the *matter*, which implies it, is itſelf *every where*, at leaſt may be found in all things that are generated and periſhable.

143 and to be apprehended only by abſtraction and analogy.

"Here then we have an idea (ſuch as it is) of that ſingular being υλη πρωτη, the *primary matter;* a being which thoſe philoſophers who are immerged in ſenſible objects know not well how to admit, though they cannot well do without it; a being which flies the perception of every *ſenſe*, and which is at beſt, even to the *intellect*, but a negative object, no otherwiſe *comprehenſible* than either by *analogy* or *abſtraction*. We gain a glimpſe of it by *abſtraction*, when we ſay that the *firſt manner* is *not* the lineaments and complexion which make the beautiful face; *nor yet* the *fleſh* and *blood* which make thoſe lineaments and that complexion; *nor yet* the liquid and ſolid aliments which make that fleſh and blood; *nor yet* the ſimple bodies of earth and water which make thoſe various aliments; but *ſomething*, which being *below* all theſe, and ſupporting them all, is yet *different* from them all, and eſſential to their exiſtence. We obtain a ſight of it by *analogy*, when we ſay, that as is the braſs to the ſtatue, the marble to the pillar, the timber to the ſhip, or any one *ſecondary matter* to any one *peculiar form;* ſo is the *firſt* and *original matter* to all *forms in general*."

Such is the doctrine of the Peripatetics concerning the *primary matter* or the baſis of bodily ſubſtances. We forbear to make any remarks upon it till we have ſeen what they ſay of *form*, the other eſſential part of every body; for what is meant by *matter* and *form* will be moſt completely ſeen when they are viewed together.

144 The Peripatetic doctrine concerning form.

"FORM (ſays the ſame elegant writer) *is that elementary conſtituent in every compoſite ſubſtance, by which it is* DISTINGUISHED, CHARACTERIZED, *and known*, *from every other*. But to be more explicit: The *firſt* and moſt ſimple of all *extenſions* is a *line:* this, when it exiſts, united with a *ſecond* extenſion, makes a *ſuperficies;* and theſe two exiſting together with a *third*, make a *ſolid*. Now this *laſt* and *complete* EXTENSION we call the *firſt* and *ſimpleſt* FORM; and when this *firſt* and *ſimpleſt form* accedes to the *firſt* and *ſimpleſt matter*, the union of the two produces *body;* which is for that reaſon defined to be *matter triply extended*. And thus we behold the riſe of *pure* and original *body* (F). It muſt be remembered, however, that *body*, under this character, is ſomething *indefinite and vague*, and ſcarcely to be made an *object* of *ſcientific contemplation*. It is neceſſary to this end that its extenſion ſhould be *bounded;* for as yet we have treated it without ſuch regard. Now, the *bound* or *limit* of *ſimple body* is *figure;* and thus it is that *figure*, with regard to *body*, becomes the next *form* after *extenſion*.

145 The three original forms which, added to matter, conſtitute body phyſical.

"But though the *boundary* of body by *figure* is one ſtep towards rendering it *definite* and *knowable*, yet is not this ſufficient for the purpoſes of nature. It is neceſſary *here*, that not only its *external* ſhould be duly bounded, but that a ſuitable regard ſhould likewiſe be had to its *internal*. This *internal adjuſtment*, diſpoſition, or *arrangement* (denominate it as you pleaſe), is called ORGANIZATION, and may be conſidered as the *third* form which appertains to body. By its acceſſion we behold the riſe of BODY PHYSICAL or NATURAL; for every ſuch body is ſome way or other *organized*. And thus may we affirm, that theſe *three*, that is to ſay, *extenſion*,

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(E) He muſt mean only bodily ſubſtances; for it is not admitted by ſuch philoſophers as make a diſtinction between mind and body, that the one ever paſſes into the other.

(F) "Original body (he ſays), when we look *downward*, has reference to the *primary matter*, its ſubſtratum: when we look *upwards*, it becomes itſelf a *matter* to *other things;* to the *elements*, as commonly called, air, earth, water, &c. and in conſequence to all the variety of *natural productions*."

extenſion, *figure*, and *organization*, are the *three original forms* to *body phyſical* or *natural*; *figure* having reſpect to its *external*, *organization* to its *internal*, and *extenſion* being common both to one and to the other. It is more than probable, that from the variation in theſe *univerſal* and (as I may ſay) *primary forms*, ariſe moſt of thoſe *ſecondary* forms uſually called *quantities ſenſible*, becauſe they are the proper objects of our ſeveral ſenſations. Such are roughneſs and ſmoothneſs, hardneſs and ſoftneſs; the tribes of colours, ſavours, odours; not to mention thoſe powers of character more *ſubtle*, the powers electric, magnetic (G), medicinal, &c.

"Here therefore we may anſwer the queſtion, how *natural* bodies are *diſtinguiſhed*. Not a ſingle one among them conſiſts of *materials in chaos*, but of materials wrought up after the moſt exquiſite manner, and that conſpicuous in their *organization*, or in their *figure*, or in *both*.—As therefore every *natural body* is diſtinguiſhed by the *differences* juſt deſcribed, and as theſe *differences* have nothing to do with the *original matter*, which being everywhere ſimilar can afford no diſtinction at all; may we not here infer the expediency of ESSENTIAL FORMS, that every *natural ſubſtance* may be eſſentially *characterized*? Theſe *forms*, though they differ from matter, can yet *never ſubſiſt without it*; but *united* with it, they help to produce every *compoſite* being, that is to ſay, in other words, every *natural ſubſtance*, in the viſible world. It muſt be remembered, however, that it is the FORM in this union which is the *ſource of all diſtinction*. It is by *this* that the *ox* is diſtinguiſhed from the *horſe*, not by that graſs on which they ſubſiſt, the *common matter* to both. To which alſo may be added, that as figures and ſenſible qualities are *the only objects of our ſenſations*, and theſe are all *parts* of *natural form*; ſo therefore (contrary to the ſentiment of the vulgar, who dream of nothing but of matter) *it is form, which is in truth the whole that we either hear, ſee, or feel*; nor is *mere matter* any thing better than an *obſcure imperfect being*, knowable only to the *reaſoning faculty* by the two methods already explained, I mean that of *analogy* and that of *abſtraction*. Here therefore we conclude with reſpect to *ſenſible forms*, that is to ſay, *forms immerged in matter* and *ever inſeparable* from it. In *theſe* and *matter* we place the ELEMENTS OF NATURAL SUBSTANCE."

If this extract appear long, let it be remembered that it contains the fulleſt and moſt perſpicuous detail which is to be found in the Engliſh language, of a doctrine of which the author of *Ancient Metaphyſics* ſuppoſes Locke to have been ignorant; and for which ignorance he affects to treat the Engliſh philoſopher with ſupercilious contempt. Had Locke really been ignorant of the ancient doctrine of *matter* and *form*, it is probable that moſt people will be of opinion, that the *contempt* expreſſed by his cenſurer might have been ſpared; but if it ſhould appear, that, as far as this theory is intelligible, it differs not, except in words, from the doctrine laid down in the *Eſſay concerning Human Underſtanding*, what ſhall we think of that zeal for ancient phraſes, which had influence ſufficient to make one reſpectable philoſopher pour contempt upon another who was an ornament to his country?

146 Matter cannot be deſtitute of ſolidity.

What Mr Harris has ſaid of *matter* and *form* reſpecting works of art, is ſufficiently intelligible, and extremely juſt. Nor ſhould we object to the account which he gives of the origin of natural body, if he had not diveſted his firſt matter of every power and every quality, ſolidity and extenſion not excepted. But though we can ſuppoſe body diveſted of any one particular figure and of every ſenſible quality, ſuch as colour, odour, taſtes, &c. and the *ſubſtratum* or *baſis* or *matter* of it ſtill to remain, yet it ſeems impoſſible to conceive it diveſted of *ſolidity* without ſuppoſing it totally annihilated. Nay, if we have any juſt notion at all of ſolidity, it is evidently inſeparable from the ſubſtratum of body, whatever that ſubſtratum be; and indeed though Mr Harris diveſts his firſt matter of every attribute, the argument by which he proves the neceſſary exiſtence of ſuch a being does not require its privation to be ſo univerſal. "Had the *primary matter* (ſays he), in its proper nature, any one particular attribute, ſo as to prevent its privation from being unlimited and univerſal, *ſuch attribute would run through all things* and be conſpicuous in all." This indeed is obvious and undeniable: but *ſolidity* and *extenſion* do in *fact* run through *all things* into which the *ſubſtratum* or *matter* of body is ever formed or ever can be conceived to be formed; and therefore there is no neceſſity for ſuppoſing the firſt matter diveſted of theſe attributes (H).

Mr Harris ſays, that both Timæus and Plato drop expreſſions

(G) That it is from the *extenſion*, *figure*, and *organization* of bodies, that their *medicinal* powers ariſe, ſeems to be undeniable; for medicines operate by contact: but it is not ſo clear that the ſame *forms*, to uſe the author's language, are the ſource of *magnetical* powers. If the magnet be ſurrounded with an atmoſphere extending to a certain diſtance, ſuch may be the caſe; but if not, the author's conjecture muſt be ill founded. See MAGNETISM.

(H) Nor does it appear that it was diveſted of them by all the ancient philoſophers. We learn from Cudworth, that "the atomical phyſiology, the moſt ancient perhaps of any, teaches that body is nothing elſe but *διάστατον ἀντίτυπον*, *extended bulk*; and that nothing is to be attributed to it but what is included in the nature and idea of it, viz. greater or leſs magnitude, with diviſibility into parts, figure, and poſition, together with motion or reſt, but ſo as that no part of body can ever move itſelf. And conſequently, this philoſophy ſuppoſes, that there is no need of any thing elſe beſides the ſimple elements of magnitude, figure, ſite, and motion, (which are all clearly intelligible, or different modes of extended ſubſtance), to ſolve the corporeal phenomena by; and therefore not of any ſubſtantial *forms* diſtinct from the matter; nor of any other qualities really exiſting in the bodies without, beſides the reſults or aggregates of thoſe ſimple elements, and the diſpoſition of the inſenſible parts of bodies in reſpect of figure, ſite, and motion; nor of any intentional *ſpecies* or *ſhows* propagated from the objects to our ſenſes: nor, laſtly, of any other kind of motion or action really diſtinct from

Of the Compoſition of Bodies.

expreſſions as if they conſidered *matter* to be *place*; but place, as will be ſeen afterwards, can be the baſis of nothing. He likewiſe quotes a paſſage from Ammonius on the predicaments, in which it is ſaid "that there never was in *actuality* either matter without body, or body without quality; and we appeal to our readers if it be not abſolutely impoſſible to contemplate ſuch a being even in *idea*. To the queſtion, Whether the firſt matter has a ſeparate exiſtence by itſelf, diſtinct from all the qualities of body, the author of *Ancient Metaphyſics* anſwers thus:—"We have no idea of it exiſting ſeparately, becauſe we find no ſuch thing in nature, from which we draw all our ideas; but whether there may not be ſuch a thing exiſting in the regions of infinite ſpace, as *matter* without *form* and *dimenſions*; is what I think no man can take upon him to decide." But with all ſubmiſſion, if a man cannot decide this queſtion with the utmoſt certainty, his three ponderous volumes are nothing better than uſeleſs paper: for the ſubject of them is things *exiſting*; and concerning exiſtence we know nothing with greater certainty, than that a being of which nothing poſitive can be affirmed, cannot poſſibly have any exiſtence.

147 Some firſt matter common to all bodies;

That, in the world which we inhabit, bodily ſubſtances of every kind, whether natural or artificial, either immediately or mediately paſs into one another, is a truth which cannot be denied: and therefore it follows, that there muſt be ſome one primary matter common to all things. In modern philoſophy this primary matter is conſidered as ſolid, and as the *ſubſtratum* of all bodies; and all thoſe things which, in the language of Mr Harris, are comprehended under the appellation of *form*, are called *qualities*: ſo that on this ſubject the ancient and modern philoſophy differ in nothing but in the latter uſing the word *qualities* inſtead of the word *form*; and defining the firſt matter to be, a *ſolid* ſubſtance every where the ſame," whilſt the ancient philoſophy conſiders it as void of ſolidity.

148 of the nature of which, all men are equally ignorant.

Of the nature of this firſt matter all philoſophers are equally ignorant: for, as Mr Harris ſays, it is in truth *form*; or, as modern philoſophers would ſay, they are in truth *qualities*, which are the whole that we either hear, or ſee or feel, or of which we have either idea or conception. Mr Locke ſays expreſsly, "that if any one will examine himſelf concerning his notion of pure ſubſtance in general, he will find that he has no other idea of it at all, but only a ſuppoſition of he knows not what ſupport of ſuch qualities as are capable of producing ſimple ideas in us."

149 How we know that the things immediately perceived are qualities.

But how, it has been aſked, do we know that the things which we perceive are qualities, and cannot exiſt without a ſubject? We anſwer, Becauſe every one of them, except ſolidity, may be changed or deſtroyed, and the ſubject in which they inhere ſtill remain. Thus, though wax may be melted or burnt, and be no longer a hard red ſubſtance of ſuch a figure and ſuch a ſmell, the matter which ſupported the hardneſs, figure, colour, and ſmell, ſtill remains; for melted wax or aſhes is as much a ſolid ſubſtance as is that which may be uſed for the ſealing of letters, &c.

It has been ſaid that ſolidity (1) is the *ſubſtratum* of body;

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from local motion (ſuch as generation and alteration), they being neither intelligible as modes of extended ſubſtance, nor any way neceſſary: Foraſmuch as the forms and qualities of bodies may well be conceived to be nothing but the reſult of thoſe ſimple elements of magnitude, figure, ſite, and motion, variouſly compounded together; in the ſame manner as ſyllables and words in great variety reſult from the different combinations and conjunctions of a few letters, or the ſimple elements of ſpeech; and the corporeal parts of ſenſation, and particularly that of viſion, may be ſolved only by local motion of bodies, that is, either by corporeal effluvia (called *ſimulacra*, *membranæ*, and *exuviæ*), ſtreaming continually from the ſurface of the objects, or rather, as the later and more refined atomiſts conceived, by preſſure made from the object to the eye, by means of light in the medium. So that ως δια βακτηριας του ταθεντος αερος το βλεπομενον αναγγελλεται, the ſenſe taking cognizance of the object by the ſubtle interpoſed medium, that is tenſe and ſtretched (thruſting every way from it upon the optic nerves), doth by that, as it were by a ſtaff, touch it. Again, Generation and corruption may be ſufficiently explained by concretion and ſecretion, or local motion, without ſubſtantial forms and qualities. And laſtly, Thoſe ſenſible ideas of light and colours, heat and cold, ſweet and bitter, as they are diſtinct things from the figure, ſite, and motion of the inſenſible parts of bodies, ſeem plainly to be nothing elſe but our own fancies, paſſions, and ſenſations, however they be vulgarly miſtaken for qualities in the bodies without us. *Cudworth's Intellectual Syſtem*, Book i. chap. 1.

This, as will be ſeen by and by, is the philoſophy of Newton, Locke, and all their followers: and that it is the genuine philoſophy of the ancient atomiſts, we may ſafely take the word of the author whom we have quoted; for no modern has been more converſant with their writings, more completely maſter of their language, or has given their ſenſe with greater accuracy. Thoſe authors, therefore, who in their zeal for ancient metaphyſics would explode the phyſiology of Newton and Locke, and ſubſtitute in its place the Ariſtotelian doctrine of *matter* and *form*, belie their own pretences; for the theory which they would baniſh is more ancient than that which they introduce; and we appeal to our readers if it be not more intelligible.

(1) The philoſophers of moſt eminence who have maintained this opinion are, *Dr Watts*; the author of the *Procedure, Extent, and Limits, of the Human Underſtanding*; and *Dr Law*, late biſhop of Carliſle, who in a note upon *King's Origin of Evil* gives the opinion of the triumvirate in the following words:—"We find by experience, that a thing will always exhibit the ſame appearances in ſome reſpects, though it admit of changes in others: or, in Mr Locke's language, that certain numbers of ſimple ideas go conſtantly together, whereas ſome others do not. The former of theſe we call the *ſubſtance*, thing, or being, itſelf; the latter are termed its modes or *accidents*. Thus the ſubſtance of *body*, as far as we know of it, conſiſts in ſolidity and extenſion; which being neceſſarily finite, it alſo becomes capable of diviſion, figure, and motion. Theſe are its original inſeparable qualities,

body; and men have been probably led into this notion from a conviction that ſuch *ſubſtratum*, whatever it be, is and muſt be ſolid; but that ſolidity is only a quality inſeparable from the firſt matter, and not that matter itſelf, muſt be evident from this conſideration, that ſolidity is the ſame in all bodies, and incapable of producing by itſelf any other effect than that of excluding from the place occupied by it every other ſolid ſubſtance. It could not of itſelf be the *ſubſtratum* of colour, taſte, or ſmell, otherwiſe all bodies would be coloured, ſapid, and odorous; and as, according to all our notions of it, it is incapable of any change, it could not by itſelf be ſo modified as to excite in us theſe ſenſations.

150 Our notion of matter relative and obſcure.

The things then immediately perceived by us, or of which we have any adequate idea or conception, are only qualities which muſt belong to a ſubject; and all that we know about this ſubject is, that it is that to which ſuch qualities belong. From this it is evident, that our notion of matter, as diſtinguiſhed from its qualities, is a relative * and obſcure notion, and muſt remain obſcure till men have other faculties. In this the philoſopher ſeems to have no advantage above the vulgar: for as they perceive colour, and figure, and motion, by their ſenſes, as well as he does; and as both are equally certain that there is a ſubject of thoſe qualities; ſo the notions which both have of this ſubject are equally obſcure; or, to ſpeak more properly, they have no *poſitive* notion of it at all. When a philoſopher calls it the *firſt matter*, a *ſubſtratum* or a *ſubject* of *inheſion*, thoſe learned words convey no meaning but what every man underſtands and expreſſes, by ſaying in common language, that it is a thing extended, ſolid, and moveable.

* *Reid's Eſſays on the Intellectual Powers of Man.*

They are therefore *qualities*, or in the language of ancient philoſophy, *forms* alone, about which, in corporeal ſubſtance, we can reaſon with preciſion and certainty; and it is ſufficient for all the purpoſes of life that we have of them an adequate knowledge. For as the *firſt matter* or original *ſubſtratum* of all bodies ſeems to be the ſame, though we know not what it is; and as one body is diſtinguiſhed from another only by its *qualities* or *powers*; a knowledge of the nature of theſe is all that can be neceſſary to direct our conduct with reſpect to the various objects with which we are ſurrounded.

151 Qualities, primary and

Qualities thus conſidered in bodies, are, firſt, ſuch as are utterly inſeparable from the body, in what ſtate ſoever it is; ſuch as in all the changes and alterations which it ſuffers, and under all the force which can be employed upon it, it conſtantly keeps. Thus, in the inſtance already given, a ſtick of ſealing wax may, by the operation of fire, be rendered liquid or reduced to ſmoke and aſhes; and when it has undergone theſe changes, it has loſt many of the ſenſible qualities which it had when a long round ſubſtance fit for the purpoſe of ſealing letters; but other qualities which were then perceivable in it ſtill remain: for not only liquid wax, but every particle of ſmoke and aſhes, is ſolid and extended, as well as the hardeſt or largeſt body; and every ſuch particle has likewiſe ſome figure, and is capable of motion or reſt. Again, If a grain of wheat or any other corporeal ſubſtance, be divided into two parts, and each part be again divided without end, ſtill the ſmalleſt particle of it will be ſolid, extended, of ſome figure, and capable of further diviſion. *Solidity*, *extenſion*, *diviſibility*, and *motion* or *reſt*, are therefore qualities inſeparable from *body*, and have on that account been with great propriety called its *original* or *primary qualities*.

152 ſecondary.

There are other qualities, which in truth are nothing in the bodies themſelves, but powers ariſing from the magnitude, figure, texture, and motion, of their inſenſible parts to produce in us various ſenſations; ſuch are *colours*, *ſounds*, *taſtes*, and *odours*. Theſe have been denominated *ſecondary qualities*; and to them may be added

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lities, which conſtitute the thing, and ſeem not to depend on any thing elſe as a *ſubject*. But a particular figure, motion, &c. are only accidents or modes of its exiſtence; which do not neceſſarily attend it, though they themſelves cannot be ſuppoſed to exiſt without it. The ſubſtance of *ſpirit* conſiſts in the powers of thinking and acting, which likewiſe admit of various modifications. This ſeems to be all that we can learn concerning the nature of things from obſervation and experience. To inquire into the *manner* how theſe, which we call *properties*, exiſt together, or to attempt to explain the *cauſe*, ground, or reaſon, of their union, is in vain. To aſſign the word *ſubſtance* for a repreſentation of it, is ſaying nothing: it is ſetting a mere word for what we have neither any idea of nor occaſion for. Indeed if we conſider theſe primary qualities as needing ſomething to inhere in, we are obliged to ſeek for ſomething to ſupport them: and by the ſame way of reaſoning, we may ſeek for ſomething elſe to ſupport that other ſomething, and ſo on; and at laſt ſhall find no other ſupport for the whole but the cauſe which produced it." "Dr Watts (continues the Biſhop) is of opinion, that it is introducing a needleſs *ſcholaſtic* notion into the real nature of things, and then fancying it to have a real exiſtence:" (*Logic*, p. 14.) The author of the *Procedure*, *Extent*, &c. affirms. "That as far we directly know the eſſential properties of any ſubſtance, ſo far we have a *direct* knowledge of the ſubſtance *itſelf*: and if we had a direct knowledge of *all* the eſſential properties of any ſubſtance, we ſhould have an *adequate* knowledge of that ſubſtance; for ſurely, if there be any meaning in words, the knowing any thing of the eſſential properties of a thing is knowing *ſo much* of its very ſubſtance."

That the ſubſtance of body conſiſts in *ſolidity* and *extenſion*, and nothing more; and that theſe depend not upon any thing elſe as a *ſubject*; cannot be true: for *ſolidity*, in our conception, is nothing but *impenetrability*; but whoever uſes the word *impenetrability*, certainly means that there is *ſomething* impenetrable. That there is ſome real thing or being different from ſolidity and extenſion, which impreſſes us with the notion that it is ſolid and extended, is ſelf-evident to all mankind: if it be not matter, theſe conceptions muſt be communicated to us by the immediate agency of the Deity, which ſeems to have been the real opinion of the Biſhop of Carliſle. But this differs not from the theory of Berkeley, which we ſhall conſider by and by.

added a third ſort, which are univerſally allowed to be barely *powers*, though they are in fact as much real qualities in the ſubject as thoſe we have juſt mentioned. Thus the power in fire to produce by its primary qualities a new colour or conſiſtency in wax or clay, is as much a quality in the fire as the power which it has to produce in us a new ſenſation of warmth or burning. That *colours*, *taſtes*, *ſounds*, and *odours*, as they are perceived by us, are mere ſenſations, has been already proved: and that the powers in the bodies which produce theſe ſenſations are not, like *ſolidity* and *extenſion*, inſeparable from the body to which they may belong, is evident; becauſe a piece of *red* wax may be reduced to *black* aſhes; and becauſe by pounding an almond we may change its clear white colour into a dirty hue, and its pleaſant taſte into one that is oily and rancid; and a ſingle rent through the body of a bell deſtroys its ſound.

The primary qualities of body have a real exiſtence independent of us and of every other creature. Thus the particular *bulk*, *number*, *figure*, and *motion*, of the *parts* of *fire* or *ſnow* are *really in the fire or ſnow*, whether any man's ſenſes perceive them or not; and therefore theſe may be called *real qualities*, becauſe they really exiſt in the bodies: But *light*, *heat*, *whiteneſs*, or *cold* (as they are perceived by us), are no more *really in fire or ſnow*, than ſickneſs is in *tartar* or pain in a *ſword*. Take away the ſenſations of them: let not the eyes ſee light or colours, nor the ears hear ſounds; let not the palate taſte nor the noſe ſmell; and all colours, taſtes, odours, and ſounds, as they are ſuch particular ſenſations, vaniſh and ceaſe, and are reduced to their cauſes, *i. e.* to the bulk, figure, and motion of the parts of the body.

153 Bodily qualities are of three ſorts.

The qualities then that are in bodies, rightly conſidered, are of three ſorts. 1. The *bulk*, *figure*, *number*, *ſituation*, and *motion* or *reſt*, of their *ſolid* parts. Of theſe, as they are in themſelves, we have clear and diſtinct notions. We know that they are in the body whether we perceive them or not, and we call them *primary* or *eſſential qualities*. 2. The power that is in any body, by reaſon of its internal texture and inſenſible primary qualities, to operate upon our ſenſes in a peculiar manner, producing in us the different ſenſations of *colours*, *ſounds*, *taſtes*, or *ſmells*, &c. Theſe we have called *ſecondary qualities*, but they are often termed *ſenſible qualities*. 3. The *power* that is in any body, by reaſon of the particular conſtitution of its primary qualities, to make ſuch a *change* in the *bulk*, *figure*, *texture*, and *motion* of *another body*, as to make it operate on our ſenſes differently from what it did before. Thus, the ſun has a power to make wax white, and fire to make lead fluid. Theſe are univerſally called *powers*; but we have no ſuch notions of them as we have of the *primary qualities* of bodies. We know that they exiſt, but we know not what they are. It has indeed been diſcovered, that the ſenſation of ſmell is occaſioned by the effluvia of bodies*; that of ſound by their vibration. The diſpoſition of bodies to reflect a particular kind of light occaſions the ſenſation of colour; and the operation of the minute parts of bodies upon the nerves of the tongue and palate is the cauſe of taſtes. Very curious diſcoveries have been made of the nature of heat and its manner of operating, and an ample field ſtill remains. We are likewiſe intuitively certain, that body can operate upon body only by impulſe; but how certain impulſes upon certain organs ſhould produce ſenſations in us to which there is nothing ſimilar in the impelling body, is equally unknown to the clown and the philoſopher.

* *Reid's Eſſays on the Intellectual Powers of Man*, and *Locke's Eſſay*, &c.

154 The doctrine of the ancient atomiſts reſpecting qualities.

Such is the diſtinction which in modern philoſophy is made between primary and ſecondary qualities; but it is a diſtinction which was likewiſe well known to that ſect of ancient philoſophers who were denominated *atomiſts*. At the head of theſe were Thales and Pythagoras (K); and we may infer from Ariſtotle, that the ſect comprehended almoſt all the phyſiologiſts who taught before himſelf and Plato: for he ſays†, Δημοκριτος και οἱ πλειστοι των φυσιολογων ατοπωτατον τι ποιουσι, παντα γαρ τα αισθητα απτα ποιουσι, και εις σχηματα αναγουσι τους χυμους: "Democritus, and *moſt* of the *phyſiologiſts*, fall into a great abſurdity; for they make all ſenſe to be touch, and reſolve ſenſible qualities into the figures of inſenſible atoms." And he adds, that "the former phyſiologiſts (without exception) ſaid not well, that there is no black and white without the ſight, nor bitter and ſweet without the taſte." He elſewhere ‡ tells us, that thoſe philoſophers explained generation and alteration without forms and qualities, by figures and local motion." Δημοκριτος και Λευκιππος ποιησαντες τα σχηματα την αλλοιωσιν και την γενεσιν εκ τουτων ποιουσι, διακρισει μεν και συγκρισει γενεσιν και φθοραν ταξει δε και θεσει αλλοιωσιν. "Democritus and Leucippus having made figures (or variouſly figured atoms) the firſt principles, make generation and alteration out of theſe; namely, generation

† *Lib. de Senſu et Senſibili*, cap. 4.

‡ *De Generatione et Corruptione*, lib. i. cap. 2.

(K) This is denied by Biſhop Warburton, who thinks nothing better ſettled than that Democritus and Leucippus were the authors of the atomic phyſiology. We highly reſpect the learning and ingenuity diſplayed in the Divine Legation of Moſes; but on this point we are convinced that its author is miſtaken. Strabo expreſsly affirms, that Moſchus the Phœnician was the author of the atomic phyſiology; and Cudworth has proved, by arguments which to us are perfectly ſatisfactory, that Thales and Pythagoras were both atomiſts, and that they derived the doctrine from Phœnicia or Egypt. They did not, indeed, ſpeculate in phyſics, but delivered their doctrines as they had received them from tradition, and they referred all motion to mind as its cauſe. Leucippus and Democritus, we believe, were the firſt ſpeculative atomiſts: but though they refined upon, and perhaps improved, the mere mechanical part of the phyſiology of their maſters, they unhappily dropt the better part of it; and, baniſhing mind from their ſyſtem of the univerſe, they became materialiſts and atheiſts. With the ſober and pious part of philoſophers this brought the atomic theory into diſrepute; and Plato and Ariſtotle, who were theiſts, when they oppoſed that theory, always pointed their arguments againſt Leucippus and Democritus, which is probably what led the learned Biſhop to conſider theſe atheiſts as the authors of the atomic phyſiology.

tion together with corruption from the concretion and ſecretion of them, but alteration from the change of their order and poſition." By the atomic phyſiologiſts the name of *quality* was generally applied only to thoſe things which we have called *ſecondary qualities*. The *primary* being conſidered as *eſſential* to *matter*, were ſeldom, if ever, called *qualities*. That the atoms, which they held to be the firſt principles of bodies, were figured, ſolid, extended, and moveable, is apparent, not only from the ſhort view of their ſyſtem which we have given from Cudworth, but likewiſe from the paſſages which we have juſt quoted from Ariſtotle: but the queſtion debated between them and their antagoniſts was, whether thoſe atoms had *ſmell*, *taſte*, and *colour*; or, as it was commonly expreſſed, whether they had *qualities*? Democritus, Leucippus, and the other atomiſts, we ſee, maintained that they had not; and the following account of the doctrine of Protagoras, another philoſopher of that ſchool, ſhews, that on this ſubject at leaſt the ancient advocates for the atomic ſyſtem reaſoned as juſtly as any of the moderns, and much more juſtly than the Peripatetics and Platoniſts by whom they were oppoſed. Plato having in his Theætetus firſt ſaid in general that the philoſophy of Protagoras made all things to conſiſt of a commixture of atoms and local motion, repreſents his doctrine concerning colours in particular, after this manner: "Firſt, As to that which belongs to the ſight, you muſt conceive what is called a white or black colour, not to be any thing abſolutely exiſting either without your eyes or within your eyes; but black and white, and every other colour, is cauſed by different motions made upon the eye, from objects differently modified; ſo that it is nothing either in the agent or patient abſolutely, but ſomething which ariſes from between them both (L)." From this paſſage it is plain, that Protagoras thought of colours exactly as Mr Locke thought, that they are not *real qualities* exiſting in bodies, but merely ſenſations excited in our minds; and indeed he is preſently after repreſented as having called them τινα εν ἡμιν φασματα, *certain fancies* or *appearances in us*. But there is in the Theætetus another paſſage, in which a fuller account is given of the atomic philoſophy, to this purpoſe: "The principle upon which all theſe things depend is this, That the whole univerſe (M) is motion of atoms and nothing elſe: which motion is conſidered two ways, and is accordingly called by two names, *action* and *paſſion*. From the mutual congreſs, and, as it were, attrition of theſe together, are begotten innumerable offſprings, which, though infinite in number, yet may be reduced to two general heads, *ſenſibles* and *ſenſations*, which are both generated at the ſame time.* The *ſenſations* are *ſeeing*, *hearing*, and the like; and the correſponding *ſenſibles* are *colours*, *ſounds*, &c. Wherefore, when the eye and its proper object meet together, both the αισθητον and the αισθησις, the *ſenſible idea* of white and black, and the *ſenſation* of ſeeing, are generated together, neither of which would have been produced if thoſe two had not met. The like is to be conceived of all other *ſenſibles*, as hot and cold, &c. None of theſe are abſolute things in themſelves, or real qualities in external objects; but they are begotten from the mutual congreſs of agent and patient, and that by motion. So that neither the agent has any ſuch thing in it before its congreſs with the patient, nor the patient before its congreſs with the agent. But the agent and patient meeting together, and begetting *ſenſation* and *ſenſibles*, both the object and the ſentient are forthwith made to be ſo and ſo qualified; as when honey is taſted, the ſenſation of taſting, and the quality of ſweetneſs, are begotten together, though the ſenſation be vulgarly attributed to the taſter, and the quality of ſweetneſs to the honey." The concluſion of all which is ſummed up thus, ουδ' εν ειναι αυτο καθ' αυτο, αλλα τινι αει γιγνεσθαι: "Not one of theſe ſenſible things is any thing abſolutely in the object without, but they are all generated or made relative to the ſentient (N)."

The language of ancient philoſophy was defective in preciſion; terms were uſed vaguely and improperly, ſo that the meaning of the author is often to be collected only from the context. When Protagoras is here made to ſay, that when the agent and patient meet together, both the object and the ſentient are forthwith made to be ſo and ſo *qualified*; as when honey is taſted, the ſenſation of taſting and the *quality* of ſweetneſs are begotten together; it could not be his meaning, that any real change is made upon the external object merely by our taſting it, but only that the actual ſenſation and the ſenſible *idea* of ſweetneſs are produced at once; juſt as he had ſaid before, that the ſenſible idea of white or black, and the ſenſation of ſeeing, are generated together. If his words be thus interpreted they expreſs a noble truth; and the whole paſſage ſhows, that the ancient atomic theory differed not from the theory of Des Cartes, Newton, and Locke, being the moſt rational, as well as the earlieſt ſyſtem of phyſics with which we have any acquaintance. By diveſting body of *eſſential forms* diſtinct from matter and motion, and by giving to the firſt matter extenſion and ſolidity, it renders the corporeal world intelligible; and accounts for thoſe appearances

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(L.) Υπολαβε τοινυν ουτωσι κατα τα ομματα πρωτον, ὁ δε καλεις χρωμα λευκον μη ειναι αυτο ἑτερον τι εξω των σων ομματων, μηδ' εν τοις ομμασι, αλλα μελαν τε και λευκον και ὁτιουν αλλο χρωμα εκ της προσβολης των ομματων προς την προσηκουσαν φοραν φανειται γεγενημενον και ὁ δη εκαστον ειναι φαμεν χρωμα, ουτε το προσβαλλον ουτε το προσβαλλομενον αλλα μεταξυ τι εκαστω ιδιον γεγονος.

(M) Protagoras was a follower of Leucippus and Democritus in every thing, and of courſe an atheiſt.—This, however, does not hinder him from having been a correct phyſiologiſt with reſpect to the compoſition of body; and as ſuch only is he quoted by us. It is, indeed, melancholy to think, that there was hardly a ſect of ancient philoſophers in which there were not many atheiſts.

(N) Αρχη δε εξ ἡς α νυν δη ελεγομεν παντα ηρτηται ἡδε αυτων, ὡς το παν κινησις ην και αλλο παρα τουτο ουδεν, της δε κινησεως δυο ειδη, πληθει μεν απειρον, ἑκατερον, δυναμιν δε το μεν ποιειν εχον, το δε πασχειν, &c.—See the *Theætetus*; ſee alſo *Cudworth's Intellectual Syſtem*, Book i. chap. 1.

pearances which are called ſecondary qualities, in a manner perfectly ſatisfactory. Ariſtotle indeed oppoſed the atomic philoſophy, and had influence enough to bring it into diſrepute for many ages; but when he inſiſted that the two conſtituent principles of body are *matter* and *form*, both independent of all ſentient beings, and which may be conceived as exiſting diſtinct from each other, he ſubſtituted for a ſimple and ſublime theory an abſurd and incomprehenſible fiction.

Chap. II. *Of the* Eſſences *of* Bodies.

155 The eſſences of bodies reſult, ;

HAVING treated of the ſubſtance, qualities, and powers of body, we may ſeem to have exhauſted this part of our ſubject; but there is ſtill more to be done. Metaphyſicians, ancient and modern, have introduced another term into the ſcience, to denote that which diſtinguiſhes one ſpecies or ſort of bodies from all other ſpecies or ſorts; and this term we ſhall briefly explain. Gold is apparently different from lead, and from every other ſpecies of metal; a horſe is apparently different from an ox, and from every other ſpecies of animals; and all animals apparently differ from all vegetables, as vegetables differ from metals.

156 according to the Peripatetics and Platoniſts, from eſſential forms;

It is only with the *bodies*, not the minds of animals, that we are at preſent concerned: and we have ſeen that all bodies are compoſed of the ſame matter.—What then is it that makes different bodies exhibit to us ſuch different appearances; or, in other words, how come they to be poſſeſſed of ſuch different qualities and powers? It is (ſay the followers of Plato and Ariſtotle) from their having different *eſſential forms*, by which every natural ſubſtance is eſſentially characterized; for of every animal, vegetable, or metal, &c. there is a *form* conceived, as exiſting before the individuals in which it is incorporated, from which reſult all the properties of that animal, vegetable, or metal, ſuch as *figure*, *ſize*, *colour*, and the other qualities perceptible by our ſenſes: but this *internal and eſſential form* itſelf, from which all other forms reſult, is not perceptible by our ſenſes, nor even by our underſtanding directly and immediately, nor otherwiſe than by the analogy formerly mentioned. Theſe eſſential forms, we are told, mean ſomething, which, though different from matter, can yet never ſubſiſt without it; ſomething which, united with it, helps to produce every *compoſite* being, that is to ſay, in other words, every natural ſubſtance in the viſible world[d].

157 But theſe forms have no exiſtence.

This aſſertion Mr Harris ſubmits with deference to his contemporaries; becauſe (ſays he) "I ſpeak perhaps of ſpectres as ſhocking to ſome philoſophers as thoſe were to Æneas which he met in his way to hell—*Terribiles viſu formæ*." The elegant author's unwillingneſs to frighten his contemporaries, was a proof of his amiable and benevolent diſpoſition; but he needed not to have ſuffered from any ſuch apprehenſion. Thoſe ſpectres, apparently ſo dreadful, had long before been laid to reſt by the incomparable Cudworth, who has demonſtrated, that *eſſential forms* different from matter and motion, as they have no real exiſtence, had no place in the moſt ancient philoſophy; and that the different appearances or ſenſible qualities which different bodies exhibit, are the reſult of the different contexture of their inſenſible parts. Thus, gold and lead are compoſed of the ſame primary matter, but the atoms or minute parts of that matter are in the one ſubſtance differently combined from what they are in the other; and this different combination is the ſole cauſe that gold is ſpecifically heavier than lead, more ductile, and of a different colour, &c. For the very ſame reaſon, iron is harder than either gold or lead, ſpecifically lighter, and poſſeſſed of many other ſenſible qualities which are not found in either of theſe ſubſtances. One vegetable differs from another externally in ſize, colour, taſte, ſmell, rapidity of growth, and proportion of parts, &c.: but all vegetables are compoſed of the ſame matter; and the external difference which prevails among them is the reſult of a different ſtructure and motion of their inſenſible parts. The ſame is to be ſaid of the differences which prevail among the bodies of animals; they all reſult from internal organization and motion, and from nothing elſe, whatever be the immediate cauſe of that motion.

158 The real eſſences of bodies unknown to us.

This particular internal texture and motion of inſenſible parts, is that which makes one ſort of bodies differ externally from every other ſort of bodies; and it is by modern metaphyſicians called the *real eſſence* of bodies. Thus, that internal texture of minute parts, which makes gold of a bright yellow, extremely ductile, ſpecifically heavier than all other metals, and ſoluble in *aqua regia*, is the real eſſence of gold; but what that eſſence is in itſelf no man can tell, as we perceive only the qualities which reſult from it. We are, however, certain, that it is different from the real eſſences of lead and iron, becauſe it produces different effects from thoſe which are produced by theſe eſſences; and different effects are never produced in the ſame circumſtances by the ſame cauſe.

159 Nominal eſſences, what they are.

We have called the internal texture and motion of the inſenſible parts of bodies their *real eſſences*, to diſtinguiſh them from other *eſſences* which are only *nominal*, and with which we are perfectly acquainted, becauſe they are the fabrication of our own minds.—Thus, a beautiful bright yellow, a certain ſpecific gravity, extreme ductility, and ſolubility in *aqua regia*, are the qualities by which we diſtinguiſh gold from all other metals. Of theſe qualities we frame a ſort of general conception, which we call the *eſſence* of gold; and every ſubſtance in which we find this eſſence, we claſs under the ſpecific name gold. For though it is obvious that our conceptions cannot be the *real eſſences* of things external, yet are they ſufficient guides to theſe eſſences, as we know that bodies which, being all formed of the ſame matter, have the very ſame ſenſible qualities, muſt likewiſe have the ſame internal organization or texture of parts, becauſe it is only in that organization or texture that one body can differ from another.—And ſo much for bodily ſubſtance, qualities, and eſſences.

Chap. III. *Of the* Existence *of* Matter.

160 Berkeley attempts to demonſtrate that matter has no exiſtence.

WE have endeavoured to prove, that all corporeal ſubſtances conſiſt of minute atoms, ſolid and extended; and that the ſenſible qualities of every body reſult from the combination and motion of the atoms of which that body is compoſed. The celebrated Berkeley, biſhop

Of the Exiſtence of Matter.

Cloyne, however, attempted to demonſtrate that theſe atoms have no real exiſtence; and that the very ſuppoſition of a ſolid, extended, and inert ſubſtance, being the archetype of our ideas, involves in it an abſurdity and contradiction.

It is univerſally allowed, that all our knowledge of matter is derived through the ſenſes, either immediately in the very act of ſenſation, or mediately by an aſſociation which is reſolvable into a proceſs of reaſoning. According to the principles which we have ſtated, and laboured to eſtabliſh, matter itſelf is no immediate object of the ſenſes; and as theſe are the principles upon which the biſhop erected his demonſtration, it will be incumbent upon us to conſider his theory, becauſe it has been repreſented as in the higheſt degree pernicious, and as leading to univerſal ſcepticiſm.

161 The view of his theory given by his antagoniſts.

The author of the *Eſſay on the Nature and Immutability of Truth*, repreſents Berkeley as teaching us, "that external objects (that is, the things which we take for external objects) are nothing but ideas in *our* minds; in other words, that they are in *every reſpect* different from what they appear to be; that matter exiſts not but in *our* minds; and that independent on *us* and *our* faculties, the earth, the ſun, and the ſtarry heavens, have no exiſtence at all; that a lighted candle hath not *one* of *thoſe qualities* which it *appears to have*; that it is not white nor luminous, nor round, nor diviſible, nor extended; but that, for any thing we know, or can ever know to the contrary, it may be an Egyptian pyramid, the king of Pruſſia, a mad dog, the iſland of Madagaſcar, Saturn's ring, one of the Pleiades, or nothing at all." With reſpect to the conſequences of this theory, he affirms, that "it is ſubverſive of man's moſt important intereſts, as a moral, intelligent, and percipient being; and not only ſo, but alſo, that if it were univerſally and ſeriouſly adopted, the diſſolution of ſociety, and the deſtruction of mankind, would neceſſarily enſue within the compaſs of a month."

The diſſolution of ſociety and the deſtruction of mankind are indeed diſmal conſequences—enough to make a man ſhudder in his cloſet. But do they really flow from Berkeley's ſyſtem? They certainly do, if it be the aim of that ſyſtem to prove that a candle has not any one quality which it appears to have, and that it may be a *mad dog;* for ſhould all philoſophers, by ſome means or other, become converts to the theory of Berkeley, as we know that the biſhops Sherlock, Smalridge, and others, actually did, the diſſolution of ſociety and the deſtruction of mankind would indeed be inevitable. The ſcribbling race, by uſing mad dogs for candles, would all become infected with the hydrophobia: and having their natural irritability augmented by the canine rabies, they would bite and tear till not a human being were left alive.

162 [illegible] theory [illegible]

But to drop this ludicrous ſtyle, ſo unſuitable to philoſophical inveſtigation and calm inquiry, we beg leave to affirm, that the theory of Berkeley is here totally and groſsly miſrepreſented, and that not one of thoſe dangerous conſequences which flow from that miſrepreſentation can be fairly deduced from any thing taught in *The Principles of Human Knowledge* and the *Dialogues on the Exiſtence of Matter*. So far is Berkeley from teaching that external things are nothing but ideas in *our* minds, and that they are in every reſpect different from what they appear to be, that he teaches the very reverſe of this in the plaineſt language poſſible. "I am of a vulgar caſt (ſays he), ſimple enough to believe my ſenſes, and leave things as I find them. It is my opinion, that the real things are thoſe very things I ſee and feel and perceive by my ſenſes. That a thing ſhould really be perceived by my ſenſes, and at the ſame time not really exiſt, is to me a plain contradiction. When I deny ſenſible things an exiſtence out of the mind, I do not mean *my* mind in particular, but *all* minds. Now it is plain they have an exiſtence exterior to my mind, ſince I find them by experience to be independent of it. There is therefore ſome other mind wherein they exiſt during the intervals between the times of my perceiving them; as likewiſe they did before my birth, and would do after my annihilation. And as the ſame is true with regard to all other finite created ſpirits, it neceſſarily follows there is an *omnipotent eternal mind*, which knows and comprehends all things, and exhibits them to our view in ſuch a manner, and according to ſuch rules, as he himſelf hath ordained, and are by us termed the laws of nature."

So far is Berkeley from teaching that, independent on *us* and *our* faculties, the earth, the ſun, and the ſtarry heavens, have no exiſtence at all, and that a lighted candle has not one of thoſe qualities which it appears to have, that he over and over affirms the direct contrary; that the univerſe has a real exiſtence in the mind of that infinite God, in whom, according to the ſcriptures, we all live, and move, and have our being; that a lighted candle has not only all thoſe qualities which it appears to have, but that, with reſpect to us, it has nothing elſe; that ſo far from being continually deceived by our ſenſes, we are never deceived by them; and that all our miſtakes concerning matter are the reſult of falſe inferences from true ſenſations.

The biſhop makes the ſame diſtinction that we have made between ideas and notions; reſtraining the uſe of the former term to denote the relicts of ſenſation, and employing the latter to denote our knowledge or conception of ſpirits and all ſuch objects as are not perceived by ſenſe. He likewiſe affirms, that we can have no *idea* of an external inert ſubſtance; becauſe an idea can be like nothing but another idea, or the ſenſation of which it is a relict: and as all mankind admit that ideas and ſenſations can have no exiſtence but in the mind of a percipient being, he therefore infers that we can have no *idea* of any thing exiſting unperceived, and by conſequence can have no idea of matter in the philoſophical ſenſe of that word. Solidity, extenſion, diviſibility, motion, figure, colour, taſte, and all thoſe things which are uſually called qualities primary and ſecondary, being according to him mere ideas, can have no exiſtence but in a mind perceiving them; but ſo far is he from ſuppoſing their exiſtence to depend upon the perception of our minds, that he ſays expreſsly, "When in broad day-light I open my eyes, it is not in my power to chooſe whether I ſhall ſee or no, or to determine what particular objects ſhall preſent themſelves to my view; and ſo likewiſe as to the hearing and other ſenſes, the ideas imprinted on them are not creatures of my will. There is therefore ſome other will or ſpirit that produces them.

Of the Exiſtence of Matter.

them. The queſtion between the materialiſts and me is not, Whether things have a real exiſtence out of the mind of *this* or *that* perſon? but, Whether they have an abſolute exiſtence, diſtinct from being perceived by *God*, and exterior to *all minds*? I aſſert, as well as they, that ſince we are affected from without, we muſt allow powers to be without in a being diſtinct from ourſelves. So far we are agreed. But then we differ as to the kind of this powerful being. I will have it to be ſpirit; they matter, or I know not what third nature. Thus I prove it to be ſpirit: From the effects I ſee produced, I conclude there are actions; and becauſe actions, volitions (for I have no notion of any action diſtinct from volition); and becauſe there are volitions, there muſt be a will. Again, The things I perceive muſt have an exiſtence, they or their archetypes, out of my mind: but being ideas, neither they nor their archetypes can exiſt otherwiſe than in an underſtanding: there is therefore an underſtanding. But will and underſtanding conſtitute in the ſtricteſt ſenſe a mind or ſpirit. The powerful cauſe, therefore, of my ideas is, in ſtrict propriety of ſpeech, a ſpirit."

163 That theory, however improbable, certainly poſſible, and

This is a faithful abſtract of Berkeley's theory given in his own words. Matter, according to him, cannot be the *pattern* or *archetype* of ideas, becauſe an idea can reſemble nothing but another idea, or the ſenſation of which it is a relict. Matter, he thinks, cannot be the *cauſe* of ideas; for every cauſe muſt be active, and matter is defined to be inert and incapable of action. He therefore infers, that all our ſenſations of what we call the qualities of body are the effect of the immediate agency of the Deity upon our minds; and that corporeal ſubſtance has no exiſtence, or at leaſt that we have no evidence of its exiſtence. That ſuch may *poſſibly* be the origin of our ſenſations, no man will deny who reflects upon the infinite power and wiſdom of the Agent from whom they are ſaid to proceed. Dr Reid himſelf, the ableſt of all Dr Berkeley's opponents, frankly acknowledges that no man "can ſhow, by any good argument, that all our ſenſations might not have been as they are, though no body or quality of body had ever exiſted."

164 in its conſequences harmleſs.

In its conſequences we do not perceive that this theory can be hurtful either to religion, to virtue, or to the buſineſs of common life; for it only explodes the notion of a ſubſtratum, which, though it may have a real exiſtence, was never thought of by the generality of mankind in any nation under heaven. Dr Beattie indeed affirms, that in "leſs than a month after the non-exiſtence of matter ſhould be univerſally admitted, he is certain there could not, without a miracle, be one human creature alive on the face of the earth. But this aſſertion muſt be the conſequence of his miſtaking Berkeley's non-exiſtence of matter for the non exiſtence of ſenſible objects, the reality and exiſtence of which the biſhop never denied. On the contrary, he expreſsly ſays, "We are ſure that we really ſee, hear, feel; in a word, that we are affected with ſenſible impreſſions; and how are we concerned any farther? I *ſee* this cherry, I *feel* it, I *taſte* it; and I am ſure *nothing* cannot be ſeen, or felt, or taſted: it is therefore *real*. Take away the ſenſations of ſoftneſs, moiſture, redneſs, tartneſs, and you take away the cherry." All this is equally true and equally conceivable, whether the combined ſenſations which indicate to us the exiſtence of the cherry be the effect of the immediate agency of God or of the impulſe of matter upon our minds; and to the lives of men there is no greater danger in adopting the former than the latter opinion.

165 A conſequence of Berkeley's theory; which

But it has been ſaid, that Berkeley's doctrine neceſſarily leads to ſcepticiſm in religion, as the ſame kind of reaſoning which he employs to prove the non-exiſtence of matter, operates equally againſt the exiſtence of mind, and conſequently againſt the poſſibility of a future ſtate of rewards and puniſhments. "The rational iſſue of this ſyſtem (we are told) is ſcepticiſm with regard to every thing excepting the exiſtence of our ideas and their neceſſary relations. For ideas being the only objects of thought, and having no exiſtence but when we are conſcious of them, it neceſſarily follows, that there is no object of our thought which can have a continued and permanent exiſtence. Body and ſpirit, cauſe and effect, time and ſpace, to which we were wont to aſcribe an exiſtence independent of our thought, all are turned out of exiſtence by this ſhort dilemma: Either thoſe things are ideas of ſenſation or reflection, or they are not: If they are ideas of ſenſation or reflection, they can have no exiſtence, but when we are conſcious of them: If they are not ideas of ſenſation or reflection, they are words without any meaning."

This ſophiſm was advanced as a conſequence from Berkeley's principles by Mr Hume; and upon theſe principles it has been deemed unanſwerable by ſubſequent philoſophers of great merit. But is it really a part of Berkeley's ſyſtem, or can it be fairly inferred from the principles on which that ſyſtem is built? Theſe queſtions it is fit that Berkeley ſhould anſwer for himſelf: and we ſhall venture to aſſert, that his anſwer will be perfectly ſatisfactory to every reader who attends to the diſtinction, which, after the biſhop, we have ſtated between ideas and notions.

166 that author foreſaw and

Though we believe this dangerous inference from Berkeley's principles is commonly attributed to Hume as its author, it did not eſcape the ſagacity of the biſhop himſelf. In the third dialogue, *Hylas*, who pleads for the exiſtence of matter, thus objects to the reaſoning of his antagoniſt. "Notwithſtanding all you have ſaid, to me it ſeems, that according to your own way of thinking, and in conſequence of your own principles, it ſhould follow, that you are only a ſyſtem of floating ideas, without any ſubſtance to ſupport them. Words are not to be uſed without a meaning. And as there is no more meaning in ſpiritual ſubſtance than in material ſubſtance, the one is to be exploded as well as the other.

167 obviated, but

To this *Philonus* anſwers: "How often muſt I repeat, that I know or am *conſcious* of my own being; and that I myſelf am not my ideas, but ſomewhat elſe; a thinking active principle, that perceives, knows, wills, and operates about ideas: I know that I, one and the ſame ſelf, perceive both colours and ſounds; that a colour cannot perceive a ſound, nor a ſound a colour; that I am therefore one independent principle, diſtinct from colour and ſound; and, for the ſame reaſon, from all other ſenſible things and inert ideas. But I am not in like manner *conſcious* either of the exiſtence or eſſence of matter. Farther, I know what I mean, when I affirm that there is a ſpiritual ſubſtance or ſupport of ideas; i. e. that a ſpirit knows and perceives ideas. But I do not know what is meant, when it is ſaid that an unperceiving ſubſtance hath inherent in it, and ſupports, either ideas or the archetypes of ideas. In the very notion or definition of material ſubſtance there is included a manifeſt repugnance and inconſiſtency. But this cannot be ſaid of the notion of ſpirit. That ideas ſhould exiſt in what doth not perceive, or be produced by what doth not act, is repugnant. But it is no repugnancy to ſay, that a perceiving thing ſhould be the ſubject of ideas, or an active being the cauſe of them. That I, who am a ſpirit or thinking ſubſtance, exiſt, I know as certainly as I know that my ideas exiſt. I know likewiſe what I mean by the terms *I* and *myſelf;* and I know this immediately or intuitively; though I do not perceive it as I perceive a triangle, a colour, or a ſound. Ideas are things inactive and perceived; and ſpirits a ſort of beings altogether different from them, by which they are perceived. I do not, therefore, ſay, that my ſoul is an idea, or like an idea. However, taking the word *idea* in a large ſenſe, my ſoul may be ſaid to furniſh me with an idea, that is, an image or likeneſs of God, though indeed extremely inadequate. For all the notion I have of God is obtained on reflecting on my own ſoul, heightening its powers, and removing its imperfections. I have, therefore, though not an inactive idea, yet in myſelf ſome ſort of an active thinking image of the Deity. And though I perceive him not by ſenſe, yet I have a notion of him, or know him, by reflection and reaſoning. My own mind and my own ideas I have an immediate knowledge of; and by the help of theſe do immediately apprehend the *poſſibility* of the exiſtence of other ſpirits and ideas. Farther, from my being, and from the dependency I find in myſelf and my ideas, I do by an act of reaſon *neceſſarily* infer the exiſtence of a God, and of all created things in the mind of God. It is granted that we have neither an immediate evidence, nor a demonſtrative knowledge, of the exiſtence of *other finite ſpirits*; but it will not therefore follow, that ſuch ſpirits are on a footing with material ſubſtances: if, to ſuppoſe the one be inconſiſtent, and if it be not inconſiſtent to ſuppoſe the other; if the one can be inferred by no argument, and there is a probability of the other; if we ſee ſigns and effects indicating diſtinct finite agents like ourſelves, and ſee no ſign or ſymptom whatever that leads to a rational belief of matter. I ſay, laſtly. That I have a *notion* of ſpirit, though I have not, ſtrictly ſpeaking, an *idea* of it. I do not perceive it as an idea, or by means of an idea; but know it by reflection. Whereas, I neither perceive matter objectively as I do an idea, nor know it as I do myſelf by a reflex act; neither do I mediately apprehend it by ſimilitude of the one or the other, nor yet collect it by reaſoning from that which I know immediately. All which makes the caſe of matter widely different from that of the Deity and all ſpirits."

Thus far we think Berkeley's theory tenible, and its conſequences harmleſs. That by the immediate agency of the Deity all our ſenſations *might* be what they are, though matter had no exiſtence, we think he has proved by arguments unanſwerable; and we are likewiſe of opinion, that by admitting the evidence of ſenſe, conſciouſneſs, and reaſon, in their fulleſt extent, and by diſtinguiſhing properly between thoſe things of which we have *ideas*, and thoſe of which we have *notions*, he has ſufficiently ſecured the exiſtence of ſpirits or percipient beings, and obviated the irreligious ſophiſtry of Hume before it was conceived by that author. But the good biſhop ſtops not here. Not ſatisfied with proving that all our ſenſations lead us immediately to the Deity, and that, for aught we know, matter, as defined by philoſophers, may have no ſeparate exiſtence, he proceeds farther, and endeavours to prove that matter cannot poſſibly exiſt. This appears even in the extracts which we have quoted from his book, in which he talks of the repugnance and inconſiſtency of the notion. In this part of his ſyſtem, we think he errs greatly, and advances an opinion altogether inconſiſtent with his own juſt principles.

168 Not ſatiſfied with this, he endeavours to prove the exiſtence of matter impoſſible.

169 His reaſoning

The repugnance of which he ſpeaks, ariſes ſolely from conſidering ſolidity and extenſion as relicts of ſenſation, or ideas of the ſame kind with thoſe of heat and cold, taſtes and ſounds. "Light and colours, heat and cold, extenſion and figures; in a word, the things we ſee and feel; what are they (ſays his lordſhip), but ſo may ſenſations, notions, ideas, or impreſſions, on ſenſe? and is it poſſible to ſeparate even in thought any of theſe from perception? Some there are who make a diſtinction betwixt *primary* and *ſecondary* qualities: by the former, they mean extenſion, figure, motion, reſt, ſolidity or impenetrability, and number: by the latter, they denote all other ſenſible qualities, as colours, ſounds, taſtes, and ſo forth.—The ideas we have of theſe they acknowledge not to be the reſemblances of any thing exiſting without the mind, or unperceived; but they will have our ideas of the primary qualities to be patterns or images of things which exiſt without the mind, in an unthinking ſubſtance which they call *matter*. But it is evident that extenſion, figure, and motion, are only ideas exiſting in the mind; that without extenſion ſolidity cannot be conceived; that an idea can be like nothing but another idea; and that conſequently neither they nor their archetypes can exiſt in an unperceiving ſubſtance. Hence it is plain, that the very notion of what is called *matter*, or *corporeal ſubſtance*, involves a contradiction in it."

170 fallacious.

This account of extenſion and ſolidity affords a ſtriking inſtance how much the moſt vigorous and upright mind is liable to be warped by prejudice in behalf of a darling theory, and how apt the cleareſt underſtanding is to be blinded by the equivocal uſe of terms. That Biſhop Berkeley poſſeſſed a vigorous and perſpicacious mind, his moſt vehement antagoniſts are eager to admit; and that his intentions were good, is known to all Europe. Yet by the equivocal uſe of the word *idea*, which the writings of Locke had then introduced into the language of philoſophy, he has here ſuffered himſelf to loſe ſight of a very proper and accurate diſtinction, which, ſo far as we know, was among the moderns firſt made by himſelf between *ideas* and *notions*. According to the biſhop, "we have a *notion* of power and a *notion* of ſpirits, but we can have no *idea* either of the one or the other; for all ideas being paſſive and inert, they cannot repreſent unto us by way of image or likeneſs that which acts. Such is the nature of *ſpirit* or that which acts, that it cannot be of itſelf perceived, but only by the effects which it produceth. It muſt be owned, however, that we have ſome *notion* of ſoul, ſpirit, and the operations of the mind, ſuch as willing, loving, hating, inaſmuch as we know or underſtand the meaning of theſe words."

Now we beg leave to affirm, that what is here ſaid of ſpirits, and of which we readily admit the truth, is equally true of material or ſolid ſubſtances. We have no *ideas* of ſolidity and extenſion, becauſe theſe things are not originally impreſſed upon the ſenſes; but we have very diſtinct though relative *notions* of them, for they are clearly perceived by the effects which they produce. That this is at leaſt poſſible, we have the acknowledgement of Biſhop Berkeley himſelf: for he "freely owns, that from a cauſe, effect, operation, ſign, or other circumſtance, there may reaſonably be inferred the exiſtence of a thing not immediately perceived; and that it were abſurd for any man to argue againſt the exiſtence of that thing, from his having no direct and poſitive notion of it." This is exactly the caſe with reſpect to ſolid ſubſtances. Theſe ſubſtances we do not immediately perceive; but we infer their exiſtence from effects, ſigns, and other circumſtances, and we have of them very clear though relative notions. Thus a man can open and ſhut his empty hand; but when he graſps an ivory ball of three or four inches diameter, he feels, that though the ſame power be exerted, his hand cannot then be ſhut. He is conſcious that there is no change in himſelf; and being intuitively certain that every effect muſt have a cauſe, he infers with the utmoſt confidence, that the cauſe which prevents his hand from ſhutting is in the ball; or, in other words, that the thing which communicates to his eye the ſenſation of colour, and impreſſes upon his hand a ſenſation of touch, muſt be ſolid or impenetrable. Solidity, however, is not the ſenſation itſelf; it is only the cauſe of the ſenſation; and therefore it is ſo far from being an idea in our minds, that we are conſcious our notion of it is of a thing totally different from all our ideas, of a thing external, at leaſt to our minds. Indeed the notion itſelf is not poſitive; it is only relative, and inferred from the effects which are produced on our ſenſes. That it is the *ſame* thing which communicates to our eye the ſenſation of colour, and has the power of reſiſting the compreſſion of our hand, is evident: becauſe, when the ball is thrown away, the reſiſtance as well as the actual ſenſation vaniſh at once.

171 The idea of colour and the notion of ſolidity not naturally inſeparable.

From this fact, which a leſs acute man would think a proof that the reſiſtance was not occaſioned by the immediate agency of the Supreme Being, but by the impenetrability of a ſolid ſubſtance of ſmall dimenſions, the biſhop argues thus againſt the *poſſibility* of ſuch a ſubſtance: "They who aſſert that figure, motion, and the reſt of the primary or original qualities, do exiſt without the mind in unthinking ſubſtances, do at the ſame time acknowledge, that colours, ſounds, heat, cold, and ſuch like ſecondary qualities, do not; which they tell us are ſenſations exiſting in the mind alone, that depend on and are occaſioned by the different ſize, texture, and motion, of the minute particles of matter. This they take for an undoubted truth, which they can demonſtrate beyond all exception. Now if it be certain, that thoſe original qualities are inſeparably united with the other ſenſible qualities, and not even in thought capable of being abſtracted from them, it plainly follows, that they exiſt only in the mind. But I deſire any one to reflect and try whether he can by any abſtraction of thought conceive the extenſion and motion of a body, without all other ſenſible qualities. For my own part, I ſee evidently that it is not in my power to frame an idea of a body extended and moved, but I muſt withal give it ſome colour or other ſenſible quality, which is acknowledged to exiſt only in the mind. In ſhort, extenſion, figure, and motion, abſtracted from all qualities, are inconceivable. Where, therefore, the other ſenſible qualities are, there muſt be theſe alſo, to wit, in the mind, and no where elſe."

In this reaſoning, though plauſible, there is an unintended fallacy. It is indeed true, that we cannot contemplate in imagination a ſolid ſubſtance without conceiving it to have ſome colour; but there is ſufficient reaſon to believe, that this union of colour and ſolidity in our minds is not the effect of nature as it operates at firſt upon our ſenſes, but merely the conſequence of early and deep-rooted aſſociation. Biſhop Berkeley himſelf has taught us, that the objects of ſight are not at a diſtance; and that if a man born blind were ſuddenly made to ſee, he would conceive the objects of his ſight as exiſting either in his eye or in his mind. This is a truth which no man will controvert who has dipt into the ſcience of optics, or who has even paid the ſlighteſt attention to the perceptions of infants; and if ſo, it follows, that to a man born blind and ſuddenly made to ſee, colour and ſolidity would not appear united. Were ſuch a perſon to lay hold of an ivory ball and raiſe it to the elevation of his eye, he would perceive whiteneſs as a new ſenſation exiſting in his eye or his mind, but he would feel reſiſtance at the extremity of his arm. He would not have the leaſt reaſon to conclude, that this whiteneſs was inſeparably united to the cauſe of this reſiſtance; and he would, in fact, draw no ſuch concluſion, till experience had taught him, that by removing the ball or cauſe of reſiſtance from his hand, he at the ſame time removed the ſenſation from his eye. After repeated experiments, he would indeed diſcover, that the cauſe of colour to the eye, was likewiſe by ſome means or other the cauſe of reſiſtance to the hand; and he would ſo aſſociate theſe in his mind, that the one would never afterwards make its appearance as an idea or a notion without bringing the other along with it. The whole difficulty, therefore, in this caſe, is to break an early and deep-rooted aſſociation; for it is plain that the aſſociated ideas were not originally united, and that ſolidity and colour were at firſt conceived as ſeparate.

If the reader perceive not the force of this reaſoning, we beg leave to recommend to him the following experiment, which, if we miſtake not, will carry conviction to his judgement, that in the laſt-quoted paſſage Biſhop Berkeley has argued fallaciouſly, and that extenſion and colour are not *inſeparably* united as ideas in the mind. Let him go into a dark room, containing a number of ſpherical bodies of various colours; let him take one of them into his hand;

and he will inſtantly *feel* reſiſtance, and have a *notion* of extenſion and ſolidity ; but will he likewiſe have the *idea* of colour inſeparably united with this notion ? The biſhop ſays he will : and if ſo, it muſt be the idea of ſome *particular* colour ; for his lordſhip has taught us, that the *abſtract* and *general* idea of colour, which is neither *red*, nor *green*, nor *blue*, &c. cannot poſſibly be formed. The man, then, we ſhall ſuppoſe, whilſt he feels reſiſtance, conceives the reſiſting body to be *green* ; and holding it ſtill in his hand, walks into the light of day. The *reſiſtance*, and conſequently the *cauſe* of reſiſtance, remains unchanged ; but what becomes of the inſeparable union of thoſe with colour, when the body, upon being actually ſeen, proves to be *black*, i. e. to have no colour at all ?—It appears, therefore, undeniable, that ſolidity and colour are not united in nature ; that the one is an eſſential quality of ſomething external to us, of which we have no *idea*, but a very diſtinct though relative *notion* ; and that the other is an actual ſenſation in our minds, cauſed by the impreſſion of ſomething external on the organ of ſenſe, which leaves behind it in the memory or imagination a poſitive and direct *idea* that exiſts no where elſe.

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Matter exiſts, but

Solid ſubſtance, therefore *may* exiſt, for though it is not immediately perceived by the ſenſes, and is a thing of which we can have no *idea*, we acquire a clear and diſtinct *notion* of it, by the very ſame means which Biſhop Berkeley thinks ſufficient to give us diſtinct notions of power and of ſpirits ; and, therefore, that notion can involve in it no contradiction. Still, however, we would not ſay with Dr Beattie, "that we could as eaſily believe, that two and two are equal to ten ; or, that whatever is, is not ; as that matter has no ſeparate exiſtence :" for it is certainly *poſſible*, that the Supreme Being, without the inſtrumentality of matter, could communicate to our minds all the ſenſations and notions from which we infer the reality of ſolid ſubſtance. All that we contend for, as having the evidence of demonſtration, is the *poſſibility* of ſolid and extended ſubſtance ; and if the thing be *poſſible*, the general voice of mankind proclaims its *probability*.—We are *conſcious* of our actual ſenſations, and we know by *experience* that they are cauſed by ſomething diſtinct from ourſelves. When a man graſps an ivory ball, he *feels* that he cannot ſhut his hand, and he knows that the reſiſtance which prevents him proceeds *not* from *himſelf*. Thus far all mankind are agreed. But Biſhop Berkeley ſays, that the reſiſtance proceeds immediately from the Supreme Being or ſome other ſpirit ; whilſt we, without pretending that his ſcheme is impoſſible, think it more natural to ſuppoſe that the man's hand is kept from ſhutting by the reſiſtance of a ſolid ſubſtance of four inches diameter ; of which ſubſtance, though we have no *idea* of it, we have as diſtinct a *notion* as Berkeley had of ſpirits. From one or other of theſe cauſes this effect muſt proceed ; and it is of little importance to life or happineſs which of them be the true cauſe, ſince it is with the effect only that we are immediately concerned. Still, however, a philoſopher would chooſe to adopt the eaſieſt and moſt natural ſide of every alternative ; which, if our notion of ſolidity be juſt, is certainly, in the preſent caſe, the exiſtence of matter.

After treating ſo largely of the compoſition of bodies, and ſhowing the general agreement of metaphyſicians, ancient and modern, with reſpect to the notion of their ſolidity, it will appear ſtrange to the leſs philoſophical part of our readers, that we ſhould now expreſs a doubt of that notion's being well-founded.—We have ourſelves no doubt, but on the contrary are fully convinced, that ſolidity is eſſential to matter. This, however, has of late been denied by philoſophers of great merit. Dr Prieſtley, after Mr Mitchell and Father Boſcovich, affirms that matter is *not ſolid* or impenetrable to other matter ; and that it has, in fact, no properties but thoſe of *attraction* and *repulſion* *. The proofs of this poſition, which appears ſo paradoxical, he draws from optical experiments, from electricity, and from the effects of heat and cold upon ſubſtances uſually conceived to be ſolid.

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is by ſome philoſophers denied to be ſolid.

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The arguments uſed in ſupport of this hypotheſis

The appearances from which the ſolidity of matter is inferred, are nothing more, he ſays, than ſuperficial appearances, and therefore have led to ſuperficial and falſe judgments, which the *real appearances* will not authorize. "*Reſiſtance*, on which alone our opinion concerning the ſolidity or impenetrability of matter, is founded, is never occaſioned by *ſolid matter*, but by ſomething of a very different nature, viz. a *power of repulſion*, always acting at a real, and in general an aſſignable diſtance, from what we call the body itſelf. When I preſs my hand againſt the table, I naturally imagine that the obſtacle to its going through the table, is the *ſolid matter* of which it conſiſts ; but a variety of philoſophical conſiderations demonſtrate that it generally requires a much greater power of preſſure than I can exert to bring my fingers into actual contact with the table. Electrical appearances ſhow that a conſiderable weight is requiſite to bring into ſeeming contact even the links of a chain hanging freely in the air, they being kept aſunder by a repulſive power belonging to a very ſmall ſurface, ſo that they do not actually touch, though they are ſupported by each other. It has been ſhown, from optical conſiderations, that a drop of water rolls upon a cabbage leaf without ever coming into actual contact with it ; and indeed all the phenomena of *light* are moſt remarkably unfavourable to the hypotheſis of the ſolidity or impenetrability of matter. When light is reflected back from a body on which it ſeems to ſtrike, it was natural to ſuppoſe that this was occaſioned by its impinging againſt the *ſolid parts* of the body ; but it has been demonſtrated by Sir Iſaac Newton, that the rays of light are always reflected by a *power of repulſion* acting at ſome diſtance from the body. Again, when part of a beam of light has overcome this power of repulſion, and has entered any tranſparent ſubſtance, it goes on in a right line, provided the medium be of a uniform denſity, without the leaſt interruption, and without a ſingle particle being reflected, till it comes to the oppoſite ſide, having met with no ſolid particles in its way, not even in the denſeſt tranſparent ſubſtances, as glaſs, cryſtal, or diamond ; and when it is arrived at the oppoſite ſide, it is ſolely affected by the laws of attraction and repulſion.

"Nay, that the component particles of the hardeſt bodies themſelves do not actually touch one another, is demonſtrable from their being brought nearer together by cold, and by their being removed farther from each other by heat. The power ſufficient to overcome

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* *Diſquiſitions on Matter and Spirit*, and *Correſpondence with Dr Price.*

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theſe internal forces of repulſion, by which the ultimate particles of bodies are prevented from coming into actual contact, is what no perſon can pretend to compute. The power requiſite to break their coheſion, or to remove them from the ſphere of each other's attraction, may in ſome meaſure be eſtimated; but this affords no *data* for aſcertaining the force that would be neceſſary to bring them into actual contact, which may exceed the other almoſt infinitely."

From theſe facts, Dr Prieſtley infers, that the mutual reſiſtance of bodies proceeds in all caſes from powers of repulſion acting at a diſtance from each body: that the ſuppoſition of the *ſolidity* or *impenetrability* of matter is deſtitute of all ſupport whatever; and that matter itſelf is nothing but powers of attraction and repulſion, and ſeveral ſpheres of them, one within another. As other philoſophers have ſaid, "Take away ſolidity, and matter vaniſhes;" ſo he ſays expreſsly, "Take away attraction and repulſion, and matter vaniſhes."

To illuſtrate this ſtrange notion, "Suppoſe (ſays he) that the Divine Being, when he created *matter*, only fixed certain *centres of various attractions and repulſions*, extending indefinitely in all directions, the whole effect of them to be upon each other: theſe centres approaching to, or receding from each other, and conſequently carrying their peculiar ſpheres of attraction and repulſion along with them, according to certain definite circumſtances. It cannot be denied that theſe ſpheres may be diverſified infinitely, ſo as to correſpond to all the kinds of bodies that we are acquainted with, or that are poſſible. For all effects in which bodies are concerned, and of which we can be ſenſible by our eyes, touch, &c. may be reſolved into attraction or repulſion. A compages of theſe centres, placed within the ſpheres of each other's attraction, will conſtitute a body that we term *compact*; and two of theſe bodies will, on their approach, meet with a repulſion or reſiſtance ſufficient to prevent one of them from occupying the place of the other, without a much greater force than we are capable of employing; ſo that to us they will appear perfectly hard.

"As in the conſtitution of all actual bodies that we are acquainted with, theſe centres are placed ſo near to each other, that in every diviſion that we can make we ſtill leave parts which contain many of theſe centres; we, reaſoning by analogy, ſuppoſe that every particle of matter is infinitely diviſible; and the *ſpace* it occupies is certainly ſo. But, ſtrictly ſpeaking, as thoſe centres which conſtitute any body are not abſolutely infinite, it muſt be naturally poſſible to come by diviſion to one ſingle centre, which could not be ſaid to be diviſible, or even to occupy any portion of ſpace, though its ſphere of action ſhould extend ever ſo far; and had only *one* ſuch centre of attraction, &c. exiſted, its exiſtence could not have been known, becauſe there would have been nothing on which its action could have been exerted; and there being no *effect*, there could not have been any ground for ſuppoſing a *cauſe*."

In anſwer to this reaſoning againſt the ſolidity of matter, Dr Prieſtley was frequently aſked by his candid and maſterly antagoniſt *, "What it is that attracts and repels, and that is attracted and repelled?" But to the queſtion he was never able to give a ſatisfactory anſwer. Indeed, how could he have been able? for, as Dr Price argues, "Excluſive of attraction and repulſion, he affirms matter to be abſolutely nothing: and therefore, though we were to allow it the power of attracting and repelling, yet as it is nothing but this power, it muſt be the power of nothing, and the very idea of it be a contradiction."

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founded on fallacious appearances and contrary to an intuitive and neceſſary truth.

If there be any claſs of truths intuitively certain, that claſs comprehends the two following propoſitions: POWER CANNOT BE WITHOUT A SUBJECT; and NOTHING CAN ACT WHERE IT IS NOT. If, therefore, there be powers of attraction and repulſion, (which ſhall be conſidered afterwards in the Chapter of MOTION), there muſt be a ſubject of thoſe powers; and if matter, whether ſolid or unſolid, be the ſubject, it cannot poſſibly attract or repel at a *diſtance*. Sir Iſaac Newton, in his letters to Dr Bentley, calls the notion that matter poſſeſſes an innate power of attraction, or that it can act upon matter at a diſtance, and attract and repel by its own agency, "an abſurdity into which, he thought, no one could poſſibly fall." Hence it follows, that the appearances from which Dr Prieſtley infers the penetrability of matter muſt be fallacious appearances, ſince they contradict an intuitive and neceſſary truth. The facts which he inſtances are, indeed, ſuch as would make moſt other men ſuſpicious of fallacy, and in his reaſonings from them he ſometimes takes for granted the truth to be proved. The links of a chain uſed for electrical purpoſes, ſuppoſing them to be in contact with each other, can touch only with very ſmall ſurfaces. The electrical fluid is of conſiderable denſity, and incapable of being abſorbed within a very narrow compaſs. This is evident, becauſe it paſſes not through paper and other porous bodies without making a paſſage for itſelf, and leaving a viſible aperture behind it; and though it aſſimilates with metals, and paſſes through them more eaſily than through other bodies, yet is it plain that it requires a certain quantity of metal to conduct it; for when the conductor falls ſhort of the neceſſary quantity, it is melted or diſſipated by the force of the fluid. This being the caſe, it follows that the links of a chain *may be* in actual contact (we do not poſitively affirm that they *are*), and yet the fluid become viſible in paſſing from link to link; for if the point of contact be too ſmall to abſorb the *whole* fluid, *part* of it muſt paſs without any metallic conductor through the atmoſphere, and thus become apparent to the eye of the ſpectator.

With reſpect to light, it is obvious that there cannot poſſibly be any *demonſtration*, in the logical ſenſe of the word, that it is reflected by a power of repulſion acting at ſome diſtance from the body; for, in the opinion of all mankind, the primary and ſolid atoms of matter are too minute to fall under the cognizance of our ſenſes, however aſſiſted by art; and therefore, if light *appears* to be reflected at a diſtance from the ſurface of the body, we muſt conclude, either that between the point of reflection and the apparent ſurface of the body, there are ſolid atoms unperceived by us, or that light is reflected by the agency of ſome other ſubſtance than matter. One of theſe concluſions, we ſay *muſt* be drawn, becauſe they are both *poſſible*, and there is no other alternative but to admit one of them, or to ſuppoſe that a thing may act where it is not; which is as clearly abſurd and *impoſſible* as that *whatever is, is not.* Again, When part of a beam of light has entered any tranſparent ſubſtance, how does Dr Prieſtley know that it goes on in a right line, without the leaſt interruption, till it comes to the oppoſite ſide? This he can know only by his ſenſes; but the beam may meet with ten thouſand interruptions from objects which the ſenſes cannot perceive, and may deſcribe a zig-zag line, of which the deflections are ſo ſmall as to elude the keeneſt eye aided by the moſt powerful glaſs.

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* *Free Diſcuſſion between Dr Price and Dr Prieſtley.*

That the component particles of the hardeſt bodies do not *all* actually touch one another, is indeed evident from the effects of cold and heat upon thoſe bodies: but it does not therefore follow that thoſe bodies have no component particles; but only, that they are fewer in number than we are apt to imagine; that all the ſolid matter in the univerſe might poſſibly be compreſſed within a very narrow ſphere; and that it is held together in different bodies and different ſyſtems by a power foreign from itſelf. Theſe are truths which all philoſophers have admitted who have thought ſufficiently on the ſubject; but who will admit Dr Prieſtley's propoſition, when it is tranſlated into common Engliſh: "That the component *nothings* of the hardeſt bodies do not actually touch one another, is demonſtrable from their being brought nearer together by cold, and by their being removed farther from each other by heat?"

176 Our moſt adequate notion of matter.

Dr Prieſtley owns, that if matter be ſolid it could act upon other matter by impulſe. We are certain, that, whatever it be, it can act upon nothing in the manner which he deſcribes; and therefore, to uſe the words of Dr Price, "matter, if it be any thing at all, muſt conſiſt of ſolid particles or atoms occupying a certain portion of ſpace, and therefore *extended*, but at the ſame time *ſimple* and *uncompounded*, and incapable of being reſolved into any other ſmaller particles. It muſt likewiſe be the different form of theſe *primary* particles, and their different combinations and arrangement, that conſtitute the different bodies and kinds of matter in the univerſe." This is exactly agreeable to the doctrines of Newton; who, after conſidering the queſtion in every point of view, concludes, that "in the beginning God formed matter in ſolid, maſſy, hard, impenetrable, moveable particles, of ſuch ſizes and figures, and with ſuch other properties, as moſt conduced to the end for which he formed them; and that thoſe primary particles being ſolid, are incomparably harder than any porous bodies compounded of them; even ſo very hard as never to wear or break in pieces: no ordinary power being able to divide what God himſelf made one in the creation." To talk, as Dr Prieſtley does, of matter's being certain *centres of various attractions and repulſions* extending indefinitely in all directions, and to deſcribe theſe centres as *not* being *phyſical points* or *ſolid atoms,* is either to ſay, that *nothing* attracts and repels; or it is to introduce the divine agency as the immediate cauſe of all our ſenſations. The former of theſe alternatives Dr Prieſtley diſclaims; the latter he ſeems willing to admit. But if it be his meaning that all our ſenſations are cauſed by the immediate agency of God or created ſpirits, his ſcheme differs not from that of Berkeley, except in being leſs elegantly expreſſed and leſs ingeniouſly ſupported. Berkeley's ſcheme is evidently *poſſible.* The commonly received ſcheme is likewiſe poſſible. It remains therefore with the reader, whether he will adopt the ſyſtem of the Biſhop of Cloyne; or admit, with all other philoſophers, that matter exiſts; that it conſiſts of parts actually diſtinct and ſeparable; and that each of theſe parts is a *monad* or ſolid atom, which requires no foreign agency to keep it united.

CHAP. IV. *Of* SPACE *and its* MODES.

177 The neceſſary adjuncts of body, what.

HAVING conſidered bodies in their ſubſtance, eſſences and qualities, and proved that they have a real exiſtence independent of us and our conceptions, we proceed now to inquire into the nature of *ſpace*, *motion*, *number*, and *duration.* Theſe are commonly called the *adjuncts* of body, and are ſuppoſed to be abſolutely inſeparable from its exiſtence. It does not indeed appear that *actual motion* is a neceſſary adjunct of body, conſidered as a mere ſolid, extended, and figured ſubſtance; but it is certainly neceſſary to the exiſtence of organized and animated bodies, and the capability of being moved enters into our conceptions of all bodies whatever. Of theſe adjuncts, that which firſt demands our attention is *ſpace:* for without a knowledge of its nature we could not have an adequate idea of motion, and without motion we could have no idea of time.

178 Our notion of ſpace, how acquired.

Every body is extended; and between two bodies not in actual contact, we perceive that a third body may be eaſily introduced. That which admits of the introduction of the third body is what we call *ſpace:* and if it be totally void of matter, it is called *pure ſpace.* Whether there be any ſpace abſolutely pure, has been diſputed; but that ſuch ſpace is poſſible, admits of no diſpute. Were any one body (a cannon ball for inſtance) to be annihilated, and the circumambient air, with every other material ſubſtance, kept from ruſhing into the ſpace which the ball had occupied, that portion of ſpace, with reſpect to matter, would be empty or pure ſpace: whether it would neceſſarily be filled with mind ſhall be conſidered afterwards. Pure ſpace, therefore, is conceivable; and it is conceived as having three dimenſions, length, breadth, and depth, which are generally called the three ſimple modes of ſpace. In this reſpect it agrees with body: but the agreement proceeds no farther; for ſpace is conceived as deſtitute of ſolidity, without which the exiſtence of body is inconceivable. It has been formerly obſerved, that whatever may be diſtinctly conceived may poſſibly exiſt; but with reſpect to the exiſtence of pure ſpace, whatever is poſſible is real: for it ſhall be ſhown in the next ſection, that were there no ſpace abſolutely pure or void of matter, there could be no motion. Our buſineſs at preſent is to inquire what the nature of ſpace is, and what notion we ought to have of its exiſtence.

179 Space ſuppoſed to be ſomething different from body and mind, and to be eternal and infinite, &c.

Many modern philoſophers conſider ſpace as ſomething entirely diſtinct both from body and mind: ſome of them aſcribe to it no leſs than four of the attributes of the Deity—*eternity*, *immobility*, *infinity*, and *neceſſary exiſtence;* and a few of them have gone ſo far as to call *infinite ſpace* the *ſenſorium* of the Deity. "The ſuppoſal of the exiſtence of *any thing whatever* (ſays Dr

Clarke *) neceſſarily includes a *preſuppoſition* of the exiſtence of *ſpace.* Nothing can poſſibly be conceived to exiſt without thereby preſuppoſing ſpace; which, therefore, I apprehend to be a *property* or *mode* of the ſelf-exiſtent Subſtance; and that, by being evidently neceſſary itſelf, it proves, that the ſubſtance of which it is a property muſt be alſo neceſſary." Elſewhere he ſays, that "ſpace is a property or mode of the ſelf-exiſtent Subſtance, but not of any other ſubſtances. All other ſubſtances are *in* ſpace, and are *penetrated* by it; but the ſelf-exiſtent Subſtance is not in ſpace, nor penetrated by it, but is itſelf (if I may ſo ſpeak) the *ſubſtratum* of ſpace, the *ground* of the exiſtence of *ſpace* itſelf." He acknowledges, however, that ſuch expreſſions as "the ſelf-exiſtent Subſtance is the *ſubſtratum* of ſpace, or ſpace is a property of the ſelf-exiſtent Subſtance, are *not*, perhaps, very proper: but what I mean (ſays he), is this: The idea of *ſpace* (as alſo of *time* or *duration*) is an abſtract or partial idea; an idea of a certain *quality* or *relation*, which we evidently ſee to be neceſſarily exiſting; and yet (which not being itſelf a *ſubſtance*) at the ſame time neceſſarily *preſuppoſes* a ſubſtance, without which it could not exiſt."

Theſe opinions reſpecting ſpace have been adopted by ſucceeding philoſophers of great merit, and particularly by Dr Price; who ſays, that "it is a maxim which connot be diſputed, that *time* and *place* are neceſſary to the exiſtence of all things. Dr Clarke (continues he) has made uſe of this maxim, to prove that infinite ſpace and duration are the eſſential properties of the Deity; and I think he was right."

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This ſuppoſition controverted.

Had authority any weight in philoſophy, we know not what modern writers we could oppoſe to the celebrated names of Clarke and Price, unleſs it were Biſhop Berkeley, Dr Law late biſhop of Carliſle, and the author of Ancient Metaphyſics. But the queſtion is not to be decided by authority. Learned and acute as Dr Clarke was, his aſſertions reſpecting ſpace are contradictory and inconſiſtent. If nothing can poſſibly be conceived to exiſt without thereby preſuppoſing the exiſtence of *ſpace*, how can ſpace be a property or mode of the ſelf-exiſtent Subſtance? Are properties prior in the order of nature, or even in our conceptions, to the ſubſtances in which they inhere? Can we frame an abſtract idea of figure, or extenſion, or ſolidity, before we conceive the exiſtence of any one figured, extended, or ſolid ſubſtance? Theſe are queſtions which every man is as capable of anſwering as the Doctors Clarke and Price, provided he can look attentively into his own mind, and trace his ideas to their ſource in ſenſation: and if he be not biaſſed by the weight of great names, we are perſuaded he will find, that if it be indeed true, that the ſuppoſal of the exiſtence of any thing whatever neceſſarily includes a *preſuppoſition* of the exiſtence of ſpace, *ſpace* cannot poſſibly be a *property* or *mode* of the ſelf-exiſtent Subſtance, but muſt of neceſſity be a *ſubſtance* itſelf.

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Space neceſſary to the exiſtence of every thing.

It is, however, *not* true, that the ſuppoſal of the exiſtence of any thing whatever neceſſarily includes a preſuppoſition of the exiſtence of ſpace. The idea of ſpace is indeed ſo cloſely aſſociated with every viſible and tangible object, that we cannot ſee the one nor feel the other without conceiving them to occupy ſo much of ſpace. But had we never poſſeſſed the ſenſes of ſight and touch, we could not have ſuppoſed the exiſtence of ſpace neceſſary to the exiſtence of any thing whatever. The ſenſes of ſmelling, taſting, and hearing, together with our internal powers of conſciouſneſs and intellect, would certainly have compelled us to believe in our own exiſtence, and to ſuppoſe the exiſtence of other things; but no object either of conſciouſneſs, ſmelling, taſting, or hearing, can be conceived as occupying ſpace. Space and every thing which fills it are conceived as of three dimenſions; but who ever ſuppoſed or can ſuppoſe an *odour*, *taſte*, or *ſound*, to have *length*, *breadth*, and *depth*; or an object of conſciouſneſs to be an ell or an inch long?

Let us ſuppoſe that body and all the viſible world had a beginning, and that once nothing exiſted but that Being which is alone of neceſſary as well as eternal exiſtence; *ſpace*, ſay the followers of Dr Clarke, would then exiſt likewiſe without bounds or limits. But we deſire to know of theſe gentlemen what ſort of a being this ſpace is. It certainly is not *ſubſtance*; neither is it a property; for we have ſeen that the very notions of it, which lead men to ſuppoſe its exiſtence *neceſſary*, render it impoſſible to be a property of the ſelf-exiſtent Being. Is it then nothing? It "is in one ſenſe *: it is nothing *actually* exiſting; but it is ſomething *potentially*; for it has the *capacity* of receiving body whenever it ſhall exiſt. It is not, and cannot, become any thing itſelf, nor hath it any actual exiſtence; but it is that without which nothing corporeal could exiſt." For this reaſon it was that Democritus and Epicurus made ſpace one of the principles of nature; and for the ſame reaſon Ariſtotle has made *privation* one of his three principles of natural things, *matter* and *form* being the other two. But though the privation of *one* form be doubtleſs neceſſary before matter can receive another (for a piece of wax or clay cannot receive the form of a *globe* before it loſe the form of a ſquare), yet Ariſtotle never dreamed that the privation of the ſquare was any property of the globe, or that *privation* itſelf was to be reckoned a real being. On the contrary, he expreſsly calls it το μη ον, or *the no being*. In this way, if we pleaſe, we may conſider ſpace, and call it the *privation of fullneſs* or of body. We have indeed a poſitive idea of it, as well as of ſilence, darkneſs, and other privations: but to argue from ſuch an idea of ſpace, that ſpace itſelf is ſomething real, ſeems altogether as good ſenſe as to ſay, that becauſe we have a different idea of *darkneſs* from that of *light*, of *ſilence* from that of *ſound*, of the *abſence* of any thing from that of its *preſence*; therefore *darkneſs*, *ſilence*, *abſence*, muſt be real things, and have as poſitive an exiſtence as *light*, *ſound*, and *body*: and to deny that we have any poſitive idea, or, which is the very ſame thing, any idea at all, of the privations above mentioned, will be to deny what is capable of the moſt complete proof (ſee N° 19.), and to contradict common ſenſe and daily experience. There are therefore ideas, and ſimple ones too, which have nothing *ad extra* correſpondent to them; no proper *idiatum*, archetype, or objective reality: and we do not ſee why the idea of ſpace may not be reckoned of that number. To ſay that *ſpace* muſt have exiſtence, becauſe it has ſome properties (for inſtance, *penetrability*, or the *capacity* of receiving body), ſeems † to be the ſame thing as to urge that *darkneſs* muſt be *ſomething* becauſe it has the capacity of *receiving light*; *ſilence* the property of admitting *ſound*; and *abſence* the property of being ſupplied by *preſence*. To reaſon in this manner is to aſſign abſolute negations; and ſuch as, in the ſame way, may be applied to *nothing*, and then call them *poſitive properties*; and ſo infer that the chimera, thus clothed with them, muſt needs be *ſomething*.

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* *Demonſtration of the Being and Attributes of God*, and *Correſpondence with a Gentleman in Glouceſterſhire*, paſſim.

* *Ancient Metaphyſics.*

† See *Notes on King's Origin of Evil*, and *Law's Enquiry into the Ideas of Space*, &c.

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Space nothing but the poſſible exiſtence of body.

But it is ſaid, that as we cannot conceive ſpace to be annihilated, it muſt be ſome real thing of eternal and neceſſary exiſtence. If this argument had not been uſed by writers of great merit, and with the beſt intention, we ſhould not have ſcrupled to call it the moſt contemptible ſophiſm that ever diſgraced the page of philoſophy. Whatever now has an *actual* exiſtence, muſt from eternity have had a *poſſible* exiſtence in the ideas of the Divine mind. Body, as an extended ſubſtance, has now an *actual* exiſtence; and therefore it muſt from eternity have had a *poſſible* exiſtence in the ideas of the Divine mind: but the *poſſible exiſtence of body* is all that we can conceive by *ſpace*; and therefore this argument, upon which ſo much ſtreſs has been laid, amounts to nothing more, than that what has from eternity been poſſible, can at no period have been impoſſible. It is evident that the *capacity* or *potentiality* of every thing exiſting muſt have been from eternity; but is capacity or potentiality a real being? All the men and women who ſhall ſucceed the preſent generation to the end of time, have at this moment a poſſibility of exiſtence, nor can that poſſibility be conceived as an impoſſibility; but is it therefore any thing actually exiſting either as a ſubſtance or a quality?

It has been urged, that ſpace muſt be ſomething more than the mere abſence of matter; becauſe if nothing be between bodies, ſuch as the walls of a room, they muſt neceſſarily touch. But ſurely it is not *ſelf-evident* that bodies muſt neceſſarily touch if nothing be between them; nor of the truth of this propoſition can any thing like a proof be brought. It is indeed intuitively certain, that "things, when they are in contact, have nothing between them:" and hence it has raſhly been inferred, that things, when they have nothing between them, are in contact; but this is an illegitimate converſion of the propoſition. Every logician knows, that to convert a propoſition, is to infer from it another whoſe *ſubject* is the *predicate*, and whoſe *predicate* is the *ſubject*, of the propoſition to be converted: but we are taught by Ariſtotle and by common ſenſe, that an *univerſal* affirmative can be converted only into a *particular* affirmative. "Things, when they are in contact, have nothing between them," is an *univerſal* affirmative propoſition; and therefore it can be converted only into the following *particular* affirmative: "Some things, when they have nothing between them, are in contact;" a propoſition which by no means includes in it the contact of the walls of an empty room. The reaſon why the walls of an empty room do not touch, is that they are *diſtant*; but is *diſtance*, in the abſtract, any thing really exiſting? Two individuals differ, or there is a difference between them; but is *difference* itſelf any real external thing? Bodies are long, broad, thick, heavy; but are *length*, *breadth*, *denſity*, *weight*, properly any thing? Have they any real ſeparate archetypes or external ideata? Or can they exiſt but in ſome ſubſtance?

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The fallacy which led to the ſuppoſition that ſpace is a real thing.

The reaſon why ſo many philoſophers have conſidered ſpace as a real external thing, ſeems to be this: Every bodily ſubſtance is extended; but ſpace is conceived to be that which contains body, and therefore to ſpace we likewiſe attribute extenſion. Extenſion is a quality which can have no exiſtence but as united with other qualities in ſome ſubſtance; and it is that of which, abſtracted from all ſubſtances, we can, properly ſpeaking, form no *idea*. We underſtand the meaning of the word, however, and can reaſon about that which it denotes, without regarding the particular ſubſtance in which extenſion may inhere; juſt as we can reaſon about whiteneſs without regarding any one white object, though it is ſelf-evident that whiteneſs, abſtracted from all objects, cannot figure in the mind as an idea. Qualities conſidered in this manner are general and relative notions, the objects of pure intellect, which make no appearance in the imagination, and are far leſs, if poſſible, to be perceived by ſenſe: but it is extremely painful to the mind to dwell upon ſuch notions; and therefore the ever-active fancy is always ready to furniſh them with imaginary *ſubſtrata*, and to make that which was a *general* and *inviſible notion* be conceived as a *particular ideal object*. In the caſe of extenſion this is the more eaſily done, that the notion which we have of a *real ſubſtratum* or ſubſtance, the ſupport of real qualities, is obſcure and relative, being the notion of *ſomething* we know not what. Now, by leaving, if we can, ſolidity and figure out of our conception, and joining the notion of *ſomething* with the notion of *extenſion*, we have at once the *imaginary ſubſtratum* of an *imaginary* quality, or the general notion of extenſion particularized in an imaginary ſubject: and this ſubject we call *ſpace*, vainly fancying that it has a real external and independent exiſtence. Whether this be not all that can be ſaid of ſpace, and whether it be not abſurd to talk of its having any real properties, every man will judge for himſelf, by reflecting upon his own ideas and the manner in which they are acquired. We ourſelves have no doubt about the matter. We conſider pure ſpace as a mere notion relative to the exiſtence of corporeal ſubſtance, as nothing more than the abſence of body, where body is poſſible; and we think the uſual diſtinction between *abſolute* and *relative* ſpace, if taken as real, the groſſeſt abſurdity. We do not however, pretend to dictate to others; but recommend it to every man to throw away all reſpect for great names, to look attentively into his own thoughts, and on this as on all metaphyſical ſubjects to judge for himſelf.

184
Place, what it is.

Having ſaid ſo much of ſpace in general, we need not waſte much time upon its modes. Indeed the only mode of ſpace, after conſidering it with reſpect to the three dimenſions of body, which now demands our attention, is that which we call *place*. As in the ſimpleſt mode of ſpace we conſider the relation of diſtance between any two bodies or points; ſo, in our idea of *place*, we conſider the relation of diſtance betwixt any thing, and any two or more points, which, being conſidered as at reſt, keep the ſame diſtance one from another. Thus, when we find any thing at the ſame diſtance now at which it was yeſterday from two or more points with which it was then compared, and which have not ſince the compariſon was made changed

their

Of Space and its Modes.

their diſtance or poſition with reſpect to each other, we ſay that the thing hath kept its *place*, or is in the *ſame place*; but if it hath ſenſibly altered its diſtance from either of theſe points, we then ſay that it hath changed its *place*.

From this view of the nature of place, we need not obſerve that it is a mere relation; but it may be worth while to advert to this circumſtance, that a thing may without falſehood be ſaid to have continued in the ſame place, and at the ſame time to have changed its place, according to the different objects with which it is compared. Thus, if two perſons find a company of cheſs-men ſtanding each upon the ſame ſquare of the cheſs board where they left them, the one may with truth affirm that they are all in the *ſame place*, or unmoved; and the other may with equal truth affirm that they have all changed *place*. The former conſiders the men only with reſpect to their diſtances from the ſeveral parts of the cheſs-board, which have kept the ſame diſtance and poſition with reſpect to one another. The latter muſt conſider the men with reſpect to their diſtance from ſomething elſe: and finding that the cheſs-board, with every thing upon it, has been removed, we ſhall ſuppoſe from one room to another, he cannot but ſay that the cheſs-men have changed their place with reſpect to the ſeveral parts of the room in which he formerly ſaw them.

This modification of diſtance, however, which we call *place*, being made by men for their common uſe, that by it they may deſign the particular poſition of objects where they have occaſion for ſuch deſignation, they determine this *place* by reference to ſuch adjacent things as beſt ſerve their preſent purpoſe, without regarding other things which, for a different purpoſe, would better determine the place of the ſame object. Thus in the cheſs-board, the uſe of the *deſignation of the place* of each cheſs-man being determined only within that chequered piece of wood, it would croſs that purpoſe to meaſure it by any thing elſe: but when theſe very cheſs-men are put up in a box, if any one ſhould aſk where the black king is, it would be proper to *determine the place* by reference to ſomething elſe than the cheſs-board; ſuch as the parts of the room or cloſet which contain the box.

185 The univerſe has no place.

That our idea of *place* is nothing but ſuch a relative poſition of things as we have mentioned, will be readily admitted, when it is conſidered that we can have no idea of the place of the *univerſe*. Every *part* of the univerſe has place; becauſe it may be compared with reſpect to its diſtance from other parts ſuppoſed to be fixed. Thus the earth and every planet of our ſyſtem has a place which may be determined by aſcertaining its diſtance from the ſun and from the orbits of the other planets; and the place of the ſyſtem itſelf may be aſcertained by comparing it with two or more fixed ſtars: but all the ſyſtems taken as *one whole* can have no *place*; becauſe there is nothing elſe to which the diſtance and poſition of that whole can be referred. It is indeed true, that the word *place* is ſometimes uſed, we think improperly, to denote that *ſpace* or portion of *ſpace* which any particular body occupies; and in this ſenſe, no doubt, the univerſe has place, as well as the earth or ſolar ſyſtem: but to talk of the place of the univerſe in the other and proper ſenſe of the word, is the groſſeſt nonſenſe.

CHAP. V. *Of* MOTION.

Of Motion.

156 Mobility eſſential to every corporeal ſubſtance, but not natural motural.

MOBILITY, or a capacity of being moved, is eſſential to every corporeal ſubſtance; and by actual motion are all the operations of nature performed. Motion, therefore, if it may be called an *adjunct* of body, is certainly the moſt important of all its adjuncts; and to aſcertain its nature and origin demands the cloſeſt attention of the metaphyſician, as well as of the mechanic and aſtronomer. With the *laws* of motion, as diſcovered by experience, we have at preſent no concern: they are explained and fully eſtabliſhed in other articles of this work (See MECHANICS, MOTION, &c.) The principal queſtions which we have to conſider are: "What is motion? and, By what power is it carried on?"

For an anſwer to the firſt of theſe queſtions, the modern metaphyſician refers every man to his own ſenſes; becauſe, in his apprehenſion, the word motion denotes a ſimple idea which cannot be defined. Among the ancients, the Peripatetics were of a different opinion; and Ariſtotle, whoſe love of dialectic made him define every thing, has attempted to give two definitions of *motion*. As ſome learned men are at preſent labouring to revive this ſyſtem, we ſhall, out of reſpect to them, mention thoſe definitions, and make upon them ſuch remarks as to us appear proper.

157 The Peripatetic definitions of motion

The author of *Ancient Metaphyſics* having obſerved, that both nature and art propoſe ſome end in all their operations; that when the end is obtained, the thing operated upon is in a ſtate of perfection or completion; and that in the operations of both nature and art there is a progreſs, and by conſequence a *change*, from one thing to another; adds, that this change is *motion*. Motion, therefore, according to him, is a change or progreſs to the end propoſed, or to that ſtate of perfection or completion which Ariſtotle calls εντελεχεια. It is not enough, however, that we know *to what* the change or progreſs is made: to have an adequate idea of motion, we muſt likewiſe know *from what* it proceeds. Now it is evident that every thing exiſting, whether by nature or art, was, before it exiſted, poſſible to exiſt; and therefore, adds the ſame author, things do in ſome ſort exiſt even before they exiſt. This former kind of exiſtence is ſaid by Ariſtotle to be εν δυναμει, that is, in *power* or *capacity*. In this way, plants exiſt in their ſeeds; animals in the embryo; works of art in the idea of the artiſts and the materials of which they are made; and, in general, every thing in the cauſes which produce it. From this power or capacity there is a progreſs to *energy* or actual exiſtence; ſo that we are now able to anſwer the queſtion, "*from what*, and *to what*, motion is a change?" for it is univerſally true of all *motion*, that it is a change from *capacity* to *energy*.

"Having thus diſcovered that *motion* lies betwixt *capacity* and *energy*, it is evident (he ſays) that it muſt have a connexion with each of them: and from this double connexion Ariſtotle has given us two definitions of it; one of them taken from the *energy*, or end to which it tends; the other from the *capacity* from which it begins. The firſt is expreſſed in two words, viz. ενεργεια ατελης, or *imperfect energy*; the other is εντελεχεια του εν δυναμει ἡ εν δυναμει; which may be tranſlated thus, *The perfection of what is in capacity, conſidered merely as in capacity.* The meaning of the laſt words is, that nothing is conſidered in the thing that is moved but merely its *capacity;* ſo that motion is the perfection of that capacity, but not of the thing itſelf. It is ſomething more (adds the learned author) than mere *capacity;* for it is capacity exerted, which when it has attained its end, ſo that the thing has arrived at that ſtate to which it is deſtined by nature or art, ceaſes, and the thing begins to exiſt ενεργεια, or *actually.*

188 unintelligible. By all the admirers of Ariſtotle, this latter definition has been preferred to the former; for what reaſon, it is difficult to ſay. They both involve in the thickeſt obſcurity that which, viewed through the ſenſes, is very eaſily underſtood; and on this, as on many other occaſions, Ariſtotle was certainly guilty of darkening counſel by words without knowledge. The author, whoſe comment on this wonderful definition we have faithfully abridged, admits that it is not intelligible till we know what *change* and *progreſs* are; but is it poſſible to conceive any *change* to take place in bodily ſubſtances without *motion?* or, if we were called upon to explain what progreſs is, could we do it better than by ſaying that it is motion *from* ſomething *to* ſomething? It is likewiſe very obvious, that before we can have an adequate idea of *motion*, we muſt, according to this definition, know perfectly what the words *capacity*, *energy*, and *perfection* denote; and yet nothing can be more true than that *perfection* denotes a complex conception, which may be eaſily defined by reſolving it into the ſimple ideas and notions of which it is compounded, whilſt *motion* is ſuſceptible of no ſuch reſolution. The perfection of a knife is compounded of the temper of the ſteel and the ſharpneſs of the edge: the perfection of a ſyſtem of philoſophy conſiſts of the importance of the ſubjects treated, the ſtrength of the author's arguments, and the perſpicuity of his ſtyle and manner; but of what is the *motion* of a ball, or an *atom*, or any thing elſe, compounded? We are aware that to this queſtion the modern Peripatetics will reply, That it is not the motion of a *ball*, or an *atom*, or any *one thing*, that their maſter has ſo learnedly defined, but motion abſtracted from *all individuals*, and made an object of pure intellect; and they will likewiſe affirm, that by the word *perfection* uſed in the definition, he does not mean *any one kind* of perfection as adapted to any particular *object* or *end*, but perfection abſtracted from *all objects* and *all ends*. The perfection of *nothing* and the motion of *nothing*, for ſuch ſurely are that motion and that perfection which are abſtracted from *all objects* and *ends*, are ſtrange expreſſions. To us they convey no meaning; and we have reaſon to think that they are equally unintelligible to men of greater acuteneſs (o). In a word, *motion* muſt be ſeen or felt; for it cannot be defined. To call it the *act of changing place*, or a *paſſage from one place to another*, gives no information; for *change* and *paſſage* cannot be conceived without previouſly conceiving *motion* (p).

189 The Peripatetic diviſion of motion abſurd. The Peripatetics having idly attempted to *define* motion, proceed next to *divide* it into four kinds or claſſes. This diviſion was by the father of the ſchool pretended to be made from the effects which it produces, and was ſaid by him to belong to three categories, viz. *quality*, *quantity*, and *where*, (ſee CATEGORY). The firſt kind is that well-known *motion* from *place* to *place*, which falls under the category laſt mentioned; the ſecond is *alteration*, by which the quality of any thing is changed, the ſubſtance remaining the ſame. This belongs to the category of *quality*. The third is *increaſe*, and the fourth *diminution*, both belonging to the category of *quantity*. The ancient atomiſts, and all the modern metaphyſicians of eminence, have with great propriety rejected this diviſion, as being nothing but a collection of abſurd diſtinctions where there is in nature no difference. It has been already ſhown, that body has no other real qualities than *ſolidity*, *extenſion*, and *figure:* but of theſe the firſt cannot be altered without deſtroying the ſubſtance; for every thing which is material is equally ſolid. The extenſion of a body may indeed be enlarged, and its figure may be altered, while the ſubſtance remains the ſame; but that alteration can be made only by moving from their *places* the ſolid atoms of which the body is compoſed. Ariſtotle's ſecond kind of motion therefore differs not from the firſt; nor do the third and fourth differ from theſe two. For a body cannot be *increaſed* without acquiring new matter, nor diminiſhed without loſing ſome of the matter of which it was

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(o) "Nunc dicendum de natura motus. Atque is quidem, cum ſenſibus clare percipiatur, non tam natura ſua, quam doctis philoſophorum commentis obſcuratus eſt. Motus nunquam in ſenſus noſtros incurrit ſine mole corporea, ſpatio et tempore. Sunt tamen qui motum, tanquam ideam quandam ſimplicem et abſtractam, atque *ab omnibus aliis rebus ſejunctam*, contemplari ſtudent. Verum idea illa tenuiſſima et ſubtiliſſima *intellectus aciem eludit:* id quod quilibet ſecum meditando experiri poteſt. Hinc naſcuntur magnæ difficultates de natura motus, et definitiones, ipſa re quam illuſtrare debent longe obſcuriores. Hujuſmodi ſunt definitiones illæ Ariſtotelis et ſcholaſticorum, qui motum dicunt eſſe *actum mobilis quatenus eſt mobile*, vel; *actum entis in potentia quatenus in potentia.* Hujuſmodi etiam eſt illud viri inter recentiores celebris, qui aſſerit *nihil in motu eſſe reale præter momentaneum illud quod in vi ad mutationem nitente conſtitui debet.* Porro conſtat, horum et ſimilium definitionum auctores in animo habuiſſe abſtractam motus naturam, ſecluſa omni temporis et ſpatii conſideratione, explicare: ſed qua ratione abſtracta illa motus quinteſſentia (ut ita dicam) intelligi poſſit non video."

Berkeley de Motu.

(p) "Multi etiam per *tranſitum* motum definiunt, obliti ſcilicet tranſitum ipſum ſine motu intelligi non poſſe, et per motum definiri oportere: Veriſſimum adeo eſt definitiones, ſicut nonnullis rebus lucem, ita viciſſim aliis tenebras afferre. Et profecto, quaſcumque res ſenſu percipimus eas clariores aut notiores definiendo efficere vix quiſquam potuerit. Cujus rei vana ſpe allecti res faciles difficillimas reddiderunt philoſophi, menteſque ſuas difficultatibus, quas ut plurimum ipſi peperiſſent, implicavere." *Id. ibid.*

originally compoſed : but matter can neither be added nor taken away without motion from place to place ; for there is now no creation *de novo;* and we have no reaſon to imagine that, ſince the original creation, a ſingle atom has been ever annihilated. It is therefore paſt diſpute, that local motion is the only motion conceivable ; and indeed, as far as we are capable of judging from what we know of body, it is the only motion poſſible.

190 Whether, if but one body exiſted, there could be motion?

This has given riſe to a queſtion which has been debated among modern philoſophers, though, as far as we know, it was never agitated among the ancients, viz. " Whether, if there were but one ſolid body exiſting, that body could poſſibly be moved." Biſhop Berkeley ſeems to be of opinion that it could not ; becauſe no motion can be conceived but what has a direction towards ſome *place*, and the relation of place neceſſarily ſuppoſes the exiſtence of two or more bodies. Were all bodies, therefore, annihilated except one globe, it would be impoſſible (he thinks) to conceive that globe in motion (Q). With reſpect to the origin of our *ideas* of motion, his reaſoning appears unanſwerable ; but we do not perceive how it concludes againſt the poſſibility of motion itſelf as exiſting in a ſingle body. It has been already ſhown in the chapter of *Simple Apprehenſion and Conception*, that though nothing can be conceived which may not poſſibly exiſt, yet many things may be poſſible which we have not faculties or means to conceive. In the preſent inſtance, were this ſolitary globe animated as our bodies are, were it endowed with all our ſenſes and mental powers, it certainly would not acquire any *idea* of motion though impelled by the greateſt force. The reaſon is obvious ; it would have no objects with which to compare its place and ſituation at different periods of time ; and the experience of a ſhip at ſea in calm weather, affords ſufficient proof that motion which is equable cannot be perceived by any other means than by ſuch a compariſon. When the waves ſwell and the ſhip pitches, it is indeed impoſſible that thoſe who are on board ſhould not perceive that they are actually in motion ; but even this perception ariſes from comparing their poſition with that of the waves riſing and falling around them : whereas in the regions of empty ſpace the animated globe could compare its poſition with nothing ; and therefore, whether impelled by equal or unequal forces, it could never acquire the *idea* of motion. It may perhaps be thought, that if this ſolitary globe were a *ſelf*-moving animal, it might acquire the *idea* of motion by inferring its exiſtence from the energy which produced it. But how, we would aſk, could an animal in ſuch circumſtances be *ſelf*-moving ? Motion is the effect of ſome cauſe ; and it has been already ſhown (ſee N° 117. of this article), that we have no reaſon to ſuppoſe that any being can be the *real* and *primary* cauſe of any effect which that being can neither conceive nor will : but as motion can be perceived only by the ſenſes, a ſolitary animal could have no idea of motion previous to its own exertions ; and therefore could neither conceive, nor will, an exertion to produce it. Let us, however, ſuppoſe, that without any end in view it might ſpontaneouſly exert itſelf in ſuch a manner as would produce *ſenſible* motion, were it ſurrounded with other corporeal objects ; ſtill we may venture to affirm, that ſo long as it ſhould remain in abſolute ſolitude, the being itſelf would acquire no *idea* of motion. It would indeed be *conſcious* of the *mental* energy, but it could not infer the exiſtence of motion as a conſequence of that energy ; for the idea of motion can be acquired only by ſenſe, and by the ſuppoſition there are no objects from which the ſenſes of this ſpherical animal could receive thoſe impreſſions, without which there can be no perception, and of courſe no ideas.

191 Anſwered in the affirmative.

Let us now ſuppoſe, that, while this animated globe is under the influence either of external impulſe or its own ſpontaneous energy, other bodies are ſuddenly brought into exiſtence : would it then acquire the idea of motion ? It certainly would, from perceiving its own change of place with reſpect to thoſe bodies ; and though at firſt it would not perhaps be able to determine whether itſelf or the bodies around it were moving, yet a little experience would decide this queſtion likewiſe, and convince it that the motion was the effect either of its own *mental energy*, or that external *impulſe* which it had felt before the other bodies were preſented to its view. But it is obvious, that the creation of new bodies at a diſtance, can make no real alteration in the ſtate of a body which had exiſted before them : and therefore, as this animated globe would now *perceive* itſelf to be moving, we may infer with the utmoſt certainty that it *was moving*

(Q) Having proved that *place*, in the proper ſenſe of the word, is merely relative, and affirmed that all *motion* is relative likewiſe, the biſhop proceeds thus : " Veruntamen ut hoc clarius appareat, animadvertendum eſt, motum nullum intelligi poſſe ſine determinatione aliqua ſeu directione, quæ quidem intelligi nequit, niſi præter corpus motum, noſtrum etiam corpus, aut aliud aliquid, ſimul intelligatur exiſtere. Nam ſurſum, deorſum, ſiniſtrorſum, dextrorſum, omneſque plagæ et regiones in relatione aliqua fundantur, et neceſſario corpus a moto diverſum connotant et ſupponunt. Adeo ut, ſi, reliquis corporibus in nihilum redactis, globus, exempli gratia, unicus exiſtere ſupponatur, in illo nullus motus concipi poſſit : uſque adeo neceſſe eſt, ut detur aliud corpus, cujus ſitu motus determinare intelligatur. Hujus ſententiæ veritas clariſſima elucebit, modo corporum omnium tam noſtri quam aliorum, præter globum iſtum unicum, annihilationem recte ſuppoſuerimus.

" Concipiantur porro duo globi, et præterea nihil corporeum, exiſtere. Concipiantur deinde vires, quomodocunque applicari : quicquid tandem per applicationem virium intelligamus, motus circularis duorum globorum circa commune centrum nequit per imaginationem concipi. Supponamus deinde cœlum fixarum creari : ſubito ex concepto appulſu globorum ad diverſas cœli iſtius partes motus concipietur. Scilicet cum motus natura ſua ſit relativus, concipi non potuit priuſquam darentur corpora correlata. Quemadmodum nec ulla relatio alia ſine correlatis concipi poteſt." *De Motu.*

moving before; and that the motion of a ſingle body, though not *perceivable* by the ſenſes, might poſſibly be produced in empty ſpace.

192
Whether motion would be poſſible in ſpace abſolutely full?

Having thus ſeen that a ſingle body is capable of motion in empty ſpace, the next queſtion that occurs on this ſubject is, Whether it would be poſſible to move a body in ſpace that is abſolutely full? Such are the terms in which this queſtion is uſually put; and by being thus expreſſed, it has given riſe to the diſpute among natural philoſophers about the exiſtence of a *vacuum*. Perhaps the diſpute might have been avoided had the queſtion been more accurately ſtated. For inſtance, had it been aſked, whether motion would be poſſible, could matter be ſuppoſed abſolutely infinite without any the leaſt interſtice or vacuity among its ſolid parts? We apprehend that every reflecting man would have anſwered in the negative. At any rate, the queſtion ought to be thus ſtated in metaphyſics; becauſe we have ſeen that ſpace, though a poſitive term, denotes nothing really exiſting. Now it being of the very eſſence of every ſolid ſubſtance to exclude from the place which it occupies every other ſolid ſubſtance, it follows undeniably, that not one particle of an infinite ſolid could be moved from its place without the previous annihilation of another particle of equal extent; but that annihilation would deſtroy the infinity. Were matter extended to any degree *leſs* than infinity, the motion of its parts would undoubtedly be poſſible, becauſe a ſufficient force could ſeparate thoſe parts and introduce among them vacuities of any extent; but without vacuities capable of containing the body to be moved, it is obvious that no force whatever could produce motion. This being the caſe, it follows, that however far we ſuppoſe the material univerſe extended, there muſt be vacuities in it ſufficient to permit the motion of the planets and all the other heavenly bodies, which we plainly perceive to revolve round a centre; and if ſo, the next queſtion to be determined is, What can *in vacuo* operate upon ſuch immenſe bodies, ſo as to produce a regular and continued motion?

193
Bodies equally indifferent to motion and reſt.

That all bodies are equally capable of motion or reſt, has by natural philoſophers been as completely proved as any thing can be proved by obſervation and experience. It is indeed a fact obvious to the moſt ſuperficial obſerver; for if either of theſe ſtates were eſſential to matter, the other would be abſolutely impoſſible. If reſt were eſſential, nothing could be moved; if motion were eſſential, nothing could be at reſt, but every the minuteſt atom would have a motion of its own, which is contrary to univerſal experience. With reſpect to motion and reſt, matter is wholly paſſive. No man ever perceived a body inanimated begin to move, or when in motion ſtop without reſiſtance. A billiard ball laid at reſt on the ſmootheſt ſurface, would continue at reſt to the end of time, unleſs moved by ſome force extrinſic to itſelf. If ſuch a ball were ſtruck by another ball, it would indeed be moved with a velocity proportioned to the impetus with which it was ſtruck; but the impelling ball would loſe as much of its own motion as was communicated to that upon which the impulſe was made. It is evident, therefore, that in this inſtance there is no *beginning* of motion, but only the communication of motion from one body to another; and we may ſtill aſk, Where had the motion its origin? If the impelling ball was thrown from the hand of a man, or ſtruck with a racket, it is plain that by a volition of the man's mind the motion was firſt given to his own arm, whence it proceeded through the racket from one ball to another; ſo that the ball, racket, and arm, were mere inſtruments, and the mind of the man the only agent or firſt mover. That motion can be *begun* by any being which is not poſſeſſed of life, conſciouſneſs, and will, or what is analogous to theſe, is to us altogether inconceivable. Mere matter or inanimated body can operate upon body only by impulſe: but impulſe, though from the poverty of language we are ſometimes obliged to talk of its agency, is itſelf merely an effect; for it is nothing more than the contact of two bodies, of which one at leaſt is in motion. An infinite ſeries of effects without a cauſe is the groſſeſt abſurdity; and therefore motion cannot have been communicated from eternity by the impulſe of body upon body, but muſt have been originally produced by a being who acts in a manner analogous to the energies of the human will.

194
Motion produced by impulſe can only be in a ſtraight line.

But though motion could not have been begun but by the energy of mind, it is generally believed that it might be continued by the mere paſſivity of body; and it is a law of the Newtonian philoſophy, that a body projected in empty ſpace would continue to move in a ſtraight line for ever. The only reaſon which can be aſſigned for this law is, that ſince body continues to move at all after the impetus of projection has ceaſed, it could not of itſelf ceaſe to move without becoming active; becauſe as much force is required to ſtop a body in motion as to communicate motion to the ſame body at reſt. Many objections have been made to this argument, and to the law of which it is the foundation; but as we do not perceive their ſtrength, we ſhall not fill our page with a formal examination of them (R). If a ſingle body could exiſt and have motion communicated to it *in vacuo* by the force

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(R) By much the ſtrongeſt and beſt urged of theſe objections which we have ſeen, is made by Dr Horſley, a man equally learned in mathematics and in ancient and modern philoſophy. "I believe with the author of Ancient Metaphyſics (ſays he), that ſome active principle is neceſſary for the continuance as well as for the beginning of motion. I know that many Newtonians will not allow this: I believe they are miſled, as I myſelf have formerly been miſled, by the expreſſion *a ſtate of motion*. Motion is a change; a continuance of motion is a farther change; a farther change is a repeated effect; a repeated effect requires a repeating cauſe. State implies the contrary of change; and motion being change, a *ſtate of motion* is a contradiction in terms." See *Ancient Metaphyſics*, vol. ii.

If our readers think this reaſoning concluſive, they may be in the right; and in that caſe they will ſee the neceſſity of admitting, even for the continuance of rectilineal motion, the *plaſtic nature*, or ſomething equivalent to force of projection, we are perſuaded, that from the very paſſivity of matter, that motion would never have an end; but it is obvious that it could be moved only in a ſtraight line, for an impulſe can be given in no other direction.

195
The Newtonian doctrine reſpecting the cauſes of the motion of the heavenly bodies.

The heavenly bodies, however, are not moved in ſtraight lines, but in curves round a centre; and therefore their motion cannot have been originally communicated merely by an impreſſed force of projection. This is admitted by all philoſophers; and therefore the Newtonians ſuppoſe that the planets are moved in elliptical orbits by the joint agency of two forces acting in different directions. One of theſe forces makes the planet tend directly to the centre about which it revolves: the other impels it to fly off in a tangent to the curve deſcribed. The former they call *gravitation*, which ſome of them have affirmed to be a property inherent in all matter; and the latter, which in a projectile force, they conſider as impreſſed *ab extra*. By the joint agency of ſuch forces, duly proportioned to each other, Sir Iſaac Newton has demonſtrated, that the planets muſt neceſſarily deſcribe ſuch orbits as by obſervation and experience they are found actually to deſcribe. But the queſtion with the metaphyſician is, Whether ſuch forces be real?

196
Mutual attraction among the heavenly bodies impoſſible.

With reſpect to projection, there is no difficulty; but that bodies ſhould mutually act upon each other at a diſtance, and through an immenſe vacuum, ſeems at firſt ſight altogether impoſſible. If the planets are moved by the forces of gravitation and projection, they muſt neceſſarily move *in vacuo*; for the continual reſiſtance of even the rareſt medium would in time overcome the force of the greateſt impetus: but if they move *in vacuo*, how can they be attracted by the ſun or by one another? It is a ſelf-evident truth, that nothing can act but where it is preſent, either immediately or mediately; becauſe every thing which operates upon another, muſt perform that operation either by its own immediate agency or by means of ſome inſtrument. The ſun and planets are not in contact; nor, if the motion of theſe bodies be *in vacuo*, can any thing material paſs as an inſtrument from the one to the other. We know indeed by experience, that every particle of unorganized matter within our reach has a tendency to move towards the centre of the earth; and we are intuitively certain, that ſuch a tendency muſt have ſome cauſe; but when we infer that cauſe to be a power of attraction inherent in all matter, which mutually acts upon bodies at a diſtance, drawing them towards each other, we talk a language which is perfectly unintelligible (s). Nay more, we may venture to affirm that ſuch an inference is contrary to fact. The particles of every elaſtic fluid fly *from* each other; the flame of a fire darts *upwards* with a velocity for which the weight of the circumambient air cannot account; and the motion of the particles of a plant when growing, is ſo far from tending toward the *centre* of the earth, that when a flowerpot is inverted, every vegetable in it, as ſoon as it is arrived at a ſufficient length, bends itſelf over the ſide of the pot, and grows with its top in the natural poſition.

197
The heavenly bodies cannot be moved by two forces impreſſed *ab extra*;

Senſible of the force of theſe arguments againſt the poſſibility

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to it, without which we have endeavoured to prove, that the heavenly bodies could not revolve round their reſpective centres in elliptical curves.

(s) A different opinion on this point is held by Profeſſor Stewart in his *Elements of the Philoſophy of the Human Mind*; a work of which the merit is ſuch as to make it painful to us to differ in in any important opinion from the ingenious author. We ſhall, however, claim the ſame liberty of diſſenting occaſionally from him that he has claimed of diſſenting from Newton, Locke, Clarke, and Cudworth, from whom he differs widely in thinking it as eaſy to conceive how bodies can act upon each other at a diſtance, as how one body can communicate motion to another by impulſe. “I allow (ſays he, p. 79.) that it is impoſſible to conceive in what manner one body acts upon another at a diſtance through a vacuum; but I cannot admit that it removes the difficulty, to ſuppoſe that the two bodies are in actual contact. That one body may be the efficient cauſe of the motion of another body placed at a diſtance from it, I do by no means aſſert; but only that we have as good reaſon to believe that this may be poſſible, as to believe that any one natural event is the efficient cauſe of another.”

If by *efficient* cauſe be here meant the *firſt* and *original* cauſe of motion, we have the honour to agree with the learned profeſſor; for we are perſuaded that body inanimated is not, in this ſenſe of the word, the cauſe of motion either at hand or at a diſtance: but if he mean (and we think he muſt, becauſe ſuch was the meaning of Newton, from whom he profeſſes to differ), that we can as eaſily conceive one body to be the inſtrumental cauſe of the motion of another from which it is diſtant, as we can conceive it to communicate motion by impulſe, we cannot help thinking him greatly miſtaken. We will not indeed affirm, with the writer whom he quotes, “that although the experiment had never been made, the communication of motion by impulſe might have been predicted by reaſoning *à priori*;” becauſe we are not certain, that without ſome ſuch experiment we ſhould ever have acquired adequate notions of the ſolidity of matter: But if all corporeal ſubſtances be allowed to be ſolid and poſſeſſed of that negative power to which philoſophers have given the name of *vis inertiæ*, we think it may be eaſily proved *à priori*, that a ſufficient impulſe of one hard body upon another *muſt* communicate *motion* to that other; for when the *vis inertiæ*, by which alone the one body is kept in its place, is leſs than the *vis impetus* with which the other ruſhes to take poſſeſſion of that place, it is evident that the former body *muſt* give way to the latter, which it can do only by motion, otherwiſe the two bodies would occupy one and the ſame place, which is inconſiſtent with their ſolidity. But that a ſubſtance poſſeſſed of a *vis inertiæ* ſhould make another ſubſtance poſſeſſed of the ſame negative power quit a place to which itſelf has no *tendency*, is to us not only *inconceivable*, but apparently impoſſible, as implying a direct contradiction.

poſſibility of an attractive power in matter which operates at a diſtance, other philoſophers have ſuppoſed that the heavenly bodies are moved in elliptical orbits by means of two forces originally impreſſed upon each planet impelling it in different directions at the ſame time. But if the tendency of the planets towards the centre of the ſun be of the ſame kind with that of heavy bodies towards the centre of the earth (and if there be ſuch a tendency at all, we have no reaſon to ſuppoſe it different), it cannot poſſibly be the effect of impulſe. A body impelled or projected *in vacuo* would continue to be moved with an equable velocity, neither accelerated nor retarded as it approached the object towards which it was directed; but the velocity of a body tending towards the centre of the earth is continually accelerated: and as we cannot doubt but that the ſame thing takes place in the motion of a body tending towards the centre of the ſun, that motion cannot be the effect of impulſe or projection.

198 nor by the agency of any material fluid.

Some of the Newtonians therefore have ſuppoſed, "That all kinds of attraction conſiſt in fine imperceptible particles or inviſible effluvia, which proceed from every point in the ſurface of the attracting body, in all right-lined directions every way; which in their progreſs lighting on other bodies, urge and ſolicit them towards the ſuperior attracting body; and therefore (ſay they) the force or intenſity of the attracting power in general muſt always decreaſe as the ſquares of the diſtances increaſe." The inference is fairly drawn from the fact, provided the fact itſelf were real or poſſible: but it is obvious, that if fine imperceptible particles or inviſible effluvia were thus iſſued from every point in the ſurface of the ſun, the earth and other planets could not move *in vacuo;* and therefore the projectile motion would in time be ſtopped by the reſiſtance of this powerful medium. Beſides, is it not altogether inconceivable, nay impoſſible, that particles iſſuing *from* the ſun ſhould draw the planets *towards* that centre? would they not rather of neceſſity drive them to a greater diſtance? To ſay, that after they have reached the planets, they change their motion and return to the place whence they ſet out, is to endue them with the powers of intelligence and will, and to transform them from paſſive matter to active mind.

Theſe difficulties in the theories of attraction and impulſe have ſet philoſophers upon fabricating numberleſs hypotheſes: and Sir Iſaac Newton himſelf, who never conſidered gravitation as any thing more than an effect, conjectured that there might be a very ſubtile fluid or ether pervading all bodies, and producing not only the motion of the planets, and the fall of heavy bodies to the earth, but even the mechanical part of muſcular motion and ſenſation. Others (T) again have ſuppoſed fire, or light, or the electric fluid, to be the univerſal agent; and ſome few (U) have acknowledged, that nothing is ſufficient to produce the phenomena but the immediate agency of mind.

With reſpect to the interpoſition of any material fluid, whether ether, fire, light, or electricity, it is ſufficient to ſay that it does not remove any one difficulty which encumbers the theory of innate attraction. All theſe fluids are elaſtic; and of courſe the particles of which they are compoſed are diſtant from each other. Whatever motion, therefore, we may ſuppoſe to be given to one particle or ſet of particles, the queſtion ſtill recurs, How is it communicated from them to others? If one body can act upon another at the diſtance of the ten-thouſandth part of an inch, we can perceive nothing to hinder its action from extending to the diſtance of ten thouſand millions of miles. In the one caſe as well as the other, the body is acting where it is not preſent; and if that be admitted to be poſſible, all our notions of action are ſubverted, and it is vain to reaſon about the cauſe of any phenomenon in nature.

199 The hypotheſis of Plato, Ariſtotle, and Cudworth.

This theory of the intermediate agency of a ſubtile fluid differs not eſſentially from the vortices of Des Cartes; which appeared ſo very abſurd to Cudworth, that with a boldneſs becoming a man of the firſt genius and learning, he rejected it, and adopted the plaſtic nature of Plato, Ariſtotle, and other Greek philoſophers. That incomparable ſcholar obſerves, that matter being purely paſſive, the motion of the heavenly bodies, the growth of vegetables, and even the formation of animal bodies, muſt be the effect either of the immediate agency of God, or the agency of a *plaſtic nature* uſed as an inſtrument by Divine Wiſdom. That they are not the effect of God's immediate agency, he thinks obvious from ſeveral circumſtances. In the firſt place, They are performed ſlowly and by degrees, which is not ſuitable to our notions of the agency of almighty Power. Secondly, Many blunders are committed in the operations of nature, ſuch as the formation of monſters, &c. which could never be were things formed by the immediate hand of God. He is therefore of opinion, that, after the creation of matter, God employed an inferior agent to give it motion and form, and to carry on all thoſe operations which have been continued in it ſince the beginning of the world. This agent he calls *plaſtic nature;* and conſiders it as a being incorporeal, which penetrates the moſt ſolid ſubſtance, and, in a manner which he pretends not to explain otherwiſe than by analogy, actuates the univerſe. He does not look upon it as a being endued with perception, conſciouſneſs, or intelligence; but merely as an inſtrument which acts under Divine Wiſdom according to certain laws. He compares it to art embodied; and quoting from Ariſtotle, ſays, Ει ενην εν τω ξυλω ἡ ναυπηγικη ὁμοιως αν τη φυσει εποιει. *If the art of the ſhipwright were in the timber itſelf, operatively and effectually, it would there act juſt as nature doth.* He calls it a certain lower life than the animal, which acts regularly and artificially for ends of which it knows nothing. It may be, he ſays, either a lower faculty of ſome conſcious ſoul, or elſe an inferior kind of life or ſoul by itſelf, but depending in either caſe upon a higher intellect. He is aware with what difficulty ſuch a principle will be admitted by thoſe philoſophers who have divided all being into ſuch as is extended and ſuch as is cogitative: but he thinks this diviſion improper. He would divide

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(T) The ſeveral followers of Mr Hutchinſon.

(U) Cudworth, Berkeley, and the author of Ancient Metaphyſics.

Of Motion.

divide beings into thoſe which are ſolid and extended, and thoſe which have life or internal energy. Thoſe beings which have life or internal energy he would again divide into ſuch as act with conſciouſneſs, and ſuch as act without it: the latter of which is this plaſtic life of nature. To prove that ſuch an inſtrument is poſſible, or that a being may be capable of operating for ends of which it knows nothing, he inſtances *bees* and other animals, who are impelled by *inſtinct* to do many things neceſſary to their own preſervation, without having the leaſt notion of the purpoſe for which they work. (See INSTINCT.) He obſerves, that there is an eſſential difference between reaſon and inſtinct, though they are both the attributes of mind or incorporeal ſubſtance: and that therefore, as we know of two kinds of mind differing ſo widely, there is nothing to hinder us from inferring a third, with powers differing as much from inſtinct as inſtinct differs from reaſon. Mankind are *conſcious* of their own operations, *know* for what *purpoſe* they generally act, and can by the power of *reflection* take a *retroſpective* view of their actions and thoughts, making as it were the mind its own object. Brutes are *conſcious* of their own operations, but they are ignorant of the *purpoſes* for which they operate, and altogether *incapable* of *reflecting* either upon their paſt conduct or paſt thoughts. Between their intellectual powers and thoſe of man, there is a much greater difference than there is between them and a plaſtic nature, which acts as an inſtrument of Divine Wiſdom without any conſciouſneſs of its own operations. Ariſtotle, from whom principally the learned author takes his notion of this plaſtic nature, compares it, with reſpect to the Divine Wiſdom which directs and ſuperintends its operations, to a mere builder or mechanic working under an architect, for the purpoſe of which the mechanic himſelf knows nothing. The words of the Stagyrite are: *Τους αρχιτεκτονας περι ἑκαστον τιμιωτερους και μαλλον ειδεναι νομιζομεν των χειροτεχνων, και σοφωτερους ὁτι τας αιτιας των ποιουμενων ισασιν οἱ δ' ὡσπερ και των αψυχων ενια, ποιει μεν, ουκ ειδοτα δε ποιει, οἱον καιει το πυρ· τα μεν ουν αψυχα φυσει τινι ποιειν τουτων ἑκαστον τους δε χειροτεχνας δι εθος* *. "We account the architects in every thing more honourable than the mere workmen, becauſe they underſtand the reaſon of the things done; whereas the other, as ſome inanimate things, only work, not knowing what they do, juſt as the fire burns: the difference between them being only this, that inanimate things act by a certain nature in them, but the workman by habit."

* *Metaphyſ.* lib. i. cap 1.

200 ſhown to be poſſible.

Sill further to prove that a being may be endowed with ſome vital energy of a ſubordinate kind, and yet be deſtitute of conſciouſneſs and perception, the learned author obſerves, that there is no reaſon to think that the ſouls of men in ſound ſleep, lethargies, or apoplexies, are conſcious of any thing; and ſtill leſs, if poſſible, to ſuppoſe that the ſouls of embryos in the womb are from the very firſt moment of their arrival there intelligent and conſcious beings: neither can we ſay, how we come to be ſo differently affected in our ſouls by the different motions made upon our bodies, nor are we conſcious always of thoſe energies by which we impreſs fantaſtic ideas on the imagination. But if it be poſſible for the ſouls of men to be for one inſtant void of conſciouſneſs and intelligence, it follows, that conſciouſneſs is not abſolutely neceſſary to thoſe energies and motions by which life is preſerved. To this it may be added, upon the beſt authority †, "that where animal or vegetable life is concerned, there is in every caſe a different relation between the cauſe and effect, and ſeemingly depending upon the concurrence or influence of ſome farther principle of change in the ſubject, than what ſubſiſts in inanimate matter, or in the cauſes and effects that are the objects of mechanical and chemical philoſophy." Now to this principle of vegetable life, without which, in a ſeed or in a plant, vegetation will neither begin nor continue, though light, heat, air, earth, and water ſhould concur in the utmoſt perfection, Cudworth expreſsly compares his plaſtic nature in the univerſe. It is ſo far (ſays he) from being the firſt or higheſt life, that it is indeed the laſt and loweſt of all lives, being really the ſame thing with the vegetative.

† *Gregory's Philoſophical and Literary Eſſays.*

201 Arguments for its truth: but

Theſe arguments, if the phenomena of elective attractions in chemiſtry be added to them, demonſtrate, we think, the *poſſibility* of ſuch a principle: and to thoſe who are inclined to affirm that no ſuch thing can exiſt, becauſe, according to the deſcription of it given by Cudworth and the ancients, it is neither body nor ſpirit, in the proper ſenſe of the words; we beg leave to aſk in the words of Locke, "who told them that there is and can be nothing but ſolid beings which cannot think, and thinking beings that are not extended? which is all that they mean by the terms body and ſpirit." All the Greek philoſophers who were not materialiſts, and even the inſpired writers of the Old and New Teſtaments, conſtantly diſtinguiſh between the *ſpirit* and the *ſoul* of a man, calling the former ſometimes *νους* and ſometimes *πνευμα*, and the latter *ψυχη*; and St Paul, who before he was a Chriſtian, was learned in philoſophy, deſcribes the conſtituent parts of man as three, *πνευμα, ψυχη, σωμα*, *ſpirit*, *ſoul*, and *body*. This diſtinction, ſetting aſide the *authority* with which it comes to us, ſeems to be well founded; for there are many operations carried on in the human body without any conſcious exertion of ours, and which yet cannot be accounted for by the laws of mechaniſm. Of theſe, Cudworth inſtances the motion of the diaphragm and other muſcles which cauſe reſpiration, and the ſyſtole and diaſtole of the heart; neither of which, he thinks, can be the effect of mere mechaniſm. But, as we are not conſcious of any energy of ſoul from which they proceed, even while we are awake, and ſtill leſs, if poſſible, while we are aſleep; he attributes them, not to the intellect or rational mind, but to this inferior vital principle called *ψυχη* (v); which, in his opinion, acts

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(v) The exiſtence of this plaſtic nature was warmly debated between Monſieur Le Clerc and Monſieur Bayle. Moſheim, who was inclined himſelf to admit ſuch a principle, gives the following view of Le Clerc's ſentiments from *Bibliothcque Choiſie*, tom. ii. p. 113. "Reſpiratio, inquit, et motus cordis, actiones ſunt, quorum nihil ad animam pertinet. Interim mechanice eas fieri, nullo modo probabile eſt. In volun-

tariis

the ſame part in the ſyſtem of the human body which the plaſtic nature acts in the ſyſtem of the world.—To make the reſemblance more ſtriking, he obſerves, that even the voluntary motion of our limbs, though it proceeds ultimately from an energy of will, ſeems to be the effect of that energy employing ſome *inſtrument* which pervades the ſinews, nerves, and muſcles of the body; and if the human ſpirit or πνευμα employ the inſtrumentality of a plaſtic nature or ψυχη in moving the ſmall machine of the body, it ſeems to be far from incredible that the Divine Wiſdom ſhould employ the inſtrumentality of a plaſtic nature in moving the great machine of the univerſe.

202 whether it be true or not, the motions of the heavenly bodies are carried on by the conſtant agency of ſomething incorporeal.

But we need not inſiſt further on the *poſſibility* of ſuch an inſtrument. Whatever may be thought of the arguments of Cudworth, of which ſome are, to ſay the leaſt of them, plauſible, though others appear to us to have very little ſtrength, Dr Clarke has proved, with a force of reaſoning not inferior to mathematical demonſtration, that the motions of the heavenly bodies are carried on by the agency of ſomething very different from matter, under every poſſible form. "For, not to ſay that, ſeeing matter is utterly incapable of obeying any *laws* in the proper ſenſe of the word, the very original laws of motion themſelves cannot continue to take place, but by ſomething ſuperior to matter, *continually* exerting on it a certain force or power according to ſuch certain and determined laws: it is now evident beyond queſtion, that the bodies of all *plants* and *animals* could not poſſibly have been formed by mere matter according to any general laws of motion. And not only ſo, but that moſt univerſal principle of *gravitation* itſelf, the ſpring of almoſt all the great and regular inanimate motions in the world, anſwering not at all the *ſurfaces* of bodies, by which alone they can act upon one another, but entirely to their *ſolid contents*, cannot poſſibly be the reſult of any motion originally impreſſed upon matter." For though it is true, that the moſt ſolid bodies with which we are acquainted are all very porous; and that, therefore a ſubtile material fluid might penetrate the bodies of the planets, and operate upon them with a force exerted internally; ſtill it is ſelf-evident, that the *greateſt* quantities of ſuch a fluid could not enter into thoſe bodies which are *leaſt* porous, and where the greateſt force of *gravitation* reſides: "and, therefore, this motion muſt of neceſſity be cauſed by ſomething which penetrates the very *ſolid ſubſtance* of all bodies, and continually puts forth in them a force or power entirely different from that by which matter acts upon matter *." Which is, as the ſame able writer obſerves, an evident demonſtration, not only of the world's being originally made by a ſupreme intelligent Cauſe; but moreover, that it depends every moment upon ſome ſuperior Being, for the preſervation of its frame; and that all the great motions in it are cauſed by ſome immaterial power *perpetually* and *actually* exerting itſelf every moment in every part of the corporeal univerſe. This preſerving and governing power, whether it be the immediate power and action of the ſame Supreme Cauſe that created the world, or the action of ſome ſubordinate inſtruments appointed by him to direct and preſide reſpectively over certain parts thereof, gives us equally in either way a very noble idea of Providence. We know with certainty, that *real* and *original power* can belong only to a being endowed with intelligence and will; and, therefore, if the exiſtence of Cudworth's (w) plaſtic nature be admitted, (and we ſee not why it ſhould be called

* *Evidence of Nat. and Revealed Religion.*

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tariis commotionibus neſciunt animi noſtri, quid facto opus ſit, ut membra commoveantur: imperant illi tantum. Eſt vero aliud neſcio quid, quod fideliter, ſi modo organa recte ſint affecta, mandata ejus exſequitur. Quidni igitur ſuſpicemur, eſſe *naturam* in corpore noſtro *viventem*, præter animam noſtram, cujus ſit animæ præceptis et juſſis morem gerere? quamquam potentia ejus ita ſit definita, ut obedire nequeat animo, niſi recte ſeſe habeant organa. Eadem forte natura, corporis noſtri motibus impulſa, animam edocet, quid factum ſit, ut ille poſſit præcipere, quæ ad conſervationem corporis neceſſaria judicat. Anima, pergit, ſit hæc vera eſſe putes, ſimilis erit domino, ſibimet ipſi ſervire neſcio, nec ulla facultate alia, quam imperandi et jubendi inſtructo. Hæc vero natura fictrix non diſſimilis erit mancipii cui nihil eorum, quæ dominus meditatur, notum eſt, quodque nihil aliud facit, quam ut juſſis pareat, et dominum de illis rebus admoneat, quæ ad ſalutem ipſius pertinent." Moſheim proceeds,—Si quis huic loco ſic occurrat, Hæc ratione tria fingi in homine principia; reſpondet vir doctus: "Nullis conſtares argumentis, binis tantum hominem partibus conſtare. Eos, qui hominem ex binis tantum partibus component, nulla ratione explicare poſſe naturam conjunctionis animi et corporis, niſi ipſum Deum ſtatuant cunctis actionibus hominum intervenire: hoc vero Divina Majeſtate prorſus indignum eſſe. Definitionem accuratam mediæ hujus naturæ poſtulantibus ſeſe talem dare non poſſe definitionem reſpondet: Hoc unum ſeſe ſcire: eſſe eam naturam interiori agendi virtute inſtructam, quæ ex ſe et animam et corpus afficere queat; naturam, quæ doceat animam quid rerum geratur in corpore; naturam denique, quæ animi mandatis, quorum tamen cauſſas neſciat, fideliter obtemperet." Reliqua, quæ illuſtrandæ hujus rei cauſſa Clericus affert, prætereo. Satis copioſa eſt in illis, quæ produximus, meditandi materia. *Moſheim. ed. Syſt. Intellect.* p. 173.

Such a principle actuating the univerſe, if it be diveſted of intelligence, and conſidered as a ſecond or inferior cauſe, under the direction of the Supreme, is acknowledged by a very able judge to be a rational hypotheſis; and ſuch, if properly purſued, would certainly open a moſt entertaining ſcene of natural philoſophy.—See *Jones's Anſwer to an Eſſay on Spirit.*

(w) Beſides Cudworth, we have mentioned Berkeley and the author of *Ancient Metaphyſics*, as holding all motion to be an effect of the immediate agency of mind or incorporeal ſubſtance. The opinion of the laſt of theſe philoſophers is not eſſentially different from Cudworth's; and therefore it is needleſs to quote from him: Berkeley was better acquainted with the principles of the Newtonian philoſophy, as well as an abler mathematician

Of Motion.

called in (x) queſtion), it can be conſidered only as an inſtrument employed by Divine Wiſdom, as a chiſſel or a ſaw is employed by the wiſdom of the mechanic.

203 This theory not inconſiſtent with the principles of Newton.

Nor let it be imagined, that this ancient theory of motion is in any degree inconſiſtent with the mathematical principles of Sir Iſaac Newton's aſtronomy, or with the calculations raiſed from thoſe principles. Having founded his aſtronomy on analogy between the phenomena of projectile and planetary motions, he aſſigned the ſame or ſimilar *forces* exiſting in nature as the efficient cauſes of both. And indeed, both in the act of deriving his *principles* from the projectile phenomena, and afterwards for the purpoſe of applying them to the planetary, it was neceſſary to analyze the elliptical motion of the heavenly bodies into a compound of two ſimple motions in right lines, produced by the action of theſe different forces; and this might alſo be uſeful for the purpoſes of teaching and demonſtration, juſt as we find it neceſſary, in all parts of ſcience, to ſeparate what in nature is inſeparable, for the convenience and aſſiſtance of the underſtanding. The planetary motions, however, are very probably ſimple and uncompounded, for no experiments can be tried in thoſe diſtant regions; and the aſtronomy of Newton, which is only the application of his mathematical principles to their menſuration from their *analogy* to projectile motions, does not at all require that the forces of gravitation and projection be aſſigned as their real exiſtent cauſes (Y). It is ſufficient for the

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matician, than either of theſe pupils of the ancients; and being likewiſe a man who on all ſubjects thought for himſelf, it may be worth while to lay before our readers a ſhort abſtract of his reaſoning reſpecting the origin of motion. His words are: "Totum id quod novimus, cui nomen *corpus* indidimus, nihil in ſe continet quod motus principium ſeu cauſa efficiens eſſe poſſit. *Vis*, *gravitas*, *attractio*, et hujuſmodi voces, utiles ſunt ad ratiocinia et computationes de motu et corporibus motis; ſed non ad intelligendam ſimplicem ipſius motus naturam, vel ad qualitates totidem diſtinctas deſignandas. Attractionem certe quod attinet, patet illam ab Newtono adhiberi, non tanquam qualitatem veram et phyſicam, ſed ſolummodo ut hypotheſin mathematicam. Quin et Leibnitius, niſum elementarem ſeu ſolicitationem ab impetu diſtinguens, fatetur illa entia non re ipſa inveniri in rerum natura, ſed abſtractione facienda eſſe. Similis ratio eſt compoſitionis et reſolutionis virium quarumcunque directarum in quaſcunque obliquas, per diagonalem et latere parallelogrammi. Hæc mechanices et computationi inſerviunt: ſed aliud eſt computationi et demonſtrationibus mathematicis inſervire, aliud rerum naturam exhibere. Revera corpus æque perſeverat in utrovis ſtatu, vel motus vel quietis. Iſta vero perſeverantia non magis dicenda eſt actio corporis, quam exiſtentia ejuſdem actio diceretur. Cæterum reſiſtentiam quam experimur in ſiſtendo corpore moto, ejus actionem eſſe fingimus vana ſpecie deluſi. Revera enim iſta reſiſtentia quam ſentimus, paſſio eſt in nobis, neque arguit corpus agere, ſed nos pati: conſtat utique nos idem paſſuros fuiſſe, ſive corpus illud a ſe moveatur, ſive ab alio principio impellatur. Actio et reactio dicuntur eſſe in corporibus; nec incommode ad demonſtrationes mechanicas. Sed cavendum, ne propterea ſupponamus virtutem aliquam realem, quæ motus cauſa ſive principium ſit, eſſe in iis. Etenim voces illæ eodem modo intelligendæ ſunt ac vox *attractio*; et quemadmodum hac eſt hypotheſis ſolummodo mathematica non autem qualitas phyſica; idem etiam de illis intelligi debet, et ob eandem rationem.

"Auferantur ex idea corporis extenſio, ſoliditas, figura, remanebit nihil. Sed qualitates iſtæ ſunt ad motum indifferentes, nec in ſe quidquam habent, quod motus principium dici poſſit. Hoc ex ipſis ideis noſtris perſpicuum eſt. Si igitur voce *corpus* ſignificatur id quod concipimus, plane conſtat inde non peti poſſe principium motus: pars ſcilicet nulla aut attributum illis cauſa efficiens vera eſt, quæ motum producat. Vocem autem proferre, et nihili concipere, id demum indignum eſſet philoſopho.

"Præter res corporeas, alterum eſt genus rerum cogitantium: in iis autem potentiam ineſſe corpora movendi, propria experientia didicimus, quando quidem anima noſtra pro lubitu poſſit ciere et ſiſtere membrorum motus, quacunque tandem ratione id fiat. Hoc certe conſtat, corpora moveri ad nutum animæ, eamque proinde haud inepte dici poſſe principium motus; particulare quidem et ſubordinatum, quodque ipſum dependeat, a primo et univerſali principio.

"Ex dictis manifeſtum eſt eos qui vim activam, actionem, motus principium, in corporibus revera ineſſe affirmant, ſententiam nulla experientia fundatam amplecti, eamque terminis obſcuris et generalibus adſtruere nec quid ſibi velint ſatis intelligere. E contrario, qui mentem eſſe principium motus volunt, ſententiam propria experientia munitam preferunt, hominumque omni ævo doctiſſimorum ſuffragiis comprobatam.

"Primus Anaxagoras τον νουν introduxit, qui motum inerti materiæ imprimeret: quam quidem ſententiam probat etiam Ariſtoteles, pluribuſque confirmat, aperte pronuncians primum movens eſſe immobile, indiviſibile, et nullum habens magnitudinem. Dicere autem, omne motivum eſſe mobile, recte animadvertit idem eſſe ac ſiquis diceret, omne ædificativum eſſe ædificabile. Plato inſuper in Timæo tradit machinam hanc corpoream, ſeu mundum viſibilem, agitari et animari a mente, quæ ſenſum omnem fugiat. Et Newtonus paſſim nec obſcure innuit, non ſolummodo motum ab initio a Numine profectum eſſe, verum adhuc ſyſtema mundanum ab eodem actu moveri. Hoc ſacris literis conſonum eſt: hoc ſchalaſticorum calcula comprobatur."

De Motu, paſſim.

(x) This we ſay upon the received opinion, that there are things wholly incorporeal. The truth of the opinion itſelf will be conſidered in a ſubſequent chapter.

(Y) Indeed Sir Iſaac himſelf is very far from poſitively aſſigning them as the *real* cauſes of the phenomena. The purpoſe for which they were introduced into his philoſophy he clearly explains in the following words: "Eadem ratione qua projectile vi gravitatis in orbem flecti poſſet et terram totam circumire, poteſt et luna, *analogy*, on which the whole philoſophy is founded, that the phenomena of motion are known from experiments and obſervations to be the *ſame* in *both* inſtances; that the *principles* or *general laws* mathematically eſtabliſhed from the *forces* of the *one* are transferred to the *phenomena* of the *other*; and that the proofs and operations deduced from theſe principles in the latter caſe, are confirmed by *facts* and *experience*, the firſt and final teſt of truth*.

*Tatham's Chart and Scale of Truth.

Chap. VI. *Of* Number.

204 Unity, as an idea, cannot

"Amongst all the ideas that we have, as there is none (ſays Mr Locke †) ſuggeſted to the mind by more ways, ſo there is none more ſimple, than that of UNITY or *one*. It has no ſhadow of variety or compoſition in it. Every object our ſenſes are employed about, every idea in our underſtandings, every thought of our minds, brings this idea along with it: and therefore it is the moſt intimate to our thoughts, as well as it is, in its agreement to all other things, the moſt univerſal idea we have; or number applies itſelf to men, angels, actions, thoughts, every thing that either doth exiſt or can be imagined." He ſeems likewiſe to be of opinion that we have the idea of *unity* before that of *many*; and that it is by repeating the ſimple idea of unity in our own minds that we come by the *complex ideas* of *two*, *three*, &c. In this opinion he is joined by Pere Buffier*; who obſerves that it is impoſſible to explain the nature of *unity*, becauſe it is the moſt ſimple idea, and that which perhaps *firſt* occurred to the mind.

† *Eſſay*, book ii. chap. xvi.

*First Truths.

That *unity* is a ſimple idea, muſt be granted; but it certainly did not firſt occur to the mind, nor can it be abſtracted from all individuals, and apprehended in Locke's ſenſe of the word as a *general idea*. Let any man look into his own mind, and then ſay whether he has a general idea of *one* or *unity* as abſtracted from every individual object mental and corporeal. In particular, when he thinks he has completely abſtracted it from body and mind, ſenſations, ideas, actions, and paſſions, &c. let him be ſure, before he pronounce it a general *abſtract* idea, that he is not all the while contemplating the idea of its *name*, or of that numerical *figure*, by which it is marked in the operations of arithmetic. Both theſe ideas are in themſelves particular; and become general in their import, only as repreſenting every individual object to which unity is in any ſenſe applicable. But in the chapter *of Abſtraction*, we have ſaid enough to convince every perſon capable of conviction that they are uſed as ſigns for whole claſſes of objects.

205 be abſtracted from every individual.

Inſtead of being an abſtract general idea, *unity*, as the baſis of number, is in fact nothing but a mere *relation*, which cannot be conceived without the related objects; and ſo far is it from being the *firſt* idea that occurred to the mind, that it is certainly the reſult of a compariſon, made by the intellect, of two or more objects. The ideas which firſt occur to the mind are, beyond all doubt, theſe which are called *ideas of ſenſation*; and many ſuch ideas every child receives before he is capable of comparing objects and forming to himſelf notions of number. *Unity*, or the idea of *one*, is indeed the element of the ſcience of *arithmetic*, juſt as a mathematical *point* is the element of the ſcience of *geometry*; but accurate notions of theſe elements are, in the progreſs of knowledge, ſubſequent to ideas of *many* and of *ſurfaces*. There is reaſon to believe that perſons totally illiterate have no notion at all of *mathematical points*; and we think it poſſible to conceive an intelligent and conſcious being in ſuch a ſituation as that he could not acquire a notion of *unity* or *one*. Were a child never to ſee or feel two objects of the *ſame kind*, we doubt if he would think of numbering them, or of making ſuch a compariſon of the one with the other as would ſuggeſt to his mind the relations of *one* and *two*; for theſe relations imply both a ſameneſs and a difference of the objects beyond the power of a child to aſcertain. The difference indeed would be perceptible to the ſenſes, but the ſenſes would perceive no ſameneſs or agreement. A guinea, a ſhilling, and a ball of lead, impreſs upon the mind different ſenſations; and therefore a child undoubtedly diſtinguiſhes theſe objects from one another: but what could make him derive from this his firſt idea of the relation of number? A guinea, a ſhilling, and a ball of lead, are not *one*, *two*, *three*, in any ſenſe which a child can comprehend. To be convinced of this, let any man throw a guinea, a ſhilling, and a ball of lead upon a table, and aſk a *clown* what is their number. From being accuſtomed to retail the *names* of number as ſigns, without affixing to them any idea of the things ſignified, he will probably anſwer with quickneſs *three*, or perhaps *one*, *two*, *three*: but if he be further aſked in what *reſpect* they are *one*, *two*, *three*, we believe his anſwer will not be ſo ready: They are not *one*, *two*, *three guineas*, or *ſhillings*, or *balls of lead*. A philoſopher knows them to be three pieces of the ſame firſt matter under different forms, and can therefore apply to them the relation of number with truth and propriety; but of the firſt matter a *clown* is entirely ignorant, and of courſe cannot call them *one*, *two*, *three*, in any ſenſe which is at once true and to him intelligible.

206 Unity, a particular relation.

To make it ſtill more evident, that it is only by comparing together things of the *ſame kind* that our *firſt* ideas of unity and number are formed, let us ſuppoſe no created being to have hitherto exiſted except the animated and intelligent globe mentioned in the laſt chapter, and we think it will be granted that ſuch a being in ſolitude could never acquire the idea of *unity*. Let

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vel vi gravitatis, *ſi modo gravis ſit*, vel alia quacunque vi qua in terram urgeatur, retrahi ſemper a curſu rectilineo terram verſus et in orbem ſuum flecti: et abſque tali vi luna in orbe ſuo retineri non poteſt. Hæc vis, ſi *juſto minor* eſſet, non ſatis flecteret lunam a curſu rectilineo: ſi *juſto major*, plus ſatis flecteret, ac de orbe terram verſus deduceret. Requiritur quippe ut ſit *juſtæ magnitudinis*: et mathematicorum eſt invenire vim, qua corpus in dato quovis orbe data cum velocitate accurate retineri poſſit; et viciſſim invenire viam curvilineam, in quam corpus e dato quovis loco data cum velocitate egreſſum data vi flectatur."——*Principia Mathem.* Def. V, Of Number.

Let us next ſuppoſe a *cubical* body to be created and exhibited to the ſenſes of this ſpherical man; the conſequence would be a *ſenſation* or feeling entirely new: but that feeling would not be of *unity*; for, as the author of *Ancient Metaphyſics* has ſomewhere well obſerved, unity is no object of ſenſation. The ſenſation would be of colour, hardneſs, ſoftneſs, roughneſs or ſmoothneſs, &c. for beyond theſe the empire of the ſenſes does not reach. Again, Let another body be created of a colour and figure totally different from the colour and figure of the cube, and the ſpherical man would then experience new ſenſations having no agreement with thoſe which he had formerly felt. Theſe different kinds of ſenſations might be compared together; but the reſult of the compariſon would not be the ideas which are denoted by the words *one* and *two*, but merely that which is expreſſed by *difference* or *diſſimilarity*. Were another cube, however, of exactly the ſame ſize and colour with the former to be brought into exiſtence, and both to be at once preſented to the view of the ſpherical man, the rudiments of the idea of number would then be generated in his mind, becauſe he could not but perceive the cubes to be in one reſpect different and in another the ſame; different as being diſtinct from each other, and agreeing in their effects upon the organs of ſenſation.

207 Men muſt have made ſome progreſs in claſſing things according to genera and ſpecies, before they acquired any notion of number.

It appears, therefore, that mankind muſt have made ſome progreſs in claſſing things according to their genera and ſpecies, before they acquired any correct ideas of the relation of number, or thought of uſing numerical names or figures as general and diſcriminating ſigns: for we ſay *one*, *two*, *three*, &c. only with reſpect to the ſpecies or genus of which each of the things denoted by theſe numbers is an individual; and if there be any thing which has no genus or ſpecies, neither number nor unity can, in the original ſenſe of the words, be predicated of it (z). We ſay indeed that there is *one* God; but perhaps we do not always attend to the meaning of the expreſſion. Language was formed to anſwer the common purpoſes of life; and thoſe purpoſes are beſt anſwered by denoting individuals by the name of the ſpecies or genus to which they belong: but *God* belongs to no ſpecies or genus, unleſs he be ſaid improperly (A) to be of the univerſal genus of *Being*; and therefore the true meaning of the word *one*, when joined to the verb *is*, and transferred from the creature to the Creator, in ſuch a ſentence as—"there *is one* God"—ſeems to be nothing more than an affirmation that God exiſts, and that to him the relation of number cannot be applied. In a word, *unity* and *number* are merely relations between the individuals of the ſame ſpecies or genus of being; and men acquire ideas of theſe relations at the ſame time and by the ſame means that they are led to claſs things into ſpecies and genera. As to the proceſſes of addition and ſubtraction, and the various purpoſes to which number is applied, theſe things belong to the ſcience of arithmetic, and fall not under the province of the metaphyſician, whoſe ſole object is to aſcertain the real nature and cauſes of things. It may, however, be worth while to obſerve, that Locke, whoſe notions of number ſeem to have been different from ours, owns, that a man can hardly have any ideas of numbers of which his language does not furniſh him with names. But if units were either real things, or even poſitive ideas, we ſee not how *names* could be neceſſary to their exiſtence; whereas, if they be nothing more than mere relations, it is obvious that they cannot be conceived but as relative either to beings actually exiſting, or to names which are the ſigns of actual beings.

Of Time.

CHAP. VII. *Of* TIME.

2[illegible] T[illegible] co[illegible] ſtin[illegible] eternity.

WHEN St Auguſtine was aſked what time is? he replied, "*Si non roges, intelligo.*" An anſwer from which it may be inferred, that he thought the nature of *time* could not be explained by a logical definition. *Time* and *eternity* are commonly conſidered as the two modes of *duration*; and if duration be taken in what Locke thinks its true and original ſenſe, to denote permanence of exiſtence, with a kind of reſiſtance to any deſtructive force, the diſtinction ſeems to be ſufficiently proper. It is indeed the beſt that we can make or comprehend; for *duration*, *time*, and *eternity*, are ſubjects which have perplexed philoſophical minds in all ages, and of which, if we have adequate notions, it is very difficult to expreſs theſe notions in language. Inſtead of attempting it by previous definitions, the method in which the ancients generally began their inquiries, we ſhall purſue the better courſe of induction recommended by Lord Bacon, and endeavour to ſhow by what means we acquire the notion of that mode of duration which is called *time* in contradiſtinction to *eternity*. We begin with time; becauſe we ourſelves exiſt in it, and it is in ſome ſenſe familiar to us. If we be able to trace our notions of this mode of duration to their ſource, we may then give a definition of it founded on fact and univerſal experience, and afterwards proceed to conſider the other mode in conjunction with infinity, to which it is nearly allied.

(z) We are happy to find our notions on this ſubject confirmed by an authority ſo reſpectable as that of Profeſſor Stewart. "Without the power of attending ſeparately to things which our ſenſes preſent to us in a ſtate of union, we never (ſays this able writer) could have had any idea of *number*: for before we can conſider different objects as forming a multitude, it is neceſſary that we ſhould be able to apply to all of them one common name; or, in other words, that we ſhould reduce them all to the ſame genus. The various objects, for example, animate and inanimate, which are at this moment before me, I may claſs and number in a variety of different ways, according to the view of them that I chooſe to take. I may reckon ſucceſſively the number of ſheep, of cows, of horſes, of elms, of oaks, of beeches; or I may firſt reckon the number of animals, and then the number of trees; or, I may at once reckon the number of all the organized ſubſtances which my ſenſes preſent to me. But whatever be the principle on which my claſſification proceeds, it is evident that the objects numbered together muſt be conſidered in thoſe reſpects only in which they agree with each other; and that if I had no power of ſeparating the combinations of ſenſe, I never could have conceived them as forming a plurality." *Elements of the Philoſophy of the Human Mind*, chap. iv.

(A) We ſay *improperly*, becauſe beings which were *created* can have nothing in *common* with that Being which is *ſelf-exiſtent*, and upon whoſe *will* and *power* all other things depend.

It has been already obſerved (ſee N° 92 of this article), that every man, while awake, has a train of ſenſations and ideas conſtantly paſſing through his mind in ſuch a manner as that the one ſucceeds the other in a regular order. It is not poſſible, either, by detaining in the mind one idea to the excluſion of all others, to ſtop the courſe of this ſucceſſion entirely; or, by hurrying ſome ideas off the ſtage, and calling others in their place, to quicken its progreſs beyond a certain degree. One man indeed has naturally a quicker ſucceſſion of ideas than another; and all men can, by great exertions, accelerate or retard in a ſmall degree the natural flow of their thoughts. A ſtudious man lays hold, as it were, of a particular idea, which he wiſhes to contemplate, and detains it in the imagination, to the excluſion of all others; a man of wit calls remote ideas into view with a rapidity of which a cool and phlegmatic reaſoner can form no conception; and a forcible *ſenſation* takes full poſſeſſion of the mind, to the excluſion of all *ideas* whatever. Whilſt the attention is wholly occupied by one idea, or by one ſenſation, the mind has no notion whatever of time; and were it poſſible to detain ſuch idea or ſenſation alone in the mind till the hand of a clock ſhould move from the number of one hour to that of another, the hour, as marked on the dial-plate and meaſured by the motion of the hand, would appear but as one inſtant abſolutely void of duration. For the truth of this aſſertion we appeal to the experience of our readers. Such of them as have ever been engaged in deep ſtudy muſt often have had their attention ſo fixed upon one object, that large portions of time, as meaſured by the clock, have paſſed away wholly unheeded; and every man who has ſeen a very ſtriking and uncommon object, muſt remember, that when the ſenſation was firſt impreſſed upon his mind, all other objects, ideas, and notions, and among the reſt the notion of time, were for a while excluded.

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Whilſt the mind is occupied by one idea or notion, there is no perception of time; which

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ariſes from comparing the ſucceſſion of our ideas with the permanence of other objects.

No ſenſation, however, keeps poſſeſſion of the whole mind after it has ceaſed to be new; nor can the moſt vigorous exertions long preſerve any one idea from being driven off the ſtage by the ſucceeding train. Now this ſucceſſion of ideas appearing and diſappearing in their turns, is that which, when compared with the permanency of ourſelves and other things, gives us our firſt and juſteſt notion of time: for whilſt we are thinking, or whilſt a ſeries of ideas is ſucceſſively paſſing through our minds and vaniſhing, we know that we ourſelves and the things around us exiſt; and this exiſtence, or continuation of exiſtence, commenſurate with the train of our fleeting ideas, is what we call the *duration* of ourſelves and the things around us.

We are aware that our firſt notions of time have been often ſaid to be derived from *motion* as perceived by our ſenſes in the objects around us. It is obſerved by Euclid, that "if there were no *motion*, there could be no ſound, nor any ſenſe of hearing." "He might have added (ſays the author of Ancient Metaphyſics), nor any other perception of ſenſe. Further, Without motion there would have been no viſible world, nor generation or production of any kind here below; and, among other things, *time* could have had no exiſtence." All this is certainly true; but that corporeal motion, though the original ſource of all our ideas, is not that which *immediately* ſuggeſts to us the notion of time, will be readily granted by him who conſiders that motion itſelf is perceived by us only when it excites or accompanies a conſtant ſucceſſion of perceptions and ideas. Motion, when equable and very ſlow, ſuch as that of the hour hand of a common watch, is not perceived by us in its courſe; nor can we diſcover that the thing has moved at all, till after we have been ſenſible of the lapſe of a conſiderable portion of what is commonly called *time;* when we diſcover that the hand of the watch has changed its place with reſpect to other objects which we know to be fixed. The ſame is true of motion remarkably quick: "Let a cannon ball (ſays Locke) paſs through a room, and in its way take with it any limb or fleſhy parts of a man; it is as clear as any demonſtration can be, that it muſt ſtrike ſucceſſively the two ſides of the room; it is alſo evident that it muſt touch one part of the fleſh firſt, and another after, and ſo in ſucceſſion: and yet I believe nobody who ever felt the pain of ſuch a ſhot, or heard the blow againſt the two diſtant walls, could perceive any ſucceſſion either in the pain or ſound of ſo ſwift a ſtroke."

Of theſe two phenomena a ſatisfactory account may be eaſily given; from which we think it will at the ſame time be apparent, that the ſucceſſion of the train of ideas in the mind is the meaſure and ſtandard of all other ſucceſſions. We know that the energy of mind which reviews a train of ſenſible ideas is of the very ſame kind with that which attends to a ſeries of paſſing ſenſations (ſee N° 68.); and therefore it is natural to ſuppoſe that we can pay attention to ſenſations and ideas paſſing with nearly equal velocities. But it has been ſhown, that every ſenſation remains in the mind or ſenſorium for a very ſhort ſpace after the object which excited it is taken away: whence it follows, that a body communicating to the organs of ſenſe a ſeries of ſimilar impreſſions ſucceeding each other with remarkable rapidity, cannot excite a train of ſimilar and diſtinct ſenſations; becauſe the effects of the firſt and ſecond impreſſions not having vaniſhed when thoſe of the third and fourth arrive, the whole train of effects muſt neceſſarily coaleſce into one uniform ſenſation. This reaſoning is confirmed by experience. Similar ſounds ſucceeding each other at conſiderable intervals, are all diſtinctly perceived; and if the motion be accelerated gradually, it may be carried to a great degree of velocity before the ſounds be confounded and coaleſce into one. "Mr Herſchel having, by means of a clock, produced ſounds or clicking noiſes, which ſucceeded each other with ſuch rapidity that the intervals between them were, as far as could be judged, the ſmalleſt poſſible, found that he could evidently diſtinguiſh one hundred and ſixty of them in a ſecond of time; but beyond that he could by no effort of attention diſtinguiſh one ſound from another. The ſame philoſopher tried another experiment on viſible ſenſations. By means of the ſame handle and work of the clock, he cauſed a wheel in it to turn

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The ſucceſſion of ideas the meaſure of all other ſucceſſions.

till it acquired the velocity of once in a ſecond. He continued to increaſe the velocity, and obſerved it while revolving at the rate of twenty times round in thirteen ſeconds, and could ſtill diſtinguiſh the teeth and ſpaces from each other; whence it appears (by a computation given at length), that he had two hundred and forty-ſix diſtinct viſible ſenſations generated by equable motion in a ſecond of time. The teeth of the wheel, he owns, were not ſo far viſible as to ſhow their ſhape diſtinctly, much leſs could they have been counted: but he very plainly diſtinguiſhed the circumference to be divided into teeth and ſpaces; and he ſuppoſes that the ſame diviſion might ſtill have been ſeen though the motion had been a little faſter, as far perhaps as two turns in a ſecond, equal to three hundred and twenty ſenſations *." The reaſon that the diviſion could not be ſeen whilſt the wheel moved more rapidly than twice round in a ſecond of time, was doubtleſs the continuance of that agitation in the brain from which each ſenſation proceeded, until a new impreſſion cauſed a new agitation, which coaleſced with the former and removed all diſtinction. Hence it is plain, that no external ſucceſſion can be perceived which moves with a greater velocity than that of which the internal train of ſenſations and ideas is capable. On the other hand, an external ſucceſſion which moves with leſs rapidity than that to which the internal flow of ideas may be reduced, either has not ſufficient force to generate ſenſations at all, or the ſucceſſive impreſſions from which the ſenſations proceed follow one another at ſuch diſtances as to permit the natural train of ideas to intervene between them, and thus deſtroy the perception of the ſucceſſion entirely.

To us, therefore, it ſeems evident, that the conſtant and regular ſucceſſion of ideas in the mind of a waking man, is the meaſure and ſtandard of all other ſucceſſions; of which, if any one either exceeds the pace of which our ideas are capable, or falls ſhort of it, the ſenſe of a conſtant and continued ſucceſſion is loſt, and we perceive it not but with certain intervals of reſt between. So that it is not motion, but the conſtant train of ideas in our minds, that ſuggeſts to us our firſt notion of time; of which motion no otherwiſe gives us any conception, than as it cauſes in our minds a conſtant ſucceſſion of ſenſations: and we have as clear a notion of time by attending to the train of ideas ſucceeding each other in our minds, as by a train of ſenſations excited by conſtant and perceptible motion.

That it is merely by comparing the permanent exiſtence of things with the fleeting ſucceſſion of ideas in our own minds that we acquire our notions of time, may perhaps be ſtill more evident from the following narrative quoted by Dr Beattie †, from *L'Hiſtoire de l'Academie Royale des Sciences pour l'année* 1719. "A nobleman of Lauſanne, as he was giving orders to a ſervant, ſuddenly loſt his ſpeech and all his ſenſes. Different remedies were tried without effect. At laſt, after ſome chirurgical operations, at the end of ſix months, during all which time he had appeared to be in a deep ſleep or deliquium, his ſpeech and ſenſes were ſuddenly reſtored. When he recovered, the ſervant to whom he had been giving orders when he was firſt ſeized with the diſtemper, happening to be in the room, he aſked whether he had executed his commiſſion, not being ſenſible, it ſeems, that any interval of time, except perhaps a very ſhort one, had elapſed during his illneſs." If this ſtory be true, here was a man, who, by the train of ideas vaniſhing at once from his mind, loſt the perception of what was to others ſix months of time; and had all mankind been in his ſtate, the ſame portion of time would have been irrecoverably loſt even to the annals of chronology.

We are aware of an objection to any inference which may be drawn reſpecting the preſent queſtion from the caſe of this nobleman. It may be ſaid, that he had loſt, together with the perception of time, the perception of every thing beſides; and that, therefore, motion may ſtill be the cauſe from which a waking man derives his notions of time. But in reply to this objection, we beg leave to aſk, Whether if a ball had been put in motion on a table, and the nobleman had been told, that a body moved with the velocity of that ball would have been carried over ſo many thouſand miles of diſtance during the time that he lay in a ſtate of inſenſibility, he could from ſuch information alone have formed any tolerable notion of the length of time in which he was inſenſible? He certainly could not, for want of a ſtandard by which to meaſure the rapidity of the motion. He would, indeed, have known inſtantly that he had been inſenſible for a conſiderable length of time, becauſe he had the evidence of former experience that a body carried by perceptible motion over a great extent of diſtance would have generated in his mind a vaſt train of ſucceſſive ſenſations; but till he had attended this ball during part of its courſe, and compared with the permanency of other objects the ſeries of ſenſations which it generated in his mind, he would not have been able to gueſs with any thing near to accuracy the length of time it would take to paſs over a thouſand miles.—The ſame inſenſibility of duration happens to every man in ſound ſleep. From having notions of time, ſuch as they are, formed in our minds, we never indeed ſuppoſe, however ſoundly we have ſlept, that the moment at which we awake in the morning is contiguous to that in which we fell aſleep at night. The reaſon is obvious; every man has been awake whilſt others were ſleeping, and has known by experience, that if they had been awake likewiſe a train of ideas would have paſſed through their minds which muſt have ſuggeſted to them the notions of time. Moſt men, too, have been frequently awake whole nights, and have thus acquired a notion of time as going on inceſſantly, whether perceived by them or not; and this notion being cloſely aſſociated with our ideas of night and morning, we inevitably ſuppoſe a portion of time to have elapſed between them, though unperceived by us in our ſleep. But were a man to ſleep without dreaming from Sunday night till Tueſday morning, and then to awake at his uſual hour as marked on the clock, there are numberleſs inſtances on record to convince us, that he would not of himſelf ſuppoſe, nor perhaps be very eaſily perſuaded, that more than one night had elapſed between his falling aſleep and the moment at which he awoke.

It being thus evident, that our notion of time is ſuggeſted by that compariſon which we inevitably make of the exiſtence of things permanent with the train of ideas inceſſantly paſſing through our minds; we may now perhaps be able to anſwer the queſtion, "What is time?" It muſt of neceſſity be one of three things, viz. either the ideal ſucceſſion itſelf; a certain quality inherent in all objects; or merely the relation of coexiſtence between things that are permanent and the trains of fleeting ideas which ſucceed each other on the theatre of the imagination. It is not the firſt of theſe; for in every train of thought, the appearance of any one idea in the mind occupies no more of the extenſion of time, than a mathematical point occupies of the extenſion of diſtance. Ten thouſand mathematical points added together would make no part of a line; and ten thouſand ideas made to coaleſce, if that were poſſible, would occupy no part of that mode of duration which is called *time*. A point is the boundary of a line, but no part of it: the appearance of an idea in the mind is inſtantaneous; and an inſtant is the boundary, but no part of time. Hence it follows, that were every thing inſtantaneous like ideas in a train, there could be no ſuch thing as time, ſince nothing could be ſaid to have in that ſenſe of the word any duration. That time is not a quality inherent in all objects, is likewiſe plain; for we have ſeen, that were *ideas* as permanent as objects, the notion of time could never have been acquired. Succeſſion, though it does not itſelf conſtitute time, is eſſential to its exiſtence; and were all motion to ceaſe, and the attention of men to be immoveably fixed upon one invariable object or cluſter of objects, *time* would ceaſe likewiſe.

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* *Watſon's Treatiſe on Time.*

† *Eſſay on Truth.*

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Time a mere relation of coexiſtence.

It remains, therefore, that time can be nothing elſe than the relation of coexiſtence apprehended between things that are permanent and thoſe trains of fleeting ideas which inceſſantly ſucceed each other on the theatre of the imagination. Thus whilſt a man is ſteadily looking at one object, which, from its being common, does not occupy his whole mind, he may be conſcious of a thouſand ideas ſtarting up in his imagination, and each in its turn vaniſhing the inſtant in which it appeared. Every one of theſe ideas had an exiſtence as well as the object at which he is looking; but the exiſtence of each of them was inſtantaneous and in ſucceſſion, whilſt the exiſtence of the external object is permanent. The object, therefore, as contraſted with the train of ideas, is ſaid to endure or to exiſt in time, whilſt each idea is deſtitute of duration, and exiſts in no time.

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Objections anſwered.

To this theory ſome objections occur, which it will be incumbent upon us to obviate. It may be ſaid, that though each idea conſidered by itſelf is inſtantaneous, and occupies no time; yet the whole train when taken together, without being compared with any thing external, is perceived to occupy a conſiderable portion of that mode of duration; and that, therefore, time itſelf muſt be ſomething more than a mere relation between a fleeting ſucceſſion of ideas and objects of more permanent exiſtence. But how, we beg leave to aſk, is the whole train perceived to occupy any portion of time? Is it not by being compared with our own exiſtence? A man, whilſt a train of ideas is paſſing through his mind, may be ſuddenly deprived of all his external ſenſes, and then indeed it will be impoſſible for him to compare the fleeting exiſtence of this internal ſucceſſion with the more permanent exiſtence of external things; but, whilſt he thinks at all, he muſt be conſcious of his *own* exiſtence, and cannot avoid perceiving, that whilſt his ideas paſs in conſtant ſucceſſion, each making an inſtantaneous appearance in his mind, he himſelf remains unchanged. Now, what is it that this perception ſuggeſts to the mind? Evidently nothing more than the relation of coexiſtence between a fleeting ſucceſſion and a permanent object; for were it poſſible that the man could be deprived of memory as well as of his ſenſes, and ſtill have ideas ſucceeding each other in his mind, he would then think all objects equally fleeting; he would indeed be himſelf a mere ſucceſſion of inſtantaneous diſtinct perſons, and could have no notion whatever of time. His exiſtence, though it ſhould ſeem to endure half a century as eſtimated by others, muſt to himſelf appear to paſs away like a flaſh of lightning.

It may be ſtill further objected to our theory, that time is meaſured by motion; and that it ſeems very abſurd to talk of meaſuring a relation, eſpecially a mere *ideal* relation, by a real external thing. In anſwer to this objection, which at firſt ſight appears formidable, we beg leave to obſerve, that all relations are equally ideal; and that yet many of them may be ſaid to be meaſured by real external things, with as much propriety as time can be ſaid to be meaſured by motion. When a man wiſhes to aſcertain the relation of quantity which one body bears to another, though he knows that ſuch a relation has no other than an ideal exiſtence, and cannot be conceived but in conjunction with the related bodies, he applies to them ſucceſſively ſome common ſtandard; and having diſcovered the relation which each bears to that, he compares the one relation with the other, and thus aſcertains the relation ſought. Juſt ſo it is with reſpect to motion meaſuring time. That which to each individual conſtitutes real time, is the relation of coexiſtence between the fleeting ſucceſſion of his own ideas and other things of a more permanent nature. But a man has often occaſion to aſcertain the time of things external which fall not under the inſpection of his ſenſes; and in ſociety all men have tranſactions with one another to be performed in ſome determinate portion of time, though there are not, perhaps, two men exiſting whoſe ordinary trains of thought flow with preciſely the ſame rapidity. To remedy theſe inconveniences, it was neceſſary to invent ſome common ſtandard, by means of which men might aſcertain the duration of actions performed at a diſtance, and be able to keep appointments made with each other. The only ſtandard proper for theſe purpoſes is ſuch a conſtant and equable motion as has ſuggeſted a flux of perceptions common to all men in all ages and countries; and hence the motions of the heavenly bodies have been univerſally made uſe of for the common regulators of time. Theſe motions, however, do not conſtitute real and natural time, any more than a foot or a yard applied to two diſtant bodies conſtitutes the relation of quantity which theſe bodies bear to each other. They are merely ſtated meaſures, to be differently applied according to the different purpoſes which we have in view.

Thus, if a man in Europe wiſhes to know what would to him have been the *real* and *natural* time of an action performed in the Eaſt Indies, he has only to be told, that it was co-exiſtent, we ſhall ſuppoſe, with a diurnal revolution of the earth; and by comparing this common meaſure with his uſual flow of thought, he can form ſome notion of the extent of that train of ideas, which, had he been preſent, would to him have been ſucceſſively co-exiſtent with the action in queſtion. But when perſons have an appointment to keep, this common meaſure of motion muſt be differently, or rather partially, applied. In ſuch caſes, it is no part of their intention to compare their own exiſtence with that of the whole train of ideas which may paſs in the mind of each; for the reſult of ſuch a compariſon, which alone conſtitutes true and natural time, would not be the ſame in perhaps any two men: but their purpoſe is, to compare their own permanent exiſtence only with that train of ſenſations which ſhall be excited in the mind by the perceptible motion of the ſun, or any other body fixed upon which moves equably; and ſuch a train muſt conſiſt of an equal number of inſtants in all men. Neither the ſun, nor the hour hand of a common watch, moves with ſuch apparent rapidity as to keep pace with the internal flow of thought of which the moſt phlegmatic man is conſcious. That theſe bodies move at all, is known only by their viſible change of place during the lapſe of a conſiderable portion of real time; and as there is in their courſe a certain number of places diſtinctly marked, to which alone it is agreed that the attention is to be turned, it is impoſſible that of time ſo computed two men can have different notions. Such time, however, is but partial; and the method of aſcertaining it, when compared with that by which we aſcertain real time, has a ſtriking reſemblance to that by which we aſcertain the relation of partial quantity between two diſtant bodies. When it is our purpoſe to aſcertain the relation of real quantity which one body bears to another, we apply the common ſtandard to each in every dimenſion of length, breadth, and depth; but when we have no other view than to aſcertain the relation of length which the one bears to the other, we apply the common ſtandard to each in that dimenſion only. Juſt ſo it is with regard to real and partial time. When an individual wiſhes to aſcertain what would to him have been the duration of any action which he did not ſee performed, he applies the common ſtandard to the exiſtence of that action, and to the uſual flow of his own thoughts: but when two men talk of the duration of any action, or agree to meet on ſuch a day, they compare the exiſtence of the action, or the diſtance intervening between the preſent moment and the day of meeting, only with that partial train of ſenſations which by the common ſtandard is generated in an equal number, and in the ſame order, in the minds of both.

214 Time muſt have had a beginning. It will be ſaid, that if time be nothing more than a mere relation ſubſiſting between trains of ideas or other fleeting objects, and things of a more permanent exiſtence; and if the univerſe had a beginning; either time muſt have had a beginning likewiſe, or the Deity cannot be immutable. We allow the force of the argument; but inſtead of an objection, we conſider it as a confirmation of the truth of our theory. The Deity, who is immutable, exiſts not in time, but in eternity; and that theſe, though from the poverty of language they are both called modes of duration, are yet very different from each other, we ſhall endeavour to prove in the next chapter.

Chap. VIII. *Of* Infinity *and* Eternity.

215 Why we treat of infinity and eternity among the adjuncts of body. As corporeal ſubſtance is certainly not infinite, and as the preſent material ſyſtem has in itſelf every evidence of its not being eternal, it may ſeem ſtrange, perhaps, to the reader, that we ſhould treat of infinity and eternity among the adjuncts of body. But in modern metaphyſics theſe words are uſed in a vague ſenſe to denote the extent of ſpace and time; and in this chapter it is our intention to do little more than aſcertain their meaning, and to ſhow, in oppoſition to ſome celebrated names, of what ſubjects they may not be predicated. There is a mathematical and a metaphyſical infinity, which, though often confounded, ought to be kept diſtinct. In mathematics, extenſion is ſaid to be diviſible *ad infinitum*, and number is ſometimes conſidered as infinite: but in metaphyſics theſe modes of expreſſion are extremely improper. A poſitive and metaphyſical infinite is that which has no limits, and to which no addition can be made; but it is obvious that there is no number which may not be enlarged, nor any poſitive idea of extenſion which has not limits, and which may not be either increaſed or diminiſhed. The infinity of the mathematician is termed *infinity of power*, and that of the metaphyſician *abſolute infinity*. The firſt conſiſts in this, that a being, however great or ſmall it be ſuppoſed, may ſtill be conceived to poſſeſs more greatneſs or minuteneſs than we can form an idea of, even after the utmoſt ſtretch of human thought. Thus when it is ſaid, that all extenſion as ſuch is infinitely diviſible, it is not meant that every extended ſubſtance contains an infinite number or *real parts*; for then the parts of an inch would be equal to thoſe of a league: but the meaning is, that in ideal extenſion we can never reach the end of ideal diviſion and ſubdiviſion. In like manner, when it is ſaid that number is infinite, the meaning is not that any poſitive number is without limits, or the poſſibility of increaſe, but that we might go on for ever, adding unit to unit, without approaching nearer to the end of the proceſs. If, therefore, the mathematician would ſpeak properly, and without the affectation of paradox, he ought to ſay that all extenſion as ſuch is *indefinitely* diviſible, and that unit might be added to unit without end; but theſe phraſes ſuggeſt notions very different from that of a metaphyſical infinite, which is ſomething poſitive to which nothing can be added (B).

216 Space and time ſuppoſed to be, the one infinite, and the other eternal: That there is ſomething poſitively infinite, has been very ſeldom queſtioned; but it has been warmly diſputed among metaphyſicians what ſubjects are infinite. Dr

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(B) Ὁυ γαρ ὁυ μηδεν εξω αλλ ὁυ αει το εξω εστι, τουτο απειρον εστι. *Ariſt. Phyſ. Auſcult.* lib. ix. cap. 9. page 492. tom. i. *Oper.*

Dr Clarke and his adherents have contended that ſpace and time are real things; that they are both of neceſſary exiſtence; that the former impreſſes us with the idea of its infinity, and that the latter is poſitively eternal. "Time and ſpace (ſays the doctor *) are the *ſine qua non* of all other *things*, and of all other *ideas*. To ſuppoſe either of them *finite*, is an expreſs *contradiction* in the idea itſelf. No man *does* or *can* poſſibly *imagine* either of them to be finite; but only either by *non-attention* or by *choice* he attends perhaps to *part* of his *idea*, and *forbears attending to* the remainder. They who ſuppoſe *ſpace* to be nothing but a *relation between two bodies* are guilty of the abſurdity of ſuppoſing that which is *nothing* to have *real qualities*: *For the ſpace which is between two bodies* is always unalterably juſt what it was, and has the very ſame dimenſions, quantity, and figure, whether *theſe* or any *other bodies* be there or any where elſe, or not at *all*. Juſt as *time* or *duration* is the ſame, whether you turn your *hour-glaſs* or no, or whether the ſun moves or ſtands ſtill, or whether there *was* or *was not any ſun*, or any *material world* at all. To ſet *bounds* to ſpace is to ſuppoſe it *bounded* by ſomething which itſelf *takes up ſpace*, and that is a *contradiction*; or elſe that it is *bounded by nothing*, which is another contradiction. To ſuppoſe ſpace *removed*, *deſtroyed*, or *taken away*, amounts to the abſurd ſuppoſition of removing a thing away *from itſelf*; that is, if in your *imagination* you *annihilate* the *whole* of *infinite ſpace*, the whole of *infinite ſpace* will ſtill remain; and if you annihilate any *part* of it, *that part* will ſtill *neceſſarily* remain, as appears by the unmoved ſituation of the *reſt*; and to ſuppoſe it *divided* or *diviſible* amounts to the ſame contradiction."

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but improperly.

The abſurdity of conſidering ſpace as a real external thing has been already evinced in Chap. IV. p. 624, where it was ſhown how we acquire the notion, and what kind of notion it is. Space, as was there obſerved, may be conceived either as the mere abſence and poſſibility of body; or as ideal extenſion, united to, and inhering in, an ideal ſubſtratum. Taken in the former ſenſe, it is an object of pure intellect; in the latter, it is an *idea* or *form* in the imagination. That the abſence of body or matter is the *ſine qua non* of all other things, and all other ideas, Dr Clarke was not diſpoſed to affirm, when he made the divine ſubſtance, to pervade every material atom in the univerſe: and to talk of the abſence of body being infinite is a palpable contradiction, unleſs Berkeley's doctrine be true, that the material world has no exiſtence. To ſay that the *poſſibility* of matter is infinite, is to uſe language which has no other meaning than that, however far the material world be on all ſides extended, its extenſion may ſtill be conceived greater and greater *ad infinitum*. This is a poſition which no philoſopher ancient or modern has ever denied; but it is ſo far from implying that we have a poſitive idea of the infinity of the material world, or of any adjunct of the material world, that it is abſolutely inconſiſtent with ſuch infinity. Whatever is capable of perpetual increaſe muſt certainly have limits, and every new addition is the limit of that to which the addition was made.

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Neither ſpace nor

Taken in the ſecond acceptation as an ideal extenſion united with an ideal *ſubſtratum*, ſpace is ſo far from being infinite in any ſenſe of the word, that we will venture to aſſert no man ever contemplated ſuch a *form* in his own imagination, without conceiving it to be bounded. Of this, at leaſt we are certain, that when we have attempted to frame a poſitive idea of pure ſpace, it has not been in our power to diveſt that idea of limits. Thoſe who can frame in their minds real and poſitive ideas wholly abſtracted from every individual object, may indeed perform in this way many feats above our abilities; but as we poſſeſs no ſuch powers of abſtraction, every thing which we can call an idea is limited in the ſame manner that the object itſelf is limited from which the idea was derived.—Thus, the largeſt expanſion that ever we beheld is the concave hemiſphere; and when we try to form the largeſt poſitive idea of pure ſpace, all that we can do is to figure to ourſelves that concave empty of body. We may, indeed, ſuppoſe its diameter to be either a million or ten thouſand millions of miles; and we may go on enlarging it *ad infinitum*: but when we return from this proceſs of intellect to the contemplation of the ideal forms of the imagination, none of theſe forms appear to us larger or more extended than the hemiſphere, which is the object of ſenſe, and they all appear to be bounded, and bounded in the very ſame way.

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time can be poſitively infinite; and why.

With reſpect to the eternity of time, we think Dr Clarke equally miſtaken as with reſpect to the infinity of ſpace. Of time, indeed, we cannot, properly ſpeaking, have any *idea* or mental *form*. Time, as we have ſeen, is a mere relation, and is in itſelf the creature of the mind which has no external *idiatum*. It is ſuggeſted, however, by the fleeting ſucceſſion of our ideas, compared with the more permanent exiſtence of other objects: and therefore ſucceſſion is eſſential to it. But nothing which has parts, whether coexiſtent or in ſucceſſion, can be poſitively infinite. For, "in an infinite ſeries of ſucceſſive generations of men, for inſtance, there will be ſeveral infinites that are parts of one another; and by conſequence one greater than another: which (as has been well argued *) is an expreſs contradiction, ſince the greater muſt neceſſarily bound the leſs, and exceed its limits by ſo much as it is greater than it; that is, muſt make it not infinite. Infinite generations contain an infinitely greater infinity of particular men. An infinite number of men muſt have twice as many hands, and ten times as many fingers, and ſo on. Infinite time has an infinity of ages; theſe a much greater infinity of years, days, hours, &c. Space likewiſe (according to Dr Clarke) has three dimenſions, all infinite. It muſt therefore, contain an infinity of ſurfaces, an infinitely greater infinity of lines, and a ſtill infinitely greater infinity of phyſical points. The caſe is the ſame in number itſelf, which, if we ſuppoſe it to contain an abſolute infinity of thouſands (and we may as well do that as imagine it to comprehend an infinity of units), it will contain ten times as many hundreds, fifty times as many ſcores, and ſo on. All this is only the *indefiniteneſs* of number, which we in vain attempt to turn into a poſitive infinite with which it is totally incompatible. For let us add *one* to any of theſe infinite ſeries of generations, ages, lines, or numbers, which we know to be always in our power, and if it was abſolutely infinite before, here is one more than infinite. If it only becomes infinite now, then one finite added to another finite makes infinity. If it be no larger after

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* *Demonſtration of the Being and Attributes of God*, and *Correſpondence with a Gentleman of Glouceſterſhire.*

* Dr Law's *Inquiry into the ideas of Space, Time, Immenſity, and Eternity.* See alſo the ſame acute writer's tranſlation of *King's Origin of Evil.*

ter the addition than it was before, then one part added to another adds nothing; all which are abſurdities. The ſame will appear, if we ſubtract a part from this ſuppoſed abſolute infinite, which may be done in any of the forementioned ſubjects, as well as in every thing which admits of parts, or may be taken in pieces by the mind."

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The uſual reply to the foregoing reaſoning ſhown

To this kind of reaſoning Dr Clarke replies as follows: "To endeavour to prove that there cannot poſſibly be any ſuch thing as *infinite time* or *ſpace*, from the impoſſibility of an addition of finite parts ever compoſing or exhauſting an infinite; or from the imaginary inequality of the number of years, days, and hours, that would be contained in the one; or of the miles, yards, and feet, that would be contained in the other, is ſuppoſing infinites to be made up of numbers of finites; that is, it is ſuppoſing finite quantities to be *aliquot* or *conſtituent parts* of infinite, when indeed they are not ſo, but do all *equally*, whether *great* or *ſmall*, whether *many* or *few*, bear the very ſame proportion to an infinite, as mathematical points do to a line, or lines to a ſuperficies, or as moments do to time, that is, none at all. No given number or quantity can be any *aliquot* or *conſtituent* part of infinite, or be compared at all with it, or bear any kind of proportion to it, or be the foundation of any argument in any queſtion concerning it."

If it be indeed true, and it is that for which we contend, that no given number or quantity can be any aliquot or conſtituent part of infinite, or be compared at all with it; then it undeniably follows, not that miles, yards and feet, are no conſtituent parts of ſpace; or years, days, and hours conſtituent parts of time; but that ſpace and time cannot poſſibly be poſitive infinites. This, we ſay, follows undeniably: for nothing is more evident, than that all quantities of the ſame kind, from the largeſt to the leaſt, bear a certain proportion to each other; and upon the ſuppoſition that ſpace is a real extending thing, miles, yards, and feet are included in it, and bear to it the relation of parts to a whole. The ſame is true of time, days, and hours. To affirm (for no proof is offered), that all finite quantities, whether great or ſmall, whether many or few, do equally bear the very ſame proportion to an infinite, as mathematical points do to a line, or as moments do to time, is plainly to beg the queſtion—"that *ſpace* conſidered as a real extended thing is *infinite*;" and to beg it, too, in oppoſition to the common ſenſe and reaſon of mankind. Mathematical points we all know to be nothing real, but merely negations of extenſion; but ſuppoſing ſpace to be ſomething real and extended, can any man perſuade himſelf that a mile or a million of miles of this ſpace is likewiſe a mere negation of extenſion? With him who can bring himſelf to this perſuaſion, we pretend not to argue. He is poſſeſſed of faculties, whether true or falſe, of which we are deſtitute.

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to be a *petitio principii.*

That finite quantities, whether great or ſmall, do all equally bear the ſame proportion to an *infinite in power*, is indeed true; but it is no great diſcovery: for ſuch an infinite, as we have ſeen, is nothing but the continued poſſibility of repeating the ſame mental proceſs of addition or multiplication; and he who can go on for ever adding, in his own imagination, foot to foot, or hour to hour, will find it equally eaſy to add, in the ſame manner, league to league, or age to age. If he can perform the one operation, he muſt likewiſe have power to perform the other; and he cannot but perceive that it is as impoſſible to come to an end, of adding league to league, or age to age, as of adding foot to foot, or hour to hour; but then he muſt know that theſe leagues, feet, ages, and hours, are not real external things, but mere ideas and notions in his mind. If ſuch powers of ideal multiplication and addition be what Dr Clarke means by the ideas of ſpace and time, it is indeed a contradiction to ſuppoſe either of them limited; for that is to ſuppoſe our powers different from what we know them to be by conſciouſneſs and experience. But to confound *powers* with the *objects* of thoſe powers, is certainly very inaccurate; and to ſuppoſe, becauſe we can go on for ever adding one portion of ideal ſpace or time to another, that therefore our ideas of ſpace and time are in themſelves poſitively infinite, is a contradiction: for to an idea poſitively infinite, it is obvious that nothing can be added. Either, therefore, ſpace and time do not impreſs us with the ideas of their poſitive infinity; or we cannot have the power of adding league to league, and age to age, without end.

"But (ſays the doctor), to ſuppoſe ſpace removed, deſtroyed, or taken wholly away, amounts to the abſurd ſuppoſition of removing a thing from itſelf; that is, if in your imagination you remove the whole of ſpace, the whole of ſpace will ſtill remain." True, every man has ideas of ſpace treaſured up in his imagination, which the ſound of the very word ſpace will at all times bring into his immediate view; and whilſt he has ſuch ideas, it is impoſſible that he ſhould not have them; which is all the myſtery of the matter, and amounts to nothing more than that a thing cannot be and not be at the ſame inſtant. When the doctor affirms, that if "you annihilate any part of ſpace, that part will neceſſarily remain, as appears by the unmoved ſituation of the reſt," we are not certain that we perfectly underſtand him. A man may ſurely think of a cubical inch without thinking of a foot or a yard; and he may ſuppoſe the inch taken away from the foot or the yard, and theſe ideal quantities ſo much leſſened by the ſubtraction. But if the doctor be here again confounding the powers of the mind with the poſitive ideas of ſpace, the ſentence when explained will be ſeen to contain nothing to his purpoſe. Every man has the power of contemplating in idea millions of miles, and millions of ages, and of adding mile to mile, and age to age, without end; and if he try to deprive himſelf of any part of this power, or to fix a limit to the mental proceſs of addition, he will find that in ſpite of himſelf his imagination will ramble beyond the limit aſſigned, and that he has attempted an impoſſibility. This, however, is ſo far from being a proof that his ideas of ſpace and time are poſitively infinite, that, as we have already obſerved, it is a proof of the contrary.

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Space and time are ſaid to be the *ſine qua non* of all other things; but

But (ſays this great man and his followers) "ſpace and time are the *ſine qua non* of all other things and all other ideas. The ſuppoſal of the exiſtence of *any thing whatever* includes neceſſarily a *preſuppoſition* of the exiſtence of *ſpace* and *time*;" and therefore, if there be any thing infinite and eternal, ſpace and time muſt likewiſe be ſo.

To every corporeal ſubſtance, and every idea of ſuch ſubſtance, ſpace and time are indeed neceſſary: for every body has extenſion and duration; and every idea of a particular body, being nothing but a ſecondary perception in the imagination or memory, muſt have the ſame relation to imaginary extenſion, that the object from which it was derived has to extenſion which is real. Every idea, too, which remains in the imagination whilſt a train of other ideas paſſes ſucceſſively in view, or whilſt external things are perceived to change, has real time.

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There are things which have no relation whatever to ſpace, or

But will any man ſay that *conſciouſneſs*, our notion of *power*, our acts of *willing*, or even *taſtes*, *ſounds*, and *ſmells*, are extended, or that the ſuppoſal of their exiſtence neceſſarily implies a preſuppoſition of the exiſtence of ſpace? We acquire our ideas of extenſion and ſpace by means of our ſenſes of touch and ſight; and we learn from experience, that things external and extended are the cauſes of our ſenſations of taſte, ſound, and ſmell. The effects are in our minds cloſely aſſociated with the ideas of their cauſes; and it is not perhaps eaſy to think of a particular ſound, taſte, or ſmell, without at the ſame time thinking of the object by which it was at firſt excited in the mind; but had we been originally formed with the powers of conſciouſneſs, thinking, and willing, and with no other ſenſes than thoſe of taſting, ſmelling, and hearing, it is obvious that we never could have had the idea of *ſpace;* and therefore, that idea cannot poſſibly be neceſſary to the preſuppoſition of every thing elſe. To conſciouſneſs, thinking, and willing, ſpace is ſo far from being neceſſary, that we cannot perceive any the moſt diſtant relation between them. It is not more difficult to conceive a part greater than the whole, than it is to conceive an ell of *conſciouſneſs*, of *thought*, or of *will;* nor is it in the power of any man to make *ſpace* and *ſweetneſs* coaleſce in his mind ſo as to form of the two ſimple ideas one complex conception. The very reverſe is the caſe with reſpect to the objects of ſight and touch. The idea of every thing which we ſee and handle neceſſarily coaleſces in the mind with the idea of ſpace, nor can we poſſibly ſeparate the one from the other; but the things which we ſee and handle are neither infinite nor capable of infinity.

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to time.

With reſpect to time, the ſame obſervations will be found to be juſt as with reſpect to ſpace. Whatever is liable to change, exiſts in time and cannot be eternal; but if there be any being immutable, and who views at once all things which to us are paſt, preſent, and to come, the exiſtence of that being is not commenſurable with time. That ſuch a being is poſſible no man can doubt, who reflects, that if we had one permanent idea invariably in the mind, we ſhould never have acquired the *notion* of ſucceſſion or of time; and that if there were *actually* no *change* in nature there could not poſſibly in nature be any ſuch *thing as time.* Every man, therefore, who can conceive exiſtence without change, muſt be convinced, that "the ſuppoſal of the exiſtence of any thing whatever does *not* neceſſarily include the preſuppoſition of the exiſtence of time; and that there may be an eternity diſtinct from time, as well as an infinity diſtinct from ſpace; nay, that nothing which is properly infinite and eternal can poſſibly occupy either ſpace or time.

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Infinity and eternity, what they are.

If it be aſked, What kind of infinity and eternity they are which have no relation to ſpace and time? Cudworth, treading in the footſteps of the ancients, has long ago anſwered, That they are "abſolute perfection, and neceſſary exiſtence. For (ſays he), *infinite underſtanding* and *knowledge* is nothing elſe but *perfect* knowledge, which hath in it no defect or mixture of ignorance, but knows whatſoever is knowable. In like manner, *infinite power* is nothing elſe but *perfect* power, which hath in it no defect or mixture of impotency—a power which can do every thing which is poſſible or conceivable. Laſtly, *Infinity of duration*, or *eternity*, is really nothing elſe but *perfection*, as including in it *neceſſary exiſtence* and *immutability;* ſo that it is a contradiction to ſuppoſe ſuch a being to have had a beginning, to ceaſe to be, or to ſuffer or be affected by any change whatever. And becauſe infinity is perfection, therefore nothing which includes in its idea or eſſence any thing of *imperfection*, as every poſitive idea of number, corporeal magnitude, and ſucceſſive duration, evidently does, can be truly and properly infinite *."

It muſt indeed by confeſſed, that the idea of ſucceſſion ſo inſinuates itſelf into our uſual ideas of exiſtence, and is ſo cloſely connected with the exiſtence of all finite beings, that we find it extremely difficult to imagine the eternal exiſtence of God, any otherwiſe than as an eternally continued ſeries or ſucceſſion. Our conſtant converſation with material objects, and the aſſociations thence ariſing, make it almoſt impoſſible for us to conſider things abſtracted from time and ſpace; yet we have the evidence of experience and conſciouſneſs, that an idea may be conceived without relation to ſpace and time, and that ſpace and time cannot be made to coaleſce with ſome of our notions. The ſame muſt be true with reſpect to infinity and eternity; for we have ſeen that neither ſpace, time, nor any thing elſe which conſiſts of parts, whether continuous or ſucceſſive, can be ſuppoſed to be poſitively infinite, as the ſuppoſition implies the moſt palpable contradiction. But that there may be perfect power, perfect knowledge, and permanent invariable exiſtence, is ſo far from implying any contradiction, that even we, whoſe faculties are ſo very narrow, can yet make ſome advances towards the conception of ſuch perfections. Thus, every man of common underſtanding knows that ſome things are in themſelves poſſible, and others impoſſible, to be performed by any power. Of theſe poſſibilities and impoſſibilities a philoſopher knows more than an illiterate man; and one philoſopher knows more than another. An intellect more perfect knows more of them than any man; and that intellect which knows them all muſt be abſolutely perfect, and incapable of improvement, becauſe it knows every thing which is to be known. The ſame is true of perfect power:—but we ſhall treat of real infinity and eternity more at large when we come to demonſtrate the being and attributes of God. At preſent it is ſufficient to have ſhown that nothing can be poſitively infinite but a being abſolutely perfect; which never was not, which can produce all things poſſible and conceivable, and upon which all other things muſt depend.

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* Intellectual Syſtem.

PART III. OF MINDS AND THEIR POWERS.

Chap. I. *Of* Mind *in* General.

226 Mind diſtinguiſhed from body.

THE ſcience of metaphyſics comprehends every thing, into the exiſtence, nature, or cauſes of which any inquiry may be made. But all things of which we have any notion or idea may be divided into mind and body, with their various powers, qualities, and adjuncts. By body is meant that which is ſolid, extended, inert, and diviſible; and its ſeveral adjuncts are ſpace, motion, number, and time. The only mind with which we are *intimately* acquainted is our own; and we know that it is poſſeſſed of the powers of ſenſation, perception, retention, conſciouſneſs, reflection, reaſon, and will. Theſe are totally different from extenſion, ſolidity, diviſibility, and motion; and therefore it is proper to diſtinguiſh the being of which they are powers by another name than that of body.

227 Probably minds of different orders.

Of bodies there are various kinds poſſeſſing various ſenſible qualities; and from analogy it is reaſonable to conclude, that there may be various claſſes of minds endowed with different kinds or degrees of power. For this indeed we have ſtronger evidence than that of analogy. Brute animals evidently poſſeſs the powers of perception and ſpontaneity with ſome degree of conſciouſneſs; but as they appear not to reflect upon their own conduct, or to have their actions influenced by motives, their minds are inferior to ours, though ſtill perfectly diſtinct from mere extended, inert, and diviſible ſubſtances. Mind, therefore, conſidered with reſpect to its powers, is evidently different from body conſidered with reſpect to its qualities. This is indeed a truth which has ſeldom if ever been controverted; but it has been long and warmly diſputed, Whether mind and body be not both compoſed of the ſame firſt matter?

228 The abſurd hypotheſis of Hobbes reſpecting mind.

Hobbes ſuppoſed, that every material atom is endowed with the faculty of ſenſation (c); but that for want of memory each ſenſation is momentaneous, being inſtantly and wholly effaced as ſoon as its cauſe is removed. Though this hypotheſis is too abſurd to require a formal and laboured confutation, it may not be improper to obſerve, that, if it were true, the hairs of a man's head would feel extreme pain when pinched by the hot iron of the hair-dreſſer; and that the nails of his fingers would be ſeverely tortured when under the operation of the knife or the raſp.

229 Other hypotheſes.

Others have ſuppoſed that each atom of matter has a *tendency towards* ſenſation and perception; and that when a ſufficient number of theſe atoms are brought together in a certain order, the *united tendencies* produce the *actual* powers which diſtinguiſh mind from groſs body. This ſuppoſition is if poſſible more abſurd than that of Hobbes. Senſation and perception are of ſuch a nature, that a mere *tendency towards* them is inconceivable. A thing muſt either be ſenſible and percipient, or inſenſible and inert: there is evidently no medium. Or if we could ſuppoſe each individual atom to have a *tendency* towards ſenſation, it would by no means follow that a number of ſuch atoms brought together in any poſſible order would become one ſentient, thinking, and active being. A number of bodies laid upon an inclined plane have each a *tendency* to roll downwards; but if the declivity of the plane be not ſuch as that their ſeparate tendencies may overcome the reſiſtance oppoſed to each individual body by friction, the *united tendencies* of all the bodies when brought together will not be able to overpower the reſiſtance of their united frictions. Juſt ſo is it with reſpect to ſenſation and perception: If the tendency of one atom cannot overcome one degree of inertneſs, the tendency of a thouſand atoms will not overcome a thouſand degrees of the ſame inertneſs.

231 Only two opinions at preſent on the ſubject.

We have juſt mentioned theſe abſurd ſuppoſitions that our article might be complete: but it is proper to inform the reader, that, ſo far as we know, neither of them has for theſe many years been maintained by any philoſopher of eminence either at home or abroad. The opinions on this ſubject, which at preſent divide the republic of letters, are two; and theſe alone are worthy of examination. One party maintains, That perception, memory, reaſon, and will, &c. are the powers of a being which muſt be immaterial and indiviſible: The other alleges, That as we know nothing of theſe powers but from our own conſciouſneſs, and as we can trace them in ourſelves to the brain and no farther, we have no reaſon to ſuppoſe that they are the powers of any ſubſtance diſtinct from matter. Both parties, however, diſtinguiſh that which in man is the ſubject of thought from his external organs of ſenſe, and agree to call it by the name of *mind;* though the one conſiders it as compoſed of the ſame firſt matter with the duſt of the ground; whilſt the other believes it to have no property whatever in common with that matter.

Were we to adopt ſome of the ancient methods of philoſophizing, this important queſtion might be ſoon decided. A moſt reſpectable writer, who has laboured to reſtore the metaphyſics of Plato and Ariſtotle, hopes to confute the materialiſts, by laying down what they muſt think arbitrary definitions of mind and matter, and then ſhowing that the one is not the other.

(c) Scio fuiſſe philoſophos quoſdam, eoſdemque *viros doctos*, qui corpora omnia ſenſu prædita eſſe ſuſtinuerunt: *Nec video*, ſi natura ſenſionis in reactione ſola collocaretur, QUOMODO *refutari poſſint*. Sed etſi ex reactione etiam corporum aliorum, phantaſma aliquod naſceretur; illud tamen, remoto objecto, ſtatim ceſſaret. Nam niſi ad retinendum motum impreſſum, etiam remoto objecto, apta habeant organa, ut habent animalia; ita tantum ſentient, ut nunquam ſenſiſſe ſe recordentur. Senſioni ergo, quæ vulgo ita appellatur, neceſſario adhæret memoria aliqua. *Hobbes's Phyſic*, cap. xxv. ſect. 5.

"In all the parts of the material world (ſays he) there is a perpetual *motion*: For the celeſtial bodies move conſtantly in one reſpect or another; and all here below is in a continual viciſſitude of generation and corruption, which cannot be without *motion*. Now, where there is *motion*, there muſt be ſomething that *moves*: What is *moved* I call *body*; what moves I call *mind*." From this definition he undertakes to prove, that mind muſt be immaterial. "That there is a relation between *moving* and *being moved* (ſays he), nobody can deny; and the relation is no other than that of *action* and *paſſion*. But the nature of relation is ſuch, that it muſt neceſſarily be between two things at leaſt; and it is further neceſſary, that the two things related ſhould exiſt together. Hence, if there be that which *moves*, there muſt be a different thing that *is moved*; and wherever the one is, the other muſt neceſſarily be; ſo that nothing can move itſelf. This being eſtabliſhed, I ſay that what *moves* muſt be either material or immaterial: for the one of theſe being the negation of the other, there can be no middle betwixt them; becauſe a thing muſt neceſſarily *be*, or not *be*. If then it be immaterial, there is an end of the queſtion: but if it be ſaid to be material, then I ſay that it muſt be *moved* itſelf before it can move any thing elſe; for it is only in that way that body can move body. If then it muſt be firſt moved itſelf, but cannot itſelf move itſelf, what is it that moves itſelf? If it be anſwered, That it is another material mover, then I repeat the ſame queſtion, to which the ſame anſwer muſt be given: and ſo we have an infinite ſeries of *material movers*, without any beginning or *principle* of *motion*. Now this is abſurd, and contradictory to this firſt principle of natural philoſophy, admitted by all philoſophers ancient and modern, That *nothing can be produced without a cauſe* *."

For the immateriality of the human mind, and of every being endowed with the powers of perception and thought, the learned writer has better arguments; but it is upon this chiefly that he reſts his perſuaſion, that mind is the only *mover* in the univerſe. It is needleſs to obſerve, that in the very definitions and axioms upon which this reaſoning is built, the thing to be proved is taken for granted: for if it be ſelf-evident, that what *moves* is, in the author's ſenſe of the word, *mind*, that what is *moved* is *body*, and that *nothing can move itſelf*, all reaſoning on the ſubject is ſuperfluous. This, however, is ſo far from being ſelf-evident, that a materialiſt may reply, "every animal moves itſelf, and yet every animal is nothing more than a ſyſtem of matter." This poſition, whether true or falſe, can neither be proved nor confuted by arguments *à priori* founded on general definitions. That animals move themſelves, and that to the ſenſes they appear to be nothing elſe than ſyſtems of matter, are facts which cannot be controverted. If we would know whether they have in them a principle of motion which is not material, we muſt ſubmit to the laws of induction (ſee LOGIC); and by inveſtigating the eſſential qualities of matter, endeavour to aſcertain whether a material ſyſtem can be rendered active. That we ourſelves have active powers, we know by the moſt complete of all evidence, viz. conſciouſneſs of their energies; and it has been already ſhown, that ſuch powers as we experience in ourſelves cannot exiſt but in a ſubject poſſeſſed of will and underſtanding. The queſtion therefore to be firſt decided between the materialiſts and immaterialiſts is, Whether the powers of conſciouſneſs, underſtanding, and will, can reſult from the particular organization of a ſyſtem of matter? If they can, we have no reaſon to attribute them in man to any other ſource: If theſe powers appear neceſſarily to require an immaterial principle for their ſupport, it will probably be granted, that an immaterial principle is the ſource of every power and every motion in the univerſe; and the doctrine of *mind*, in the ſtricteſt ſenſe of the word, will be ſufficiently eſtabliſhed.

231 The proper method of inveſtigating the nature of mind.

CHAP. II. *Of the* SUBSTANCE *of the* HUMAN MIND.

232 Arguments for the immateriality of the human mind.

THE moſt celebrated materialiſt of this or perhaps of any other age is Dr Prieſtley; who having in his own imagination diveſted matter of ſolidity, and reduced it to mere centres of attraction and repulſion, obſerves, that "if one *kind of ſubſtance* be capable of ſupporting all the known *properties* of man; that is, if thoſe properties have nothing in them that is abſolutely incompatible with one another; we ſhall be obliged to conclude (unleſs we openly violate the rules of philoſophizing, which will not authorize us to *multiply cauſes* or kinds of ſubſtance *without neceſſity*), that no other kind of ſubſtance enters into his compoſition; the ſuppoſition being manifeſtly *unneceſſary*, in order to account for any appearance whatever.—All the properties that have hitherto been attributed to matter, may be compriſed under thoſe of attraction and repulſion. Beſides theſe, man is poſſeſſed of the powers of *ſenſation* or *perception*, and *thought*. But if, without giving the reins to our imaginations, we ſuffer ourſelves to be guided in our inquiries by the ſimple rules of philoſophizing above mentioned, we muſt neceſſarily conclude, that theſe powers alſo may belong to the ſame ſubſtance that has alſo the properties of attraction, repulſion, and *extenſion* (D), which I as well as others call by the name of *matter*. The reaſon of the concluſion is ſimply this, that the powers of ſenſation or perception and thought, as belonging to man, have never been found but in conjunction with a certain *organized ſyſtem of matter*; and therefore that thoſe powers neceſſarily exiſt in and depend upon ſuch a ſyſtem. This at leaſt muſt be our concluſion, till it can be ſhown that theſe powers are incompatible with the other known properties of the ſame ſubſtance; and for this I ſee no ſort of pretence."

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* *Ancient Metaphyſics.*

(D) When Dr Prieſtley mentions the *extenſion* of corporeal ſubſtance, it muſt be remembered that he does not mean the extenſion of any real thing poſſeſſed of an independent exiſtence. The extenſion belongs wholly to the *ſphere* or the *combination* of ſpheres of *attraction* and *repulſion*. The centre itſelf, which attracts and repels, he repeatedly affirms not to have the dimenſions even of a phyſical point; and he ſometimes ſeems to entertain a doubt whether it be any thing more than a mere relative notion.

This is what Dr Prieſtley calls the proper and direct proof that the ſentient principle in man is the material ſubſtance of the brain; and he enforces it by the following obſervations: "Had we formed a judgement concerning the neceſſary ſeat of thought by the circumſtances that *univerſally accompany it*, which is our rule in all other caſes, we could not but have concluded that in man it is a property of the *nervous ſyſtem*, or rather of the brain; becauſe, as far as we can judge, the faculty of thinking, and a certain ſtate of the brain, always accompany and correſpond to one another; which is the very reaſon why we believe that any property is inherent in any ſubſtance whatever. There is no inſtance of any man retaining the faculty of thinking when his brain was deſtroyed; and whenever that faculty is impeded or injured, there is ſufficient reaſon to believe that the brain is diſordered in proportion; and therefore we are neceſſarily led to conſider the latter as the ſeat of the former. Moreover, as the faculty of thinking in general ripens and comes to maturity with the body, it is alſo obſerved to decay with it; and if, in ſome caſes, the mental faculties continue vigorous when the body in general is enfeebled, it is evidently becauſe in thoſe particular caſes the *brain* is not much affected by the general cauſe of weakneſs. But, on the other hand, if the brain alone be affected, as by a blow on the head, by actual preſſure within the ſkull, by ſleep, or by inflammation, the mental faculties are univerſally affected in proportion. Likewiſe, As the mind is affected in conſequence of the affections of the body and brain, ſo the body is liable to be reciprocally affected by the affections of the mind, as is evident in the viſible effects of all ſtrong paſſions, hope or fear, love or anger, joy or ſorrow, exultation or deſpair. Theſe are certainly irrefragable arguments, that it is properly no other *than one and the ſame thing* that is ſubject to theſe affections, and that they are neceſſarily dependent upon one another. In fact, there is juſt the ſame reaſon to conclude, that the powers of ſenſation and thought are the neceſſary reſult of a particular organization, as that ſound is the neceſſary reſult of a particular concuſſion of the air. For in both caſes equally the one conſtantly accompanies the other; and there is not in nature a ſtronger argument for a neceſſary connexion of any cauſe and any effect. To adopt an opinion different from this, is to form an hypotheſis without a ſingle fact to ſupport it *."

Though the ingenious author thinks, that if there be any foundation for the eſtabliſhed rules of philoſophizing, this reaſoning ought to be concluſive, he yet ſubjoins, for the greater ſatisfaction of his readers, ſome additional arguments, or rather, as he ſays, diſtinct illuſtrations of the great argument. They are as follow:

1. "That the faculty of thinking neceſſarily depends, for its *exerciſe* at leaſt, upon a ſtock of ideas, about which it is always converſant, will hardly be queſtioned by any perſon. But there is not a ſingle idea of which the mind is poſſeſſed but what may be proved to have come to it from the bodily ſenſes, or to have been conſequent upon the perceptions of ſenſe. The notion, therefore, of the *poſſibility* of thinking in man, without an organized body, is not only deſtitute of all evidence from actual appearances, but is directly contrary to them; and yet theſe appearances ought alone to guide the judgement of philoſophers.

2. "The only reaſon why it has been ſo earneſtly contended for, that there is ſome principle in man that is not material, is, that it might ſubſiſt, and be capable of ſenſation and action, when the body is dead. But if the mind was naturally ſo independent of the body, as to be capable of ſubſiſting by itſelf, and even of appearing to more advantage, after the death of the body; it might be expected to diſcover ſome ſigns of its independence before death, and eſpecially when the organs of the body were obſtructed, ſo as to leave the ſoul more at liberty to exert itſelf; as in a ſtate of *ſleep* or *ſwooning*, which muſt reſemble the ſtate of death; in which it is pretended that the ſoul is moſt of all alive, moſt active, and vigorous. But judging by appearances, the reverſe of all this is the caſe.

3. "If the mental principle was, in its own nature immaterial and immortal, all its particular faculties would be ſo too; whereas we ſee that every faculty of the mind without exception is liable to be impaired, and even to become wholly extinct, before death. Since, therefore, all the faculties of the mind, ſeparately taken, appear to be mortal, the ſubſtance or principle in which they exiſt muſt be pronounced to be mortal too.

4. "If the ſentient principle in man be immaterial, it can have no *extenſion*; it can neither have length, breadth, nor thickneſs; and conſequently every thing within it, or properly belonging to it, muſt be *ſimple* and *indiviſible*. Let us now conſider how this notion agrees with the phenomena of ſenſation and ideas. It will not be denied, but that ſenſations or ideas properly exiſt *in the ſoul*, becauſe it could not otherwiſe retain them, ſo as to continue to perceive and think after its ſeparation from the body. Now, whatever ideas are in themſelves, they are evidently produced by external objects, and muſt therefore correſpond to them; and ſince many of the objects or archetypes of ideas are diviſible, it neceſſarily follows, that the ideas themſelves are diviſible alſo. But, how is it poſſible that a thing (be the nature of it what it may) that is *diviſible*, ſhould be contained in a ſubſtance, be the nature of *it* likewiſe what it may, that is *indiviſible?* If the archetypes of ideas have extenſion, the ideas which are expreſſive of them, and are actually produced by them according to certain mechanical laws, muſt have extenſion likewiſe; and therefore the mind in which they exiſt, whether it be material or immaterial, muſt have extenſion alſo. But how any thing can have extenſion and yet be immaterial, without coinciding with our idea of mere empty *ſpace*, I know not."

To the argument, which is here chiefly inſiſted on as being agreeable to the eſtabliſhed rules of philoſophizing, a very able reply has been made, which we ſhall give in the words of its elegant and ſpirited author. But before we attempt to dig up the foundation of the doctor's ſyſtem, it may not be improper to demoliſh, if poſſible, the additional buttreſſes by which it is ſtrengthened. An experienced general, before he ſtorm a citadel which he knows to be ſtrongly

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* *Diſquiſitions on Matter and Spirit.*

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ly fortified and ſkilfully defended, will take care to raze every leſs important redoubt from which the enemy might annoy him in his rear.

233 Anſwered. Becauſe the faculty of thinking in general ripens, comes to maturity, and decays with the body, and the body on the other hand is affected by the affections of the mind, the doctor affirms that we have the ſame reaſon to conclude, that the powers of ſenſation and thought are the neceſſary reſult of a particular organization, as that ſound is the neceſſary reſult of a particular concuſſion of the air. This argument is concluſive only upon the ſuppoſition that there is no *poſitive* evidence whatever for the immateriality of the being which is the ſubject of thought. If the other reaſonings for the materiality and immateriality of the mind be of equal weight, this argument ought doubtleſs to turn the balance; but if there be the ſmalleſt preponderancy in behalf of the immaterialiſts, it is a mere begging of the queſtion to attempt to counteract it by any inference which can be drawn from the mutual affections of the body and mind. If two ſuch heterogeneous beings as an immaterial mind and an organized body can be ſuppoſed united in one perſon, they muſt neceſſarily affect each other; and to affirm, on account of this reciprocal affection, that they are *one and the ſame*, is equally abſurd as to ſay that an electrician and his apparatus are *one and the ſame*. Dr Prieſtley himſelf did not at firſt perform his electrical experiments with ſo much eaſe as after he had acquired facility by long practice, nor could he even yet perform them ſo neatly with a bad as with a good apparatus.

That which the doctor calls the firſt illuſtration of his argument might be admitted, and the force of the argument itſelf be conſiſtently denied. Some kind of organized body may be neceſſary to the mind as an inſtrument without which it could not exert its faculties; but it would certainly be raſh to infer that the mind muſt *therefore* be a ſyſtem of matter. An anvil and a hammer are neceſſary to the exerciſe of the blackſmith's art; but what would be thought of him who ſhould from this fact conclude, that the blackſmith himſelf muſt be a ſyſtem of iron! This, therefore, inſtead of illuſtrating the great argument, ſeems to be wholly foreign from the queſtion in debate; and it has in fact been admitted by Dr Price *, and thouſands of others who reject the doctrine of materialiſm, as an impious abſurdity. The ſecond illuſtration, however, is more to the purpoſe; and as it is not new, we ſhall give it an old anſwer.

Why do not we perceive external objects in our *ſleep* or in a *ſwoon*? " Becauſe (ſays Mr Wollaſton †), the *paſſages* are become impracticable, the *windows* ſhut, and the *nerves* being obſtructed, or ſomehow rendered for the time uſeleſs, can tranſmit no information to it. Why, however, does it not reaſon and think about *ſomething or other*? Becauſe, all the *marks* by which things are remembered, being for the preſent choked up or diſordered, the remembrance of thoſe *objects* about which it is wont to employ itſelf, and even of the words (or other ſigns) in which it uſes to reaſon, and to preſerve the deductions and concluſions it makes, is all ſuſpended at leaſt for the time: and ſo its tables being covered, its books cloſed, and its tools locked up, the requiſites for reaſoning are wanting, and no ſubject offers itſelf to exerciſe its thoughts, it having yet had little or no opportunity to take in *higher objects* and more *refined matter* for contemplation. And, to conclude, if it be demanded, Why any one ſhould imagine that the *ſoul* may think, perceive, act, *after death*, when it doth not do this in ſleep, &c.? the anſwer is, Becauſe thoſe *encloſures* and *impediments* which occaſioned the forementioned intermiſſions, and thoſe great limitations under which it labours at all times, will be removed with its enlargement out of the body. When it ſhall in its *proper vehicle* be let go, and take its flight into the open fields of heaven, it will then be bare to the immediate impreſſions of objects: And why ſhould not thoſe impreſſions which affected the *nerves*, that moved and affected the vehicle and ſoul in it, *affect the vehicle immediately* when they are immediately made upon it, without the interpoſition of the nerves? The hand which feels an object at the end of a *ſtaff*, may certainly be allowed to feel the ſame much better by *immediate contact* without the ſtaff."

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The opinion, that the ſoul is united to ſome fine vehicle, which dwells with it in the brain, and goes off with it at death, was not peculiar to Mr Wollaſton. It was thought extremely probable by Dr Hartley, and ſhall be ſhown afterwards to have been a very ancient opinion; but we do not quote it at preſent as either well or ill founded, but only as ſufficient, in conjunction with the reaſoning of its author, to obviate the force of Dr Prieſtley's ſecond illuſtration of his argument for the materiality of mind, provided the argument itſelf be not more powerful than any which the immaterialiſts can bring againſt it.

The doctor's third illuſtration we have already obviated, when we accounted for the mind and the body mutually affecting each other; and we might refer to Dr Price's anſwer (E) to the fourth, as being, in our opinion, a full confutation of it. But as that author's notions of *mind* and *ideas* differ in ſome reſpects from our own, we ſhall examine this objection to the doctrine of the immaterialiſts upon principles which we believe Dr Prieſtley more inclined to admit.

That the ſentient principle in man, if it be immaterial,

* *Correſpondence with Dr Prieſtley.*

† *Religion of Nature delineated.*

(E) In *Diſquiſitions*, p. 37 and 102, it is aſſerted, that ideas are certainly diviſible. " This ſeems to me very abſurd. It would be as proper to aſſert ideas to be hard or round. The idea of an object is the apprehenſion, view, or notion of it; and how can this be diviſible? Perception is a ſingle and indiviſible act. The object perceived may be diviſible; but the *perception* of it by the mind cannot be ſo. It is ſaid in page 95, *that if ideas are not things diſtinct from the mind, a mind with ideas and a mind without ideas would be the ſame.*—I maintain, that ideas are not diſtinct from the mind, but its conceptions; or not *things* themſelves, but *notions* of things. How does it follow from hence, that a mind with or without ideas is the ſame? It would ſeem that this follows much more from the contrary aſſertion." *Correſpondence between Dr Price and Dr Prieſtley.*

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terial, can have no extenſion, is a truth which we think cannot be controverted; and if ſo, every thing in that principle muſt be *ſimple* and *indiviſible*. Thus far we agree with Dr Prieſtley; but with reſpect to what follows we differ from him entirely. The agitation in the brain, which is the immediate cauſe of ſenſation, muſt indeed correſpond to the impreſſion *ab extra* by which it is produced, and therefore muſt have the property of extenſion; but that agitation, whatever it be, is not itſelf ſenſation any more than a bludgeon is a blow, or a ſword is a wound. Dr Prieſtley, indeed, in anſwer to Dr Price, affirms, that, according to Hartley's theory, ideas are only *vibrations in the brain*; but whoever ſhall take the trouble to examine that theory himſelf, will not find that its author ever advances ſuch an opinion, or conſiders vibrations as any thing more than the inſtruments by which ſenſations and ideas are excited in the ſentient principle. A real and proper idea, as we have often repeated, is nothing elſe than a fainter ſenſation: but no ſenſation, from whatever cauſe it may proceed, is itſelf extended; nor could we, without memory, the reaſoning faculty, and the power of local motion, have acquired from mere ſenſe any notion of extenſion at all: (ſee ſect. 3. Chap. 1. Part I.) Senſations and ideas are thoſe *appearances* (if we may ſo ſay), which vibrations or ſome other motion in the brain excite in the mind; but a *half* appearance is an abſurdity. A man may view *half a tree* with his eyes, and he may contemplate the idea of *half a tree* in his mind; but he cannot have *half a view* or *half an idea* of any thing. Senſations and ideas reſult from the mutual agency of the brain and ſentient principle upon each other; and if the agency of the brain be vibration, more of it may vibrate at one time than at another: but ſurely the mere relation between its agency at any time and the agency of the mind, can neither have extenſion nor be diviſible; for who ever thought of extending or dividing relations? On this ſubject it is extremely difficult to write with perſpicuity and preciſion; and what we have ſaid may very poſſibly be miſunderſtood. Our notion is to ourſelves clear and determinate; but language, which was not invented by metaphyſicians, wants words in which it may be properly expreſſed. Perhaps the reader may underſtand what we mean, when we ſay that a ſenſation or an idea is the inſtantaneous effect of the mutual agency of the brain and ſentient principle. Of this we think every man, by a little attention, may be perfectly convinced, though it may be impoſſible ever to diſcover the preciſe nature of this agency; and if ſo, it is plain that ſenſations and ideas cannot be divided, for no inſtantaneous effect of any kind is diviſible. A ſenſation, and of courſe a ſimple and original idea, neither has extenſion itſelf, nor ſuggeſts the notion of extenſion *ab extra*. By running the hand or any other member along a ſolid body, we feel continued reſiſtance: this feeling, or the idea of this feeling, becomes in time ſo cloſely aſſociated with all our ſenſations of touch and ſight, that the one cannot be ſeparated from the other; and theſe aſſociations are what Dr Prieſtley calls *extended ideas*. Upon the whole then, we think it apparent, that our ſenſations, and the relicts of our ſenſations, are unextended and indiviſible (F); and that though they ſuggeſt

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(F) We affirm this only of *human* ſenſations and ideas, becauſe theſe are the only ſenſations and ideas of which we are conſcious, and about which we can reaſon. Other animals are ſentient as well as man, and appear to have their ſenſations excited by impreſſions *ab extra*; but whether in every ſpecies of animals a ſingle impreſſion excites but one ſenſation common to the whole animal, or different ſenſations which are felt each by a different faculty or ſentient principle, is a queſtion which we are not able to anſwer. We make this remark, becauſe from the phenomena of ſenſation in the earthworm and other reptiles, ſome philoſophers of eminence having ſuppoſed, that in theſe creatures the ſentient faculty belongs to the material ſyſtem, and is diviſible with it; have thence concluded, we think raſhly, that all arguments for the immateriality of the human mind are founded merely on our ignorance. We call this concluſion raſh; becauſe, though we know perfectly what a human ſenſation is, we have ſo little knowledge of the nature of ſenſation in worms, that what may be true of the one *principle* of ſenſation may be falſe of the other. Indeed, if we are to judge from the phenomena, this is actually the caſe. It appears from experiments made by Abbe Spallanzani and others, that if a certain number of rings be cut off either from the anterior or poſterior part of a worm, or even from both, the remainder will not only continue to live and be ſentient, but will alſo regenerate a new head and a new tail, and become again a complete worm. Nothing like this takes place in man or in the higher orders of animals; and therefore, were it certain that the ſentient principle in the worm is diffuſed through the whole ſyſtem, and diviſible with it, we could not infer that the principle of ſuch ſenſations as we are conſcious of, is likewiſe extended and diviſible. It is, however, ſo far from being certain that the ſentient principle is diffuſed through the whole worm, that nothing neceſſarily follows from this fact, but that its ſeat is at ſome diſtance from either extremity. Nay, were it true, as perhaps it is, that a worm may be ſo divided, as that each of the two ſections ſhall retain life, ſenſation, and this reproductive power, we would not therefore be authorized to conclude that the ſentient principle is *one* coextended and diviſible with the material ſyſtem. The earthworm, like many other reptiles, being an hermaphrodite, which unites in itſelf both ſexes, may poſſibly conſiſt of two animated ſyſtems; which, though united by ſome bond of connexion, by which ſenſation is communicated from the one to the other, are yet in themſelves perfectly diſtinct. Should this, upon proper inveſtigation, be found to be the caſe; and ſhould it likewiſe be found, that when a worm is divided into three or more parts, only one or two of theſe parts continue to live, there would be no room whatever for ſuppoſing that even in theſe creatures the principle of ſenſation is extended and diviſible. In the mere power of reproducing amputated parts, when that power is conſidered by itſelf, there is nothing more wonderful than in the growing of the nails of our fingers, or the hairs

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geſt to us the exiſtence of extended things *ab extra*, the ſentient being *may* be unextended and indiviſible.

Having thus examined Dr Prieſtley's auxiliary arguments for the materiality of mind, we now proceeed to conſider his main and direct proof. To this, as we have obſerved, ſo able a reply has been made, that it would be injuſtice to our readers not to lay it before them, in the words of its author. " I readily acknowledge (ſays this ſpirited eſſayiſt *), that the power of ſenſation or perception never having been found but in conjunction with a certain organized ſyſtem of matter, we ought, as philoſophers, to conclude that this power neceſſarily exiſts in, and reſults from, that organized ſyſtem, unleſs it can be ſhown to be incompatible with other known properties of the ſame ſubſtance. On the other hand, it muſt be admitted, that conſtant conjunction implies *neceſſary* connexions only when reaſons cannot be diſcovered to prove the conjunction to be accidental and arbitrary. In the preſent inſtance, it is alleged, that diſcerptibility is a property of matter abſolutely incompatible with the property of ſenſation or perception; or in other words, that ſenſation is a power or property incapable of diviſion. But as the power of the entire ſyſtem is clearly nothing more than the ſum or aggregate of the powers of all the parts, it neceſſarily follows, that the primary particles of which the ſyſtem is compoſed muſt, upon the material hypotheſis, poſſeſs diſtinct powers of ſenſation; and that thoſe powers combined conſtitute the indiviſible power of ſenſation belonging to the ſyſtem; or, in other words, that the *indiviſible* power of ſenſation is a *diviſible* power, nay, an infinitely diviſible power, if matter be, as philoſophers in general allow, an infinitely diviſible ſubſtance—a concluſion obviouſly and groſsly ridiculous. We are then compelled to acknowledge, that ſenſation or perception is not the property of a material ſubſtance; i. e. if the common mode of expreſſion be retained, it is the property of an immaterial ſubſtance; or, to avoid verbal contention, it is a property not reſulting from, or neceſſarily connected with, the organical ſyſtem, but a property wholly foreign, ſuperinduced, and adventitious (G).

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Direct proof that the ſentient principle in man cannot be a ſyſtem of matter.

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* *Eſſays, Philoſophical, Hiſtorical, and Literary*, vol. ii.

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hairs of our heads. The only thing which ſeems to militate againſt the ſimplicity of the principle of ſenſation in worms, is the continuance of life, &c. with both parts of a worm when cut into two by a knife or pair of ſciſſars; but if a worm be found to have two ſeats of ſenſation analogous to the brain in higher animals, and if it be likewiſe found that life continues only in ſuch ſections as retain at leaſt one ſeat of ſenſation, the ſentient principle in the worm may be as ſimple and indiviſible as in any animal whatever. We neither wiſh nor expect much ſtreſs to be laid upon theſe hints and conjectures. Should they induce any of our phyſiological readers, who have leiſure, and are at the ſame time ſkilled in philoſophy, properly ſo called, to inſtitute a ſet of experiments upon worms and ſuch reptiles, and to trace apparent effects to their higher cauſes, they might eventually lead to important diſcoveries. In the mean time, it is ſufficient for our purpoſe to obſerve, that whatever be the ſentient principle or principles in the earthworm, it is obvious that the whole animal cannot in any caſe be conſcious, as man undoubtedly is, of *one individual ſenſation;* and that therefore no arguments built upon the phenomena accompanying ſenſation in worms, can be of any importance in the controverſy about the materiality or immateriality of the human mind.

(G) This argument is not new. It was long ago urged by Dr Clarke againſt Mr Dodwell; and ſome of our readers may not be ill pleaſed to ſee it ſtated by ſo maſterly a reaſoner: " That the ſoul cannot poſſibly be *material*, is demonſtrable from the ſingle conſideration of bare ſenſe or conſciouſneſs. For matter being a diviſible ſubſtance, conſiſting always of ſeparable, nay of actually ſeparate and diſtinct parts, it is plain that unleſs it were eſſentially conſcious, in which caſe every particle of matter muſt conſiſt of innumerable ſeparate and diſtinct conſciouſneſſes, no ſyſtem of it, in any poſſible compoſition or diviſion, can be an individual conſcious being. For ſuppoſe three or three hundred particles of matter, at a mile or any given diſtance one from another, is it poſſible that all theſe ſeparate parts ſhould in that ſtate be one individual conſcious being? Suppoſe then all theſe particles brought together into one ſyſtem, ſo as to touch one another, will they thereby, or by any motion or compoſition whatſoever, become one whit leſs truly diſtinct beings than they were when at the greateſt diſtance? How then can their being diſpoſed in any poſſible ſyſtem make them one individual conſcious being? If you will ſuppoſe God by his infinite power ſuperadding conſciouſneſs to the united particles, yet ſtill theſe particles being really and neceſſarily as diſtinct beings as ever, cannot be *themſelves* the *ſubject* in which that individual conſciouſneſs inheres; but the conſciouſneſs can only be ſuperadded by the addition of ſomething, which in all the particles muſt ſtill itſelf be but one individual being. The ſoul, therefore, whoſe power of thinking is undeniably one individual conſciouſneſs, cannot poſſibly be a material ſubſtance." *Clarke's Letter to Mr Dodwell*, 2d edition.

That the ſame mode of reaſoning was known to the ancients, Cudworth has ſhown by numerous quotations; and as an argument certainly loſes nothing by antiquity, or by having occurred to thinking men in diſtant ages, we ſhall lay before our readers two paſſages from Plotinus, of which the extract from Clarke's letter (though we are perſuaded it was not borrowed by the author) muſt be conſidered as little more than a paraphraſtical tranſlation.——τι τοινυν φησουσιν, οἱ την ψυχην σωμα ειναι λεγοντες, πρωτον μεν περι ἑκαστου μερους της ψυχης της εν τω αυτω σωματι, ποτερον ἑκαστον ψυχην, οἱα εστι και ἡ ὁλη; και παλιν του μερους το μερος; ουδεν αρα το μηγεθος συνεβαλλετο τη ουσια αυτης· καιτοι εδειγε ποσου τινος οντος· αλλα και ὁλον πολλαχη, οπερ σωμασι παρειναι αδυνατον, εν πλειοσι το αυτο ὁλον εναι, και το μερος ὁ περ το ὁλον, ὑπαρχειν· ει δε ἑκαστον των μερων, ου ψυχην φησουσιν, εξ αψυχων ψυχη αυτοις υπαρξει. *En.* IV. *Lib.* vii. *Cap.* 5.

The ſame argument is elſewhere ſtated thus: ει δε ἑκαστον ζωην εχοι, και εν αρκει· ει δε μηδενος αυτων ζωην εχοντος ἡ συνοδος πεποιηκε ζωην, ατοπον· μαλλον δε αδυνατον συμφορησιν σωματων ζωην εργαζεσθαι, και νουν γενναν τα ανοητα. *En.* IV. *Lib.* vii. *Cap.* 2.

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“ In oppoſition to this reaſoning, the materialiſts affirm, that entire ſyſtems may poſſeſs, and they think themſelves warranted to pronounce that organized ſyſtems of matter actually do poſſeſs, powers eſſentially different from thoſe which inhere in the ſeveral parts. Amongſt various familiar though ſtriking illuſtrations of this truth, it has been ſaid, that a roſe poſſeſſes the property of ſweetneſs or fragrance, a globe the property of ſphericity, a harpſichord the property or power of producing harmony, *aqua regia* the property of diſſolving gold, &c. though the component particles of theſe different organized ſyſtems are themſelves totally deſtitute of the powers and properties here enumerated.

“ The immaterialiſts, in reply, aſſert, that it is not only falſe in fact, but a direct contradiction, and an abſolute impoſſibility in the nature of things, that a ſyſtem ſhould poſſeſs any property which does not inhere in its component parts. To aſſert that the power of the whole is the ſum or aggregate of the powers of all the parts, is an identical and ſelf-evident propoſition, the whole and all the parts being terms preciſely ſynonymous. Whoever, therefore, calls in queſtion the truth of this axiom, muſt maintain that the power of the whole is ſomething different from the power of all the parts, i. e. that the power of the whole is *not* the power of the whole.

“ It will be eaſy to demonſtrate the correſpondence of facts with this plain and ſimple theory. For this purpoſe, it is neceſſary to obſerve, that the properties of matter, or what are generally denominated ſuch, may be divided into real and nominal, which Locke and others have called primary and ſecondary qualities. Figure, magnitude, and motion, are qualities really inherent in matter; but figure, magnitude, and motion, eternally varied, can produce only different combinations of figure, magnitude, and motion. There are alſo powers, or qualities, vulgarly conſidered as inherent properties of matter organically diſpoſed, which are really and truly qualities or affections of the mental or percipient principle, and have no exiſtence when not perceived. Thus the ſweetneſs or fragrance of the roſe, conſidered as mere ſweetneſs and fragrance, can be nothing but an affection of the mind; conſidered as a quality of the roſe, they can mean nothing more than a certain arrangement, configuration, and motion of parts, which in ſome inexplicable manner produces the ſenſation of ſweetneſs. In this inſtance, therefore, the power of the whole is plainly the aggregate of the powers reſiding in the parts, by the motion and organization of which a certain effect is produced upon a foreign and percipient ſubſtance.

“ But a globe, we are told, poſſeſſes the property of ſphericity, though not a ſingle particle amongſt that infinite number of which the globe is conſtituted is itſelf of a ſpherical form. The fallacy of this illuſtration is, however, as eaſily demonſtrable as that of the former. The ſphericity of a globe is evidently the ſum or aggregate of the curvilinear or convex parts which compoſe its ſurface; and the property of the whole is neither more nor leſs than the combined properties of all its parts. No one doubts, that by new compoſitions or arrangement of material particles poſſeſſing magnitude, figure, and motion, an endleſs diverſity of phenomena may be produced, to which it may be neceſſary to apply new names. New names, however, do not conſtitute new properties; and though we give to a globe the appellation of an entire ſyſtem, and aſcribe to it the property of ſphericity, we know at the ſame time that it is really nothing more than a collection of thouſands of millions of particles, actually ſeparate and diſtinct, arranged in that particular form which we denominate ſpherical. But this can never be regarded as in the remoteſt manner analogous to the *creation* of the power of perception, in conſequence of a certain organical arrangement or diſpoſition of impercipient particles. Though ſphericity is, indeed, the property of the entire ſphere, yet every part of the ſphere, if divided, poſſeſſes its ſhare of ſphericity. But if the percipient principle be divided, what would become of the power of perception? A ſphere equally divided becomes two hemiſpheres; Does a perception, when divided in like manner, become two demi-perceptions?

“ The ſame reaſonings may eaſily be transferred, and applied to the harpſichord. Can any one be abſurd enough to affirm that the power of harmony reſides in the harpſichord, as the power of perception does in the mind? After the utmoſt ſkill of the artificer has been exerted, we diſcover nothing more in the harpſichord than new modifications of the old properties of figure, magnitude, and motion, by means of which certain vibrations are communicated to the air, which, conveyed by the medium of the auditory nerves to the ſenſorium, produce the ſenſation of harmonic ſounds. Theſe new modifications are therefore attended, indeed, with new and very wonderful effects; but then thoſe effects are produced upon, and are themſelves modifications of, the ſentient or percipient faculty. And though it is wholly incomprehenſible to us in what manner theſe effects, that is, theſe *ſenſations*, are produced, we well know, and perfectly comprehend, that they are not new powers belonging to any organized ſyſtem of matter; that they have no exiſtence but in a mind perceiving them; and that they are far from militating againſt that grand and univerſal axiom, that the power of the whole is nothing more than the united powers of all the parts.

“ As to the laſt inſtance adduced, of the power of *aqua regia* to diſſolve gold, though neither the ſpirit of ſalt, nor the ſpirit of nitre of which it is compounded, ſeparately poſſeſſes that power, it is plain, that from the union of theſe two ſubſtances, certain new modes of configuration and motion reſult; and the ſolution of gold is the conſequence of this new arrangement and motion of the parts. But the particles of which the menſtruum is compoſed were always poſſeſſed of the properties of figure and motion; and what is ſtyled a new property, is clearly nothing more than a new effect of the old properties differently modified. In a word, the advocates for materialiſm may ſafely be challenged to produce, in the whole compaſs of nature, a caſe which bears the leaſt analogy to that which theſe inſtances are moſt unphiloſophically adduced to prove and to illuſtrate. It is an abſurdity which tranſubſtantiation itſelf does not exceed, to maintain that a whole is in reality any thing different from its component parts: and all nature riſes up in confutation of an aſſertion ſo monſtrous and extravagant. To affirm that perception can ariſe from any combination of impercipient particles, is as truly ridiculous, as to affirm that a combination of the ſeven primary colours with the four cardinal virtues may conſtitute a planet. It is equivalent to an aſſertion, that an epic poem might be compoſed of parallelograms, cones, and triangles. In a word, it is an abſurdity not leſs real, and little leſs obvious, than that of the blind man who thought that the idea of a ſcarlet colour reſembled the ſound of a trumpet."

If a matter be taken in the common aceptation, to be a ſolid, extended, and inert ſubſtance, this reaſoning for the immateriality of the ſentient principle in man appears to us to have the force of demonſtration, 235 Reply by the materialiſts ſhown which no difficulties or partial objections, ariſing from our inability to conceive the band of union between two ſuch heterogeneous ſubſtances as mind and body, can ever weaken, and far leſs overturn. But the modern materialiſts deny that matter is either ſolid or inert. "All thoſe facts (ſay they) which led philoſophers to ſuppoſe that matter is impenetrable to other matter, later and more accurate obſervations have ſhown to be owing to *ſomething elſe* than ſolidity and impenetrability, viz. a *power of repulſion*, which for that reaſon they would ſubſtitute in its place. The property of *attraction* or repulſion (ſays Dr Prieſtley) appears to me not to be properly what is *imparted* to matter, but what really *makes it to be what it is;* inſomuch, that without it, it would be nothing at all; and as other philoſophers have ſaid,—'Take away ſolidity, and matter vaniſhes,' ſo I ſay, 'Take away attraction and repulſion, and matter vaniſhes.'" If this be admitted, the ingenious author hopes that we ſhall not conſider matter with that contempt and diſguſt with which it has generally been treated, there being no thing in its real nature that can juſtify ſuch ſentiments reſpecting it.

We know not why, upon any hypotheſis, mat- 236 to be abſurd. ter ſhould be viewed with contempt and diſguſt.— Whether penetrable or impenetrable, every conſiſtent theiſt conſiders it as one of the creatures of God, perfectly fitted to anſwer all the purpoſes for which it was intended: but were it really deſtitute of ſolidity, and endowed with the powers of attraction and repulſion, we ſhould ſtill be obliged to conſider it as incapable of the powers of ſenſation and thought. If we have any notion at all of what is meant by centres of attraction and repulſion (of which indeed we are far from being confident), it appears to us to be intuitively certain, that nothing can be the reſult of any poſſible combination of ſuch centres, but new and more enlarged ſpheres of attraction and repulſion. But ſurely conſciouſneſs, ſenſation, and will, are as different from attraction and repulſion, as a cube is from the ſound of a trumpet, or as the ſenſations of a felon in the agonies of death are from the attraction of the rope by which he is hanged. If this be admitted, and we are perſuaded it will be denied by no man whoſe underſtanding is not clouded by an undue attachment to paradoxes, the ſentient principle cannot poſſibly be matter: for if, when the powers of attraction and repulſion are taken away, matter vaniſhes; and if conſciouſneſs and ſenſation are not attraction and repulſion; it is not more evident that three and two are not nine, than that the ſubſtance which attracts and repels cannot be that which is conſcious and percipient.

Locke, who was certainly no materialiſt, as he repeatedly affirmed, and indeed demonſtrated, that thought could never be the reſult of any combinations of figure, magnitude, and motion, was yet of opinion, that God by his almighty power might endow ſome ſyſtems of matter with the faculties of thinking 237 Locke's opinion haſty and ill-founded, and willing. It is always with reluctance than we controvert the opinions of ſo great a man; and it is with ſome degree of horror that we venture in any caſe to call in queſtion the power of Omnipotence.— But Omnipotence itſelf cannot work contradictions; and it appears to us nothing ſhort of a contradiction, to ſuppoſe the individual power of perception inhering in a ſyſtem which is itſelf extended and made up of a number of ſeparate and diſtinct ſubſtances. For let us ſuppoſe ſuch a ſyſtem to be ſix feet long, three feet broad, and two feet deep (and we may as well ſuppoſe a ſyſtem of theſe dimenſions to be percipient, as one that is ſmaller), then it is plain, that every idea muſt be extended, and that part of it muſt be in one place, and part in another. If ſo, the idea of a ſquare inch will be ſix feet long, three feet broad, and two feet deep; and what is ſtill harder to be digeſted, the ſeveral parts of this idea will be at a great diſtance from each other, without any bond of union among them. The being which apprehends one extremity of the idea, is, by the ſuppoſition, ſix feet diſtant from the being which apprehends the other extremity; and though theſe two diſtinct beings belong to one ſyſtem, they are not only ſeparable, but actually ſeparated from each other as all the particles of matter are. What is it then that apprehends as *one* the whole of this extended idea? Part of it may be apprehended by one particle of matter, and part of it by another; but there is nothing which apprehends, or can apprehend, the whole. Perhaps it will be ſaid, the power of apprehenſion is not divided into parts, but is the power of the one ſyſtem, and therefore apprehends at once the whole idea. But a power or faculty cannot be ſeparated from its ſubject, power which inheres in nothing being confeſſedly impoſſible; and a material ſyſtem is not *one ſubject* in which any individual power or faculty can inhere. There muſt, therefore, be united to the ſyſtem ſome *one* being, which is the ſubject of thought, and which is unextended as well as indiviſible. This, we ſay, follows undeniably. For, let us ſuppoſe, that an extended being without ſeparable parts is poſſible, and that ſuch a being is percipient; it is obvious, that the whole of any one of its perceptions could not be in one place. Now, though we ſhould grant to Dr Prieſtley and other materialiſts, that every idea of an extended ſubſtance has itſelf three dimenſions, and is incorporated and commenſurate with the whole percipient ſyſtem; what, upon this ſuppoſition, ſhall we think of conſciouſneſs and of the perception of truth? Is conſciouſneſs or truth extended? If ſo, one ſide or ſuperfices of conſciouſneſs, or of a truth, may be greater or leſs than another, above or below, to the right or to the left; and it will be very proper and philoſophical to ſpeak of the length, breadth, and depth, of conſciouſneſs or of truth. But ſurely to talk of the place, or the extenſion of theſe things, is as abſurd as to talk of the colour of ſound, or the ſound of a triangle; and we might as well ſay, that conſciouſneſs is green or red, as that it is an ell or an inch long;

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long; and that truth is blue, as that it has three dimenſions.

238 becauſe the ſentient being cannot be extended.

This reaſoning is ſomewhat differently ſtated by Cudworth; who obſerves, that if the ſoul be an extended ſubſtance, "it muſt of neceſſity be either a phyſical point (i. e. the leaſt extenſion poſſible, if there be any ſuch leaſt extenſion), or elſe it muſt conſiſt of more ſuch phyſical points joined together. As for the former of theſe, it is impoſſible that *one ſingle atom*, or *ſmalleſt point* of extenſion, ſhould be able to perceive diſtinctly all the *variety* of things, i. e. take notice of all the *diſtinct* and *different* parts of an *extended object*, and have a *deſcription* or *delineation* of the whole of them upon itſelf (for that would be to make it the leaſt, and not the leaſt, poſſible extenſion at the ſame time: Beſides, to ſuppoſe every ſoul to be but one *phyſical point*, or the ſmalleſt *poſſible extenſion*, is to ſuppoſe ſuch an eſſential difference in matter or extenſion, as that ſome of the *points* thereof ſhould be *naturally* devoid of all *life*, *ſenſe*, and *underſtanding*; and others again, naturally *ſenſitive* and *rational*. And even ſhould this abſurdity be admitted, it would yet be utterly inconceivable how there ſhould be *one*, and *but* one, *ſenſitive* and *rational* atom in every man; how this atom of ſo *ſmall* dimenſions ſhould actuate the whole ſyſtem; and how it ſhould conſtantly remain the ſame from infancy to old age, whilſt all the other parts of the ſyſtem tranſpire perpetually, and are ſucceeded by new matter (H).

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"But if, according to the ſecond hypotheſis, ſouls be extended ſubſtances conſiſting of many points one without another, and all concurring in every ſenſation; then muſt every one of theſe points perceive either a *point* only of the object, or elſe the *whole*. Now, if every *point* of the *extended ſoul* perceives only a *point* of the *object*, then is there no *one thing* in us that perceives the whole, or that can compare one part of the object with another. On the other hand, if every *point* of the *extended ſoul* perceive the *whole object* at once, then would there be *innumerable perceptions* of the ſame object in every ſenſation; as many, indeed, as there are points in the extended ſoul.—And from both theſe ſuppoſitions it would alike follow, that no man is *one ſingle percipient* or perſon, but that in every man there are innumerable diſtinct *percipients* or *perſons*; a concluſion directly contrary to the infallible evidence of conſciouſneſs (I)."

Cogent as theſe arguments for the immateriality of

(H) Should it be ſaid, that this eſſential difference between the atoms of matter is not fortuitous; that ſome of them are created intelligent for the expreſs purpoſe of animating ſyſtems of others which are unintelligent; and that theſe intelligent atoms do not operate upon the ſyſtems with which they are united, by the *vis inertiæ*, *ſolidity*, or *extenſion*, of matter, but by the energies of underſtanding and will: Should this (we ſay) be alleged, ſurely it may be aſked, for what purpoſe they are conceived to have the quality of extenſion? It is evidently of no uſe; and it has been already ſhown, and ſhall be more fully ſhown afterwards, that by our notions of conſciouſneſs and underſtanding, we are ſo far from being led to ſuppoſe the ſubject of theſe powers extended, that we cannot ſuppoſe any relation whatever between them and extenſion. But if theſe intelligent atoms be diveſted of their quality of extenſion, they will be transformed from matter to mind, and become the very things for the exiſtence of which we plead.

(I) As the materialiſts endeavour to prejudice the public againſt the motion of an unextended ſoul, by repreſenting it as a fiction of *Des Cartes*, altogether unknown to the ancients, it may not be improper to give our readers an opportunity of judging for themſelves how far this repreſentation is juſt.—*Plotinus*, reaſoning about the nature of the ſoul from its energies of ſenſation, expreſſes himſelf in theſe words:—*ετι μελλει αισθανεσθαι τινος, ἐν αυτο δει ειναι, και τω αυτω παντος αντιλαμβανεσθαι και ει δια πολλων αισθητηριον πλειω τα εισιοντα, ἡ πολλαι περι ἐν ποιοτητας και δι ἑνος ποικιλον, όιον προσωπον· ου γαρ αλλο μεν ρινος αλλο δε οφθαλμων, αλλα ταυτον όμου παντων και ει το μεν δι ομματων το δε δι ακοης, εν τι δει ειναι εις ὁ αμφω· ἡ πως αν ειτοι ότι ἑτερα ταυτα, μη εις το αυτο όμου των αισθητεων ελθον των.* "That which perceives in us, muſt of neceſſity be one thing, and by one and the ſame indiviſible perceive all; and that whether they be more things entering through ſeveral organs of ſenſe, as the many qualities of one ſubſtance, or one various and multiform thing, entering through the ſame organ, as the countenance and picture of a man. For it is not one thing in us that perceives the noſe, and another thing the eyes; but it is one and the ſelf-ſame thing that perceiveth all. And when one thing enters through the eyes, another through the ears, both theſe alſo muſt of neceſſity come at laſt to one indiviſible; otherwiſe they could not be compared together, nor one of them be affirmed to be different from the other, the ſeveral ideas of them meeting nowhere in one place." Purſuing the ſame argument, and having obſerved, that if what perceiveth in us be extended, then one of theſe three things muſt of neceſſity be affirmed, that either every part of this extended ſoul perceives a part only of the object, or every part of it the whole object; or elſe, that all comes to ſome one point, which alone perceives both the ſeveral parts of the object and the whole: he obſerves of the firſt of theſe ſuppoſitions,—*μεγεθει οντι τουτω, ξυμμεριζοιτο αν· ωστε αλλο αλλου μερος, και μηδενα ἡμων όλου του αισθητου αντιληψιν εχειν· ώσπερ αν ει εγω μεν αλλου· συ δε αλλου αισθοιο*: "If the ſoul be a magnitude, then muſt it be divided, together with the ſenſible object, ſo that one part of the ſoul muſt perceive one part of the object, and another another; and nothing in it, the whole ſenſible; juſt as I ſhould have the ſenſe of one thing, and you of another." Of the ſecond ſuppoſition he writes in this manner: *ει δε ότιουν παντος αισθησεται· εις απειρα διαιρεισθαι του μεγεθους πεφυκοτος απειρους και αισθησεις καθ' εκαστον αισθητον συμβησεται γιγνεσθαι ἑκαστω οιον του αυτου απειρους εν τω ἡγεμονουντι ἡμων εικονας*: "But if every part of the extended ſoul perceive the whole ſenſible object, ſince magnitude is infinitely diviſible, there muſt be in every man infinite ſenſations and images of one object."—And as for the third and laſt part of this disjunction, Plotinus by aſſerting the infinite diviſibility of body, here ſhows that the ſuppoſition of any one phyſical point is in itſelf an abſurdity. But if it were not, he agrees with Ariſtotle of the ſentient principle appear to be, they have been lately treated with the moſt ſovereign contempt by a writer who profeſſes to be a diſciple of Dr Prieſtley's, but who ſeems not to have learned the modeſty or the candour of his maſter. Dr Prieſtley labours to prove, that to account for the phenomena of perception and volition, &c. it is not neceſſary to ſuppoſe an immaterial principle in man. Mr Cooper with greater boldneſs affirms, and undertakes to demonſtrate with all the parade of mathematical preciſion *, that ſuch a principle is impoſſible. Though the authority of this philoſopher in ſuch inquiries as depend not immediately upon the retort and the furnace, is certainly not great, he yet utters his dogmas with ſuch confidence, that it may not be improper to examine the chief arguments upon which they reſt.

* *Tracts Ethical, Theological, and Political*, vol. i.

239 An attempt to prove the impoſſibility of immaterial ſubſtance

"Suppoſe (ſays he) the ſoul to have no common property with matter; then, no thing can act upon any other but by means of ſome common property. Of this we have not only all the proof that induction of known and acknowledged caſes can furniſh, but that additional proof alſo which ariſes from the impoſſibility of conceiving how the oppoſite propoſition *can* be true. But by the ſuppoſition, the ſoul has no property in common with matter; and therefore the ſoul cannot act upon matter. But by the ſuppoſition of every ſyſtem of immaterialiſm (except thoſe of Malebranche, Berkeley, and Leibnitz), it is deemed an eſſential property of the ſoul, that it acts upon the body, or upon matter; therefore the ſoul can and cannot act upon matter at the ſame time, and in the ſame reſpect. But this is a contradiction in terms; and as two contradictions cannot both be true at the ſame time, the ſuppoſition of the exiſtence of an immaterial ſoul cannot be true; that is, the ſoul does not exiſt."

240 ſhown to be futile.

This reaſoning, the reader will obſerve, is carried on with all the pomp of mode and figure. The propoſitions hang upon each other like the ſeveral ſteps of an algebraic proceſs: but as in ſuch proceſſes one error unwarily admitted produces a falſe reſult, ſo in demonſtrative reaſonings one unſound argument admitted into the premiſes is neceſſarily productive of error in the concluſion. When the author affirms, "that no thing can act upon any other but by means of ſome common property," he affirms without the ſhadow of proof what is certainly not ſelf-evident. He ſays, indeed, that of this we have all the proof that induction of known and acknowledged caſes can furniſh; but unleſs conſciouſneſs be calculated to deceive us, this is unqueſtionably a miſtake. Matter, he repeatedly affirms, has no other properties than thoſe of attraction and repulſion: but a man moves his arm by a mere energy of will; and therefore, according to this demonſtrator, an energy of will muſt be either material attraction or material repulſion. If ſo, it is reaſonable to conclude, that when a man draws his hand towards his head, the centre of his brain exerts its power of *attraction*; and that when he extends his arm at full length before him, the ſame centre exerts its power of *repulſion*. We beg pardon of our readers for detaining them one moment upon ſuch abſurdities as theſe: yet we cannot diſmiſs the argument without taking the liberty to aſk our all-knowing author, How it comes to paſs that the ſame centre ſometimes attracts and ſometimes repels the ſame ſubſtance at the ſame diſtance; nay, that it both attracts and repels ſubſtances of the ſame kind, at equal diſtances, and at the very ſame inſtant of time? This muſt be the caſe, when a man puts one hand to his head, and thruſts another from him; and therefore, if theſe operations be the effect of attraction and repulſion, it muſt be of attraction and repulſion to which induction of known and acknowledged caſes furniſhes nothing ſimilar or analogous, i. e. of ſuch attraction and repulſion as, according to Mr Cooper's mode of reaſoning, does not exiſt. The truth is, that we are not more certain that we ourſelves exiſt, than that an energy of will is neither attraction nor repulſion; and therefore, unleſs all matter be endued with will, it is undeniable, that, whatever be the ſubſtance of the ſoul, one thing acts upon another by a property not common to them both. In what *manner* it thus acts, we pretend not to know: but our ignorance of the *manner* of any operation is no argument againſt the *reality* of the *operation itſelf*, when we have for it the evidence of conſciouſneſs and daily experience; and when the author ſhall have explained to general ſatisfaction how material centres attract and repel each other at a diſtance, we ſhall undertake to explain how one thing acts upon another with which it has no common properties.

241 A ſecond attempt of the ſame kind

Suſpicious, as it ſhould ſeem, that this reaſoning has not the complete force of mathematical demonſtration, the author ſupports his opinion by other arguments. "Whatever we know (ſays he), we know by means of its properties, nor do we in any caſe whatever certainly know any thing but theſe; and we infer in all caſes the exiſtence of any thing which we ſuppoſe to exiſt from the exiſtence of its properties. In ſhort, our idea of any thing is made up of a combination of our ideas of its properties. Gold is heavy, ductile, tenacious, opaque, yellow, ſoluble in *aqua regia*, &c. Now, let any one ſuppoſe for an inſtant that gold is deprived of all theſe, and becomes neither heavy, ductile, tenacious, opaque, yellow, ſoluble, &c. what remains, will it be gold? Certainly not. If it have other properties, it is another ſubſtance. If it have no properties remaining, it is nothing. For nothing is that which hath no properties. Therefore, if any thing loſe all its properties, it becomes nothing; that is, it loſes its exiſtence. Now, the exiſtence of the ſoul is inferred, like the exiſtence of every thing elſe, from its ſuppoſed properties, which are the phenomena of thinking, ſuch as perception, recollection, judgement, and volition. But in all caſes of *perfect* ſleep, of the operation of a ſtrong narcotic, of apoplexy, of ſwooning, of drowning where the vital powers are not extinguiſhed, of the effects of a violent blow on the back

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Ariſtotle in aſking πως τω αμιρει το μεριστον—thereby plainly indicating, that the ſentient principle is totally ſeparated from extenſion, and can neither be conſidered as extended like a ſuperficies or ſolid, nor unextended as a phyſical point.

back part of the head, and all other leipothymic affections, there is neither perception, recollection, judgement, nor volition; that is, all the properties of the ſoul are gone, are extinguiſhed. Therefore, the ſoul itſelf loſes its exiſtence for the time. If any man ſhall ſay, that theſe properties are only *ſuſpended* for the time, I would deſire him to examine what idea he annexes to this ſuſpenſion; whether it be not neither more nor leſs than that *they are made not to exiſt for the time*. Either no more is meant, or it is contradictory to matter of fact; and moreover, if more *be* meant, it may eaſily be perceived to involve the archetypal exiſtence of abſtract ideas, and to contradict the axiom, *impoſſibile eſt idem eſſe et non eſſe*."

242 ſhown to be equally weak.

For the benefit of ſhort-ſighted inquirers, it is to be wiſhed that the author had favoured the public with this *proof* which might have been ſo eaſily brought; for we can diſcern no connexion whatever between the ſuſpenſion of the exerciſe of the powers of the mind, and the archetypal exiſtence of abſtract ideas, or the abſurd propoſition that it is *poſſible for the ſame thing to be and not to be*. We think, however, that we underſtand enough of this reaſoning which he has given us to be able to pronounce with ſome confidence that it is nothing to the purpoſe. For, in the *firſt* place, we beg leave to obſerve, that between the properties of gold and the powers of thinking, &c. there is no ſimilarity; and that what may be true when affirmed of the one, may be falſe when affirmed of the other. The powers of the mind are all more or leſs active; the enumerated properties of gold are all paſſive. We know by the moſt complete of all evidence, that the exerciſe of power *may be* ſuſpended, and the power itſelf remain unimpaired; but to talk of the ſuſpenſion of the energies of what was never energetic, if it be not to contradict the axiom *impoſſibile eſt idem eſſe et non eſſe*, is certainly to employ words which have no meaning. Yet even this argument from the properties of gold might have led the author to ſuſpect that ſomething elſe may be meant by the ſuſpenſion of the exerciſe of powers, than that *thoſe powers are made not to exiſt for the time*. In a room perfectly dark gold is not yellow; but does it loſe any of its eſſential properties, and become a different ſubſtance, merely by being carried from light to darkneſs? Is a man while in a dark room deprived of the faculty of ſight, and one of the powers of his mind made not to exiſt for the time? The author will not affirm that either of theſe events takes place. He will tell us that gold exhibits not its yellow appearance, merely becauſe the proper medium of light paſſes not from it to the eye of the percipient, and that it is only for want of the ſame medium that nothing is ſeen by us in perfect darkneſs. Here, then, by his own confeſſion, is a power of the mind, and a property of an external object, both ſuſpended in their energies, without being annihilated; and no proof has yet been brought that all the powers of the mind may not in the ſame manner be ſuſpended in their energies without being made not to exiſt. As light is neceſſary to viſion, but is not itſelf either the thing which ſees or the thing which is ſeen; ſo may the brain be neceſſary to the phenomena of thinking, without being either that which thinks, or that which is thought upon: and as actual viſion ceaſes when light is withdrawn, though the eye and the object both continue to exiſt; ſo may the *energy* of thinking ceaſe when the brain is rendered unfit for its uſual office, though the being which thinks, and the power of thought, continue to exiſt, and to exiſt unimpaired. That this is actually the caſe every man muſt be convinced who believes that in thinking he exerts the ſame powers to-day that he exerted yeſterday; and therefore our author's ſecond demonſtration of the nonexiſtence of mind is, like his firſt, founded upon aſſertions which cannot be granted.

243 A third attempt of the ſame kind

Another of theſe pretended demonſtrations is as follows: "If the ſoul exiſt at all, it muſt exiſt ſomewhere; for it is impoſſible to frame to one's ſelf an idea of any thing exiſting, which exiſts nowhere. But if the ſoul exiſt ſomewhere, by the terms it occupies ſpace, and therefore is extended; but whatever has extenſion, has figure in conſequence thereof. The ſoul then, if it exiſt, hath the properties of extenſion and figure in common with matter. Moreover, by the ſuppoſition of every immaterial hypotheſis (except thoſe of Malebranche, Berkeley, and Leibnitz), it acts upon body, i. e. upon matter; that is, it attracts and repels, and is attracted and repelled, for there is no conceivable affection of matter but what is founded on its properties of attraction and repulſion; and if it be attracted and repelled, its reaction muſt be attraction and repulſion. The ſoul then has the properties of extenſion, figure, attraction and repulſion, or ſolidity. But theſe compriſe every property which matter, as ſuch, has ever been ſuppoſed to poſſeſs. Therefore the ſoul is matter, or material. But by the ſuppoſition it is immaterial; therefore it does not exiſt. For nothing can exiſt whoſe exiſtence implies a contradiction."

244 ſhown to confute itſelf.

Mr Cooper, we ſee, ſtill proceeds in the direct road of mathematical demonſtration; but in the preſent inſtance we beg leave to ſtop him in the very beginning of his courſe, and to aſk *where* the univerſe exiſts? When he ſhall have given ſuch an anſwer to this queſtion as men of common ſenſe may be able to comprehend, we may perhaps attempt to tell him where an unextended ſoul exiſts. If this demonſtration be not a collection of words without meaning, the exiſtence of ſpace as a real thing is taken for granted. Space, therefore, has extenſion, and of courſe figure; but we believe Mr Cooper will find ſome difficulty in aſcertaining the figure of infinite ſpace. The mind certainly acts upon body. For this we have the evidence of conſciouſneſs and experience; but we have no evidence whatever that it muſt therefore attract and repel, and be attracted and repelled. It has been already obſerved, that the mind, whatever be its ſubſtance, acts upon the body by energies of will. What theſe are every man knows with the utmoſt certainty and preciſion; whilſt we may venture to aſſert, that no man knows preciſely what corpuſcular attraction and repulſion are, ſuppoſing the exiſtence of ſuch powers to be poſſible. When we ſpeak of attraction and repulſion, we have ſome obſcure notion of bodies acting upon each other at a diſtance; and this is all that we know of the matter. But when we think of an energy of the human will, the idea of diſtance neither enters nor can enter into our notion of ſuch an energy. Theſe are facts which we pretend not to prove by a mathematical or a chemical proceſs. Every man muſt be convinced of their truth by evidence more complete than any proof, viz. immediate conſciouſneſs of his own thoughts and volitions. This being the caſe, we may turn Mr Cooper's artillery againſt himſelf, and, becauſe mind acts upon body by powers different from attraction and repulſion, argue that body neither attracts nor repels; and were it true, as it is certainly falſe, that nothing could act upon another but by means of ſome property common to both, we might infer that every atom of matter is endowed with the powers of volition and intelligence, and by conſequence that every man is not one but ten thouſand conſcious beings, a concluſion which our philoſopher ſeems not inclined to admit.

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Objections to the doctrine of immaterialiſm ſtated and anſwered.

Having finiſhed his *demonſtrations*, the author ſtates other objections to the doctrine of immaterialiſm, which, as they are not his own nor new, have greater weight. "It appears no more than reaſonable (ſays he), that if the doctrine of materialiſm be rejected as inadequate to explain the phenomena, theſe latter ſhould at leaſt be explained in ſome manner or other better upon the *ſubſtituted* than the *rejected* hypotheſis; ſo that it is reaſonable to require of an immaterialiſt that his ſuppoſition of a diſtinct ſoul ſhould explain the *rationale* of the phenomena of thinking. But, ſtrange to ſay, ſo far from attempting to explain theſe phenomena on the immaterial hypotheſis, it is acknowledged on all hands that even on this hypotheſis the phenomena are inexplicable." This objection it would certainly be no difficult taſk to obviate; but from that trouble, ſmall as it is, we are happily exempted by the objector. "I would have it underſtood (ſays he), that no materialiſt ever undertook to ſay *how* perception reſults from our organization. What a materialiſt undertakes to aſſert is, that perception, *whatever* it be, or *however* it reſults from, does actually reſult from our organization." According to Mr Cooper, then, the *rationale* of thinking is equally inexplicable by materialiſts and immaterialiſts; and the truth is, that we know the *rationale* of hardly any one operation in nature. We ſee that the ſtroke of a racket produces motion in a billiard ball; but how it does ſo, we believe no man can ſay. Of the fact, however, we are certain; and know that the motion is produced by ſome power, about the effects of which we can reaſon with preciſion. In like manner we know with the utmoſt certainty, that we ourſelves have the powers of perception and volition; and that theſe powers cannot be conceived as either an ell or an inch long. How they reſult from the mutual agency of an immaterial and material ſubſtance upon each other, we are indeed profoundly ignorant; but that ſuch is the fact, and that they are not the reſult of mere organization, we muſt neceſſarily believe, ſo long as it is true that the power of the entire ſyſtem is nothing more than the ſum or aggregate of the powers of all its parts. The immaterial hypotheſis contains in it ſomething inexplicable by man: The material hypotheſis likewiſe contains, by the confeſſion of its advocates, ſomething that it equally inexplicable; and is over and above burdened with this contradiction, that the whole is ſomething different from all its parts. It is therefore *no* "ſingular phenomenon in literary hiſtory, that one hypotheſis ſhould be rejected as inadequate to account for appearances, and that the hypotheſis ſubſtituted ſhould, even by the acknowledgment of its abettors, be ſuch as not only not to explain the *rationale* of the appearances, but from the nature of it, to preclude all hopes of ſuch an explanation." This is exactly the caſe with reſpect to a *vacuum* in aſtronomy. That hypotheſis does not in the leaſt tend to explain the rationale of the motions of the planets; but yet it muſt be admitted in preference to a *plenum*, becauſe upon this laſt hypotheſis motion is impoſſible.

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Whether as many things may be aſſerted of the ſoul as of the body.

"Suppoſing the exiſtence of the ſoul, it is an unfortunate circumſtance (ſays Mr Cooper), that we cannot properly aſſert poſitively any thing of it at all." Were this the caſe, it would indeed be a very unfortunate circumſtance; but can we not aſſert poſitively as many things of the ſoul as we can of the body? Can we not ſay with as much propriety and certainty, that the ſoul has the powers of perception and volition, &c. as that the body is ſolid and extended, or as that matter has the powers of attraction and repulſion? We know perfectly what perception and volition are, though we cannot have *ideas* or mental images of them; and if our author knows what attraction and repulſion are, we believe he will not pretend to have of them ideas entirely abſtracted from their objects. "But granting the ſoul's exiſtence, it may be aſked (ſays he), Of what uſe is an hypotheſis of which no more can be aſſerted than its exiſtence?" We have juſt obſerved, that much more can be aſſerted of the ſoul than its exiſtence, viz. that it is ſomething of which perception and will are properties; and he himſelf aſſerts nothing of matter but that it is ſomething of which attraction and repulſion are properties.

"This ſoul, of which theſe gentlemen (the immaterialiſts) are conſcious, is immaterial eſſentially. Now, I deny (ſays our author), that we can have any idea at all of a ſubſtance purely immaterial." He elſewhere ſays, that nothing can exiſt which is not extended, or that extenſion is inſeparable from our notions of exiſtence. Taking the word *idea* in its proper ſenſe, to denote that appearance which external objects make in the imagination, it is certainly true that we can have no *idea* of an immaterial ſubſtance; but neither have we, in that ſenſe, any idea of matter abſtracted from its qualities. Has Mr Cooper any *idea* of that which attracts and repels, or of attraction and repulſion, abſtracted from their objects? He may, perhaps, have, though we have not, very adequate ideas of bodies acting upon each other at a diſtance; but as he takes the liberty to ſubſtitute aſſertions for arguments, we beg leave in our turn to aſſert, that thoſe ideas neither are, nor can be, more clear and adequate than our notion of perception, conſciouſneſs, and will, united in one being.

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Extenſion not inſeparable from all notions of exiſtence.

That extenſion is no otherwiſe inſeparable from our notions of exiſtence than by the power of an early and perpetual aſſociation, is evident from this circumſtance, that, had we never poſſeſſed the ſenſes of ſight and touch, we never could have acquired any idea at all of extenſion. No man, who has thought on the ſubject, will venture to affirm, that it is abſolutely impoſſible for an intelligent being to exiſt with no other ſenſes than thoſe of ſmell, taſte, and hearing. Now it is obvious that ſuch a being muſt acquire ſome notion of exiſtence

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iſtence from his own conſciouſneſs: but into that notion extenſion could not poſſibly enter; for neither ſounds, taſtes, ſmells, nor conſciouſneſs, are extended; and it is a fundamental article of the materialiſts creed, that all our ideas are relicts of ſenſation. Since then exiſtence may be conceived without extenſion, it may be inferred that they are not inſeparable from each other; and ſince cogitation cannot be conceived with extenſion, we may reaſonably conclude, that the being which thinks is not extended.

Mr Cooper indeed, with his maſter, talks of extended ideas and extended thoughts: but we muſt aſſert, in the words of Cudworth, that "we cannot conceive a *thought* to be of ſuch a certain *length*, *breadth*, and *thickneſs*, meaſurable by *inches*, *feet*, and *yards*; that we cannot conceive the *half*, or *third*, or *twentieth* part of a thought; and that we cannot conceive every thought to be of ſome determinate *figure*, ſuch as *round* or *angular*, *ſpherical*, *cubical*, *cylindrical*, or the like. Whereas if extenſion were inſeparable from exiſtence, *thoughts* muſt either be mere *nonentities*, or extended into *length*, *breadth*, and *thickneſs*; and conſequently all truths in us (being nothing but complex thoughts) muſt be long, broad, and thick, and of ſome determinate figure. The ſame muſt likewiſe be affirmed of volitions, appetites, and paſſions, and of all other things belonging to cogitative beings; ſuch as knowledge and ignorance, wiſdom and folly, virtue and vice, &c. that theſe are either all of them abſolute *nonentities*, or elſe extended into three dimenſions, and meaſurable not only by *inches* and *feet*, but alſo by ſolid meaſures, ſuch as *pints* and *quarts*. But if this be abſurd, and if theſe things belonging to ſoul and mind (though doubtleſs as great realities at leaſt as the things which belong to body) be *unextended*, then muſt the ſubſtances of ſouls or minds be themſelves unextended, according to that of Plotinus, *νους ου διαστας αφ ἑαυτου*, and therefore the human ſoul cannot be material."

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That the human mind cannot exert its faculties but in union with ſome corporeal ſyſtem, an opinion probable and

Mr Cooper employs many other arguments to prove the materiality of the ſentient principle in man; but the force of them extends no farther than to make it in the higheſt degree probable, that the mind cannot exert its faculties but in union with ſome organized corporeal ſyſtem. This is an opinion which we feel not ourſelves inclined to controvert; and therefore we ſhall not make any particular remarks upon that part of our author's reaſonings. That an immaterial and indiſcerptible being, ſuch as the ſoul, is not liable to be *diſſolved* with the body, is a fact which cannot be controverted: for what has no parts can periſh only by *annihilation*; and of annihilation the annals of the world afford no inſtance. That an immaterial being, endowed with the powers of perception, and volition, &c. *may be capable* of exerting theſe powers in a ſtate of ſeparation from all body, and that at leaſt one immaterial Being does actually ſo exert them, or other powers analogous to them, are truths which no man whoſe arrogance does not ſurpaſs his judgement will venture to deny; but the queſtion at preſent between the moſt rigid immaterialiſts and their opponents, is, whether there be ground to think that the human ſoul is ſuch a being?

Now, when Mr Baxter and his followers confidently affirm, that human perception muſt *neceſſarily* ſubſiſt after the diſſolution of the preſent mortal and periſhable ſyſtem; and that the ſoul, when diſencumbered of *all body*, will have its faculties greatly *enlarged*; they affirm what to us appears incapable of proof. That a diſembodied ſoul *may* perceive, and think, and act, and that its powers of intellection *may* have a wider range than when they were circumſcribed by a corporeal ſyſtem, which permitted their action upon external objects only through five organs of ſenſe, is certainly *poſſible*; and the argument by which the materialiſts pretend to prove it *not* poſſible, is one of the moſt contemptible ſophiſms that ever diſgraced the page of philoſophy. To affirm, that becauſe our intellectual powers, in their embodied ſtate, ſeem to decay with the ſyſtem to which they are united, the mind, when ſet free, muſt therefore have no ſuch powers at all, is equally abſurd as to ſay, that becauſe a man ſhut up in a room which has but one window ſees objects leſs and leſs diſtinctly as the glaſs becomes more and more dimmed, he muſt in the open air be deprived of the power of viſion. But becauſe the human ſoul *may*, for any thing that we ſee to the contrary, ſubſiſt, and think, and act, in a ſeparate ſtate, it does not therefore neceſſarily follow that it *will* do ſo; and every thing that we know of its nature and its energies leads us to think, that without ſome kind of body by which to act as by an inſtrument, all its powers would continue dormant. There is not the ſhadow of a reaſon to ſuppoſe that it exiſted and was conſcious in a prior ſtate; and as its memory at preſent unqueſtionably depends upon the ſtate of the brain, there is all the evidence of which the caſe will admit, that if it ſhould ſubſiſt in a future ſtate diveſted of all body, though it might be endowed with new and enlarged powers of *perception*, it could have no *recollection* of what it did and ſuffered in *this world*, and therefore would not be a fit object either of reward or of puniſhment. This conſideration has compelled many thinking men, both Pagans and Chriſtians, to ſuppoſe that at death the ſoul carries with it a fine material vehicle, which is its immediate ſenſorium in this world, and continues to be the ſeat of its recollection in the next. Such, we have ſeen, was the opinion of Mr Wollaſton and Dr Hartley; it was likewiſe the opinion of Cudworth and Locke, who held that the Supreme Being alone is the only mind wholly ſeparated from matter; and it is an opinion which even Dr Clarke, one of the ableſt advocates for immaterialiſm, would not venture poſitively to deny.

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ancient.

Nor is this opinion peculiar to a few moderns. Cudworth, after giving a vaſt number of quotations from Pythagoreans and Platoniſts, which prove to a demonſtration that they held the Deity to be the only mind which perceives and acts without the inſtrumentality of matter, obſerves, "from what hath been ſaid, it appeareth, that the moſt ancient aſſertors of the incorporeity and immortality of the human ſoul, yet ſuppoſed it to be always conjoined with ſome body." Thus *Hierocles* plainly: *ἡ λογικη ουσια συμφυες εχουσα σωμα, οὑτω παρα του δημιουργου εις το ειναι παρηλθεν, ως μητε το σωμα ειναι αυτην, μητε ανευ σωματος· αλλ αυτην μεν ασωματον. αποπερατουσθαι δε εις σωμα το ὁλον αυτης ειδος.* *The rational nature having alway a kindred body, ſo proceeded from the demurgus, as that neither itſelf is body, nor yet can it be without body; but though itſelf be incorporeal, yet its whole form is terminated in a body.*

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body. Agreeably to this the definition which he gives of a man is, ψυχη λογικη μετα συμφους αθανατου σωματος, *a rational ſoul, together with a kindred immortal body*; and he affirms, that our preſent animated terreſtrial body, or mortal man, is nothing but εἴδωλον ανθρωπου, *the image of the true man*, or an acceſſion from which it may be ſeparated. Neither does he affirm this only of human ſouls, but alſo of all other rational beings whatſoever below the Supreme Deity, that they always naturally actuate ſome body. Wherefore a demon or angel (which by *Hierocles* are uſed as ſynonymous words), is alſo defined by him after the ſame manner, ψυχη λογικη μετα φωτεινου σωματος, *a rational ſoul, together with a lucid body*. And accordingly *Proclus* upon *Plato's Timæus affirmeth*, παντα δαιμονα των ημετερων κρειττονα ψυχων, και νοεραν εχειν, ψυχην, και οχημα αιθεριον: *That every demon, ſuperior to human ſouls, hath both an intellectual ſoul and an ethereal vehicle, the entireneſs thereof being made up or compounded of theſe two things*. So that there is hardly any other difference between demons or angels, and men, according to theſe philoſophers, but only this, that the former are lapſable into aërial bodies only, and no further; but the latter into terreſtrial alſo. Now, *Hierocles* poſitively affirms this to have been the true cabala, and genuine doctrine of the ancient Pythagoreans, entertained afterwards by Plato: και τουτο των Πυθαγορειων ἠν δογμα, ὁ δε Πλατων υστερον εξεφηνεν, απεικασας ξυμφυτω δυναμει υποπτερου ζευγους τε και ἡνιοχου; πασαν θειαν τε και ανθρωπινην ψυχην. *And this was the doctrine of the Pythagoreans, which Plato afterwards declared; he reſembling every both human and divine ſoul* (i. e. in our modern language, every created rational being) *to a winged chariot, and a driver or charioteer both together*: meaning by the chariot, an animated body; and by the charioteer, the incorporeal ſoul actuating it.

That this Pythagorean opinion of the Deity's being the only mind which thinks and acts without material organs was very generally received by the ancient Chriſtians, might be proved by a thouſand quotations: We ſhall content ourſelves with producing two from the learned *Origen*. "Solius Dei (ſaith this philoſophic father of the church), id eſt, Patris, Filii, et Spiritus Sancti, naturæ id proprium eſt, ut ſine materiali ſubſtantia, et abſque ulla corporeæ adjectionis ſocietate, intelligatur ſubſiſtere *." "Materialem ſubſtantiam opinione quidem et intellectu ſolum ſeparari, a naturis rationalibus, et pro ipſis, vel poſt ipſas effectam videri; ſed nunquam ſine ipſa eas vel vixiſſe, vel vivere: Solius namque Trinitatis incorporea vita exiſtere putabitur †." Should Mr Cooper and his friends aſk, What is the uſe of a ſoul which cannot act without the inſtrumentality of matter? or why we ſhould ſuppoſe the exiſtence of ſuch a ſubſtance? we beg leave, in our turn, to aſk theſe gentlemen, What is the uſe of a brain which cannot ſee without eyes? and why they ſhould ſuppoſe all our ſenſations to terminate in ſuch an internal ſyſtem, ſince the vulgar certainly ſuppoſe their ſenſations to ſubſiſt in their reſpective organs? How this ancient notion, which makes body ſo eſſential a part of man, is conſiſtent with the immortality of the human ſoul, we ſhall inquire in a ſubſequent chapter; in which we ſhall endeavour to aſcertain what kind of immortality we have reaſon to expect, and upon what evidence our expectation muſt reſt. Previous to this inquiry, however, it is neceſſary to enter upon another, which is of the firſt importance, and which every materialiſt has endeavoured to perplex; we mean that which concerns *perſonal identity*: for if, as has been often ſaid, no man is the ſame perſon two days ſucceſſively, it is of no importance to us whether the ſoul be mortal or immortal.

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WHETHER we are to live in a future ſtate, as it is the moſt important queſtion which can poſſibly be aſked, ſo it is the moſt intelligible one which can be expreſſed in language. Yet ſtrange perplexities have been raiſed about the meaning of that identity or ſameneſs of perſon, which is implied in the notion of our living now and hereafter, or indeed in any two ſucceſſive moments; and the ſolution of theſe difficulties hath been ſtranger than the difficulties themſelves. To repeat all that has been ſaid on the ſubject would ſwell this chapter to a diſproportionate bulk. We ſhall therefore content ourſelves with laying before our readers the ſentiments of Biſhop Butler, and the fancies and demonſtrations of the philoſopher of Mancheſter. We are induced to adopt this courſe, becauſe we think the illuſtrious biſhop of Durham has exhauſted the ſubject, by ſtating fairly the opinions which he controverts, and by eſtabliſhing his own upon a foundation which cannot be ſhaken, and which are certainly not injured, by the objections of Mr Cooper.

251 though it cannot be defined, eaſily underſtood and aſcertained by conſciouſneſs and memory.

"When it is aſked (ſays this philoſophical prelate *) in what perſonal identity conſiſts? the anſwer ſhould be the ſame as if it were aſked in what conſiſts ſimilitude or equality?—that all attempts to define would but perplex it. Yet there is no difficulty at all in aſcertaining the idea or notion: For as, upon two triangles being compared or viewed together, there ariſes to the mind the notion of ſimilitude; or, upon twice two and four, the notion of equality: ſo likewiſe, upon comparing the conſciouſneſs of one's ſelf or one's own exiſtence in any two moments, there as immediately ariſes to the mind the notion of perſonal identity. And as the two former compariſons not only give us the notions of ſimilitude and equality, but alſo ſhow us that two triangles are ſimilar, and that twice two and four are equal; ſo the latter compariſon not only gives us the notion of perſonal identity, but alſo ſhows us the identity of ourſelves in theſe two moments—the preſent, ſuppoſe, and that immediately paſt, or the preſent and that a month, a year, or twenty years paſt. In other words, by reflecting upon that which is myſelf now, and that which was myſelf twenty years ago, I diſcern they are not two, but one and the ſame ſelf.

250 Theſe, however, do not make perſonal identity.

"But though conſciouſneſs of what is preſent and remembrance of what is paſt do thus aſcertain our perſonal identity to ourſelves; yet, to ſay that remembrance makes perſonal identity, or is neceſſary to our being the ſame perſons, is to ſay that a perſon has not exiſted a ſingle moment, nor done one action, but what he can remember; indeed none but what he reflects upon. And one ſhould really think it ſelf evident, that conſciouſneſs of perſonal identity preſuppoſes and therefore cannot conſtitute perſonal identity; any more than knowledge, in any other caſe, can conſtitute truth, which it preſuppoſes.

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* *Peri Archon.* lib. 1 cap 6.

† Lib. 2. cap. 2.

* *Diſſertation 1ſt, ſubjoined to the Analogy of Religion, &c.*

"The inquiry, what makes vegetables the ſame in the common acceptation of the word, does not appear to have any relation to this of perſonal identity; becauſe the word *ſame*, when applied to them and to perſon, is not only applied to different ſubjects, but is alſo uſed in different ſenſes. When a man ſwears to the ſame tree, as having ſtood fifty years in the ſame place, he means only the ſame as to all the purpoſes of property and uſes of common life, and not that the tree has been all that time the ſame in the ſtrict philoſophical ſenſe of the word: For he does not know whether any one particle of the preſent tree be the ſame with any one particle of the tree which ſtood in the ſame place fifty years ago. And if they have not one common particle of matter they cannot be the ſame tree in the proper and philoſophic ſenſe of the word *ſame;* it being evidently a contradiction in terms to ſay they are, when no part of their ſubſtance and no one of their properties is the ſame; no part of their ſubſtance, by the ſuppoſition; no one of their properties, becauſe it is allowed that the ſame property cannot be transferred from one ſubſtance to another: And therefore, when we ſay that the identity or ſameneſs of a plant conſiſts in a continuation of the ſame life, communicated under the ſame organization to a number of particles of matter, whether the ſame or not; the word *ſame*, when applied to life and to organization, cannot poſſibly be underſtood to ſignify what it ſignifies in this very ſentence, when applied to matter. In a looſe and popular ſenſe, then, the life, and the organization, and the plant, are juſtly ſaid to be the ſame, notwithſtanding the perpetual change of the parts. But, in a ſtrict and philoſophical manner of ſpeech, no man, no being, no mode of being, no any thing, can be the ſame with that with which it has indeed nothing the ſame. Now ſameneſs is uſed in this latter ſenſe when applied to perſons. The identity of theſe, therefore, cannot ſubſiſt with diverſity of ſubſtance.

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What it is.

"The thing here conſidered, and demonſtratively, as I think, determined, is propoſed by Mr Locke in theſe words: *Whether it* (i. e. the ſame ſelf or perſon) *be the ſame identical ſubſtance?* And he has ſuggeſted what is a much better anſwer to the queſtion than that which he gives it in form: For he defines perſon *a thinking intelligent being*, &c. and perſonal identity, *the ſameneſs of a rational being;* and then the queſtion is, Whether the ſame rational being is the ſame ſubſtance? which needs no anſwer; becauſe being and ſubſtance are in this place ſynonymous terms. The ground of the doubt, whether the ſame perſon be the ſame ſubſtance, is ſaid to be this, that the conſciouſneſs of our own exiſtence, in youth and in old age, or in any two joint ſucceſſive moments, is not *the ſame individual action*, i. e. not the ſame conſciouſneſs, but different ſucceſſive conſciouſneſſes. Now it is ſtrange that this ſhould have occaſioned ſuch perplexities: for it is ſurely conceivable that a perſon may have a capacity of knowing ſome object or other to be the ſame now which it was when he contemplated it formerly; yet in this caſe, where, by the ſuppoſition, the object is perceived to be the ſame, the perception of it in any two moments cannot be one and the ſame perception. And thus, though the ſucceſſive conſciouſneſſes which we have of our own exiſtence are not the ſame, yet are they conſciouſneſſes of one and the ſame thing or object; of the ſame perſon, ſelf, or living agent. The perſon of whoſe exiſtence the conſciouſneſs is felt now, and was felt an hour or a year ago, is diſcerned to be, not two perſons, but one and the ſame perſon; and therefore is one and the ſame.

254
Falſe notions of perſonal identity

"Mr Locke's obſervations upon this ſubject appear haſty; and he ſeems to profeſs himſelf diſſatisfied with ſuppoſitions which he has made relating to it. But ſome of thoſe haſty obſervations have been carried to a ſtrange length by others; whoſe notion, when traced and examined to the bottom, amounts, I think, to this: 'That perſonality is not a permanent but a tranſient thing: That it lives and dies, begins and ends, continually: That no one can any more remain one and the ſame perſon two moments together, than two ſucceſſive moments can be one and the ſame moment: That our ſubſtance is indeed continually changing: but whether this be ſo or not, is, it ſeems, nothing to the purpoſe; ſince it is not ſubſtance, but conſciouſneſs alone, which conſtitutes perſonality; which conſciouſneſs, being ſucceſſive, cannot be the ſame in any two moments, nor conſequently the perſonality conſtituted by it*." Hence it muſt follow, that it is a fallacy upon ourſelves to charge our preſent ſelves with any thing we did, or to imagine our preſent ſelves intereſted in any thing which befel us yeſterday; or that our preſent ſelf will be intereſted in what will befal us to-morrow; ſince our preſent ſelf is not in reality the ſame with the ſelf of yeſterday, but another ſelf or perſon coming in its room, and miſtaken for it; to which another ſelf will ſucceed to morrow. This, I ſay, muſt follow: for if the ſelf or perſon of to-day and that of to-morrow are not the ſame, but only like perſons; the perſon of to-day is really no more intereſted in what will befal the perſon of to-morrow, than in what will befal any other perſon. It may be thought, perhaps, that this is not a juſt repreſentation of the opinion we are ſpeaking of; becauſe thoſe who maintain it allow that a perſon is the ſame as far back as his remembrance reaches: And indeed they do uſe the words *identity* and *ſame* perſon; nor will language permit theſe words to be laid aſide. But they cannot, conſiſtently with themſelves, mean that the perſon is really the ſame: For it is ſelf-evident, that the perſonality cannot be really the ſame, if, as they expreſsly aſſert, that in which it conſiſts is not the ſame. And as, conſiſtently with themſelves, they cannot, ſo I think it appears they do not, mean that the perſon is *really* the ſame, but only that he is ſo in a fictitious ſenſe, in ſuch a ſenſe only as they aſſert: for this they do aſſert, that any number of perſons whatever may be the ſame perſon. The bare unfolding this notion, and laying it thus naked and open, ſeems the beſt confutation of it. However, ſince great ſtreſs is ſaid to be put upon it, I add the following things:

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overthrown.

"*Firſt*, This notion is abſolutely contradictory to that certain conviction, which neceſſarily and every moment riſes within us, when we turn our thoughts upon ourſelves, when we reflect upon what is paſt, and look forward to what is to come. All imagination, of a daily change of that living agent which each man calls himſelf

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* *Anſwer to Dr Clarke's third Defence of his Letter to Mr Dodwell*, ſecond edit p. 44. 56, &c.

ſelf for another, or of any ſuch change throughout our whole preſent life, is entirely borne down by our natural ſenſe of things. Nor is it poſſible for a perſon in his wits to alter his conduct with regard to his health or affairs, from a ſuſpicion that though he ſhould live to-morrow he ſhould not however be the ſame perſon he is to day.

“ *Secondly*, It is not an *idea* or abſtract *notion*. or quality, but a being only, which is capable of life and action, of happineſs and miſery. Now all beings confeſſedly continue the ſame during the whole time of their exiſtence. Conſider then a living being now exiſting, and which has exiſted for any time alive: this living being muſt have done, and ſuffered, and enjoyed, what it has done, and ſuffered, and enjoyed, formerly (this living being, I ſay, and not another), as really as it does, and ſuffers, and enjoys, what it does, and ſuffers, and enjoys, this inſtant. All theſe ſucceſſive actions, ſufferings, and enjoyments, are actions, enjoyments, and ſufferings, of the ſame living being; and they are ſo prior to all conſiderations of its remembering or forgetting, ſince remembering or forgetting can make no alteration in the truth of paſt matter of fact. And ſuppoſe this being endued with limited powers of knowledge and memory, there is no more difficulty in conceiving it to have a power of knowing itſelf to be the ſame being which it was ſome time ago, of remembering ſome of its actions, ſufferings, and enjoyments, and forgetting others, than in conceiving it to know, or remember, or forget, any thing elſe.

“ *Thirdly*, Every perſon is conſcious that he is now the ſame perſon or ſelf he was as far back as his remembrance reaches: ſince when any one reflects upon a paſt action of his own, he is juſt as certain of the perſon who did that action, namely himſelf (the perſon who now reflects upon it), as he is certain that the action was at all done. Nay, very often a perſon's aſſurance of an action having been done, of which he is abſolutely aſſured, ariſes wholly from the conſciouſneſs that he himſelf did it: and this he, perſon, or ſelf, muſt either be a ſubſtance or the property of ſome ſubſtance. If *he*, if perſon, be a ſubſtance; then conſciouſneſs that he is the ſame perſon, is conſciouſneſs that he is the ſame ſubſtance. If the perſon, or *he*, be the property of a ſubſtance, ſtill conſciouſneſs that he is the ſame property is as certain a proof that his ſubſtance remains the ſame, as conſciouſneſs that he remains the ſame ſubſtance would be; ſince the ſame property cannot be transferred from one ſubſtance to another.

“ But though we are thus certain than we are the ſame agents, living beings, or ſubſtances, now, which we were as far back as our remembrance reaches; yet it is aſked, Whether we may not poſſibly be deceived in it? And this queſtion may be aſked at the end of any demonſtration whatever; becauſe it is a queſtion concerning the truth of perception by memory: and he who can doubt whether perception by memory can in this caſe be depended upon, may doubt alſo whether perception by deduction and reaſoning, which alſo include memory, or indeed whether intuitive perception itſelf, can be depended upon. Here then we can go no farther: for it is ridiculous to attempt to prove the truth of our faculties, which can no otherwiſe be proved than by the uſe or means of thoſe ſuſpected faculties themſelves.”

256 Objection to the foregoing reaſoning.

This reaſoning, which we believe will to moſt men appear unanſwerable, Mr Cooper hopes to overturn by the following obſervations*: “ If all imagination of a daily change in us be borne down by our natural ſenſe of things, then (ſays he) does our natural ſenſe of things poſitively contradict known fact; for a daily, a momentaneous, change in us, i. e. in our bodies, does actually take place.” True, a daily change in our bodies does take place, and ſo likewiſe does a daily change in our clothes; but ſurely no man was ever led by his natural ſenſe of things to ſuppoſe, that his limbs or external organs were the ſeats of ſenſation and will, any more than that his coat or his ſhoes were any real parts of his trunk or of his feet. But it is only that which thinks and wills than any man conſiders in this caſe, as himſelf or his perſon; and if our natural ſenſe of things, or conſciouſneſs, tell us, that what thinks and wills has continued the ſame from a diſtance of time as far back as we can remember, it is certain, that, whether it be material or immaterial, it has continued from that period, otherwiſe we can be certain of nothing. “ But (ſays our philoſopher) other known and aſcertained facts are frequently borne down by our natural ſenſe of things: for how many thouſand years before the days of *Copernicus* was the motion of the earth round the ſun entirely borne down by our natural ſenſe of things, which made us give full credit to the motion of the ſun round the earth? Do not the generality of mankind believe, upon the evidence of their natural ſenſe of things, that every part of their body remains exactly the ſame to-day as it was yeſterday?”

257 Anſwered.

To the former of theſe queſtions we anſwer poſitively, that before the days of *Copernicus* the motion of the earth round the ſun was *not* borne down by our *natural ſenſe* of things, but by ill-founded hypotheſes and inconcluſive reaſonings. By the natural ſenſe of things, nothing can be meant, in this place, but the evidence of conſciouſneſs or of external ſenſation; but the *actual motion* either of the ſun or of the earth is not perceived either by conſciouſneſs or by ſenſation. Of conſciouſneſs nothing is the object but the internal energies and feelings of our own minds; and with regard to the motion of the ſun or of the earth, nothing is perceived by the ſenſe of ſight but that, after conſiderable intervals of time, theſe two great bodies have repeatedly changed their places in the heavens with reſpect to each other. This is all that on this ſubject our *natural ſenſe of things* leads us to believe; and is not this infallibly true? Afterwards indeed, by taking for granted the truth of propoſitions, for which neither ſenſe nor conſciouſneſs affords the ſhadow of evidence; the vulgar now, and all mankiad formerly, reaſoned themſelves into the opinion, that the earth ſtands ſtill, and that the ſun moves round it. In vulgar philoſophy it is taken for granted, that in the univerſe there is not a *relative* but an *abſolute upwards* and an *abſolute downwards*; that our heads are abſolutely upward, and our feet downward; and that were the earth to revolve round its axis, theſe poſitions would be reverſed, that our heads would be placed beneath our feet, and that we ourſelves would fall from the earth into

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* *Tracts*, &c.

Of Perſonal Identity.

into empty ſpace. Upon theſe falſe hypotheſes the vulgar reaſon correctly. They know that bodies cannot change their place without motion; they know that in the time of their remembrance the ſun and the earth have been perpetually varying their places with reſpect to each other; they know that they themſelves have never fallen, nor had a tendency to fall, into empty ſpace; and hence they infer that it is the ſun and not the earth that moves (K). But will any man ſay that the abſurd ſuppoſitions from which this concluſion is logically deduced, have the evidence either of ſenſation or of conſciouſneſs, as the permanency of that living agent which each man calls himſelf has?

To our author's ſecond queſtion we likewiſe reply with confidence, that the generality of mankind do *not* believe, upon their natural ſenſe of things, that every part of their body remains exactly the ſame to-day as it was yeſterday. It would be ſtrange indeed if they did, after having repeatedly experienced the waſte of increaſed perſpiration or ſweating; after having witneſſed men emaciated by ſickneſs, and again reſtored to plumpneſs in health; and after having perhaps loſt whole limbs, which certainly their natural ſenſe of things teaches them to conſider as parts of their body. In all theſe caſes, the generality of mankind are as ſenſible of changes having taken place in their bodies as he who has attended ever ſo cloſely to phyſiological inquiries, though not one of them has the leaſt imagination of a change having taken place in the living agent which each man calls himſelf.

Biſhop Butler obſerves, that if the living agent be perpetually changing, it is a fallacy upon ourſelves to charge our preſent ſelves with any thing we did, to imagine our preſent ſelves intereſted in any thing which befel us yeſterday, or that our preſent ſelf will be intereſted in what will befal us to morrow. To this judicious obſervation our daring philoſopher replies, "that as the man of to-morrow, though not in all points the ſame with, yet depends for his exiſtence upon, the man of to-day, there is ſufficient reaſon to care about him." Could he have ſaid, that as the man of to-day depends for his exiſtence on the man of to-morrow, there is ſufficient reaſon for the preſent man to care about the future man; or that as the man of to-morrow depends for his exiſtence on the man of to-day, there is to day ſufficient reaſon for the future man to care about the preſent man; we ſhould in either caſe, if the anachroniſm had been kept out of ſight, have ſeen the force of his argument. Every man has ſufficient reaſon to care about the ox upon which he is to be fed; but we cannot ſo clearly perceive what reaſon the ox has to care about the man.

Not ſatisfied, it would ſeem, with this reply, our author proceeds to affirm, "that the man of to-morrow, poſſeſſing a reminiſcence of the actions of the man of to-day, and knowing that theſe actions will be referred to him both by himſelf and others (which is certainly knowing that both himſelf and others are moſt iniquitous wretches), they cannot be indifferent to the man of to day, who looks forward to the properties of the man of to-morrow;" i. e. the reminiſcence and knowledge of a future man conſtitute all the relation that ſubſiſts between a preſent man and his actions; a diſcovery worthy of an original genius. But as on the ſubject of perſonal identity we pretend to no originality, we ſhall leave this propoſition to the meditation of our readers, and take the liberty to aſk our author a queſtion or two reſpecting this ſame reminiſcence, which he is graciouſly pleaſed to acknowledge for a property.

Of Perſonal Identity.

He defines identity, "the continued exiſtence of any being unaltered in ſubſtance or in properties;" and he repeatedly acknowledges that no identical quality or property can be transferred from one ſubject to another. Let us now ſuppoſe, that a man has a reminiſcence of an individual action performed a month ago, and that this reminiſcence is accompanied with a conſciouſneſs that the action was performed by himſelf. This ſuppoſition, whether true or falſe, may certainly be made; for it implies nothing more than what every man firmly believes of himſelf in every act of remembrance. Let us again ſuppoſe, that, at the diſtance of ten or twenty years, the man known by the ſame name has a reminiſcence of the ſame action, with a conſciouſneſs that he himſelf performed it. Is this reminiſcence the ſame with the former? or is it a different reminiſcence? If it be the ſame, either the perſon remembering at the diſtance of ten or twenty years is the ſame with him who remembered at the diſtance of a month, or there is an identical quality transferred from one ſubſtance to another, which is admitted to be impoſſible. If reminiſcence be itſelf a real and immediate quality of any ſubſtance, and not the mere energy of a power, and if the one reminiſcence be different from the other, the ſubjects in which theſe two different qualities inhere muſt likewiſe be different. Yet the man who has the reminiſcence at the diſtance of a month, has the evidence of conſciouſneſs that the action was performed by him; and the man who has the reminiſcence at the diſtance of ten or twenty years, has likewiſe the evidence of conſciouſneſs that the ſame action was performed by him and not by another. By the confeſſion of Hume and of all philoſophers, conſciouſneſs never deceives; but here is the evidence of one conſciouſneſs in direct oppoſition to another; and therefore, as two contradictory propoſitions cannot both be true, either the one reminiſcence is the ſame with the other, or reminiſcence is no real quality. That one act of reminiſcence ſhould be numerically the ſame with another, which followed it at the diſtance of twenty years, is plainly impoſſible; whence it ſhould ſeem, that reminiſcence itſelf is no real and immediate quality of any ſubſtance. But if this be ſo, what is reminiſcence? We anſwer, it is plainly neither more nor leſs than the *energy* of a power, which

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(K) This inference too has been ſo often drawn, that it comes in time to coaleſce in the mind with the *ſenſations*, from which the motion either of the ſun or of the earth is deduced with infallible certainty; and hence it is conſidered as part of that truth which ſenſation immediately diſcovers. *See our Chapter of Association*.

which though dormant between its energies, remains unchanged from the one to the other, and which being itſelf the real and immediate quality of a ſubject, that ſubject muſt likewiſe remain unchanged. That powers may remain dormant, and yet unchanged, every man muſt be convinced; who, having ſtruck any thing with his hand, knows that he has power to repeat the ſtroke, and yet does not actually repeat it. Two blows with the hand immediately following each other are numerically different, ſo that the one cannot with truth be ſaid to be the other; but we have the evidence of external ſenſe, that they are both ſtruck by the ſame member. In like manner, two energies of reminiſcence directed to the ſame object, and ſucceeding each other at any interval of time, cannot poſſibly be one and the ſame energy; but as the latter energy may include in it the former as well as the object remembered by both, we have the evidence of conſciouſneſs that both are energies of the ſame power; and we have ſeen, that to ſuppoſe them any thing elſe, may be demonſtrated to involve the groſſeſt abſurdities and contradictions.

Mr Cooper has other arguments to obviate the force of Biſhop Butler's demonſtration of perſonal identity; ſuch, as, that a "high degree of *ſimilarity* between the two ſucceeding men is ſufficient to make the one care about the other;" and, that "a good man, knowing that a future being will be puniſhed or rewarded as the actions of the preſent man deſerve, will have a ſufficient motive to do right and to abſtain from wrong." But if there be any one of our readers who can ſuffer himſelf to be perſuaded by ſuch aſſertions as theſe, that the living agent which he calls himſelf is perpetually changing, and at the ſame time, that ſuch change is conſiſtent with the expectation of future rewards and puniſhments, he would not be reclaimed from his error by any reaſoning of ours. We ſhall therefore truſt ſuch trifling with every man's judgement, and proceed to examine our author's *demonſtration*, that perſonal identity has no exiſtence. But here it is no part of our purpoſe to accompany him through his long chemical ramble, or to controvert his arguments for the nonidentity of vegetable and animal bodies. The only thing to which, after Biſhop Butler, we have aſcribed identity, is that which in man is ſentient and conſcious; and the nonidentity of this thing, whatever it be, Mr Cooper undertakes to demonſtrate from the known properties of ſenſations and ideas.

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A pretended demonſtration that perſonal identity is impoſſible.

This demonſtration ſets out with a very ominous circumſtance. The author, after conducting impreſſions *ab extra*, from the extremities of the nerves to the brain, affirms, that *ſenſations* and *ideas* are nothing but "motions in the brain perceived;" i. e. when a man thinks he is looking at a mountain, not only at reſt, but to appearance immoveable, he is groſsly deceived: for he perceives nothing all the while but *motion in his brain!* Were not the deſire of advancing novelties and paradoxes invincible in ſome minds, we ſhould be aſtoniſhed at finding ſuch an aſſertion as this fall from the pen of any man who had paid the ſlighteſt attention to the different energies of his own intellect. Motions in the brain, as we have repeatedly obſerved, are the immediate cauſes of our ſenſations; but is it conceiveable, is it poſſible, that any thing ſhould be the cauſe of itſelf? The motion of a ſword through the heart of a man, is the immediate cauſe of that man's death; but is the ſword or its motion *death* itſelf, or can they be conceived as being the *ſenſations* of the *man* in the *agonies* of *dying?* But ſenſations and ideas, whatever they be, exiſt in ſucceſſion; and therefore, argues our demonſtrator, no two ſenſations or ideas can be one and the ſame ſenſation or idea. The concluſion is logically inferred; but what purpoſe can it poſſibly ſerve? What purpoſe! why it ſeems "ſenſations and ideas are the only *exiſtences whoſe exiſtence* we certainly know (a charming phraſe, the *exiſtence* of *exiſtences*, and as original as the theory in which it makes its appearance); and, therefore, from the nature of ſenſations and ideas there is no ſuch thing as permanent identity." Indeed! what then, we may be permitted to aſk, is the import of the word *we* in this ſentence? Does it denote a ſeries of ſenſations and ideas, and does each ſenſation and each idea certainly know not only itſelf, but all its anceſtors and all its deſcendants? Unleſs this be admitted, we are afraid that ſome other exiſtence beſides ſenſations and ideas muſt be allowed to be certainly known, and even to have ſomething of a permanent identity. Nay, we think it has been already demonſtrated (ſee Chapter of TIME), that were there not ſomething permanent, there could be no time, and of courſe no notion of a firſt and laſt, or indeed of ſucceſſion, whether of ſenſations or ideas. And therefore, if we have ſuch a notion, which the author here takes for granted, and upon which indeed his demonſtration reſts, it follows undeniably that there is ſomething permanent, and that we *know* there is ſomething permanent, which obſerves the ſucceſſion of ſenſations and ideas.

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Shown to be abſurd and ridiculous.

"All this, indeed, Mr Cooper in effect grants; for he is not much ſtartled at the appearance of contradictions in his theory. "I find (ſays he), by perpetually repeated impreſſions which I perceive, that my hands, body, limbs, &c. are connected, are parts of one whole. I find, by perpetually repeated perceptions alſo, that the ſenſations excited by them are conſtantly ſimilar, and conſtantly different from the ſenſations excited by others." He has then repeated perceptions: but how can this be poſſible, if *he* be not different from the perceptions, and if *he* do not *remain unchanged* while the perceptions ſucceed each other at greater or leſs intervals of time? A ſtriking object paſſing with rapidity before the eyes of a number of men placed beſide each other in a line of battle, would undoubtedly excite a ſucceſſion of ſenſations; but ſurely that ſucceſſion would not take place in the mind of *any individual* in the line, nor could any *ſingle man* in this caſe ſay with truth that he had *repeated* perceptions of the object. In like manner, were that which is ſentient perpetually changing, no man could poſſibly ſay or ſuppoſe that he had repeated perceptions of any thing; for upon this ſuppoſition, the man of to-day would have no more connexion with the man who bore his name yeſterday, or twenty years ago, than the man in the line had with the firſt.

Upon the whole, we cannot help thinking that Biſhop Butler's demonſtration of perſonal identity remains unſhaken by the batteries of Mr Cooper.—It reſts, indeed, Of Perſonal Identity.

deed, upon the ſolid baſis of conſciouſneſs and memory; and if implicit credit be not given to the evidence of theſe faculties, we cannot proceed a ſingle ſtep in any inquiry whatever, nor be certain of the truth even of a mathematical demonſtration.

A difficulty removed.

260 But as we have ourſelves ſuppoſed, that to ſenſation, reminiſcence, and every actual energy of the mind of man, the inſtrumentality of ſome material ſyſtem is neceſſary, it may perhaps be thought incumbent on us to ſhow how the perpetual flux of the particles of matter which compoſe the brain, as well as all the other parts of the body, can conſiſt with the identity of the perſon who perceives, remembers, and is conſcious. If this cannot be done, our hypotheſis, ancient and plauſible as it is, muſt be given up; for of perſonal identity it is impoſſible to doubt. In this caſe, however, we perceive no difficulty; for if there be united to the brain an immaterial being, which is the ſubject of ſenſation, conſciouſneſs, and will, &c. it is obvious, that all the *intellectual powers* which properly conſtitute the perſon, muſt be inherent in that being. The material ſyſtem, therefore, can be neceſſary only as an inſtrument to excite the energies of thoſe powers; and ſince the powers themſelves remain unchanged, why ſhould we ſuppoſe that their energies may not be continually exerted by ſucceſſive inſtruments of the ſame kind, as well as by one permanent inſtrument? The powers of perception and volition are not in the material ſyſtem, any more than the ſenſation of ſeeing is in the rays of light, or the energy of the blackſmith in the hammer with which he beats the anvil. Let us ſuppoſe a man to keep his eye for an hour ſteadily fixed upon one object. It will not ſurely be denied, that if this could be done, he would have one uninterrupted and unvaried perception of an hour's duration, as meaſured by the clock. Yet it is certain that the rays of light which alone could occaſion that perception would be perpetually changing. In like manner, a blackſmith, whilſt he continues to beat his anvil, continues to exert the ſame power whether he uſes one hammer all the time, or a different hammer at each ſtroke. The reaſon is obvious; the eye, with all its connexions of brain and mind in the one caſe, and the perſon of the ſmith in the other, remain unchanged; and in them alone reſide the faculty of ſenſation and the power of beating, though neither the faculty nor the power can be exerted without material inſtruments. But were it poſſible that millions of men could in the ſpace of an hour take their turns in rotation with each new ray of light, it is ſelf-evident, that in this caſe, there would be nothing permanent in ſenſation; and, therefore, there could not be one uninterrupted and unvaried perception, but millions of perceptions, during the hour, totally diſtinct from and unconnected with each other. Let us now ſuppoſe a man to fix his eye upon an object for the ſpace of a minute, and at the diſtance of a day or a month to fix it upon the ſame object a ſecond time. He would not indeed, in this caſe, have one uninterrupted and unvaried perception, but he would be conſcious of the energy of the very ſame faculty the ſecond time as at the firſt. Whereas, were one man to view an object to day, and another to view the ſame object to-morrow, it is obvious, that he who ſhould be laſt in the ſucceſſion could know nothing of the energy of that faculty by which the object was perceived the firſt day, becauſe there would be nothing common to the two perceptions.

Of the Immortality of the Soul.

Thus then we ſee, that *perſonal identity* may with truth be predicated of a compound being, though the material part be in a perpetual flux, provided the immaterial part remain unchanged; and that of ſuch a being only is a reſurrection from the dead poſſible.—For ſince the motions of the brain do nothing more than excite to energy the permanent powers of the mind, it is of no ſort of conſequence to that energy, whether theſe motions be continued by the ſame numerical atoms, or by a perpetual ſucceſſion of atoms arranged and combined in the very ſame manner. We ſhall, therefore, be the ſame perſons at the reſurrection as at preſent, whether the mind be united to a particular ſyſtem compoſed of any of the numberleſs atoms which have in ſucceſſion made parts of our preſent bodies, or to a ſyſtem compoſed of totally different atoms, provided that new ſyſtem be organized in exactly the ſame manner with the brain or material vehicle, which is at preſent the immediate inſtrument of perception. This (we ſay) is ſelf-evident; but were the immaterial part to change with the changing body, a reſurrection of the ſame perſons would be plainly impoſſible.

CHAP. IV. *Of the* IMMORTALITY *of the* SOUL.

The immortality of the ſoul the general belief in all nations.

261 WHEREVER men have been in any degree civilized, and in ſome nations where they have been in the moſt ſavage ſtate, it has been the general perſuaſion, that the mind or ſoul ſubſiſts after the diſſolution of the body. The origin of this perſuaſion, about which diſputes have been raiſed, no Chriſtian heſitates to attribute to revelation. The Egyptians, from whom the Greeks derived many of their theological and philoſophical principles, appear to have taught the immortality of the ſoul, not as a truth diſcovered by the exertions of human reaſon, but as a dogma derived to them from the earlieſt ages by tradition. This indeed may be confidently inferred from the character and conduct of their firſt Greek diſciples. Thoſe early wiſe men who fetched their philoſophy immediately from Egypt, brought it home as they found it, in detached and independent placits. Afterwards, when ſchools were formed, and when man began to philoſophize by hypotheſis and ſyſtem, it was eagerly inquired upon what foundation in *nature* the belief of the ſoul's immortality could reſt; and this inquiry gave riſe to the various diſquiſitions concerning the *ſubſtance* of the ſoul, which have continued to exerciſe the ingenuity of the learned to the preſent day. It was clearly perceived, that if conſciouſneſs, thought, and volition, be the reſult of any particular modification of matter and motion, the living and thinking agent muſt periſh with the diſſolution of the ſyſtem; and it was no leſs evident, that if the being which perceives, thinks, and wills, be not material, the mind of man *may* ſubſiſt after the reſolution of the body into its component particles. The diſcovery of the immateriality of the mind was therefore one *ſtep towards* the proof of its immortality; and in the opinion of many philoſophers, whoſe hopes ought to reſt on a ſurer baſis, it was alone a complete proof.—"They who hold ſenſitive perception in brutes (ſays a pious writer)

writer *) to be an argument for the immateriality of their ſouls find themſelves under the neceſſity of allowing thoſe ſouls to be immortal."

262 The philoſophers of ancient Greece believed likewiſe in its pre-exiſtence

The philoſophers of ancient Greece, however, felt not themſelves under any ſuch neceſſity. Whatever were their opinions reſpecting the ſouls of brutes, they clearly perceived that nothing which had a beginning of exiſtence could be naturally immortal, whether its ſubſtance were material or immaterial.—"There never was any of the ancients before Chriſtianity (ſays the accurate Cudworth), that held the ſoul's future permanency after death, who did not likewiſe aſſert its pre-exiſtence; they clearly perceiving, that if it were once granted that the ſoul was generated, it could never be proved but that it might be alſo corrupted. And, therefore, the aſſertors of the ſoul's immortality commonly began here, firſt to prove its pre exiſtence, proceeding thence to eſtabliſh its permanency after death. This is the method of proof uſed in Plato: Ην που ἡμων ἡ ψυχη πριν εν τω δε τω ανθρωπινω ειδει γενεσθαι, ὡστε και ταυτη αθανατον τι εοικεν ἡ ψυχη ειναι. *Our ſoul was ſomewhere before it came to exiſt in this human form, and thence it appears to be immortal, and as ſuch will ſubſiſt after death.*

263 and abſolute eternity.

To give this argument for immortality any ſtrength, it muſt be taken for granted, not only that the ſoul exiſted in a *prior* ſtate, but that it exiſted from all *eternity*; for it is obvious, that if it had a beginning in any ſtate, it may have an end either in that ſtate or in another. Accordingly, Plato aſſerts in plain terms its eternity and ſelf-exiſtence, which, as we learn from Cicero, he inſers from its being the principle of motion in man. Quin etiam cæteris, quæ moventur, hic fons, hoc principium eſt movendi. *Principii autem nulla eſt origo.* Nam ex principio oriuntur omnia: ipſum autem nulla ex re alia naſci poteſt: nec enim eſſet id principium, quod gigneretur aliunde †." This, it muſt be acknowledged, is very contemptible reaſoning; but the opinion which it was intended to prove was held by all the philoſophers. They were unanimous in maintaining the *ſubſtance* of the ſoul, though not its *perſonality*, to be eternal *à parte ante* as well as *ad partem poſt*; and Cicero, where he tells us that this opinion paſſed from *Pherecydes Syrus*, to Pythagoras, and from Pythagoras to *Plato*, expreſſes their notion of the ſoul's duration by the word *ſempiternus* ‡, which, in its original and proper ſenſe, is applicable only to that which has neither beginning nor end.

Indeed none of the philoſophers of ancient Greece appear to have believed a creation (ſee CREATION) poſſible: for it was a maxim univerſally received among them, *De nihilo nihil fit, in nihilum nil poſſe reverti*; that *nothing can come from nonentity, or go to nonentity.* This maxim, as held by the theiſtical philoſophers, the learned Cudworth labours to interpret in a ſenſe agreeable to our notions of the origin of the world; but the quotations urged by himſelf muſt convince every competent reader that on this occaſion he labours in vain. For inſtance, when Ariſtotle writes of Parmenides and Meliſſus, that ουδὲν ουδε γινεσθαι φασιν ουδε φθειρεσθαι των οντων, *they ſay that no real entity is either made or deſtroyed*; what can be his meaning, but that thoſe philoſophers taught that nothing could be either created or annihilated? He teſtifies the ſame thing of *Xenophanes* and *Zeno*, when he ſays that it was a fundamental principle of their philoſophy—μη ενδεχεσθαι γινεσθαι μηδεν εκ μηδενος—*that it is impoſſible that any thing ſhould be made out of nothing.* And of Empedocles, when he relates απαντα ταυτα κακεινος ὁμολογει ὁτι εκ τε μη οντος αμηχανον εστι γινεσθαι το τε ον εξολλυσθαι ανηνυστον και αρρηκτον—*That he acknowledges the very ſame thing with other philoſophers*, viz. *that it is impoſſible that any thing ſhould be made out of nothing, or periſh into nothing.* But it is needleſs to multiply quotations reſpecting the opinions of ſingle philoſophers. Of all the phyſiologers before himſelf and Plato, Ariſtotle ſays, without exception, περι ταυτης ὁμογνωμονουσι της δοξης οἱ περι φυσεως, ὁτι το γιγνομενον εκ μη οντων γιγνεσθαι αδυνατον †—*That they agree in this opinion, that it is impoſſible that any thing ſhould be made out of nothing*: and he calls this the common principle of naturaliſts; plainly intimating, that they conſidered it as the greateſt abſurdity to ſuppoſe that any real entity in nature could either be brought from nothing or reduced to nothing.

The author of the *Intellectual Syſtem*, in order, perhaps, to hide the impiety of this principle, endeavours to perſuade his readers, that it was urged only againſt the hypotheſis of forms and qualities of bodies conſidered as real entities, diſtinct from matter. But how it could be ſuppoſed to militate againſt that particular opinion, and not againſt the poſſibility of all creation, is to us perfectly inconceivable. The father of the ſchool which analyzed body into matter and form, together with by far the greater part of his followers, taught the eternity of both theſe principles (1.); and therefore maintained, as ſtrenuouſly as any atomiſt, the univerſal maxim, *De nihilo nihil fit.* Even Plato himſelf, whoſe doctrine of *ideas* is ſuppoſed to wear a more favourable aſpect than Ariſtotle's *forms* to the truths of revealed religion, taught the *eternity* of *matter*; but whether as a ſelf-exiſting ſubſtance, or only as an emanation from the Deity, is a queſtion which has

* See the *Procedure, Extent, and Limits of the Underſtanding.*

† Tuſcul. lib. i. cap. 23

‡ Tuſcul. lib. i.

† Phyſic. lib. i. cap. 5.

(1.) *Ariſtotelem*, et pleroſque Peripateticorum, in vulgus notum eſt, in hac fuiſſe ſententia—nec *natum* eſſe, nec *interiturum* unquam hunc mundum. Vid. PETRUS GASSENDUS *Phyſic.* ſect. i. lib. i. cap. 6. *JAC. THOMASIUS de Stoica mundi exuſtione*, Diſſ. 4. et alii. Plures ita haud dubie ſenſerunt philoſophorum veterum. Hinc video *MANILIUM* in *Aſtronomico*, lib. i. inter philoſophorum de mundo ſententias hanc, ac ſi præcipua eſſet, primo commemorare loco:

Quem ſive ex nullis repetentem ſemina rebus,
NATALI QUOQUE EGERE *placet, ſemperque* FUISSE,
ET FORE, PRINCIPIO *pariter* FATO*que carentem.*

Moſheim's edition of Cudworth's Intellectual Syſtem, lib. i. cap. 3. ſect. 33. note 60. On this [illegible]ct ſee alſo *Ancient Metaphyſics.*

Of the Immortality of the Soul.

has been diſputed. That he admitted no proper creation, may be confidently inferred from Plutarch; who, writing upon the generation of animals, according to the doctrine laid down in the *Timæus*, has the following paſſage: Βελτιον ουν, Πλατωνι πειθομενους τον μεν κοσμον ὑπο θεου γεγονεναι λεγειν και αδειν· ὁ μεν γαρ καλλιστος των γεγονοτων ὁ δε αριστος των αιτιων την δε ΟΥΣΙΑΝ και ΥΔΗΝ ἐξ ἡς γεγονεν ου γενομενην, αλλα ὑποκειμενην αει τω δημιουργω εις διαθεσιν και ταξιν αυτης, και προς εξομοιωσιν, ὡς δυνατον ην παρασχειν· ου γαρ εκ του μη οντος ἡ γενεσις, αλλ᾽ εκ του μη καλως, μηδ᾽ ικανως εχοντος, ὡς οικιας και ἱματιου, και ανδριαντος*. *It is therefore better for us to follow Plato, and to ſay and ſing that the world was made by God. For as the world is the beſt of all works, ſo is God the beſt of all cauſes. Nevertheleſs, the* SUBSTANCE OR MATTER *out of which the world was made, was* NOT *itſelf made, but was always ready at hand, and ſubject to the artificer, to be ordered and diſpoſed by him. For the making of the world was not the production of it out of nothing, but out of an antecedent bad and diſorderly ſtate, like the making of a houſe, garment, or ſtatue.*

If, then, this be a fair repreſentation of the ſentiments of Plato, and ſurely the author underſtood thoſe ſentiments better than the moſt accompliſhed modern ſcholar can pretend to do, nothing is more evident, than that the founder of the academy admitted of no proper creation, but only taught that the matter which had exiſted from eternity in a chaotic ſtate, was in *time* reduced to order by the *Demiurgus* or Supreme Being. And if ſuch were the ſentiments of the divine Plato, we cannot heſitate to adopt the opinion of the excellent Moſheim, which the reader will probably be pleaſed to have in his own words: "Si à Judæis diſcedas, neſcio an ullus antiquorum philoſophorum mundum negaverit æternum eſſe. Omnes mihi æternum profeſſi videntur eſſe mundum: hoc uno vero disjunguntur, quod nonnulli ut *Ariſtoteles*, *formam* et *materiam* ſimul hujus orbis, alii vero, quorum princeps facile Plato, *materiam* tantum *æternam*, formam vero, à Deo comparatam, dixerunt †."

Now, it is a fact ſo generally known, as not to ſtand in need of being proved by quotations, that there was not among them a ſingle man who believed in the exiſtence of mind as a being more excellent than matter, and eſſentially different from it, who did not hold the ſuperior of at leaſt equal antiquity with the inferior ſubſtance. So true is this, that Syneſius, though a Chriſtian, yet having been educated in one of the ſchools of philoſophy, could not, by the hopes of a biſhopric, be induced to diſſemble this ſentiment: αμελω την ψυχην ουκ αξιωσω ποτε σωματος ὑστερογενη νομιζειν ‡. —*I ſhall never be perſuaded to think my ſoul younger than my body.* This man probably believed, upon the authority of the ſcriptures, that the matter of the viſible world was created in time; but he certainly held with his philoſophic maſters, that his own ſoul was as old as any atom of it, and that it had conſequently exiſted in a prior ſtate before it animated his preſent body.

264 They ſuppoſed all ſouls to be emanations from the firſt mind;

Thoſe who maintained that the world was uncreated, maintained upon the ſame principle that their ſouls were uncreated likewiſe; and as they conceived all bodies to be formed of one firſt matter, ſo they conceived all ſouls to be either emanations from the one firſt Mind, or diſcerpted parts of it. Ariſtotle, who diſtinguiſhes between the intellectual and ſenſitive ſouls, ſays expreſsly of the former, that it "enters from without, and is DIVINE;" adding this reaſon for his opinion, that "its energy is not blended with that of the body—λειπεται δε τον νουν μονον θυρα εν επεισιεναι, και θειον ειναι μονον· ουδε γαρ αυτου τη ενεργεια κοινωνει σωματικη ενεργεια*. As to the Stoics, *Cleanthes* held (as Stobæus informs us †), that "every thing was made out of one, and would be again reſolved into one." But let Seneca ſpeak for them all: "Quid eſt autem, cur non exiſtimes in eo *divini* aliquid exiſtere, qui DEI PARS eſt? Totum hoc, quo continemur, et unum eſt, et Deus: et ſocii ejus ſumus, et membra ‡—*Why ſhould you not believe ſomething to be divine in him, who is indeed* PART OF GOD? *That* WHOLE *in which we are contained is* ONE, *and that one is* GOD; *we being his companions and* MEMBERS. Epictetus ſays, *The ſouls of men have the neareſt relation to God, as being* PARTS OR FRAGMENTS *of him,* DISCERPTED *and* TORN *from his* SUBSTANCE; συναφεις τω θεω, ἁτε αυτου μορια ουσαι και αποσπασματα. Plato writes to the very ſame purpoſe, when, without any ſoftening, he frequently calls the ſoul *God*, and *part of God*. And Plutarch ſays, that "Pythagoras and Plato held the ſoul to be immortal; for that, launching out into the ſoul of the univerſe, it returns to its parent and original—Πυθαγορας, Πλατων, ἀφθαρτον ειναι την ψυχην· εξιουσαν γαρ εις την του παντος ψυχην, αναχωρειν προς το ομομενες ||." Plutarch declares his own opinion to be, that "the ſoul is not ſo much the work and production of God, as a PART of him; nor is it made BY him, but FROM him, and OUT of him: ἡ δε ψυχη ουκ εργον εστι μονον, αλλα και μερος· ουδ᾽ ΥΠ᾽ αυτου, αλλ᾽ ΑΠ᾽ αυτου, και ΕΞ αυτου γεγονεν §." But it is needleſs to multiply quotations. Cicero delivers the common ſentiments of his Greek maſters on this head, when he ſays ¶, "A natura deorum, ut doctiſſimis ſapientiſſimiſque placuit, HAUSTOS animos et LIBATOS habemus." And again: "Humanus autem animus DECERPTUS EX MENTE DIVINA: cum alio nullo, niſi cum ipſo Deo (ſi hoc fas eſt dictu), comparari poteſt."

265 But differed in opinion as to the mode of their ſeparation.

Whilſt the philoſophers were thus unanimous in maintaining the ſoul to be a part of the ſelf-exiſtent Subſtance, they differed in opinion, or at leaſt expreſſed themſelves differently, as to the mode of its ſeparation from its divine parent. Cicero and the Stoics talk as if the Supreme Mind were extended, and as if the human ſoul were a part literally torn from that mind, as a limb can be torn from the body. The Pythagoreans and Platoniſts ſeem to have conſidered all ſouls as emanations from the divine Subſtance rather than as parts torn from it, much in the ſame way as rays of light are emanations from the ſun. Plato, in particular, believed in two ſelf-exiſtent principles, God and matter. The former he conſidered as the ſupreme Intelligence, incorporeal, without beginning, end, or change; and diſtinguiſhed it by the appellation of το αγαθον, *the Good*. Matter, as ſubſiſting from eternity, he conſidered as without any one *form* or *quality* whatever, and as having a natural tendency to diſorder. Of this chaotic maſs God formed a perfect world, after the eternal pattern in his own mind, and endowed it with a ſoul or emanation from himſelf. In the language of Plato, therefore, the univerſe being animated by a ſoul which proceeds from God, is called the *ſon of God;* and

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* *Plut. Op.* tom. ii. p. 1014.

† *Notes on Cudworth's Intellectual Syſtem.*

‡ *Epiſt.* 105.

* *De Generatione Animalium*, lib. ii, cap. 3.

† *Eclog. Phyſ.* c. 20.

‡ *Epiſt.* 92.

|| *De Placitis Philoſophorum*, lib. iv. cap. 7.

§ *Plato Quæſt.*

¶ *De Divinatione*, lib. i. cap. 49.

and ſeveral parts of nature, particularly the heavenly bodies, are *gods*. The human ſoul, according to him, is derived by emanation from God, through the intervention of this ſoul of the world; and receding farther from the firſt intelligence, it is inferior in perfection to the ſoul of the world, though even that ſoul is debaſed by ſome material admixture. To account more fully for the origin and preſent ſtate of human ſouls, Plato ſuppoſes *, that " when God formed the univerſe, he ſeparated from the ſoul of the world inferior ſouls, equal in number to the ſtars, and aſſigned to each its proper celeſtial abode; but that thoſe ſouls, (by what means, or for what reaſon, does not appear), were ſent down to the earth into human bodies, as into ſepulchres or priſons." He aſcribes to this cauſe the depravity and miſery to which human nature is liable; and maintains, that it " is only by diſengaging itſelf from all animal paſſions, and riſing above ſenſible objects, to the contemplation of the world of intelligence, that the ſoul of man can be prepared to return to its original ſtate." Not inconſiſtently with this doctrine, our philoſopher frequently ſpeaks of the ſoul of man as conſiſting of three parts: or rather he ſeems to have thought that man has three ſouls; the firſt the principle of intelligence, the ſecond of paſſion, and the third of appetite (M); and to each he aſſigns its proper place in the human body. But it was only the intellectual ſoul that he conſidered as immortal.

Ariſtotle taught, in terms equally expreſs, that the human ſoul is a part of God, and of courſe that its ſubſtance is of eternal and neceſſary exiſtence. Some of his followers, indeed, although they acknowledged *two firſt principles*, the active and the paſſive, yet held, with the Stoics, but *one ſubſtance* in the univerſe; and to reconcile theſe two contradictory propoſitions, they were obliged to ſuppoſe matter to be both active and paſſive. Their doctrine on this ſubject is thus delivered by Cicero: " De natura ita dicebant, ut eam dividerent in res duas, ut altera eſſet efficiens, altera autem quaſi huic ſe præbens, ea quæ efficeretur aliquid. In eo, quod efficeret, vim eſſe cenſebant; in eo autem quod efficeretur, materiam quandam; in UTROQUE TAMEN UTRUMQUE. Neque enim materiam ipſam cohærere potuiſſe, ſi nulla vi contineretur, neque VIM SINE ALIQUA MATERIA: nihil eſt enim, quod non alicubi eſſe cogatur †." *They divided nature into two things, as the firſt principles; one whereof is the efficient or artificer, the other that which offers itſelf to him for things to be made out of it. In the efficient principle, they acknowledged active force; in the paſſive, a certain matter; but ſo, that in* EACH BOTH OF THESE WERE TOGETHER: *foraſmuch as neither the matter could cohere together unleſs it were contained by ſome active force, nor* THE ACTIVE FORCE SUBSIST OF ITSELF WITHOUT MATTER; *becauſe that is nothing which may not be compelled to be ſomewhere.* Agreeably to this ſtrange doctrine, Arrian, the interpreter of Epictetus, ſays of himſelf, *ειμι ανθρωπος, μερος των παντων, ὡς ὡρα ἡμερας*, " I am a man (a part of the *το παν* or *univerſe*), as an hour is part of the day."

Ariſtotle himſelf is generally ſuppoſed to have believed in the eternal exiſtence of two ſubſtances, *mind* and *matter*; but treating of the generation of animals, he ſays, *ενδε το παντι θερμοτης ψυχικη, ωστε τροπον τινα παντα ψυχης ειναι πληρη διο συνισταται ταχεως ὁποταν εμπεριληφθη* ‡. *In the univerſe there is a certain animal heat, ſo as that after a manner all things are full of mind; wherefore they are quickly completed (or made complete animals) when they have received a portion of that heat.* This *heat*, from which, according to Cicero ||, the Stagyrite derived all ſouls, has, it muſt be confeſſed, a very material appearance; inſomuch that the learned Moſheim ſeems to have been doubtful whether he admitted of any immaterial principle in man; but for this doubt there appears to us to be no ſolid foundation. Ariſtotle expreſsly declares, that *this heat is not fire* nor any *ſuch power, but a ſpirit which is in the ſeeds* or *elementary principles of bodies*; *τουτο δε ου πυρ, ουδε τοιαυτη δυναμις εστιν, αλλα το εμπεριλαμβανομενον εν τω σπερματι και εν τω αφρωδει πνευμα* §. And as the excellent perſon himſelf acknowledges (N), that Ariſtotle taught the exiſtence of two principles, God and matter, not indeed ſubſiſting

* *Enfield's Abridgement of Brucker's Hiſtory of Philoſophy.*

† *Academicium*, lib. i. cap. 6.

‡ *De Generatione Animalium*, lib. iii. cap. 11.

|| *Tuſcul.* lib. i. c. 3.

§ *De Generatione Animalium*, lib. ii. c. 3.

(M) " Plato triplicem finxit animam; cujus principatum, id eſt, rationem, in capite, ſicut in arce, poſuit: et duas partes ſeparare voluit, iram et cupiditatem, quas locis diſcluſit; iram in pectore, cupiditatem ſubter præcordia locavit." *Ciceronis Tuſc. Queſt.* lib. i. cap. 10.

This hypotheſis has been adopted by the learned author of Ancient Metaphyſics: but it cannot be proved by argument, and is in direct oppoſition to conſciouſneſs. Were there three diſtinct minds in each man—the principles of intelligence, of paſſion, and of appetite, it is obvious that *each man* would be *three perſons*, and that *none* of theſe perſons could know any thing of the powers and properties of the *other two*. The intelligent perſon could not reaſon about *paſſion* or *appetite*; nor could the perſons who know nothing but paſſion and appetite reaſon about *intelligence*, or indeed about any thing elſe. The very queſtion at iſſue, therefore, furniſhes the moſt complete proof poſſible, that the ſame individual which each man calls himſelf, is the principle of intelligence, of paſſion, and of appetite: for if the Platonic hypotheſis were true, that queſtion could never have been ſtarted, as no one individual of the human race could have underſtood all its terms. It may be juſt worth while to mention, that the author of Ancient Metaphyſics, attributing all motion, and even the coherence of the minute particles of body, to the immediate agency of mind, of courſe furniſhes every human body with at leaſt *four minds*. This fourth mind differs not from the *plaſtic nature* of Cudworth, and is likewiſe a Platonic notion apparently better founded. That there are in our bodies motions perpetually carried on by the agency of ſomething which is not the principle of either our intelligence, our paſſions, or our appetites, is a fact which cannot be denied; but if thoſe motions proceed immediately from mind, it muſt either be from the *ſupreme* mind, or from ſome *ſubordinate* mind, acting under the ſupreme, but wholly *diſtinct from and independent* of that which each man calls himſelf.

(N) " Non cum illis componi prorſus poteſt ARISTOTELES, qui bina rerum ſeparataque ſtatuunt principia, Deum ing ſeparately, but eternally linked together by the cloſeſt union; we think it follows undeniably, that this heat, from which he derived all ſouls, muſt be that mind which he called *God*, and which he conſidered as the actuating ſoul of the univerſe.

Upon theſe principles neither Ariſtotle nor the Stoics could believe with Plato, that in the order of nature there was firſt an emanation from the Supreme Mind to animate the univerſe, and then through this univerſal ſoul other emanations to animate mankind. The Stagyrite believed, that the Supreme Mind himſelf is the ſoul of the world, and that human ſouls are immediately derived from him. The genuine Stoics, acknowledging but one ſubſtance, of neceſſity conſidered both the ſouls and bodies of men as portions of that ſubſtance, which they called το εν; though ſtill they affected to make ſome unintelligible diſtinction between body and mind. But however the various ſchools differed as to thoſe points, they were unanimous as to the ſoul's being a part of the ſelf-exiſting Subſtance; and Cicero gives their whole ſyſtem from Pacuvianus in words which cannot be miſunderſtood:

> Quicquid eſt hoc, omnia animat, format, alit, auget, creat,
> Sepelit, recipitque in ſeſe omnia, omniumque idem eſt Pater:
> Indidemque eadem, quæ oriuntur de integro, atque eodem occidunt.

266 Upon theſe principles they maintained the neceſſary exiſtence of the ſoul;

To theſe verſes he immediately ſubjoins the following query: "Quid eſt igitur, cur, cum domus ſit omnium una, eaque communis, cumque *animi hominum* SEMPER *FUERINT*, *FUTURIQUE SINT*, cur ii, quid ex quoque eveniat, et quid quamque rem ſignificet, perſpicere non poſſint *?" And upon the ſame principle he elſewhere argues, not merely for the immortality, but for the *eternity* and *neceſſary exiſtence* of the ſoul: "Animorum nulla in terris origo inveniri poteſt: His enim in naturis nihil ineſt, quod vim memoriæ mentis, cogitationis habeat; quod et præterita teneat, et futura provideat, et complecti poſſit præſentia; quæ ſola divina ſunt. Nec invenietur unquam, unde ad hominem venire poſſint, niſi à Deo. Ita quicquid eſt illud, quod ſentit, quod ſapit, quod vult, quod viget, cæleſte et divinum eſt; OB EAMQUE REM ÆTERNUM SIT NECESSE EST †." This was indeed ſecuring the future permanency of the ſoul in the moſt effectual manner; for it is obvious, that what had not a beginning can never have an end, but muſt be of eternal and neceſſary exiſtence.

267 but not in its diſtinct and perſonal capacity.

But when the ancients attributed a proper eternity to the ſoul, we muſt not ſuppoſe that they underſtood it to be eternal in its *diſtinct* and *perſonal exiſtence*. They believed that it proceeded or was *diſcerpted* in *time* from the ſubſtance of God, and would *in time* be again *reſolved* into that ſubſtance. This they explained by a cloſe veſſel filled with ſea water, which ſwimming a while upon the ocean, does, on the veſſel's breaking, flow in again, and mingle with the common maſs. They only differed about the time of this reunion; the greater part holding it to be at death; but the Pythagoreans not till after many tranſmigrations. The Platoniſts went between theſe two opinions; and rejoined pure and unpolluted ſouls immediately to the Univerſal Spirit; but thoſe which had contracted much defilement, were ſent into a ſucceſſion of other bodies, to be purged and purified, before they returned to their parent ſubſtance *."

268 A ſimilar doctrine held by the Bramins.

A doctrine ſimilar to this of Plato has been held from time immemorial by the Bramins in India, whoſe ſacred books teach, "That intellect is a PORTION of the GREAT SOUL of the univerſe, breathed into all creatures, to animate them for a certain time; that after death it animates other bodies, or returns like a *drop* into that *unbounded ocean* from which it firſt aroſe; that the ſouls of men are diſtinguiſhed from thoſe of other animals, by being endowed with reaſon and with a conſciouſneſs of right and wrong; and that the ſoul of him who adheres to right as far as his powers extend, is at death ABSORBED INTO THAT DIVINE ESSENCE, never more to re-animate fleſh. On the other hand, the ſouls of thoſe who do evil, are not at death diſengaged from all the elements; but are immediately clothed with a body of fire, air, and *akaſh* (a kind of celeſtial element, through which the planets move, and which makes no reſiſtance) in which they are for a time puniſhed in hell. After the ſeaſon of their grief is over, they reanimate other bodies: and when they arrive through theſe tranſmigrations at a ſtate of purity, they are abſorbed into God, where all PASSIONS are UTTERLY UNKNOWN, and where CONSCIOUSNESS IS LOST IN BLISS †."

269 This doctrine incompatible with a future ſtate of rewards and puniſhments, and

Whether the Greeks derived their notions of the divinity and tranſmigration of ſouls from the eaſt, or whether both they and the Bramins brought the ſame doctrines at different periods from Egypt, it is foreign from the purpoſe of this article to inquire. Certain it is, that the philoſophers of Greece and India argued in the very ſame manner, and upon the very ſame principles, for the *natural* immortality of the ſoul; and that the immortality which they taught was wholly incompatible with God's moral government of the world, and with a future ſtate of rewards and puniſhments. That this is true of the doctrine of the Bramins, is evident from the laſt quoted ſentence: for if the ſoul, when abſorbed into the Divine eſſence, loſes all conſciouſneſs of what it did and ſuffered in the body, it cannot poſſibly be rewarded for its virtues practiſed upon earth. That the philoſophers of Greece taught the ſame ceſſation of conſciouſneſs, might be inferred with the utmoſt certainty, even though we had not Ariſtotle's expreſs declaration to that purpoſe: For as they all believed their ſouls to have exiſted before they were infuſed into their bodies, and as each muſt have been conſcious that he remembered nothing of his former ſtate (o), it was impoſſible to avoid concluding,

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* *De Divinatione*, lib. i. p. 57.

† *Frag. de Conſolatione.*

* *Warburton's Divine Legation.*

† See *Preliminary Diſſertation to Dow's Hiſtory of Indoſtan.*

Deum et materiam. Arctiſſime enim utrumque hoc initium conjunxit Stagyrita, atque ipſa naturæ neceſſitate Deum cohærere cum mole hac corporea putavit." *Cudworth's Intellectual Syſtem*, Book i. Chap. iv. Sect. 6. note 3.

(o) This is expreſsly acknowledged by Cicero, though he held with his Greek maſters the eternity of the ſoul.

In

cluding, that in the future ſtate of his ſoul as little would be remembered of the preſent. Accordingly Ariſtotle teaches, that "the agent intellect only is immortal and eternal, but the paſſive corruptible."—τουτο μονον αθανατον και αϊδιον ὁ δε παθητικος νους φθαρτος *. Cudworth thinks this a very doubtful and obſcure paſſage; but Warburton, whoſe natural acuteneſs often diſcovered the ſenſe of ancient authors when it had eſcaped the ſagacity of abler ſcholars, has completely proved, that by the *agent intellect* is meant the *ſubſtance* of the ſoul, and by the *paſſive* its *particular perceptions*. It appears therſore that the Stagyrite, from the common principle of the ſoul's being a part of the Divine ſubſtance, draws a concluſion againſt a future ſtate of rewards and puniſhments; which though all the philoſophers (except Socrates) embraced, yet all were not ſo forward to avow.

* *De Anima*, lib. iii. cap. 6.

270 Groſsly abſurd in itſelf;

That the hypotheſis of the ſoul's being a part of the Divine ſubſtance is a groſs abſurdity, we ſurely need not ſpend time in proving. The argument long ago urged againſt it by St Auſtin muſt ere now have occurred to every reader. In the days of that learned father of the church, it was not wholly given up by the philoſophers; and in his excellent work of the *City of God*, he thus expoſes its *extravagance* and impiety: "Quid infelicius credi poteſt, quam Dei partem vapulare, cum puer vapulat? Jam vero *partes Dei* fieri *laſcivas*, *iniquas*, *impias*, atque omnino *damnabiles*, quis ferre poteſt niſi qui prorſus inſanit?

271 yet the only principle from which the ſoul can be inferred to be eſſentially immortal.

But though this hypotheſis be in the higheſt degree abſurd and wholly untenible, we apprehend it to be the only principle from which the *natural* or *eſſential* immortality of the ſoul can poſſibly be inferred. If the ſoul had a *beginning* it *may* have an *end;* for nothing can be more evident than that the being which had not exiſtence of itſelf cannot of itſelf have perpetuity of exiſtence. Human works, indeed, continue in being after the power of the workman is withdrawn from them; but between human works and the Divine there is this immenſe difference, that the former receive from the artiſt nothing but their form; whereas the latter receive from the Creator both their form and their ſubſtance. Forms are nothing but modifications of ſubſtance; and as ſubſtances depend upon God and not upon man, human works are continued in being by that fiat of the Creator, which made the ſubſtances of which they are compoſed ſuſceptible of different forms, and of ſuch a nature as to retain for a time whatever form may be impreſſed upon them. Human works therefore are continued in being by a power different from that by which they are finiſhed; but the works of God depend wholly upon that power by which they were originally brought into exiſtence; and were the Creator to withdraw his ſupporting energy, the whole creation would ſink into nothing.

272 Baxter's argument for the [illegible] eſſential immortality of the ſoul

Self-evident as this truth certainly is, ſome eminent philoſophers *ſeem* to have queſtioned it. "No ſubſtance or being (ſays Mr Baxter *) can have a natural tendency to annihilation, or to become nothing. That a being which once exiſts ſhould ceaſe to exiſt is a real effect, and muſt be produced by a real cauſe: But this cauſe could not be planted in the nature of any ſubſtance or *being* to become a tendency of its nature; *for it could not be a free cauſe*, otherwiſe it muſt be a *being* itſelf, the ſubject of the *attribute freedom*, and therefore not the property of another *being;* *nor a neceſſary cauſe*; for ſuch a cauſe is only the effect of ſomething impoſing that neceſſity, and ſo no cauſe at all."

* *Inquiry into the Nature of the Human Soul*, vol. i. ſect. 3.

273 Inconcluſive,

That the author's meaning in this argument is good, cannot, we think, be controverted; but he has not expreſſed himſelf with his uſual accuracy. He ſeems to confound *cauſes* with the *abſence* of cauſes, and the *effects* of the *former* with the *conſequences* of the *latter*. The viſible world was brought into exiſtence by the actual energy of the power of God; and as the viſible world had nothing of itſelf, it can *remain* in exiſtence only by a *continuance* of the *ſame energy*. This energy therefore is at the preſent moment as *real a cauſe* as it was ſix thouſand years ago, or at any period when it may have been firſt exerted; and the viſible world is its *real and permanent effect*. But would the ceaſing of this energy be likewiſe a *cauſe?* It would certainly be followed with the annihilation of the viſible world, juſt as the withdrawing of the ſun-beams would be followed with darkneſs on the earth. Yet as no one has ever ſuppoſed that darkneſs, a nonentity, is a *poſitive effect* of the ſun or of his beams, but only a mere negative conſequence of their abſence; ſo, we think, no one who believes in creation can conſider that deſtruction which would inevitably follow the withdrawing of the energy by which all things are ſupplied, as the *poſitive effect* of a contrary energy, or as any thing more than a *negative conſequence* of the ceaſing of that volition or energy of power by which God at firſt brought things into exiſtence. For "where the *foundation* of exiſtence lies *wholly* in the power of an infinite Being *producing*, the *ground* of the *continuance* of that exiſtence muſt lie wholly in the ſame power *conſerving;* which has, therefore, with as much truth as frequency, been ſtyled a continued creation (r)."

274 and in effect given up by himſelf.

The force of this reaſoning Mr Baxter certainly ſaw, when he ſaid, that "a tendency to perſevere in the ſame ſtate of nature, and a tendency to change it, are contradictories, and impoſſible to be planted in the ſame ſubject at once: or, not to urge the contradiction, if the laſt prevailed, the remaining in the ſame ſtate for any given time would be impoſſible. We forget the true cauſe of all theſe tendencies, *the will of God*, which it is abſurd to ſuppoſe contrary to itſelf. The tendency in matter to perſevere in the ſame ſtate of reſt or motion, is nothing but *the will of the Creator*, who preſerves all things in their exiſtence and manner of exiſtence: nor can we have recourſe to any other cauſe

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In anſwer to ſome very fooliſh aſſertions concerning the evil of death, he ſays, "Ita, qui nondum nati ſunt, miſeri jam ſunt, quia non ſunt: et nos ipſi, ſi poſt mortem miſeri futuri ſumus, miſeri fuimus antequam nati. Ego autem *non commemini, antequam ſum natus, me miſerum. Tuſcul.* lib. i. cap. 6.

(r) See Stillingfleet's *Origines Sacræ*, where this queſtion is treated in a very maſterly manner by one of the ableſt metaphyſicians of the 17th century. See alſo our article PROVIDENCE.

Of the Immortality of the Soul.

cauſe for the preſervation of immaterial ſubſtance in its exiſtence. Therefore theſe tendencies are to be aſcribed to the will of God, and it is abſurd to ſuppoſe them contrary."

275
Analogical evidence of the immortality of the ſoul, and a moral proof of a future ſtate of rewards and puniſhments.

All this is unqueſtionably true. The exiſtence or nonexiſtence of matter and of created ſpirits depends wholly upon the will of God; and we cannot ſuppoſe him to be willing to-day the reverſe of what he willed yeſterday, becauſe we know that all his volitions are directed by unerring wiſdom. We have likewiſe the evidence of experience, that nothing is ever ſuffered to periſh but particular ſyſtems, which periſh only *as ſyſtems* by a decompoſition of their parts. A being, which like the ſoul has no parts, can ſuffer no decompoſition; and therefore, if it periſh, it muſt periſh by annihilation. But of annihilation there has not hitherto been a ſingle inſtance; nor can we look for a ſingle inſtance without ſuppoſing the volitions of God to partake of that unſteadineſs which is characteriſtic of man. Corporeal ſyſtems, when they have ſerved their purpoſe, are indeed reſolved into their component parts; but the matter of which they were compoſed, ſo far from being *loſt*, becomes the matter of *other ſyſtems* in endleſs ſucceſſion. Analogy, therefore, leads us to conclude, that when the human body is diſſolved, the immaterial principle by which it was animated continues to think and act, either in a ſtate of ſeparation from all body, or in ſome material vehicle to which it is intimately united, and which goes off with it at death; or elſe that it is preſerved by the Father of ſpirits, for the purpoſe of animating a body in ſome future ſtate. When we conſider the different ſtates through which that living and thinking *individual*, which each man calls himſelf, goes, from the moment that it firſt animates an embryo in the womb, to the diſſolution of the man of fourſcore; and when we reflect likewiſe on the wiſdom and *immutability* of God, together with the various diſſolutions of corporeal ſyſtems, in which we know that a ſingle atom of matter has never been loſt; the preſumption is certainly ſtrong, that the ſoul ſhall ſubſiſt after the diſſolution of the body. But when we take into the conſideration the *moral* attributes of God—his juſtice and goodneſs, together with the unequal diſtribution of happineſs and miſery in the preſent world: this preſumption from analogy amounts to a *complete moral proof* that there ſhall be a future ſtate of rewards and puniſhments (Q) (ſee MORAL *Philoſophy* and RELIGION): and if we eſtimate the duration of the rewards by the benevolence of Him by whom they are to be conferred, we cannot imagine them ſhorter than eternity.

CHAP. V. *Of* NECESSITY *and* LIBERTY.

Of Neceſſity and Liberty.

276
Freedom of agency implied in accountableneſs.

IN the preceding chapter we have adverted to that great *moral proof* for a future ſtate, and the immortality of the ſoul, ariſing from the relation in which man, as a being accountable for his conduct, ſtands to a God of almighty power, infinite wiſdom, and perfect juſtice. But the circumſtance of accountableneſs implies freedom of agency; for it is contrary to all our notions of right and wrong (ſee MORAL *Philoſophy*), that a man ſhould be either rewarded or puniſhed for actions which he was neceſſitated or compelled to perform.

277
Every man has power to do what he wills:

Human actions are of three kinds: one, where we act by inſtinct, without any view to conſequences; one, where we act by will, in order to obtain ſome end; and one, where we act againſt will. It is the ſecond kind of actions only which confers upon the agent merit or demerit. With reſpect to the firſt, he acts blindly (ſee INSTINCT), without deliberation or choice; and the external act follows from the inſtinctive impulſe, no leſs neceſſarily than a ſtone by its gravity falls to the ground. With reſpect to the laſt, he is rather an inſtrument than an agent; and it is univerſally allowed, that were a ſtrong man to put a ſword into the hand of one who is weaker, and then to force it through the body of a third perſon, he who held the ſword would be as guiltleſs of the murder as the ſword itſelf. To be entitled to rewards, or liable to puniſhment, a man muſt act voluntarily; or in other words, his actions muſt proceed from that energy of mind which is termed *volition*; and, we believe, it has never been denied, that all men have power to do whatſoever they *will*, both with reſpect to the operations of their minds and the motions of their bodies, uncontrouled by any foreign principle or cauſe. "Every man (ſays Prieſtley) is at liberty to turn his thoughts to whatever ſubject he pleaſes, to conſider the reaſons for or againſt any ſcheme or propoſition, and to reflect upon them as long as he ſhall think proper; as well as to walk wherever he pleaſes, and to do whatever his hands and other limbs are capable of doing." Without ſuch liberty as this, morality is inconceivable.

278
But different opinions entertained of the freedom of volition.

But though philoſophers have in general agreed with reſpect to the power which a man has to perform ſuch actions as he wills, they have differed widely in opinion reſpecting the nature of his volitions. That theſe are the reſult of motives, has ſeldom if ever been queſtioned; but whether that reſult be neceſſary ſo as that the agent has no ſelf-determining power to decide between different motives, has been warmly diſputed by men equally candid, impartial, and intelligent. The principal writers on the ſide of neceſſity are, Hobbes, Collins, Hume, Leibnitz, Lord Kames, Hartley, Edwards, Prieſtley, and perhaps Locke. On the other ſide are Clarke, King, Law, Reid, Butler, Price, Bryant, Wollaſton, Horſley, Beattie, and Gregory,

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(Q) It was by ſuch arguments that Socrates reaſoned himſelf into the belief of a future ſtate of rewards and puniſhments. He was ſingular, as we have already obſerved, in this belief; and he was as ſingular in confining himſelf to the ſtudy of morality. "What could be the cauſe of this belief, but this reſtraint, of which his belief was a natural conſequence? For having confined himſelf to morals, he had nothing to miſlead him; whereas the reſt of the philoſophers, applying themſelves with a kind of fanaticiſm to *phyſics* and *metaphyſics*, had drawn a number of abſurd, though ſubtle, concluſions, which directly oppoſed the conſequences of thoſe moral arguments."
Warburton's Div. Leg. vol. ii.

gory, &c. To give a ſhort view of this celebrated queſtion, is all that our limits will permit; and as we do not think ourſelves competent to ſettle the diſpute, it were perhaps a thing deſirable to give the oppoſite reaſonings in the words of thoſe eminent authors themſelves. It muſt, however, be obvious to the reader, that the ſtyle and manner of ſo many different writers are extremely various, and that to introduce them all into our abſtract, would make the whole a maſs of confuſion. We ſhall, therefore, ſelect one writer to plead the cauſe of neceſſity, ſupplying his defects from thoſe who, though inferior to him on the whole, may yet have argued more ably on ſome particular points which the queſtion involves: and to this combined reaſoning we ſhall ſubjoin ſuch anſwers as to us appear moſt concluſive. Hartley, Hume, and Prieſtley, are perhaps the moſt profound reaſoners on the ſide of neceſſity; but there is ſo much more perſpicuity in the arguments of Lord Kames, that we cannot help preferring them, as being on the whole better calculated to give the ordinary reader a fair view of the ſubject.

279
Scheme of neceſſity, according to Lord Kames.

" Into actions done with a view to an end (ſays his lordſhip *), deſire and will enter: deſire to accompliſh the end goes firſt; the will to act, in order to accompliſh the end, is next; and the external act follows of courſe. It is the will then, that governs every external act done as a mean to accompliſh an end; and it is deſire to accompliſh the end that puts the will in motion; deſire, in this view, being commonly termed the *motive* to act. But what is it that raiſes deſire? The anſwer is ready: It is the proſpect of attaining ſome agreeable end, or of evading one that is diſagreeable. And if it be inquired, what makes an object agreeable or diſagreeable? the anſwer is equally ready: It is our nature that makes it ſo. Certain viſible objects are agreeable, certain ſounds, and certain ſmells: other objects of theſe ſenſes are diſagreeable. But there we muſt ſtop; for we are far from being ſo intimately acquainted with our own nature as to aſſign the cauſes.

" With reſpect to inſtinctive actions, no perſon, I preſume, thinks that there is any freedom. With reſpect to voluntary actions, done in order to produce ſome effect, the neceſſity is the ſame, though leſs apparent at firſt view. The external action is determined by the will: the will is determined by deſire; and deſire by what is agreeable or diſagreeable. Here is a chain of cauſes and effects, not one link of which is arbitrary, or under command of the agent: he cannot will but according to his deſire; he cannot deſire, but according to what is agreeable or diſagreeable in the objects perceived: nor do theſe qualities depend on his inclination or fancy; he has no power to make a beautiful woman ugly, nor to make a rotten carcaſs ſmell ſweetly.

" Many good men, apprehending danger to morality from holding our actions to be neceſſary, endeavour to break the chain of cauſes and effects above mentioned; maintaining, that whatever influence deſire or motives may have, it is the agent himſelf who is the cauſe of every action; that deſire may adviſe, but cannot command; and, therefore, that a man is ſtill free to act in contradiction to deſire and to the ſtrongeſt motives.

" That a being may exiſt which in every caſe acts blindly and arbitrarily, without having any end in view, I can make a ſhift to conceive: but it is difficult for me even to imagine a thinking and rational being, that has affections and paſſions, that has a deſirable end in view, that can eaſily accompliſh this end; and yet after all can fly off or remain at reſt, without any cauſe, reaſon, or motive, to ſway it. If ſuch a whimſical being can poſſibly exiſt, I am certain that man is not that being. There is not perhaps a perſon above the condition of a changeling, but can ſay *why* he did ſo and ſo, what moved him, what he intended. Nor is a ſingle fact ſtated to make us believe that ever a man acted againſt his own will or deſire, who was not compelled by external force.—On the contrary, conſtant and univerſal experience proves, that human actions are governed by certain inflexible laws; and that a man cannot exert his ſelf-motive power but in purſuance of ſome deſire or motive.

" Had a motive always the ſame influence, actions proceeding from it would appear no leſs neceſſary than the actions of matter. The various degrees of influence that motives have on different men at the ſame time, and on the ſame man at different times, occaſion a doubt, by ſuggeſting a notion of chance. Some motives, however, have ſuch influence as to leave no doubt: a timid female has a phyſical power to throw herſelf into the mouth of a lion roaring for food; but ſhe is withheld by terror no leſs effectually than by cords: if ſhe ſhould ruſh upon a lion, would not every one conclude that ſhe was frantic? A man, though in a deep ſleep, retains a phyſical power to act, but he cannot exert it. A man, though deſperately in love, retains a phyſical power to refuſe the hand of his miſtreſs; but he cannot exert that power in contradiction to his own ardent deſire, more than if he were faſt aſleep. Now, if a ſtrong motive have a neceſſary influence, there is no reaſon for doubting, but that a weak motive muſt alſo have its influence, the ſame in kind, though not in degree. Some actions indeed are ſtrangely irregular; but let the wildeſt actions be ſcrutinized, there will always be diſcovered ſome motive or deſire, which, however whimſical or capricious, was what influenced the perſon to act. Of two contending motives, is it not natural to expect that the ſtronger will prevail, however little its exceſs may be? If there be any doubt, it muſt ariſe from a ſuppoſition, that a weak motive may be reſiſted arbitrarily. Where then are we to fix the boundary between a weak and a ſtrong motive? If a weak motive can be reſiſted, why not one a little ſtronger, and why not the ſtrongeſt? Between two motives oppoſing each other, however nearly balanced, a man has not an arbitrary choice but muſt yield to the ſtronger. The mind, indeed, fluctuates for ſome time, and finds itſelf in a meaſure looſe: at laſt, however, it is determined by the more powerful motive, as a balance is by the greater weight after many vibrations.

" Such, then, are the laws that govern our voluntary actions. A man is abſolutely free to act according to his own will; greater freedom than which is not conceivable. At the ſame time, as man is made accountable for his conduct to his Maker, to his fellow creatures, and to himſelf, he is not left to act arbitrarily; for at that rate he would be altogether unaccountable: his will is regulated by deſire; and deſire by what pleaſes or diſpleaſes him.—Thus, with regard to human conduct, there is a chain of laws eſtabliſhed by nature; no one link of which is left arbitrary. By that wiſe ſyſtem, man is made accountable; by it he is made a fit ſubject for divine and human government: by it perſons of ſagacity foreſee the conduct of others; and by it the preſcience of the Deity with reſpect to human actions is clearly eſtabliſhed."

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* *Sketches of the Hiſtory of Man*, Book iii. Sketch 2. part 1. ſect. 8.

Of the doctrine of neceſſity, a more perſpicuous or plauſible view than this is not to be found in any work with which we are acquainted. It is indeed defective, perhaps, as his lordſhip only *hints* at the *nature* of that relation which ſubſiſts between motive and action; but from his comparing the fluctuations of the mind between two contending motives, to the vibrations of a balance with different weights in the oppoſite ſcales, there is no room to doubt but that he agreed exactly in opinion with Mr Hume and Dr Prieſtley. Now, both theſe writers hold, that the relation of motives to volition and action, is the very ſame with that which ſubſiſts between cauſe and effect in phyſics, as far as they are both known to us.

280 Mr Hume, and

" It is univerſally allowed (ſays Mr Hume *), that matter, in all its operations, is actuated by a neceſſary force; and that every natural effect is ſo preciſely determined by the energy of its cauſe, that no other effect, in ſuch particular circumſtances, could poſſibly have reſulted from it. The degree and direction of every motion is, by the laws of nature, preſcribed with ſuch exactneſs, that a living creature may as ſoon ariſe from the ſhock of two bodies, as motion in any other degree or direction than what is actually produced by it. Would we, therefore, form a juſt and preciſe idea of *neceſſity*, we muſt conſider whence that idea ariſes, when we apply it to the operation of bodies. But our idea of this kind of neceſſity and cauſation ariſes entirely from the uniformity obſervable in the operations of nature, where ſimilar objects are conſtantly conjoined together, and the mind is determined by cuſtom to infer the one from the appearance of the other. Theſe two circumſtances form the whole of that neceſſity which we aſcribe to matter. Beyond the *conſtant conjunction* of ſimilar objects, and the conſequent *inference* from one to the other, we have no notion of any neceſſity or connexion." He then gives a pretty long detail to prove a great uniformity among the actions of men in all nations and ages; and concludes that part of his argument with affirming, " not only that the conjunction between motives and voluntary actions is as regular and uniform as that between the cauſe and effect in any part of nature; but alſo, that this regular conjunction has been univerſally acknowledged among mankind, and has never been the ſubject of diſpute either in philoſophy or common life." He afterwards obſerves, " That men begin at the wrong end of this queſtion concerning liberty and neceſſity, when they enter upon it by examining the faculties of the ſoul, the influence of the underſtanding, and the operations of the will. Let them firſt diſcuſs a more ſimple queſtion, namely, the operations of body, and of brute unintelligent matter, and try whether they can there form any idea of cauſation and neceſſity, except that of a conſtant conjunction of objects, and ſubſequent inference of the mind from one to another. If theſe circumſtances form in reality the whole of that neceſſity which we conceive in matter, and if theſe circumſtances be alſo univerſally acknowledged to take place in the operations of the mind, the diſpute is at an end; at leaſt muſt be owned to be thenceforth merely verbal. When we conſider how aptly *natural* and *moral* evidence link together, and form only one chain of argument, we ſhall make no ſcruple to allow that they are of the ſame nature, and derived from the ſame principles.—Between a connected chain of natural cauſes and voluntary actions, the mind feels no difference in paſſing from one link to another; nor is leſs certain of a future event which depends upon motives and volitions, than if it were connected with the objects preſent to the memory and ſenſes by a train of cauſes, cemented together by what we are pleaſed to call a *phyſical* neceſſity. The ſame experienced union has the ſame effect on the mind, whether the united objects be motives, volition and action, or figure and motion. We may change the names of things, but their nature and their operation on the underſtanding never change."

281 Dr Prieſtley.

Dr Prieſtley, in words a little different, teaches the very ſame doctrine which was taught by Mr Hume.—" In every determination of the mind (ſays he *), or in caſes where volition and choice are concerned, all the previous circumſtances to be conſidered are the *ſtate of mind* (including *every thing belonging to the will itſelf*), and the *views of things* preſented to it; the latter of which is generally called the *motive*, though under this term ſome writers comprehend them both. To diſtinguiſh the *manner* in which events depending upon *will* and *choice* are produced, from thoſe in which no volition is concerned, the former are ſaid to be produced *voluntarily*, and the latter *mechanically*. But the ſame general maxims apply to them both. We may not be able to determine *à priori* how a man will act in any particular caſe; but it is becauſe we are not particularly acquainted with his *diſpoſition of mind*, *preciſe ſituation*, and *views of things*. But neither can we tell in which way the wind will blow to-morrow, though the *air* is certainly ſubject to no other than neceſſary laws of motion.

" It is univerſally acknowledged, that there can be no effect without an adequate cauſe. This is even the foundation on which the only proper argument for the being of a God reſts. And the neceſſarian aſſerts, that if, in any given ſtate of mind, with reſpect both to *diſpoſition* and *motives*, two different determinations or volitions be poſſible, it can be ſo on no other principle, than that one of them ſhall come under the deſcription of an *effect without a cauſe*; juſt as if the beam of a balance might incline either way, though loaded with equal weights. It is acknowledged, that the mechaniſm of the balance is of one kind, and that of the mind of another; and, therefore, it may be convenient to denominate them by different words; as, for inſtance, that of the balance may be termed a *phyſical*, and that of the mind a *moral* mechaniſm. But ſtill, if there be a *real mechaniſm* in both caſes, ſo that there can be only one reſult from the ſame previous circumſtances, there will be a *real neceſſity*, enforcing an abſolute certainty in the event. For it muſt be underſtood, that all that is ever meant by *neceſſity in a cauſe*, is that which produces *certainty in the effect*."

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* *Inquiry concerning Human Underſtanding*, ſect. 8.

* *The Doctrine of Philoſophical Neceſſity illuſtrated.*

Such is the nature of human volitions, according to every neceſſarian of eminence who has written on the ſubject ſince the days of Hobbes: and if this theory be juſt, if there be a conſtant and inſeparable conjunction of motives and actions ſimilar to that of cauſe and effect in phyſics, it is obvious, that in volition the mind is as inert as body is in motion.

282 View of human liberty.

This conſequence is indeed avowed and inſiſted upon by Hume, Prieſtley, and their adherents; whilſt the advocates for human liberty, on the other hand, contend for an abſolute exemption of the will from all internal *neceſſity*, ariſing from its own frame and conſtitution, the impulſe of ſuperior beings, or the operations of objects, reaſons, or motives, &c. By this they do not mean, that between motives and volitions there is no relations whatever, or that a man can ever chooſe evil as evil, or refuſe good as good. Such an aſſertion would be contrary to conſciouſneſs and univerſal experience. But what they endeavour to prove is, that the conjunction of motive and volition is not inſeparable, like that of cauſe and effect in phyſics; that a man may in moſt caſes chooſe according to any one of two or more motives preſented to his view; that by chooſing any thing, he may make it in ſome meaſure agreeable by his own act, or, to ſpeak more properly, may bend his deſire to it; that in volition, the mind is not inert; and that, therefore, we are under no *neceſſity* to act in a particular manner in any given caſe whatever.

That the conjunction of motive and action is not conſtant like that of cauſe and effect in phyſics, and that by conſequence the mind in forming volitions is not inert, has been evinced by Dr Gregory with the force and preciſion of mathematical demonſtration.—Former writers on the ſide of liberty had often obſerved, that upon the ſuppoſition of the *inertia* of mind, a man, with equal and oppoſite motives preſented at once to his view, would, during their continuance, remain perfectly at reſt, like a balance equally loaded in both ſcales. The obſervation is admitted to be juſt by all the advocates for neceſſity; but they contrive to evade its conſequences, by denying that in any given caſe a man can be at once aſſailed by two equal and oppoſite motives. Thus, when it is ſaid that a porter, ſtanding with his face due north, muſt remain in that poſition at perfect reſt, as long as equal motives ſhall at once be offered to him for travelling eaſtward and weſtward, the neceſſarians admit the force of the argument; but when it is added that a guinea, offered for every mile that he ſhould travel in each of theſe oppoſite directions, ought therefore to fix him at reſt till one of the offers be withdrawn, they deny that the deſire of gaining the guineas is the *whole* of the motives which operate upon his mind. He may have, ſay they, ſome ſecret reaſon which we cannot diſcern for preferring the one direction to the other; and that reaſon, added to the guinea, will make him go eaſtward or weſtward, juſt as an ounce thrown into either ſcale of a balance poiſed by equal weights will make that ſcale preponderate. Though we think that this ſolution of the difficulty can ſatisfy no man who is not already biaſſed to the neceſſarian ſyſtem; and though, even were it to be admitted, it ſeems to militate againſt the conſtant conjunction of motives and actions, unleſs it can be proved that the porter muſt travel the road which he has been neceſſitated to chooſe with reluctance and a heavy heart; yet as it may admit of endleſs quibbling upon ambiguous words, the philoſophical world is much indebted to Dr Gregory † for an argument which, in our opinion, can neither be overturned nor evaded, and which demonſtrates that the conjunction of motive and action cannot be conſtant and inſeparable, like that of cauſe and effect in phyſics.

283 Demonſtration that the conjunction of motive and action is conſtant.

His reaſoning is to this purpoſe: Suppoſe a porter to be offered a guinea for every mile that he ſhall travel directly eaſtward. If there be no phyſical cauſe or moral motive to keep him at reſt, or to induce him to move in another direction, there cannot be a doubt, upon either hypotheſis, but he will gladly embrace the propoſal, and travel in the direction pointed out to him, till he ſhall have gained as much money as to ſatisfy his moſt avaricious deſires. The ſame thing would have happened, if a guinea had been offered for every mile that he ſhould travel due ſouth. In theſe two caſes taken ſeparately, the relation between the man's motions and his actions would be ſtrikingly analogous to that between a ſingle impulſe and motion in phyſics. Let us now ſuppoſe the two offers to be made at the ſame inſtant, and the man to be aſſured that if he travel eaſtward he can have no part of the reward promiſed for his travelling to the ſouth, and that if he travel ſouthward he can have no part of the reward promiſed for his travelling to the eaſt. What is he to do in this caſe? If his mind be inert in volition, and if the two motives operate upon him with the ſame neceſſity that cauſes operate in phyſics, it is obvious that the man could travel neither towards the eaſt nor towards the ſouth, but in a diagonal direction from north-weſt to ſouth-eaſt; and this he muſt do *willingly*, although perfectly ſatisfied that he could gain nothing by his journey. As this inference is contrary to fact and univerſal experience, the doctor very juſtly concludes that the premiſes, from which it is deduced by mathematical reaſoning, muſt be falſe and abſurd; or, in other words, that the relation between motive and action cannot be that of conſtant conjunction, like the relation between cauſe and effect in phyſics.

He uſes many arguments of the ſame kind, and equally convincing, to prove the abſurdity of ſuppoſing the inertneſs of mind, and only an occaſional conjunction of motives and actions; but we forbear to quote them, both becauſe we wiſh his book to be read, and becauſe we think the ſingle argument which we have borrowed from him ſufficient to demoliſh the theory of Prieſtley and Hume, which reſts wholly upon the hypotheſis of the *conſtant* conjunction of motive and action.

But is it then not really true, that the external action is determined by the will, the will by deſire, and deſire by what is agreeable or diſagreeable? That the external action is univerſally determined by the will, is certainly true; but that the will is neceſſitated and univerſally determined by the deſire is as certainly falſe. If

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† *Eſſay on the Relation between Motive and Action.*

Potiphar's wife was handſome, and made her propoſal to Joſeph with any degree of female addreſs; and if his conſtitution was like that of other young men; there cannot be a doubt but that he felt a *deſire* to do what ſhe requeſted of him: yet we know that he *willed* to do otherwiſe, and in direct oppoſition to his *deſire* fled from the room. Perhaps it may be ſaid, that his volition to flee was the effect of a contrary and ſtronger *deſire* not to ſin againſt God; but this is confounding the reader, by calling two energies of mind, between which there is little or no ſimilarity, by the ſame name. He perceived, or knew, that to comply with his miſtreſs's requeſt would be to ſin againſt God; he knew that he ought not to ſin againſt God, and therefore he choſe or determined himſelf not to do it. We can eaſily conceive how the preſence, attitudes, and addreſs, of the lady might be agreeable to him, and excite deſire. There may very poſſibly be more than one of our readers, who, during the courſe of their lives, have experienced ſomething of the ſame kind: but could abſtract truth be in the ſame way agreeable, ſo as to excite in his mind a *deſire* of virtue ſufficient to annihilate or baniſh the *deſire* of the woman? As well may it be ſaid that one ſenſation can annihilate another, that the beautiful colours of the rainbow can remove the ſenſation of ſtench from the mind of him who is plunged into the midſt of a dunghill, or that the ſmell of a roſe can make a man inſenſible to the pain of a ſtroke inflicted by a bludgeon. Senſitive deſire, and the perception of duty, are things ſo totally different, that to conſider them as operating againſt each other, like different weights in the oppoſite ſcales of a balance, is as abſurd as to ſuppoſe that ſound can operate againſt colour, or colour againſt ſmell. A man may prefer ſound to colour, or colour to ſmell, and act accordingly; but the determination muſt be wholly his own, unleſs theſe two ſenſations be themſelves either agents or phyſical cauſes of the *ſame kind*, like the weights in the oppoſite ſcales of the balance.

284 Men do not always determine themſelves by the ſtrongeſt motive.

The advocates for liberty do not pretend, that in matters of importance a man ever acts without ſome motive or reaſon for his conduct. All that they inſiſt upon is, that between two or more motives of different kinds he has a liberty of choice, and that he does not always determine himſelf by that which he knows to be the greateſt. Without ſuch freedom, they think men might be often brought into ſituations where they could not act at all, and where inaction would at the ſame time be in the higheſt degree abſurd. Thus, were two bags of gold containing each a thouſand or ten thouſand guineas, to be placed on the ſame table, before a man whoſe family is periſhing for want, and were the man to be told that he might take either of them, but not both, is it conceivable that he would be held in perpetual ſuſpence between the two? No; he would inſtantly and with alacrity take up one of them, without feeling the leaſt regret for the want of the other. This action would, indeed, be the conſequence of a very powerful motive, the deſire to obtain honeſtly that wealth of which he and his family ſtood ſo much in need. That motive, however, being general, would draw him equally to both bags; and it remains with the neceſſarians to ſay by what elſe than a ſelf-determining power he could take either the one or the other. When it is affirmed, that ſuch ſelf-determination would be an effect without a cauſe, the advocates for liberty cannot help thinking that their antagoniſts are guilty of advancing as an argument a *petitio principii*; for the affirmation is true, only if the mind in volition be inert, and the *inertia* of the mind is the ſole queſtion at iſſue. If the mind be not inert, it is plain, that in conſequence of a man's ſelf-determination, no effect would be produced without a ſufficient cauſe. At any rate, motives cannot be cauſes. In the proper ſenſe of the word, a cauſe is that which produces an effect; but the production of an effect requires active power; and power being a quality, muſt be the quality of ſome being by whom it may be exerted. Power may be dormant, and therefore power without will produces no effect. Are motives, then, real beings endowed with power and will? No; they are only views of things or mental conceptions, which in the ſtricteſt ſenſe of the word are paſſive; and between two motives the mind determines itſelf, without receiving an impulſe from either.

Nor is it only between motives of equal force that men have the power of determining themſelves. Whoever believes in a future ſtate of rewards and puniſhments, and yet acts in a manner which he knows to be offenſive to Him who is to be the future and final judge, unqueſtionably prefers to the ſtrongeſt of all motives, another which even to himſelf appears to have comparatively but very little ſtrength. Whether there be men who occaſionally act in this manner, is a queſtion which can be decided only by an appeal to every one's conſciouſneſs. That there are, we can have no doubt; for we never met with a ſingle individual, not biaſſed by ſyſtem, who was not ready to acknowledge, that during the courſe of his life he had done many things, which at the time of action he clearly perceived to be contrary to his true intereſt. Without a ſelf determining power in the mind, this could never be the caſe. Did motives operate with the neceſſity of phyſical cauſes, it is obvious that in every poſſible ſituation the ſtrongeſt muſt conſtantly prevail; and that he who in certain circumſtances had in time paſt done any particular thing, would on a return of the ſame circumſtances do the very ſame thing in every time future. Dr Prieſtley, indeed, wiſhes to perſuade his readers that this is actually the caſe. "In every determination of the mind (ſays he), or in caſes where volition and choice are concerned, all the previous circumſtances to be conſidered are the *ſtate of mind* (including) *every thing belonging to the will itſelf*), and the various views of things preſented to it;" and he affirms, that "whenever the ſame preciſe circumſtances occur twice, the very ſame determination or choice will certainly be made the ſecond time that was made the firſt." This is an aſſertion of which no man can controvert the truth; for it is an identical propoſition. If in the circumſtances previous to the determination of the mind, *every thing* belonging to the *will itſelf* muſt be included, it is ſelf-evident that he who in any given circumſtances has acted a particular part, will on a return of theſe circumſtances act the ſame part a ſecond time; for this is only ſaying, that he who on two different occaſions ſhall exert volitions of the ſame tendency, will not on theſe occaſions exert volitions of which the tendencies are different. But the queſtion to be decided is, Whether a man, in the ſame general ſtate of mind, poſſeſſed of the ſame degree of health, and conſcious of the ſame appetites, muſt, in external circumſtances perfectly alike, neceſſarily exert at all times the ſame volitions. That the human mind is under no ſuch neceſſity, we think every man's conſciouſneſs and experience may abundantly ſatisfy him; for there are, perhaps, but very few who have not at one time reſiſted temptations, to which at another they have choſen to yield.

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If they did, folly as well as merit and demerit would be baniſhed from the world.

That there is a relation between motives and actions, muſt be confeſſed; but that relation is neither *neceſſity*, nor conſtant conjunction. If it were, all actions would be perfectly rational; and folly, as well as merit and demerit, would be baniſhed from the conduct of men. What is the particular nature of that relation which ſubſiſts between the voluntary actions of men, and the motives from which they proceed, can be known to every individual only by an attentive and unbiaſſed reflection on the operations of his own mind. Without this reflection, no man can be made to underſtand it by the reaſonings of philoſophers, and with it no man can need the aid of thoſe reaſonings. That a ſelf-determining power, ſuch as that for which we plead, contributes to the ſum of human happineſs, has been ſhown by Archbiſhop King and his ingenious tranſlator; who have proved, with the force of demonſtration, that the mind can take pleaſure in the object of its choice, though that object be in itſelf neither agreeable nor diſagreeable to our natural appetites; and that if it could not, it would be in vain in ſuch a world as ours to hope for any portion of felicity. Into that detail our limits will not permit us to enter: but to the reader who wiſhes for further information, we beg leave to recommend the laſt edition of King's Origin of Evil, by Dr Law late biſhop of Carliſle; without, however, vouching for the truth of all the opinions advanced by either of thoſe learned writers.

Before we conclude this chapter, it may be proper to obſerve, that it is only in volition that we are conſcious of any original active power in ourſelves, and that without ſuch conſciouſneſs we could never have acquired the *notion* of active power. In our deſires and appetites, we neither are active nor ſuppoſe ourſelves active. Lord Kames, and moſt neceſſarians, confound deſire with volition; but that they are perfectly diſtinct is plain from this circumſtance, that we daily *deſire* many things which we know to be wholly *out* of our own power*, whereas no man ever *willed* what he did not believe to be *in* his own power. We all *deſire* or wiſh that our children may be virtuous, wiſe, and happy; and though we are conſcious that it is not in our power to make them ſo, we cannot baniſh the deſire from our breaſts. But madmen only have ever *willed* virtue, wiſdom, and happineſs, to any perſon; and if there was ever a man ſo extravagantly mad as to exert ſuch a volition as this, he has at the time fancied himſelf a divinity, and therefore believed that the object of his volition depended upon himſelf. When the aſtronomer, whoſe character is ſo admirably drawn by our great maſter of moral wiſdom †, fancied himſelf the regulator of the weather and the diſtributor of the ſeaſons, he might *will* either *rain* or *ſunſhine* as he thought proper, becauſe he conſidered the object of his volition as depending upon a power imparted to him from heaven; but though he might *deſire* he could not *will*, the riſing or the falling of *winds*, for theſe he confeſſed were not ſubjected to his authority. In a word, without freedom in volition, power is inconceivable; and therefore it is as certain that we are free agents, as that we have any notion of active powers.

CHAP. VI. *Of the* BEING *and* ATTRIBUTES *of* GOD.

It has been already obſerved, that as of bodies there are various kinds, endowed with various properties; ſo the probability is, that of minds endowed with different powers, or different degrees of power, the variety may be as great, or perhaps greater. The exiſtence and powers of our own minds are made known to us by conſciouſneſs and reflection; and from our dependent ſtate, and the mutability of the objects around us, we are neceſſarily led to infer the exiſtence of another mind, which is independent, unchangeable, eternal, and the cauſe of all things which have a beginning of exiſtence. Between that mind and our own, we can hardly avoid believing that there are many orders of "thrones, dominations, princedoms, virtues, powers;" but as we have no intuitive knowledge of ſuch intermediate beings, and cannot from any thing which we perceive diſcern the *neceſſity* of their exiſtence, they are not properly the object of ſcience. The exiſtence however, and many of the attributes, of One Firſt Cauſe, are capable of the ſtricteſt demonſtration; "for the inviſible things of Him from the creation of the world are clearly ſeen, being underſtood by the things which are made."

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The exiſtence of God capable of demonſtration.

Of this great truth, the moſt important by far which can occupy the mind of man, many demonſtrations have been given both by divines and by philoſophers. We ſhall lay before our readers ſuch a one as to us appears perfectly concluſive, being founded on the intuitive knowledge which we have of our own exiſtence, and therefore independent of all theories about the nature and reality of the material world.

287
Some one independent Being has exiſted from eternity.

Every man, whether he adopt the common theory or that of Berkeley reſpecting matter, is conſcious that he *himſelf* exiſts, and muſt therefore grant that *ſomething now* exiſts. But, if any thing exiſts *now* *, then muſt ſomething have *always* exiſted; otherwiſe that thing which *now* exiſts, muſt either have been created by *nothing*, i. e. have been *cauſed by no cauſe*, or elſe it muſt have *created itſelf*, acting before it exiſted. Both theſe ſuppoſitions are ſo palpably abſurd, that no atheiſt has avowed them, either among the ancients or the moderns. We muſt therefore admit, either that there is ſome one *independent* being, which now exiſts, and always has exiſted; or that the things which we know to exiſt at preſent (every man's *ſelf* for inſtance), were produced by *ſomething* which had its *exiſtence* from *ſomething elſe*, which alſo depended upon *ſome other cauſe*, and ſo on in an *infinite ſeries of cauſed* or *ſucceſſive beings*. But this laſt ſuppoſition, though it has been often made, is as groſsly abſurd as either of the two former. For of this infinite ſeries, either *ſome one* part has *not* been ſucceſſive to any other, or

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* *Reid's Eſſays on the Active Powers of Man.*

† *Raſſelas Prince of* [illegible]

* *See Notes to King's Origin of Evil.*

Of the Being and Attributes of God.

or elſe *all* the ſeveral parts of it have been ſucceſſive. If ſome one part of it was *not ſucceſſive*, then it had a *firſt part*; which deſtroys the ſuppoſition of its infinity (R). If *all* the ſeveral parts of it have been ſucceſſive, then have they all once been *future;* but if they have *all* been future, a time may be conceived when none of them had exiſtence: and if ſo, then it follows, either that all the *parts*, and conſequently the *whole* of this infinite ſeries, muſt have ariſen from *nothing*, which is abſurd; or elſe that there muſt be ſomething in the *whole* beſides what is contained in *all the parts*, which is alſo abſurd.

As the poſſibility or impoſſibility of an infinite ſeries of dependent beings is the main queſtion at iſſue between the atheiſts and us, we ſhall ſtate the preceding reaſoning in a manner ſomewhat different. For this purpoſe, let us ſuppoſe ſome one to affirm, that the courſe of generation has had no beginning, and conſequently that the number of ſucceſſive births has been infinite. We would aſk ſuch a perſon, Whether before the birth of Abraham, for example *, there had paſt an infinite ſeries of generations or not? If not, the courſe of generation muſt have had a beginning, which is the concluſion for which we contend. But if the ſeries paſt was infinite, then at the birth of Joſeph the great-grandſon of Abraham, it is evident, that more generations were paſt, and that the number then was greater than that which was ſuppoſed to be infinite; ſo that upon this ſuppoſition we have a number that is both infinite and not infinite, which is a manifeſt contradiction. Should it be ſaid that the number of generations was infinite, as well at the birth of Abraham as at the birth of Joſeph; it will then follow, that one infinite may be greater than another of the very ſame kind; and conſequently that an infinite may be bounded, *i. e.* be finite. But ſhould it be alleged, that the number of births at Abraham's was finite, and became infinite when it reached to Joſeph's, it will then follow, that one finite number added to another may make an infinite number, which is directly contrary to every poſſible notion of infinity. We might argue in the ſame manner againſt an infinite ſeries of every kind, the very ſuppoſition of which involves the moſt palpable contradictions. See Chap. *Of* INFINITY *and* ETERNITY.

288 whoſe duration is not commenſurate with ſucceſſion, and

From the impoſſibility of an infinite ſeries it neceſſarily follows, that there exiſts, and muſt have exiſted from eternity, ſome one independent being, whoſe duration cannot be commenſurate with ſucceſſion, and to whom the relation of time is not applicable. Here will ſome atheiſts preſently imagine, that by the ſame mode of reaſoning they may diſprove the exiſtence of God: for do not they who thus deſtroy the eternity of the world, deſtroy at the ſame time the eternity of the Creator? If time itſelf be not eternal, how can the Deity or any thing elſe be ſo?

In urging theſe queſtions, it muſt be taken for granted that time is eſſential to all exiſtence, and that God cannot be eternal otherwiſe than by a ſucceſſive flux of infinite time. But it has been already ſhown (N° 224.), that ſucceſſive duration is not eſſential to exiſtence; that we can even *conceive* exiſtence without ſucceſſion; and it may here be added, that if we ſuppoſe a perfect being alone in nature, we ſhall find it impoſſible to imagine any *ſucceſſion of ideas*, any *flux of moments*, or any *alteration* or *increaſe* whatever in his knowledge and eſſence. Such duration as we are acquainted with can have no relation to an immutable Being, while ſuppoſed to exiſt alone; but as ſoon as he determined to exerciſe his ſeveral attributes in the production of ſomething diſtinct from himſelf, then, and not till then, have we reaſon to think that *time*, *ſucceſſion*, and *increaſe*, began. Theſe atheiſtical queſtions, therefore, inſtead of containing an objection to the exiſtence of a Deity, afford a plain demonſtration of it: for ſince it is not more evident that ſomething now exiſts than that ſomething muſt have exiſted from eternity; and ſince it has been ſhown, that neither the world in its preſent ſtate, nor time, nor any thing capable of change or ſucceſſion, can poſſibly be eternal; it follows, that there muſt neceſſarily be ſome Being who, in the order of nature, is before time, and who, in the ſtability and immutable perfection of his own intelligence, comprehends at once his *yeſterday*, *to day*, and *for ever*. "The atheiſts (ſays the excellent Cudworth *) can here only ſmile, or make wry faces, and ſhow their little wit in quibbling upon *nunc-ſtans*, or a *ſtanding now of eternity*; as if that *ſtanding eternity* of the *Deity* (which with ſo much reaſon hath been contended for by the ancient *genuine theiſts*) were nothing but a *pitiful ſmall moment of time ſtanding ſtill*, and as if the duration of all beings whatſoever muſt needs be like our own: whereas the duration of every thing muſt of neceſſity be agreeable to its nature; and therefore, as that whoſe *imperfect nature* is ever *flowing* like a river, and conſiſts in *continual motion* and *changes* one after another, muſt needs have accordingly a *ſucceſſive* and *flowing duration* ſliding perpetually from *preſent* into *paſt*, and always haſting on towards the *future*, expecting ſomething of itſelf which is not yet in being; ſo muſt that whoſe perfect nature is *eſſentially immutable* have *permanent and unchanging duration*, never loſing any thing of itſelf once preſent, nor yet running forward to meet ſomething of itſelf which is not yet in being."

289 who is ſelf-exiſtent, and

From the eternity of the Supreme Being we neceſſarily infer his independence or ſelf-exiſtence; for that which never had a *beginning* of exiſtence cannot poſſibly have any cauſe of that exiſtence, or in any manner depend upon any other being, but muſt exiſt of itſelf, or be *ſelf-exiſtent*.

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Eternity *ad partem poſt*, or *neceſſary exiſtence*, or the impoſſibility of ever ceaſing to be, follows from independence: For to the nature of that which exiſts without any cauſe, exiſtence muſt be eſſential. But a being whoſe exiſtence is of itſelf and eſſential to its nature, cannot be *indifferent* to exiſtence or nonexiſtence, but muſt exiſt *neceſſarily*. And here it may be proper to obſerve, that the word *neceſſity*, when applied to exiſtence, may be taken in two acceptations very different from each other †; either as it ariſes from the relation which the exiſtence of that being, of which it is affirmed, has to the exiſtence of *other things*; or from the relation which the *actual* exiſtence of that thing has to the *manner* of its *own* exiſtence.

* See an *Eſſay towards an Eviction of the Being and Attributes of God, by Seth Ward* —Printed at Oxford, 1655.

* *Intellectual Syſtem*, book i. chap. 5.

† *Notes to King on Evil*, and *Law's Inquiry into the Ideas of Space*, &c.

(R) Των απειρων ουκ εϛιν ουδεν πρωτον, *Ariſt. Phyſ.* lib. viii. cap. 5. ſect. 4.

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What is meant by neceſſary exiſtence.

In the former ſenſe, when neceſſity of exiſtence has relation to the exiſtence of other things, it denotes that the ſuppoſition of the *non*-exiſtence of that thing of which neceſſity is affirmed, implies the nonexiſtence of things which we *know to exiſt*. Thus, ſome independent being does *neceſſarily exiſt;* becauſe, to ſuppoſe *no independent* being, implies that there are *no dependent beings;* the contrary of which we know to be true.

In the ſecond ſenſe, when the neceſſity of exiſtence ariſes from the relation which the actual exiſtence of any thing has to the *manner* of its own exiſtence, neceſſity means, that the thing, of which it is affirmed, exiſts after ſuch a manner as that it never could in *time paſt* have *been nonexiſtent*, or can in *time future ceaſe to be.* Thus, *every independent being*, as it exiſts without a cauſe, is *neceſſarily* exiſting; becauſe exiſtence is *eſſential* to ſuch a being; ſo that it never could *begin* to exiſt, and never can *ceaſe to be:* For to ſuppoſe a being to begin to exiſt, or to loſe its exiſtence, is to ſuppoſe a *change* from nonentity to entity, or *vice verſa;* and to ſuppoſe ſuch a change is to ſuppoſe a cauſe upon which that being depends. Every being, therefore, which is independent, i. e. which had no cauſe of its exiſtence, muſt exiſt *neceſſarily*, and cannot poſſibly have begun to exiſt in time paſt, or ceaſe to be in time future.

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Only one neceſſarily-exiſtent being in the former ſenſe; and

Theſe two kinds of neceſſity as applied to exiſtence, though they have been often confounded, are in themſelves perfectly diſtinct: For though a being cannot be neceſſarily exiſtent in the *former* ſenſe without being ſo in the latter alſo; yet may it be neceſſarily exiſtent in the latter ſenſe without being ſo in the former. For any thing that we know to the contrary, there may be two or more beings exiſting *neceſſarily* in the latter ſenſe of the word *neceſſity*, i. e. with regard to *independence* and the *manner* of their own exiſtence: but in the former ſenſe of the word, i. e. in relation to *this ſyſtem*, there can be but *one neceſſarily* exiſtent being; for it is obvious that no more are neceſſary to account for the production of the *dependent* beings which we know to exiſt. To ſuppoſe the nonexiſtence of *all independent* beings, implies the nonexiſtence of all dependent beings, ourſelves, and every thing elſe; but to ſuppoſe the nonexiſtence of all independent beings except *one*, involves in the ſuppoſition no ſuch abſurdity.

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Though there might be more than one in the latter, they would be no gods to us.

Thus the phenomena of nature lead us, by the ſtricteſt reaſoning, to one firſt cauſe, which is ſufficient for their production; and therefore none but *one* firſt cauſe can in this ſenſe of the word be *neceſſary:* And though ſeveral more *independent* beings might poſſibly exiſt, yet they would be no gods to us: they would have no relation to us demonſtrable by reaſon, nor we any thing to do with them. For if the ſuppoſition of their exiſtence were not requiſite to the production of this ſyſtem, which it obviouſly would not be, we could *perceive* no neceſſity for it at all; we could never diſcover it by our own faculties, and therefore it could be nothing to us. And though two or three ſuch beings ſhould exiſt, and act in the formation and government of their *reſpective* ſyſtems, or *agree in one;* yet till their exiſtence and operations were made known to us, and a natural relation diſcovered, nothing would be due from us to them. They would have no *religious* or *moral* relations to us; and we ſhould have no reaſon to call more than one of them *our* creator, preſerver, and governor, which is the proper ſenſe of the word *God*.

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Impoſſible to demonſtrate that there can be but one ſelf-exiſtent Being.

To ſhow in this manner that there is only *one* eternal ſelf exiſtent Being which bears the relation of *God to us*, ſeems to be going as far as is neceſſary, or as natural light will lead us. Thoſe who endeavour to *demonſtrate* that there *cannot poſſibly* be *more than one* ſelf-exiſtent Being, either reaſon in a circle, or proceed upon principles which their antagoniſts cannot be compelled to grant. When they deduce the Divine unity from independence or omnipotence, they evidently preſuppoſe it in their definition of theſe attributes: and when they infer it from the nature of ſpace and duration, which they conſider as modes of the ſelf-exiſtent Being, they take it for granted, that ſpace and duration have a real exiſtence, independent of us and our thoughts; and that the one is infinite and the other eternal, contrary to what has been already proved, we think, with the force of demonſtration. The celebrated Dr Clarke made much uſe of ſpace and duration in his attempt to demonſtrate that there can be but one ſelf-exiſtent Being; but he argues for the ſame thing from the nature of neceſſity as applied to exiſtence.

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Dr Clarke's firſt demonſtration of the unity

"Neceſſity (ſays he *), abſolute in itſelf, is *ſimple* and *uniform* and *univerſal*, without any poſſible *difference, difformity*, or *variety*, whatſoever: and all *variety* or *difference* of *exiſtence* muſt needs ariſe from ſome *external* cauſe, and be *dependent upon it*, and *proportionable* to the efficiency of that *cauſe*, whatſoever it be. *Abſolute neceſſity*, in which there can be *no variation* in *any kind* or *degree*, cannot be the *ground* of exiſtence of a *number* of beings, however *ſimilar* and *agreeing:* becauſe, without any *other difference*, even *number* is itſelf a manifeſt *difformity* or *inequality* (if I may ſo ſpeak) of *efficiency* or *cauſality*."

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examined, and ſhown to be inconcluſive:

Such is this great man's firſt argument from neceſſity, to prove that there cannot be more than one ſelf-exiſtent Being. But what is this *neceſſity* which proves ſo much? It is the ground of exiſtence (he ſays) of that which exiſts of itſelf; and if ſo, it muſt, in the order of nature, and in our conceptions, be antecedent to that being of whoſe exiſtence it is the ground. Concerning ſuch *a* principle, there are but three ſuppoſitions which can poſſibly be made; and all of them may be ſhown to be abſurd and contradictory. We may ſuppoſe either the *ſubſtance* itſelf, ſome *property* of that ſubſtance, or ſomething *extrinſic* to both, to be this *antecedent ground* of exiſtence prior in the order of nature to *the firſt cauſe*.

One would think, from the turn of the argument which here repreſents this antecedent neceſſity as *efficient* and *cauſal*, that it were conſidered as ſomething *extrinſic* to the firſt cauſe †. Indeed if the words have any meaning in them at all, or any *force* of argument, they muſt be ſo underſtood, juſt as we underſtand them of any external cauſe producing its effect. But as an *extrinſic* principle is abſurd in itſelf, and is beſides rejected by Dr Clarke, who ſays expreſsly, that "of the thing which derives not its being from any other thing, this *neceſſity* or ground of exiſtence muſt be *in* the thing itſelf," we need not ſay a word more of the laſt of theſe ſuppoſitions.

Let

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* *Demonſtration of the Being and Attributes of God*, Prop. 7.

† *Diſſertation on the Argument à priori*, added to *Law's Inquiry into the Ideas of Space, Time, Immenſity*, &c.

Of the Being and Attributes of God.

Let us then conſider the firſt; let us take the *ſubſtance* itſelf, and try whether *it* can be conceived as *prior* or *antecedent* to itſelf in our conceptions or in the order of nature. Surely we need not obſerve that nothing can be more abſurd or contradictory than ſuch a ſuppoſition. Dr Clarke himſelf repeatedly affirms, and it would be ſtrange indeed if he did not affirm, that no *being*, no *thing* whatever, can be conceived as in any reſpect prior to the firſt cauſe.

The only remaining ſuppoſition is, that ſome *attribute* or *property* of the ſelf-exiſtent Being may be conceived as in the order of nature *antecedent* to that being. But this, if poſſible, is more abſurd than either of the two preceding ſuppoſitions. An *attribute* is *attributed* to its *ſubject* as its ground or ſupport, and *not* the *ſubject* to its *attribute*. A *property*, in the very notion of it, is *proper* to the ſubſtance to which it belongs, and *ſubſequent* to it both in our conceptions and in the order of nature. An *antecedent* attribute, or *antecedent* property, is a ſoleciſm as great, and a contradiction as flat, as an *antecedent ſubſequent* or *ſubſequent antecedent*, underſtood in the ſame ſenſe and in the ſame ſyllogiſm. Every property or attribute, as ſuch, preſuppoſes its ſubject; and cannot otherwiſe be underſtood. This is a truth ſo obvious and ſo forcible, that it ſometimes extorts the aſſent even of thoſe who upon other occaſions labour to obſcure it. It is confeſſed by Dr Clarke*, that "the ſcholaſtic way of proving the *exiſtence* of the ſelf-exiſtent Being from the abſolute perfection of his nature, is υστερον προτερον. For all or any perfections (ſays he) preſuppoſe exiſtence; which is a *petitio principii*." If therefore properties, modes, or attributes in God, be conſidered as perfections (and it is impoſſible to conſider them as any thing elſe), then, by this confeſſion of the great author himſelf, they muſt all or any of them *preſuppoſe* exiſtence. It is indeed immediately added in the ſame place, "that bare neceſſity of exiſtence does not preſuppoſe, but infer exiſtence;" which is true only if ſuch neceſſity be ſuppoſed to be a principle *extrinſic*, the abſurdity of which has been already ſhown, and is indeed univerſally confeſſed. If it be a *mode* or *property*, it muſt *preſuppoſe* the exiſtence of its ſubject, as certainly and as evidently as it is a *mode* or a *property*. It might perhaps *à poſteriori* infer the exiſtence of its ſubject, as effects may infer a cauſe; but that it ſhould infer in the other way *à priori* is altogether as impoſſible as that a *triangle* ſhould be a *ſquare*, or a *globe* a *parallelogram*.

* *Anſwer to the Sixth Letter.*

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A ſecond demonſtration of the ſame author

Doubtful, as it would ſeem, of the force of his firſt argument, which even thoſe who pretend to be convinced by it acknowledge to be obſcure, the doctor gives a ſecond, which we muſt confeſs appears to us to be ſtill more obſcure, and if poſſible leſs concluſive. "To ſuppoſe two or more *diſtinct beings* exiſting *of themſelves* neceſſarily and *independent* of each other, implies (he ſays) this *contradiction*, that *each* of them being independent from the other, they may either of them be ſuppoſed to exiſt *alone*; ſo that it will be no contradiction to ſuppoſe the other not to exiſt; and conſequently *neither of them* will be neceſſarily exiſting. Whatſoever therefore exiſts neceſſarily is the one ſimple eſſence of the ſelf-exiſtent Being; and whatſoever differs from that is not neceſſarily exiſting, becauſe in abſolute neceſſity there can be no *difference* or *diverſity* of exiſtence.

Of the Being and Attributes of God.

"Neceſſity is uſed here in two different ſenſes*, both as *abſolute* and *relative*. In the former, neither of the two beings can exiſt without the other, i. e. without our ſuppoſing the other to exiſt alſo, ſince that is equally neceſſary. In the latter, either of them may exiſt alone, i. e. without the help of the other, or without the ſuppoſition of the other as requiſite to its own exiſtence. The conſequence, therefore, that either of them may exiſt alone, and ſo neither of them is neceſſary, is a mere *equivocation* on *neceſſity*, uſing it both in an abſolute and relative ſenſe at the ſame time." But as this is a queſtion of the higheſt importance, and as the author was a man of great worth, we ſhall conſider his argument upon the ſuppoſition that the word *neceſſity* has from the beginning to the end of it the ſame invariable meaning.

* *Law's Inquiry into the Ideas of Space*, &c. chap. 6.

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examined, and ſhown to be equally inconcluſive.

It has been already obſerved, that there are only two ſenſes in which that word can be applied to the exiſtence of any being; and whether it be here uſed in the one or the other of theſe ſenſes, the reaſoning, if reſolved into a ſyllogiſm, will appear to be inconcluſive. If the word be taken in that ſenſe of neceſſity which ariſes from the relation that dependent beings which we know to exiſt bear to ſome one independent Being, the argument will ſtand thus:

> From a known effect no more cauſes can be *neceſſarily* inferred than what are ſufficient to account for that effect: but
> *One* ſelf exiſtent and independent Being is ſufficient to account for all the phenomena of nature; therefore, from the phenomena, &c.
> *No more* than *one* ſuch Being can be *neceſſarily* inferred to exiſt.

But though no more than *one* independent being can in this ſenſe of the word *neceſſarily* exiſt, it by no means follows from this ſyllogiſm, that two or more ſuch beings may not *poſſibly* exiſt. It is, indeed, a plain contradiction to ſay, that two or more ſelf-exiſtent beings are in this ſenſe *neceſſary*; but ſurely there is no contradiction in ſaying, that two or twenty ſuch beings are *poſſible*. We could not, therefore, by this argument convict a perſon of abſurdity, who ſhould affirm that two or more independent beings *actually* exiſt. We might, indeed, deny the exiſtence of them all but *one*, becauſe one is ſufficient to account for thoſe phenomena, from which alone we know that *any* independent being exiſts: but becauſe one of them might be ſuppoſed to exiſt *alone*, ſo that it would be no contradiction to ſuppoſe the other not to exiſt; we know not how the doctor came to affirm, in direct oppoſition to his own demonſtration, that *not one* of them would be neceſſarily exiſting.

Neceſſity, as applied to exiſtence, in the other ſenſe of the word, ariſes, as we have ſeen, from the relation which the *actual* exiſtence of the being, of which it may be affirmed, has to the *manner* of that being's exiſtence. It is the ſame neceſſity, we are told*, with that which is the cauſe of the unalterable proportion between two and four; and it is conſidered as the *formal* cauſe or *ground* of the exiſtence of an independent being. Were it not for the ſtrange expreſſions *formal cauſe* and *ground* of *exiſtence*, we ſhould have no objection to this account of that *neceſſity* by which a being independent undoubtedly exiſts: but this kind of

* *Anſwer to the Sixth Letter* from a Gentleman in Glouceſterſhire.

of neceſſity is a principle which will not ſupport the ſuperſtructure which the learned author labours to raiſe upon it. The ſame *neceſſity* which is the cauſe of the unalterable proportion between *two* and *four*, is likewiſe the cauſe of the unalterable proportion between *three* and *ſix*, between *four* and *eight*, and between *five* and *ten*, &c. But if it can be the cauſe of ſo many different proportions of the ſame kind, why may it not be the *formal cauſe* or *ground* of exiſtence to as *many independent beings* of the ſame kind as well as to *one?* The following ſyllogiſm, we apprehend, to be legitimate both in mode and figure, and its concluſion is directly contrary to the propoſition which the doctor deduces from the ſame notion of neceſſity.

> If neceſſity, conſidered as a *formal cauſe* or *ground* of *exiſtence*, be in *one inſtance* of its cauſality the formal cauſe or ground of exiſtence to *many things* of the ſame kind, it *may* likewiſe in *every other inſtance* of its cauſality, be the formal cauſe or ground of exiſtence to many things of the ſame kind.
>
> But ſuch neceſſity, in that inſtance of its cauſality where it is the formal cauſe or ground of exiſtence to the unalterable proportion between two and four, *is* the formal cauſe or ground of exiſtence to *many proportions* of the ſame kind.
>
> Therefore, the ſame neceſſity in that other inſtance of its cauſality, where it is ſaid to be the formal cauſe or ground of exiſtence to *one* independent being, undoubtedly *may be* the formal cauſe or ground of exiſtence to *many independent beings* of the ſame kind.

299 Neceſſity, a dangerous principle.

Thus it appears, that *neceſſity*, in any ſenſe in which it can be properly affirmed of exiſtence, cannot be the foundation of any argument to prove the impoſſibility of more than one ſelf-exiſtent being. It is indeed a principle from which we apprehend that no poſitive concluſion whatever can be deduced by reaſoning *à priori*. That neceſſity of exiſtence may be predicated of a being which is independent and uncreated, is ſelf-evident; becauſe to the *nature* of ſuch a being exiſtence is eſſential. But whilſt *that nature* itſelf remains wholly *incomprehenſible* by us, it is impoſſible that we ſhould diſcover, by our own unaſſiſted reaſon, whether it can be the nature of *only one* or of *more than one* independent being. To argue from neceſſity, as if it were the cauſe or ground of exiſtence to ſuch a being, is certainly abſurd, if it be not impious; for if that to which exiſtence is eſſential, does not exiſt without any cauſe efficient or formal, we ſhall be obliged to inquire after a cauſe or ground of this cauſe, and thus be involved in all the abſurdities and contradictions of an infinite ſeries. We have inſiſted the longer on this point, becauſe *neceſſity*, as the foundation of the argument *à priori*, has ſometimes been employed to very bad purpoſes. Attempts have been made from the notion of *neceſſary* exiſtence, to prove that the Supreme Being cannot be a free agent, and to ſet the firſt principles of the religion of nature at variance with thoſe which are revealed in the Scriptures.

300 The unity of God highly probable.

But though we are firmly perſuaded that the divine unity cannot be *demonſtrated à priori*, we are far from thinking it incapable of any *proof*. On the contrary, the common arguments *à poſteriori* drawn from the *order* and *harmony* of the world, have always ſatisfied us, and in our opinion muſt ſatisfy every perſon capable of proportioning his aſſent to evidence, that the Creator and Preſerver of ſuch a ſyſtem has but *one will* and *one intelligence*, and therefore is himſelf but *one being*. But *proof* is one thing, and *demonſtration* is, in the proper ſenſe of the word, another (G). And if we cannot arrive at *abſolute* certainty concerning this important truth by the light of nature, we ought to be the more thankful for that revelation, which has put the unity of God paſt diſpute to all who believe the holy Scriptures.

301 God omnipotent.

The being which is ſelf-exiſtent and independent muſt be alſo *omnipotent*. That ſuch a being has *active power in ſome degree*, is ſhown at the ſame time and by the ſame medium that we prove his exiſtence; and ſince he depends upon no cauſe for his exiſtence or his power, he cannot depend upon any for the exertion of that power, and conſequently no *limits* can be applied to it. Limitation is an *effect* of ſome *ſuperior cauſe*, which in the preſent inſtance there cannot be: conſequently to ſuppoſe *limits* where there can be no *limiter*, is to ſuppoſe an *effect* without a *cauſe*. For a being to be *limited* or *deficient* in any reſpect *, is to be *dependent* in that reſpect on ſome *other* being which gave it juſt ſo much and no more; conſequently that being which in *no reſpect* depends upon any other is in *no reſpect* limited or deficient. In all beings capable of increaſe or diminution, and conſequently incapable of *perfection* or *abſolute infinity*, *limitation* or *defect* is indeed a neceſſary conſequence of exiſtence, and

* *Notes to King on Evil.*

(G) John Gerhard and John Voſſius both cite *Gabriel Biel* as acknowledging the unity of God to be incapable of rigid demonſtration; and with the ſentiments of that ſchoolman, thoſe two learned divines profeſs their own to agree.

Sed Biel (1. Sant. Diſt. 2. Q. 10. Art. 3.), ſtatuit "quod tantum *unum* eſſe Deum, ſit *creditum* et *non-demonſtratum* ratione naturali nobis in via poſſibili." Id nos ita interpretamur; etiamſi ex *naturæ libro* rationes *non contemnendæ* pro *unitate* divinæ eſſentiæ aſſerenda erui poſſint, eas tamen ad fidei πληροφοριαν cordibus noſtris ingenerandam, non ſatis efficaces eſſe. Ergo mens prius confirmanda eſt ex *verbo Dei*, et illuſtribus teſtimoniis in quibus ſe Deus generi humano patefecit: Poſtea utiliter poteſt addi conſideratio philoſophicarum demonſtrationum. *Gerhard. Loc Comm.* tom. i. p. 106.

Diſſentit *Gabriel Biel*, qui ante annos hoſce 140 *Tubingenſi* Gymnaſio præfuit. Is cenſet *probabiles* magis rationes eſſe quam *evidentes* et *certas*.—Verum eſto ſane, ut ſolæ non ſint αποδεικτικαι: At magnum iis pondus addit *traditio* vetus; tum autem quod argumenta iſthæc, ſi non prorſus αποδεικτικα, ſaltem uſque adeo *probabilia* ſint, ut της πολυθειας patroni nihil ullius momenti adferre valeant cur pluſquam unum ſtatuere deum potius conveniat. *Voſſ. de Idolatria*, lib. i. c. 2.

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and is only a *negation* of that perfection which is wholly incompatible with their nature; and therefore in theſe beings it requires no further cauſe. But in a being *naturally capable* of *perfection* or abſolute *infinity*, all *imperfection* or *finiteneſs*, as it cannot flow from the *nature* of that being, ſeems to require ſome *ground* or *reaſon*; which reaſon, as it is foreign from the being itſelf, muſt be the effect of ſome other external cauſe, and conſequently cannot have place in the *firſt cauſe*. That the ſelf-exiſtent being is *capable* of perfection or abſolute infinity muſt be granted, becauſe he is manifeſtly the ſubject of one infinite or perfect attribute, viz. *eternity*, or abſolute invariable exiſtence. In this reſpect his exiſtence has been ſhown to be perfect, and therefore it *may* be perfect in every other reſpect alſo. Now that which is the ſubject of one infinite attribute or perfection, muſt have all its attributes infinitely or in perfection; ſince to have any perfections in a finite limited manner, when the ſubject and theſe perfections are both *capable* of ſtrict *infinity*, would be the forementioned abſurdity of poſitive limitation without a cauſe. To ſuppoſe this eternal and independent being limited *in* or *by* its own *nature*, is to ſuppoſe ſome *antecedent nature* or *limiting quality* ſuperior to that being, to the exiſtence of which no *thing*, no *quality*, is in any reſpect *antecedent* or *ſuperior*. And to ſuppoſe that there is no ſuch thing as *active power* in a being which is evidently the fountain of all power, is the groſſeſt of all abſurdities. The ſame method of reaſoning will prove knowledge and every other perfection to be *infinite* in the Deity, when once we have proved that perfection to belong to him at all; at leaſt it will ſhow, that to ſuppoſe it limited is unreaſonable, ſince we can find no manner of *ground* for limitation in any reſpect; and this is as far as we need go, or perhaps as natural light will lead us.

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Omnipotence can do every thing which does not imply a contradiction.

Of the omnipotence of the ſupreme Being ſome philoſophers, as well theiſts as atheiſts, have talked very abſurdly. *Hobbes* *, with a view to make this attribute appear impoſſible and ridiculous, affirms "that God by his omnipotence or infinite power could turn a tree into a ſyllogiſm." And *Des Cartes* †, though certainly no atheiſt, childiſhly aſſerts, that all things whatever, even abſtract truth and falſehood, do ſo depend upon the arbitrary will and power of God, as that if he had pleaſed, "twice two ſhould not have been four, nor the three angles of a plain triangle equal to two right ones." But the true notion of Omnipotence, ſo far from implying a power to turn a tree into a ſyllogiſm, or to make twice two not equal to four, implies only that the being poſſeſſed of it can actually perform whatever can be conceived by the moſt perfect underſtanding; conception in this caſe being the meaſure of poſſibility. Now every thing may be conceived by a mind ſufficiently enlarged which does not involve in it a direct contradiction; but what we clearly diſcern to imply a contradiction, ſuch as that a thing may be and not be at the ſame inſtant, cannot be conceived by any intellect, or made to exiſt by any power. And thus has this attribute of the Divinity been always ſtated, not only by the wiſer Chriſtians, but alſo by moſt of the ancient philoſophers themſelves, who expreſsly admit that "nothing is exempted from the divine power, but only to make that which hath been done to be undone (H)."

* *Leviath.* chap. 3.

† *Reſponſ. ad Objectiones Sextas*, § 6.

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Creation poſſible to Omnipotence.

And here it may be aſked, Whether creation, in the proper ſenſe of the word (ſee CREATION), be within the compaſs of infinite power. All the ancient philoſophers, who were unenlightened by the rays of divine revelation, held that it is not *; grounding their opinion upon this maxim, *Ex nihilo nihil fit.* But the maxim will ſupport no ſuch concluſion.—The ancients, or at leaſt the Peripatetic ſchool, with the metaphyſics of which we are beſt acquainted, conſidered four kinds of cauſes, the *efficient*, the *material*, the *formal*, and the *final*; and though they extended the maxim to the firſt *two*, if not to all theſe cauſes, it is a ſelf-evident truth only when applied to the *efficient cauſe*. Without the actual exertion of *power*, it is indeed moſt certain that nothing could be brought into exiſtence; but it is ſo far from being clear that pre-exiſtent matter, or, as Ariſtotle choſe to expreſs himſelf, a *material cauſe*, muſt be ſuppoſed for infinite power to operate upon, that, we think, every man may find complete evidence of the contrary in himſelf. That ſenſation, intelligence, conſciouſneſs, and volition, are not the reſult of any modifications of figure and motion, is a truth as evident as that conſciouſneſs is not ſwift, nor volition ſquare. If then theſe be the powers or properties of a being diſtinct from matter, which we think capable of the completeſt proof, every man who does not believe that his mind has exiſted and been conſcious from eternity, muſt be convinced that the power of creation has been exerted in himſelf. If it be denied that there is any immaterial *ſubſtance* in man, ſtill it muſt be confeſſed, that, as matter is not eſſentially conſcious, and cannot be made ſo by any particular organization, there is ſome real *thing* or *entity*, call it what you pleaſe, which has either exiſted and been conſcious from eternity, or been in time brought from non-entity into exiſtence by an exertion of infinite power.

* See *Moſheim's Diſſertation on this Subject, in his Edition on Cudworth's Intellectual Syſtem.*

To this perhaps ſome one may object, that upon our own ſuppoſition of the inability of the human mind to exert its faculties but in union with ſome material and organized ſyſtem, the mind of every man may have exiſted from eternity without being conſcious of its own exiſtence; and that, therefore, we have in ourſelves no evidence of *creation*, but only of the union of two ſelf-exiſtent ſubſtances, which in their prior ſtate had been diſtinct and ſeparate from each other. But ſuch an objection as this, we beg leave to reply, can ariſe from nothing but miſapprehenſion of our hypotheſis, and of the reaſons by which we think it ſupported. We ſuppoſe, that to the exertion of the human faculties, a body of ſome kind or other may be neceſſary as an inſtrument, not merely from what we obſerve of the dependence of perception

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(H) Το δε γεγονος ουκ ενδεχεται μη γενεσθαι· διο αγαθως Αγαθων.
Μονου γαρ αυτου και θεος στερισκεται,
Αγενητα ποιειν, ἁσσ᾽ αν ᾗ πεπραγμενα. *Ariſt. ad Licomach.* lib. vi. cap. 2.

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tion and memory on the ſtate of the brain, but becauſe we cannot conceive a Creator of infinite wiſdom and goodneſs to immerſe in ſyſtems of matter, minds to which he knows that ſuch ſyſtems muſt be always uſeleſs and often hurtful. We believe, therefore, that our ſouls and bodies were created and formed for each other; but as our preſent adverſaries admit not of a Creator, we muſt aſk them, How their ſelf-exiſtent ſouls have been diſpoſed of from eternity, and by what power they have all in due ſucceſſion been united each to its proper body? As before the union they were not conſcious, they could not unite themſelves; and to ſuppoſe them united by ſome ſuperior intelligence, is to ſuppoſe them in ſome reſpects dependent on that intelligence, which ſeems not to accord with their ſelf-exiſtence. Whatever is ſelf-exiſtent and eternal muſt be independent; and if poſſeſſed of any power, cannot be conceived to have that power limited.—We repeat, therefore, that every man has in himſelf ſufficient evidence that creation is poſſible; for if infinite power can create an immaterial and percipient being, it may ſurely be ſuppoſed capable of creating dead and unintelligent matter.

But the creation of the material ſyſtem may be ſhown to be in the higheſt degree probable by other arguments. The ſame reaſoning which proves the impoſſibility of an infinite ſeries and of eternal time, proves that the univerſe cannot have exiſted from eternity in its preſent ſtate. But if it has not exiſted from eternity in its preſent ſtate, it belongs to the opponents of creation to ſay what was its former. We talk indeed of *chaos;* but ſuch language, when a Creator is not admitted, is moſt unphiloſophical trifling. It appears from the moſt accurate inquiries that have been made into the ſubſtance and eſſence of body [*], that the atoms of which each maſs is compoſed are held together by a foreign force. If by chaos be meant matter, when this force is ſuppoſed to be removed, we muſt beg leave to ſay, that of ſuch a ſubſtance we have neither idea nor notion, and cannot diſtinguiſh it from nonentity. The original atoms of matter, we believe indeed to require no other agency to keep each entire than that *fiat* by which it was created; but ſtill, as thoſe atoms are conceived to be ſolid and extended, they muſt be capable of diviſion by infinite power; and if that *fiat* or influence which makes them ſolid and extended were removed, they would loſe ſolidity and extenſion, and of courſe become nothing. So far is it, therefore, from being true, that the creation of matter appears to be impoſſible, that we are compelled by every thing that we know of it to believe that matter cannot poſſibly be ſelf-exiſtent.

“Becauſe it is undeniably certain, concerning ourſelves (ſays Cudworth [†]), and all imperfect beings, that none of theſe can create any *new ſubſtance*, men are apt to meaſure all things by their own ſcantling, and to ſuppoſe it univerſally impoſſible for any power whatever thus to create. But ſince it is certain, that imperfect beings can themſelves produce *ſome things* out of nothing pre-exiſting, as *new cogitations*, *new local motion*, and *new modifications* of things corporeal, it is ſurely reaſonable to think that an abſolutely perfect Being can do *ſomething more*, i. e. create *new ſubſtances*, or give them their whole being. And it may well be thought as eaſy for God or an Omnipotent Being, to make a whole world, matter and all, ἐξ οὐκ ὄντων, as it is for us to create *a thought* or to move a finger, or for the ſun to ſend out rays, or a candle light; or laſtly, for an opaque body to produce an image of itſelf in a glaſs or water, or to project a ſhadow: all theſe imperfect things being but the *energies*, *rays*, *images*, or *ſhadows*, of the Deity. For a ſubſtance to be made out of nothing by *God*, or a *Being infinitely perfect*, is not for it to be made out of nothing in the impoſſible ſenſe, becauſe it comes from him who is *all*. Nor can it be ſaid to be impoſſible for any thing whatever to be made by that which hath not only *infinitely greater perfection*, but alſo *infinite active power*. It is indeed true, that infinite power itſelf cannot do things in their own nature impoſſible; and, therefore, thoſe who deny creation, ought to prove, that it is abſolutely impoſſible for a *ſubſtance*, though not for an *accident* or *modification*, to be brought from nonexiſtence into *being*. But nothing is in itſelf impoſſible, which does not imply a contradiction: and though it be a contradiction for a thing to be and not to be at the ſame time, there is ſurely no contradiction in conceiving an imperfect being, which before was not, afterwards to be.” To call in queſtion the poſſibility of creation, becauſe we have no *adequate conception* how a thing can be brought into exiſtence, would be in the higheſt degree abſurd; for it may be doubted, whether we have *adequate* conceptions of any thing except our own ideas and their various relations (1).

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God a free agent; but

The Being which is ſelf-exiſtent, omnipotent, and omniſcient, is not a *neceſſary*, but a *free* agent; for *active*

[*] *Baxter's Inquiry into the Nature of the Human Soul.*

[†] *Intellectual Syſtem*, Book i. chap. 5.

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(1) “Ridicula foret et inepta ejus temeritas, qui corporum ideo creationem ſibi duceret negandum eſſe, quod ejus creationis *clarum et perſpicuam notionem* effingere cogitatione nobis haud licet. Infinita enim eſt rerum copia, quarum perſpicuis et apertis caremus notionibus. Et ſi omnia neganda continuo nobis eſſent, quorum confuſam tantum et imperfectam conſequi poſſumus notionem, omnia fere nobis eſſent neganda, exceptis *relationibus*, quas inter notiones quaſdam abſtractas eſſe intelligimus. Quis interiorem ſibi naturam rerum, tam corporum, quam ſpirituum, cognitam eſſe dixerit? Et eſſe tamen has naturas, omni plane dubitatione vacat. Quis quemadmodum altera harum naturarum agat in alteram, ſeſe ſcire, affirmet? Quis cauſas ſibi patere, propter quas hi vel illi effectus, quos videmus quotidie contingere, à certis veniant corporibus, jure glorietur? Nec tamen quiſquam eſt, qui vel illam animæ in corpus operationem, vel hos effectus in dubium revocare auſit. Teneamus igitur ea, quæ certo novimus, nec idcirco nos ab illis dimoveri patiamur, quod multa rurſus ſunt, quorum naturam ignoramus; contra multa nos fugere et cognitionem noſtram ſuperare, æquo at tranquillo feramus animo. *Joannis Clerici contra eos qui negant, ex nihilo ulla ratione fieri poſſe aliquid, obſervationes; in Moſhemii edit. Intellec. Syſt.*

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tive power implies *freedom*, and *infinite* power *infinite* freedom. What, therefore, hath no bounds ſet to its power, what can have no oppoſition made to its will, nor reſtraint laid on its actions, muſt both will and act freely. "If the Supreme Cauſe were not a being endowed with liberty and choice, but a mere neceſſary agent, then would it follow, as Dr Clarke well obſerves *, that nothing which is not, could *poſſibly* have been; and that nothing which is, could *poſſibly* not have been; and that no mode or circumſtance of the exiſtence of any thing could *poſſibly* have been in any reſpect otherwiſe than it now actually is. All which being evidently moſt falſe and abſurd; it follows, on the contrary, that the Supreme Cauſe is not a mere neceſſary agent, but a Being endued with liberty and choice."

To this reaſoning it has been lately replied †, that "Clarke muſt have known, that all thoſe who contend againſt the free agency of the Deity, do of courſe acknowledge, that nothing could have happened, or does happen, or will happen, but what actually has happened, or doth happen, or will happen; and that it is moſt falſe and abſurd to deny it." It is, therefore, according to the neceſſarians, abſolutely impoſſible, that at preſent there could exiſt upon this earth more or fewer perſons than are now actually alive; that the earth could move in any other direction than from weſt to eaſt; or that there could be more or fewer planets in the ſolar ſyſtem. Yet is it moſt certain, that there *have been fewer perſons* on the earth than there are now; that there is not a cultivated country in Europe which could not contain *more* people than now inhabit it; that the comets move in very different directions from that of weſt to eaſt; and that as, till very lately, we *conceived* only ſix primary planets in the ſyſtem, it is evidently *poſſible* that the ſyſtem *might contain* no more. Upon the ſuppoſition, therefore, that the Supreme Being acts under a phyſical neceſſity, the ſame things are poſſible and not poſſible at the ſame time, which is the groſſeſt of all abſurdities. It might have been objected with much more plauſibility, that the Firſt Cauſe cannot poſſibly be free, becauſe he muſt needs do always what is beſt in the whole; but it will be ſeen by and by, that among different created ſyſtems, there is no reaſon for ſuppoſing any one abſolutely *beſt*.

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himſelf unchangeable.

But though this Being be *free*, and as ſuch the author of *change* in other beings, yet he muſt himſelf be *unchangeable;* for all changes have a beginning, and conſequently are effects of ſome *prior cauſes*. But there can be nothing prior to the exiſtence of this Being, as he is *eternal;* neither any *cauſe* of it, as he is *independent;* nor conſequently any *change* in it, except we could ſuppoſe him to *change himſelf*, which is the ſame abſurdity as to *produce* himſelf, i. e. to be at *the ſame time both effect* and *cauſe*.

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Omniſcience, &c. proved in a different manner.

Omniſcience, as well as ſome of the foregoing attributes of the Supreme Being, may perhaps be more eaſily deduced thus ‡. We find in ourſelves ſuch qualities as *thought* and *intelligence*, *power* and *freedom*, &c. for which we have the evidence of conſciouſneſs as much as for our own exiſtence. Indeed it is only by our conſciouſneſs of theſe that our exiſtence is known to ourſelves. We know likewiſe that theſe are *perfections*, and that to have them is better than to be without them. We find alſo that they have not been in us from eternity. They muſt, therefore, have had a *beginning*, and conſequently ſome *cauſe*, for the very ſame reaſon that a *being* beginning to exiſt in time requires a cauſe. Now this cauſe, as it muſt be *ſuperior* to its *effect*, muſt have thoſe perfections in a *ſuperior* degree; and if it be the *firſt cauſe*, it muſt have them in an *infinite* or *unlimited* degree, ſince *bounds*, or *limitation* without a limiter, would, as we have already ſhown, be an *effect* without a *cauſe*.

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It is indeed obvious, that the *omniſcience* of the Supreme Being is implied in his very exiſtence. "For all things being not only preſent to him, but alſo entirely *depending* upon him, and having *received* both their *being* itſelf and all their powers and faculties *from him*, it is manifeſt that as he knows all things that are, and penetrates every part of their ſubſtance with his all-ſeeing eye, ſo muſt he likewiſe know *all poſſibilities* of things, that is, all effects that *can be*. For, being alone ſelf-exiſtent, and having alone given to all things all the powers and faculties with which they are endued, it is evident that he muſt of neceſſity know perfectly what all and each of theſe powers and faculties, *which are derived wholly from himſelf*, can poſſibly produce. And ſeeing at one boundleſs view, or more properly in his own ideas, all the poſſible compoſitions and diviſions, variations, and changes, circumſtances and dependencies of things, all their poſſible relations one to another, and their diſpoſitions or fitneſſes to certain and reſpective ends, he muſt without poſſibility of error know exactly what is beſt and propereſt in every one of the numberleſs poſſible caſes, or methods of diſpoſing things; and underſtand perfectly how to order and direct the reſpective means to bring about what he ſo knows to be in its kind, or on the whole, the beſt and fitteſt in the end. This is what is meant by infinite wiſdom, or omniſcience †;" and it has been readily admitted by every man who has believed in the exiſtence of a God as the creator and preſerver of all things.

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God foreknows the actions of free agents.

Doubts, however, have been entertained by theiſts, and pious theiſts, whether omniſcience itſelf can certainly foreknow what are called contingent events, ſuch as the actions of free agents; and ſome few there are profeſſing to be even Chriſtians, who have boldly pronounced ſuch knowledge to be impoſſible. That we have no adequate notion *how* events, which are called contingent, can be certainly foreknown, muſt indeed be granted; but we are not, therefore, authorized to ſay that ſuch knowledge is impoſſible, unleſs it can be clearly ſhown to imply a contradiction. They who ſuppoſe that it implies a contradiction, muſt likewiſe ſuppoſe, that, where there is not a chain of neceſſary cauſes, there can be no certainty of any future event; but this is evidently a miſtake. "For let us ſuppoſe that there is in man a power of beginning motion, and of acting with what has been of late called *philoſophical* freedom; and let us ſuppoſe farther that the actions of ſuch a man cannot poſſibly be foreknown; will there not yet be in the nature of things, notwithſtanding this ſuppoſition, the ſame *certainty of event* in every one of the man's actions, as if they were ever ſo fatal and neceſſary? For inſtance, ſuppoſe the man, by an internal principle of motion, and an abſolute freedom of mind, to do ſome particular action *to-day*, and ſuppoſe it was not poſſible that this action ſhould have been foreſeen *yeſterday*, was there not nevertheleſs the ſame *certainty of event* as if it had been foreſeen, and abſolutely neceſſary? That is, would it not have been as *certain a truth* yeſterday, and from eternity, that this action was in event *to be performed to-day*, notwithſtanding the ſuppoſed freedom, as it is now a *certain and infallible truth* that it is performed? Mere *certainty of event*, therefore, does not in any meaſure imply *neceſſity* ‡." And ſurely it implies no contradiction to ſuppoſe, that every future event which in the nature of things is *now certain*, may *now be certainly known* by that intelligence which is omniſcient. The *manner* how God can foreknow future events, without a *chain of neceſſary cauſes*, it is indeed impoſſible for us to explain: yet ſome ſort of *general notion* of it we may conceive. "For, as a man who has no influence over another perſon's actions, can yet often perceive beforehand what that other will do; and a wiſer and more experienced man, with ſtill *greater probability* will foreſee what another, with whoſe diſpoſition he is perfectly acquainted, will in certain circumſtances do; and an angel, with ſtill *leſs degrees of error*, may have a further proſpect into men's future actions: ſo it is very reaſonable to conceive, that God, without influencing men's wills by his power, or ſubjecting them to a chain of neceſſary cauſes, cannot but have a knowledge of future free events, as much *more certain* than men or angels can poſſibly have, as the *perfection* of *his* nature is greater than that of *theirs*. *The diſtinct manner how* he foreſees theſe things we cannot, indeed, explain; but neither can we explain the *manner* of numberleſs other things, of the reality of which, however, no man entertains a doubt *." We muſt therefore admit, ſo long as we perceive no contradiction in it, that God always knows all the free actions of men, and all other beings endued with liberty; otherwiſe he would know many things now of which he was once ignorant; and conſequently his *omniſcience* would receive addition from events, which has been already ſhown to be contrary to the true notion of infinity.— In a being incapable of change, knowledge has nothing to do with *before* or *after*. To every purpoſe of knowledge and power, all things are to him equally preſent. He knows perfectly every thing that is, and what to us is future he knows in the very ſame manner as he knows what to us is preſent.

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* *Demonſtration of the Being and Attributes of God.*

† *Cooper's Tracts.*

‡ *Notes to King on Evil.*

† *Clarke's Demonſtration, &c.*

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God infinitely perfect, all ſufficient, and omnipreſent.

Thus have we demonſtrated the neceſſary exiſtence of a being who is *eternal*, *independent*, *unchangeable*, *omnipotent*, *free in his actions*, and *omniſcient*; and this is the being whom we worſhip as GOD. *Eternity*, *independence*, *immutability*, *omnipotence*, *liberty*, and *omniſcience*, which ſeem to be all the *natural* attributes which we can diſcover in the divine nature, as they are conceived to be differently combined, make us ſpeak of him in different terms. His enjoying in an abſolute manner every conceivable power or perfection, makes us call him a Being *infinitely perfect*. His being capable of no want, defect, or unhappineſs of any kind, denotes him to be *all ſufficient in himſelf*; and the unlimited exerciſe of his knowledge and power, demonſtrates him to be *omnipreſent*. That ſuch a Being muſt be incomprehenſible by us, and by every creature, is a truth ſelf evident; and yet in all ages men of the beſt intentions have been vainly attempting this impoſſibility. The manner of his omniſcience, for inſtance, has been the ſubject of much diſputation among thoſe who ought to have reflected that they know not how their own minds were preſent to their own bodies.—The celebrated Dr Clarke and his adherents, who conſidered ſpace as the *ſine qua non* of all other things, inſiſted, that God muſt be infinitely extended; and that, as wherever his ſubſtance is, there his attributes muſt be, it is thus that his knowledge and power are preſent with every creature. But this notion labours under inſuperable difficulties.

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The manner of the divine omnipreſence incomprehenſible.

For "if the Divine ſubſtance be infinitely extended, then will there be part of it in this place and part in that. It muſt be commenſurate with all particular beings, ſo that ſome will occupy more and ſome leſs of its dimenſions. By this account it will be very proper and philoſophical to ſay, that God is not in *heaven*, but only a *part* of him; and that an *elephant* or a *mountain*, a *whale* or a wicked *giant*, have more of the eſſence or preſence of God with them, than the *holieſt* or *beſt* man in the world, unleſs he be of equal ſize: all which, as has been well obſerved ‡, are at leaſt harſh and grating expreſſions. As the attributes of the Divine Being muſt be conſidered in the ſame manner with his ſubſtance, we ſhall likewiſe, upon this notion of omnipreſence, have a part of his knowledge and power in this place, and a part of them in that; and of theſe parts the one muſt be greater or leſs than the other, according to the dimenſions of the place with which it is commenſurate; which is a ſuppoſition that appears to us harſher, if poſſible, than even the former.

"Should it be ſaid that the divine attributes are not to be conſidered as having parts (though we ſee not how they can be conſidered otherwiſe than as their ſubject), they muſt then exiſt *completely* in every point of this immenſe expanſion. Be it ſo; and what follows? Why, every point of this infinitely expanded being will be omniſcient and omnipotent by itſelf; an inch of it will have as much wiſdom and power as a yard, a mile, or the whole; and, inſtead of one infinite wiſdom and power, we ſhall have millions: For as theſe parts of the ſubſtance are conceived *diſtinctly*, and one individual part is not another, ſo muſt the attributes be likewiſe conceived, and the individual power and knowledge of one part be diſtinct from that of another." And if ſo, it follows, that one point of this expanded being has equal power and intelligence with the whole; ſo that the notion of extenſion being *neceſſary* to God's preſence with every creature, involves in it the moſt palpable contradiction. That God is at all times and in all places ſo preſent with every creature as to have an abſolute knowledge of and power over it, is indeed capable of the ſtricteſt demonſtration; but we think it great preſumption to aſſign the particular *mode* of his preſence, eſpecially ſuch a one as is neither agreeable to the nature of an abſolutely perfect Being, nor in the leaſt neceſſary to the exerciſe of any one perfection which he can be proved to poſſeſs. Philoſophers and divines have offered ſeveral names for the manner in which God is preſent with his works; but we chooſe rather to confeſs, that the *manner* of his preſence is to us, and probably to every creature, wholly incomprehenſible. Nor need we be ſurpriſed or ſtaggered at this, when we reflect that the manner in which our own minds are

preſent

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‡ *Clarke's Demonſtration.*

* *Clarke's Demonſtration, &c.*

‡ *Watt's Eſſays, and Law's Inquiry into the Ideas of Space, Time, Immenſity, &c.*

Of the Being and Attributes of God.

preſent with our bodies is to us as incomprehenſible as the manner in which the ſupreme Mind is preſent with every thing in the univerſe. That our minds have a power over our limbs, we know by experience: but that they are not extended or ſubſtantially diffuſed through them, is certain; becauſe men daily loſe arms and legs, without loſing any part of their underſtanding, or feeling their energies of volition in the ſmalleſt degree weakened. But we need purſue this ſubject no farther. It has been confeſſed by one of the moſt ſtrenuous advocates * for the extenſion of the Deity and all minds, that "there is an incomprehenſibleneſs in the *manner* of every thing, about which no controverſy can or ought to be concerned."

310 God's moral attributes reſult from his natural perfections.

The moral attributes of God may be deduced from his natural ones, and are immediate conſequences of them when exerciſed on other beings. They may be termed his *ſecondary relative* attributes, as they ſeem to be the perfection of his *external acts* rather than any *new internal* perfections. And though the exiſtence of any moral quality or action is not capable of ſtrict *demonſtration*, becauſe every moral action or quality, as ſuch, depends upon the *will* of the agent, which muſt be abſolutely free; yet we have as great aſſurance that there are moral qualities in God, and that he will always act according to theſe qualities, as the nature of the thing admits; and may be as well ſatisfied of it, as if it were capable of the moſt rigid demonſtration. This important point, however, cannot be ſo clearly or ſo firmly eſtabliſhed by abſtract reaſoning as by taking a ſcientific view of the works of creation, which evince the goodneſs, holineſs, and juſtice, of their Author, as well as his perfect wiſdom and infinite power. The conſideration, therefore, of the moral attributes of God, together with his providence, and the duties thence incumbent on man, is the proper buſineſs of other articles (ſee RELIGION, THEOLOGY, and MORAL *Philoſophy*).

311 How they ought to be conceived.

At preſent we ſhall only obſerve, that by reaſoning *à priori* from his exiſtence and his natural perfections, we muſt neceſſarily infer that his actions are the reſult of unmixed benevolence. Every wiſe agent has ſome end in view in all his actions; it being the very eſſence of folly to act for no end: but there cannot be an end of action which is not either ſelfiſh or benevolent. Selfiſhneſs is the offspring of want and imperfection, and is therefore the ſource of moſt *human* actions; becauſe men are weak and imperfect beings, capable of daily additions to their happineſs. When the thief plunders a houſe at midnight, when the highwayman robs a traveller on the road, and even when the aſſaſſin murders the man who never injured him; it will be found that their actions ſpring not from an innate deſire to inflict miſery upon others, but from a proſpect of reaping advantage to themſelves. The object of the thief and the robber is obvious: it is to gain money, which is the mean of procuring the comforts of life. Even the aſſaſſin has always the ſame ſelfiſh end in view: either he is *bribed* to commit the murder, or he fancies that his horrid deed will remove an *obſtacle* from the way to his own happineſs. But they are not vicious men *only* who act from ſelfiſh conſiderations: much of human *virtue*, when traced to its ſource, will be found to have its origin in the deſire of happineſs. When a man gives his money to feed the hungry and to clothe the naked, he believes that he is acting agreeably to the will of Him to whom he and the poor ſtand in the ſame relation; and he looks for a future and eternal reward. By continuing the practice, he ſoon acquires the habit of benevolence; after which, indeed, he looks for no further reward, when performing particular actions, than the immediate pleaſure of doing good. This ſelfiſhneſs of man is the neceſſary conſequence of his progreſſive ſtate. But the Being who is independent, omnipotent, omniſcient, and, in a word, poſſeſſed of every poſſible perfection, is incapable of progreſſion, or of having any acceſſion whatever made to his happineſs. He is immutable; and muſt of neceſſity have been as happy from eternity, when exiſting alone, as after the creation of ten thouſand worlds. When, therefore, he willed the exiſtence of other beings, he could have nothing in view but to communicate ſome reſemblance of his own perfections and happineſs. That he had *ſome* end in view, follows undeniably from his infinite wiſdom. That he could not have a *ſelfiſh* end, follows with equal certainty from his own infinite perfections; and as there is no medium, in the actions of a wiſe Being, between ſelfiſhneſs and benevolence, we muſt neceſſarily conclude, that the creation was the reſult of unmixed benevolence or perfect goodneſs. The other moral attributes of the Deity, his juſtice, mercy and truth, ought therefore to be conſidered only as ſo many different views of the ſame *goodneſs* in the *Creator*, and various ſources of *happineſs* to the *creature*. Theſe are always *ſubordinate* to and *regulated* by this one principal perfection and brighteſt ray of the Divinity.

"Thus we conceive his *juſtice* to be exerted on any being no farther than his goodneſs neceſſarily requires, in order to make that being, or others, *ſenſible* of the *heinous nature* and *pernicious effects of ſin* *, and thereby to bring them to as great a degree of happineſs as their ſeveral natures are capable of. His *holineſs* hates and abhors all wickedneſs, only as its neceſſary conſequences are abſolute and unavoidable miſery; and his veracity or faithfulneſs ſeems to be concerned for truth, only becauſe it is connected with and productive of the happineſs of all rational beings; to provide the propereſt means for attaining which great end, is the exerciſe of of his *wiſdom*." Such is the view of God's moral attributes, which the abſtract contemplation of his natural perfections neceſſarily gives; and whether this way of conceiving them be not attended with leſs difficulty than the common manner of treating them under the notion of two infinites *diametrically oppoſite*, muſt be left to the judgement of the reader.

312 The origin of evil.

But if the Creator and ſupreme Governor of all things be a Being of infinite power, perfect wiſdom and pure benevolence, how came evil into the works of creation? This is a queſtion which has employed the ſpeculative mind from the firſt dawning of philoſophy, and will continue to employ it till our faculties be enlarged in a future ſtate, when philoſophy ſhall give place to more perfect knowledge. To theſe meditations, as has been well obſerved ‡, humanity is not equal. Volumes have been written on the ſubject; but we believe that the following extract from

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* *Mr Jackſon's Exiſtence and Unity*, &c. page 110.

* *Notes to King on Evil.*

‡ *Johnſon's Review of a free Inquiry into the Origin of Evil.*

Dr Clarke contains all that can be advanced with certainty, and all that is neceſſary to vindicate the ways of God to man.

"All that we call evil (ſays that able reaſoner†), is either an *evil of imperfection*, as the want of certain faculties and excellencies which other creatures have; or *natural evil*, as pain, death, and the like; or *moral evil*, as all kinds of vice. The *firſt* of theſe is not properly an evil: for every power, faculty, or perfection, which any creature enjoys, being the free gift of God, which he was no more obliged to beſtow than he was to confer being or exiſtence itſelf, it is plain, that the want of any certain faculty or perfection in any kind of creatures, which never belonged to their nature, is no more an evil to them, than their never having been created or brought into being at all could properly be called an evil." To this we may add, that as no created being can be ſelf-exiſtent and independent, imperfection is unavoidable in the creation, ſo that the evil of defect (as it is moſt abſurdly called) muſt have been admitted, or nothing could ever have exiſted but God. "The *ſecond* kind of evil, which we call *natural* evil, is either a neceſſary conſequence of the former, as *death* to a creature on whoſe nature immortality was never conferred; and then it is no more properly an evil than the former: Or elſe it is counterpoiſed in the whole with as great or greater good, as the *afflictions and ſufferings of good men*: and then alſo it is properly no evil: Or elſe it is a *puniſhment*; and then it is a neceſſary conſequence of the *third* and laſt ſort of evil, viz. *moral evil*. And *this* ariſes wholly from the abuſe of *liberty*, which God gave to his creatures for other purpoſes, and which it was reaſonable and fit to give them for the perfection and order of the whole creation: only they, contrary to God's intention and command, have abuſed what was neceſſary for the perfection of the whole, to the corruption and depravation of themſelves. And thus have all ſorts of evils entered into the world, without any diminution to the infinite goodneſs of its Creator and Governor."

313 Whether the preſent be the beſt ſyſtem poſſible.

But though evil could not be totally excluded from the univerſe, are we not authorized to infer, from the infinite power, wiſdom, and goodneſs of the Creator, that the preſent ſyſtem is upon the whole the very beſt ſyſtem poſſible? Undoubtedly we are, if of poſſible ſyſtems there *can be a beſt*: but this is ſo far from being evident, that we think it implies a contradiction. A beſt of beings there is, viz. God, who is poſſeſſed of infinite perfections; but there cannot be a beſt of creatures or of created ſyſtems. To prove this, we need only reflect, that wherever creation ſtops, it muſt ſtop infinitely ſhort of infinity; and that how perfect ſoever we conceive any creature or ſyſtem of creatures to be, yet the diſtance between that and God is not leſſened, but continues infinite. Hence it follows, that the nature of God and his omnipotence is ſuch, that whatever number of creatures he has made, he may ſtill add to that number; and that however good or perfect the ſyſtem may be on the whole, he might ſtill make others equally good and perfect.

314 Origin of that queſtion.

The diſpute, whether a being of infinite power, wiſdom, and benevolence, muſt be ſuppoſed to have created the *beſt poſſible ſyſtem*, and the embarraſſment of men's underſtandings about it, ſeem to have ariſen from their taking the words *good*, *better*, and *beſt*, for abſolute qualities inherent in the nature of things, whereas in truth they are only relations ariſing from certain appetites. They have indeed a foundation, as all relations have, in ſomething abſolute, and denote the thing in which they are founded; but yet they themſelves imply nothing more than a relation of congruity between ſome appetite and its objects. This is evident; becauſe the ſame object, when applied to an appetite to which it has a congruity, is good; and bad, when applied to an appetite to which it has no congruity. Thus, the earth and air to terreſtrial animals are good elements, and neceſſary to their preſervation: to thoſe animals the water is bad, which yet affords the beſt receptacle to fiſhes. *Good*, therefore, being relative to appetite, that muſt be reckoned the beſt creature by us which has the ſtrongeſt appetites, and the ſureſt means of ſatisfying them all, and ſecuring its own permanent happineſs. And though the *ſubſtance* of creatures is chiefly to be regarded as contributing to their perfection, yet we have no way of meaſuring the perfection of different ſubſtances but by their qualities, *i. e.* by their appetites by which they are ſenſible of good and evil, and by their powers to procure thoſe objects from which they receive that ſenſe of things which makes them happy.

315 No ſyſtem abſolutely beſt.

It is plain, therefore, that whatever ſyſtem we ſuppoſe in nature, God might have made another equal to it; his infinite wiſdom and power being able to make other creatures equal in every reſpect to any that we know or can conceive, and to give them equal or ſtronger appetites, and as certain or more certain ways of ſatisfying them. We ſee in many caſes, that very different means will anſwer the ſame end. A certain number of regular pyramids will fill a ſpace; and yet irregular ones will do it as well, if what we take from the one be added to another; and the ſame thing may be done by bodies of the moſt irregular and different figures in the ſame manner: and therefore we may very well conceive, that the anſwering of appetites, which is all the *natural good* that is in the world, may as well be obtained in another ſyſtem as in this; provided we ſuppoſe, that where the appetites of the ſentient beings are changed, the objects are alſo ſuited to them, and an equal congruity among the parts of the whole introduced. This is ſo eaſily conceived, that in an indefinite number of poſſible worlds, we do not ſee why it may not be done in numberleſs ways by infinite power and wiſdom.

316 God not neceſſitated by his goodneſs to create the preſent in preference to all other worlds.

If then it be plain, that there might have been many other worlds, or even but one, equal to this in all reſpects as to goodneſs, there could be no neceſſity, either phyſical or moral, that God ſhould create the one rather than the other; becauſe nothing could make the one better, or to him more agreeable, than the other, but his own free choice. Either, therefore, God muſt be poſſeſſed of abſolute freedom, or, among a number of poſſibilities equally perfect, he could not have made a choice, and ſo nothing would ever have been created. It is not, then, as Leibnitz and others argue, the natural and neceſſary goodneſs of ſome particular things, *repreſented by the divine ideas*, which determines God to prefer them to all others, if underſtood of his *firſt* act of producing them; but it is his own free choice which, among many equal *potential* goods, makes ſome things *actually* good, and determines them into exiſtence. When thoſe are once ſuppoſed to exiſt, every thing or action becomes good which tends to their happineſs and preſervation; and to ſuppoſe their all-perfect Author to have any other end in view than their preſervation and happineſs, is the ſame abſurdity as to ſuppoſe that knowledge may produce ignorance; power, weakneſs; or wiſdom folly.

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† *Demonſtration of the being and Attributes of God.*

We have now finiſhed what we propoſed under the article Metaphyſics. It has ſwelled in our hands to a large extent; and yet it can be conſidered as little more than an introduction to that ſcience, which comprehends within its wide graſp every thing exiſting. The reader who wiſhes to purſue theſe intereſting ſpeculations, ſhould ſtudy diligently the authors whom we have conſulted, and to whom we have been careful to refer in the margin. Were we to make a ſelection, we ſhould without heſitation recommend Ariſtotle and Plato among the ancients; and Cudworth, Locke, Hartley, and Reid, among the moderns. Theſe philoſophers, indeed, on many points, differ exceedingly from one another; but he who wiſhes not to adopt opinions at random, ſhould know what can be ſaid on both ſides of every queſtion.

METAPLASMUS, in *Grammar*, a tranſmutation or change made in a word, by adding, retrenching, or altering a ſyllable or letter thereof.

METAPONTUM, or METAPONTIUM, in *Ancient Geography*, a town of Lucania, on the Sinus Tarentinus, to the weſt of Tarentum; built by the Pylians who returned from Troy; and where Pythagoras is ſaid to have taught in the time of Servius Tullius. *Metapontini*, the people; who pretended to ſhow, in a temple of Minerva, the tools with which Epeus built the wooden horſe, (Juſtin). Now a tower, called *Torre di Mare*, in the Baſilicata of Naples.

METASTASIO, L'ABBE PIERRE BONAVENTURE, a celebrated Italian poet, whoſe real name was *Trapaſſi*, was born at Aſſiſe, on January 3d, 1698. His talent for poetry was firſt unfolded by the reading of Taſſo; and he began to compoſe verſes at ten years of age. "A prodigy of this nature (ſays Metaſtaſio) made ſuch an impreſſion on my maſter, the celebrated Gravina, that he thenceforth conſidered me as a plant worthy of being cultivated by his own hands." Metaſtaſio was only fourteen years of age when he compoſed his tragedy entitled *Il Giuſtino;* in which he appears too cloſe and ſcrupulous an imitator of the Grecian drama. Our young poet unfortunately loſt his patron in 1717; who left him his heir, "as being a young man of the moſt promiſing abilities." Metaſtaſio, at the age of nineteen, being, in conſequence of this inheritance, ſuperior to thoſe wants which repreſs the exertions of genius, and to which men of abilities are too often ſubject, gave full ſcope to his inclination for poetry. He began his dramatic career with the *Didonne Abandonnata*, which was acted at Naples in 1724; the muſic was compoſed by Sarro. He ſoon acquired ſuch celebrity, that in 1729 he was invited to Vienna by the emperor Charles VI.; who appointed him imperial poet, and granted him a penſion of 4000 florins. From that time ſome of his works were preſented at every court feſtival; and notwithſtanding the extreme magnificence of theſe entertainments, they would now be forgotten were it not for the verſes which he compoſed upon the occaſion. The courts of Vienna and Madrid vied with each other in the preſents which they conferred upon him. From Maria Thereſa he received a ſnuff box and a port-folio ſet with diamonds, and a golden candleſtick with a ſcreen. Ferdinand VI. king of Spain, informed of the great merit of Metaſtaſio by Farinelli, of whom he was a paſſionate admirer, ſent him a preſent of a caſket mounted with gold, and furniſhed with the different implements of writing. This favourite of kings and of the muſes was of a cheerful temper, and was exceedingly temperate: to this he was probably indebted for the uninterrupted health which he enjoyed, and for the entire poſſeſſion of his ſenſes and faculties to the moſt advanced period of old age. He took his meals, aroſe, and went to bed, always at ſtated hours. This exactneſs and order were ſcrupulouſly obſerved even in the moſt trifling actions of his life. He uſed to ſay in jeſt, that he dreaded hell for no other reaſon but becauſe it was a place *ubi nullus ordo, ſed ſempiternus horror inhabitat.* He had even his ſtated hours for making verſes; to which he ſcrupulouſly adhered, without waiting for the moment of poetical enthuſiaſm. He was equally regular in the duties of the Chriſtian as in the labours of the ſcholar. His behaviour was that of a true philoſopher: his ambition extended no farther than the attainment of literary fame; and he deſpiſed every civil mark of diſtinction. When Charles VI. offered him the titles of *Count* or of *Baron*, which add no real worth or dignity to the poſſeſſor, but frequently make him appear in a more ridiculous light, he inſtantly begged the favour that he would allow him ſtill to continue *Metaſtaſio*. The empreſs Maria Thereſa afterwards wiſhed to beſtow upon him the ſmall croſs of St Stephen; but he excuſed himſelf on account of his age, which would prevent him from aſſiſting at the feſtivals of the order. He was attacked by a fever on the 2d of April 1782; and he died on the 12th of the ſame month, at the age of 84. Before his death he received the ſacrament according to the form of the Romiſh church; and Pius VI. who was then at Vienna, ſent him his apoſtolical benediction *in articulo mortis.* He left about 150,000 florins. He compoſed a great number of tragic operas, and ſeveral ſmall dramatic pieces which have been ſet to muſic. We have different editions of them in 4to, 8vo, and 12mo; and M. Richelet has publiſhed a tranſlation of them into French, in 12 vols, ſmall 12mo.

The greateſt part of Metaſtaſio's writings will confer immortality on their author. His dialogue is natural,

tural, ſimple, and eaſy; his ſtyle is always pure and elegant, and ſometimes ſublime and pathetic. His ſubjects are noble, intereſting, and excellently adapted for repreſentation. He was perfectly acquainted with the reſources of his art, and has ſubjected the opera to rules. He ſtripped it of its machinery, and of the marvellous, which was fitted to excite the gaze of aſtoniſhment, but which gave no inſtruction to the underſtanding, and made no impreſſion on the heart. His deſcriptions are copied from nature; the ſituations of his characters never fail to raiſe an intereſt in the reader, and often excite the tear of pity. His fables are celebrated; his characters are noble and well ſupported; his plots are excellently conducted, and happily unravelled. "There are ſcenes (ſays Voltaire) worthy of Corneille when he does not declaim, and of Racine when he is not feeble." His operas, in point of the pathetic, may be compared with our fineſt tragedies; and may be read with great pleaſure, independent of the charms of the muſic. We muſt not, however, expect to find in Metaſtaſio that exact regularity, and that fertile ſimplicity, which conſtitutes the excellence of ſome of our tragic poets: But though he ſometimes tranſgreſſes the unities of time and place, he always preſerves the unity of intereſt. Notwithſtanding all theſe advantages, ſome critics will not allow him the merit of invention, which is the firſt qualification of a poet. They conſider him only as a ſucceſsful imitator of the French tragic writers, from whom a great part of his beauties are borrowed, and place him at the head of the fineſt wits in Italy, but deny that he poſſeſſed genius. He was a fond admirer of the ancients; and this admiration, increaſing with the ſolidity of his underſtanding, continued to the laſt period of his life. He recommended reading them, as he himſelf had done, in a chronological order. His memory was excellent, and continued unimpaired even in old age. Horace was his favourite author, and he could repeat almoſt the whole of his verſes. Metaſtaſio, who, as we have obſerved, was the pupil of the celebrated Gravina, added a gentleneſs of character peculiar to himſelf to the accuracy of thinking and great erudition of his maſter. His abilities and fame were reſpected by the critics in general; and whereas the life of moſt men of letters is one continued warfare, his days happily glided away in tranquillity and peace. The circumſtance which occaſioned the change of his name is thus related in a late anecdote: "Gravina's barber, who, like moſt of his profeſſion, was a great talker, one day informed him, that in the *Place de la Valicella*, where he had his ſhop, a young boy came every evening, and ſung extempore verſes of his own compoſition, ſo harmonious and elegant that all the paſſengers ſtopped to liſten to them. Gravina, upon this information, added one to the number of the young poet's audience, and found the verſes ſo ſuperior to the idea which he had formed of them from the account of the barber, and ſo much above the capacity of a child of ten or eleven years of age, that he inſtantly determined to undertake the cultivation of ſo promiſing a plant. His firſt care was to put the young *Trepaſſi* (which was the boy's name) to ſchool; but apprehending that the ordinary methods of education might check the progreſs of ſo uncommon talents, he took him home to his own houſe, and changed his name into *Metaſtaſio*, which ſignifies the ſame thing in Greek. In ſhort, by a plan of education and by inſtructions ſuited to his genius, Gravina laid the foundation of that reputation which he predicted, and which Metaſtaſio now enjoys." *Vies des Hommes Illuſtres d'Italie*, tom. i. p. 187.

METASTASIS, in medicine, a tranſpoſition or ſettlement of ſome humour or diſeaſe in ſome other part; and ſometimes it ſignifies ſuch an alteration of a diſeaſe as is ſucceeded by a ſolution.

METATARSUS (*μετα beyond*, and *ταρσος the tarſus*), in anatomy, that part of the human ſkeleton containing the middle of the foot. See ANATOMY, *Index*.

METATHESIS, in grammar, a ſpecies of the metaplaſmus; being a figure whereby the letters or ſyllables of a word are tranſpoſed, or ſhifted out of their uſual ſituations, as *piſtris* for *priſtis*, *Lybia* for *Libya*, &c.

This word is, by phyſicians, uſed with reſpect to morbific cauſes, which when they cannot be evacuated, are removed to places where they are leſs injurious.

METELIN, the modern name of the iſland of Leſbos. See LESBOS and MITYLENE.

In the Iriſh Philoſophical Tranſactions for 1789, we have a deſcription of this iſland by the earl of Charlemont, in which he ſpeaks with raptures of its beauties. "The mountains, whoſe rugged tops exhibit a pleaſing interſperſion of rocks and fine groves, have their green ſides, for many miles along the coaſt, covered with olives, whoſe leſs agreeable verdure is corrected, embelliſhed, and brightened by a lively mixture of bays and laurels aſpiring to the height of foreſt trees, of myrtles and pomegranates, of arbutes rich at once in bloſſom and in berry, of mulberries growing wild and laden with fruit, &c. Winter is here unknown, the verdure is perpetual, and the frequency of evergreens gives to December the colour of June. The parching heat of ſummer is never felt; the thick ſhade of trees, and thouſands of cryſtal ſprings which everywhere ariſe and form themſelves into unnumbered rivulets, joined to the refreſhing ſea breeze, the conſtant corrective and companion of noontide heat, qualify the burning air and render the year a never-ending May. The houſes are conſtructed in ſuch a manner as to have the beſt view of theſe natural beauties. Each is a ſquare tower neatly built of hewn ſtone, ſo high as to overtop the trees, and to command a view of the ſea and neighbouring iſlands. The lower ſtories are granaries and ſtorehouſes; and the habitable apartments are all at the top, to which you aſcend by a ſtone ſtair, built for the moſt part on the outſide, and ſurrounding the tower; ſo that from the apartment the trees are overlooked, and the whole country is ſeen; while the habitations themſelves, which are very numerous, peering above the groves, add life and variety to the enchanting proſpect, and give an air of human population to theſe woodlands, which might otherwiſe be ſuppoſed the region of Dryads, of Naiads, and of Satyrs."

The moſt remarkable thing, however, in this iſland is a cuſtom by which the women have here openly uſurped thoſe rights of ſovereignty which in other countries are ſuppoſed to belong eſſentially to the men. "Contrary (ſays his lordſhip) to the uſage of all other countries, the eldeſt daughter here inherits; and the ſons, like daughters everywhere elſe, are portioned off with ſmall dowers, or, which is ſtill worſe, turned out pennyleſs to ſeek their fortune. If a man have two daughters, the eldeſt, at her marriage, is entitled to all her mother's poſſeſſions, which are by far the greater part of the family eſtate, as the mother, keeping up her prerogative, never parts with the power over any portion of what ſhe has brought into the family, until ſhe is forced into it by the marriage of her daughter; and the father alſo is compelled to ruin himſelf by adding whatever he may have ſcraped together by his induſtry. The ſecond daughter inherits nothing, and is condemned to perpetual celibacy. She is ſtyled a *calogria*, which ſignifies properly a religious woman or nun, and is in effect a menial ſervant to her ſiſter, being employed by her in any office ſhe may think fit to impoſe, frequently ſerving her as waitingmaid, as cook, and often in employments ſtill more degrading. She wears a habit peculiar to her ſituation, which ſhe can never change; a ſort of monaſtic dreſs, coarſe, and of a dark brown. One advantage, however, ſhe enjoys over her ſiſter, that whereas the elder, before marriage, is never allowed to go abroad, or to ſee any man, her neareſt relations only excepted, the calogria, except when employed in domeſtic toil, is in this reſpect at perfect liberty. But when the ſiſter is married, the ſituation of the poor calogria becomes deſperate indeed, and is rendered ſtill more humiliating by the compariſon between her condition and that of her happy miſtreſs. The married ſiſter enjoys every ſort of liberty; the whole family fortune is hers, and ſhe ſpends it as ſhe pleaſes; her huſband is her obſequious ſervant, her father and mother are dependent upon her, ſhe dreſſes in a moſt magnificent manner, covered all over, according to the faſhion of the iſland, with pearls and with pieces of gold, which are commonly ſequins; thus continually carrying about her the enviable marks of affluence and ſuperiority, while the wretched calogria follows her as a ſervant, arrayed in ſimple homeſpun brown, and without the moſt diſtant hope of ever changing her condition. Such a diſparity may ſeem intolerable, but what will not cuſtom reconcile? Neither are the misfortunes of the family yet at an end. The father and mother, with what little is left them, contrive by their induſtry to accumulate a ſecond little fortune; and this, if they ſhould have a third daughter, they are obliged to give to her upon her marriage; and the fourth, if there ſhould be one, becomes her calogria; and ſo on through all the daughters alternately. Whenever the daughter is marriageable, ſhe can by cuſtom compel the father to procure her a huſband; and the mother, ſuch is the power of habit, is fooliſh enough to join her in teaſing him into an immediate compliance, though its conſequences muſt be equally fatal and ruinous to both of them. From hence it happens, that nothing is more common than to ſee the old father and mother reduced to the utmoſt indigence, and even begging about the ſtreets, while their unnatural daughters are in affluence; and we ourſelves have frequently been ſhown the eldeſt daughter parading it through the town in the greateſt ſplendour, while her mother and ſiſter followed her as ſervants, and made a melancholy part of her attendant train.

"The ſons, as ſoon as they are of an age to gain a livelihood, are turned out of the family, ſometimes with a ſmall preſent or portion, but more frequently without any thing to ſupport them; and thus reduced, they either endeavour to live by their labour, or, which is more uſual, go on board ſome trading veſſel as ſailors or as ſervants, remaining abroad till they have got together ſome compentency, and then return home to marry and to be henpecked. Some few there are who, taking advantage of the Turkiſh law, break through this whimſical cuſtom, who marry their calogrias, and retain to themſelves a competent proviſion: but theſe are accounted men of a ſingular and even criminal diſpoſition, and are hated and deſpiſed as conformiſts to Turkiſh manners, and deſerters of their native cuſtoms; ſo that we may ſuppoſe they are few indeed who have the boldneſs to depart from the manners of their country, to adopt the cuſtoms of their deteſted maſters, and to brave the contempt, the deriſion, and the hatred, of their neighbours and fellow-citizens.

"Of all theſe extraordinary particulars I was informed by the French conſul, a man of ſenſe and of indiſputable veracity, who had reſided in this iſland for ſeveral years, and who ſolemnly aſſured me that every circumſtance was true: but indeed our own obſervation left us without the leaſt room for doubt, and the ſingular appearance and deportment of the ladies fully evinced the truth of our friend's relation. In walking through the town, it is eaſy to perceive, from the whimſical manners of the female paſſengers, that the women, according to the vulgar phraſe, *wear the breeches*. They frequently ſtopped us in the ſtreets, examined our dreſs, interrogated us with a bold and manly air, laughed at our foreign garb and appearance; and ſhowed ſo little attention to that decent modeſty which is or ought to be the true characteriſtic of the ſex, that there is every reaſon to ſuppoſe they would, in ſpite of their haughtineſs, be the kindeſt ladies upon earth, if they were not ſtrictly watched by the Turks, who are here very numerous, and would be ready to puniſh any tranſgreſſion of their ungallant laws with arbitrary fines. But nature and native manners will often baffle the efforts even of tyranny. In all their cuſtoms theſe manly ladies ſeem to have changed ſexes with the men. The woman rides aſtride, the man ſits ſideways upon the horſe; nay, I have been aſſured that the huſband's diſtinguiſhing appellation is his wife's family name. The women have town and country houſes, in the management of which the huſband never dares interfere. Their gardens, their ſervants, are all their own; and the huſband, from every circumſtance of his behaviour, appears to be no other than his wife's firſt domeſtic, perpetually bound to her ſervice, and ſlave to her caprice. Hence it is that a tradition obtains in the country, that this iſland was formerly inhabited by Amazons; a tradition, however, founded upon no ancient hiſtory that I know of. Sappho indeed, the moſt renowned female that this iſland has ever produced, is ſaid to have had manly inclinations; in which, as Lucian informs us, ſhe did but conform with the ſingular manners of her countrywomen: but I do not find that the mode in which ſhe choſe to ſhow theſe inclinations is imitated by the preſent female inhabitants, who ſeem perfectly content with the dear prerogative of abſolute ſway, without endeavouring in any other particular to change the courſe of nature; yet will this circumſtance ſerve to ſhow, that the women of Leſbos had always ſomething peculiar, and even peculiarly maſculine, in their manners and propenſities. But be this as it may, it is certain that no country whatſoever can afford a more perfect idea of an Amazonian commonwealth, or better ſerve to render probable thoſe ancient relations which our manners would induce us to eſteem incredible, than this iſland of Metelin. Theſe lordly ladies are for the moſt part very handſome in ſpite of their dreſs, which is ſingular and diſadvantageous. Down to the girdle, which as in the old Grecian garb is raiſed far above what we uſually call the waiſt, they wear nothing but a ſhift of thin and tranſparent gauze, red, green, or brown, through which every thing is viſible, their breaſts only excepted, which they cover with a ſort of handkerchief; and this, as we were informed, the Turks have obliged them to wear, while they look upon it as an encumbrance, and as no inconſiderable portion of Turkiſh tyranny. Long ſleeves of the ſame thin material perfectly ſhow their arms even to the ſhoulder. Their principal ornaments are chains of pearl, to which they hang ſmall pieces of gold coin. Their eyes are large and fine; and the noſe, which we term Grecian, uſually prevails among them, as it does indeed among the women of all theſe iſlands. Their complexions are naturally fine; but they ſpoil them by paint, of which they make abundant uſe; and they disfigure their pretty faces by ſhaving the hinder part of the eyebrow, and replacing it with a ſtraight line of hair neatly applied with ſome ſort of gum, the brow being thus continued in a ſtraight and narrow line till it joins the hair on each ſide of their face. They are well made, of the middle ſize, and for the moſt part plump; but they are diſtinguiſhed by nothing ſo much and ſo univerſally as by a haughty, diſdainful, and ſupercilious air, with which they ſeem to look down upon all mankind as creatures of an inferior nature, born for their ſervice, and doomed to be their ſlaves; neither does this peculiarity of countenance in any degree diminiſh their natural beauty, but rather adds to it that ſort of bewitching attraction which the French call *piquant*."

His lordſhip has been at great pains to inveſtigate the origin of ſuch a ſingular cuſtom; but is unable to find any other example in hiſtory than that of the Lycians, who called themſelves by the names of their mothers, and not of their fathers. When aſked by their neighbours who they were? they deſcribed themſelves by their maternal genealogy. If a gentlewoman ſhould marry a ſlave, the children by that marriage were accounted noble; but ſhould the firſt man among them marry a foreign woman, the children would be accounted ignoble. This cuſtom is mentioned by ſeveral ancient authors. A difficulty of no little magnitude occurs, however, in accounting for the derivation of the inhabitants of Leſbos from the Lycians. This is ſolved in the following manner: In times of the moſt remote antiquity, the iſland of Leſbos was peopled by the Pelaſgi, who, under their leader Xanthus, the ſon of Trioppas king of Argos, firſt inhabited Leſbos: previous to that time they had dwelt in a certain part of Lycia which they had conquered; and in this country we may ſuppoſe they had learned the cuſtom in queſtion.

METELLUS, the ſurname of the family of the Cæcilii at Rome, the moſt known of whom were ——A general who defeated the Achæans, took Thebes, and invaded Macedonia, &c.—Q. Cæcilius, who rendered himſelf illuſtrious by his ſucceſſes againſt Jugurtha the Numidian king, from which he was ſurnamed *Numidicus.* Another who ſaved from the flames the palladium, when Veſta's temple was on fire. He was then high prieſt. He loſt his ſight and one of his arms in the action; and the ſenate, to reward his zeal and piety, permitted him always to be drawn to the ſenate houſe in a chariot, an honour which no one had ever before enjoyed. He alſo gained a great victory over the Carthaginians, &c. Q. Cæcilius Celer, another who diſtinguiſhed himſelf by his ſpirited exertions againſt Catiline. He married the ſiſter of Clodius, who diſgraced him by her incontinence and laſciviouſneſs. He died 57 years before Chriſt. He was greatly lamented by Cicero, who ſhed tears at the loſs of one of his moſt faithful and valuable friends. L. Cæcilius, a tribune in the civil wars of J. Cæſar and Pompey. He favoured the cauſe of Pompey, and oppoſed Cæſar when he entered Rome with a victorious army. He refuſed to open the gates of Saturn's temple, in which were depoſited great treaſures; upon which they were broke open by Cæſar, and Metellus retired when threatened with death. Q. Cæcilius, a warlike general who conquered Crete and Macedonia, and was ſurnamed *Macedonicus.* He had four ſons, of whom three were conſuls, and the other obtained a triumph, all during their father's lifetime. A general of the Roman armies againſt the Sicilians and Carthaginians. Before he marched, he offered ſacrifices to all the gods except Veſta; for which neglect the goddeſs was ſo incenſed, that ſhe demanded the blood of his daughter Metella. When Metella was going to be immolated, the goddeſs placed a heifer in her place, and carried her to a temple at Lanuvium, of which ſhe became the prieſteſs. Another, ſurnamed *Dalmaticus* from his conqueſt over Dalmatia, A. U. C. 634.—Cimber, one of the conſpirators againſt J. Cæſar. It was he who gave the ſignal to attack and murder the dictator in the ſenate houſe. —Pius, a general in Spain, againſt Sertorius, on whoſe head he ſet a price of 100 talents and 20,000 acres of land.

METEMPSYCHOSIS, (formed of μετα "beyond," and εμψυχω "I animate or enliven"), in the ancient philoſophy, the paſſage or tranſmigration of the ſoul of a man, after death, into the body of ſome other animal.

Pythagoras and his followers held, that after death men's ſouls paſſed into other bodies, of this or that kind, according to the manner of life they had led. If they had been vicious, they were impriſoned in the bodies of miſerable beaſts, there to do penance for ſeveral ages: at the expiration whereof, they returned afreſh to animate men. But, if they lived virtuouſly, ſome happier brute, or even a human creature, was to be their lot.

What led Pythagoras into this opinion was, the perſuaſion he had that the ſoul was not of a periſhable nature: whence he concluded that it muſt remove into ſome other body upon its abandoning this. Lucan treats this doctrine as a kind of officious lie, contrived to mitigate the apprehenſion of death, by perſuading men that they only changed their lodging, and only ceaſed to live to begin a new life.

Reuchlin denies this doctrine; and maintains that the metempſychoſis of Pythagoras implied nothing more than a ſimilitude of manners, deſires, and ſtudies, formerly exiſting in ſome perſon deceaſed, and now revived in another alive. Thus when it was ſaid that Euphorbus was revived in Pythagoras, no more was meant than that the martial virtue which had ſhone in Euphorbus at the time of the Trojan war, was now, in ſome meaſure, revived in Pythagoras, by reaſon of the great reſpect he bore the *athletæ*. For thoſe people wondering how a philoſopher ſhould be ſo much taken with men of the ſword, he palliated the matter, by ſaying, that the ſoul of Euphorbus, i. e. his genius, diſpoſition, and inclinations, were revived in him. And this gave occaſion to the report, that Euphorbus's ſoul, who periſhed in the Trojan war, had tranſmigrated into Pythagoras.

Ficinus aſſerts, that what Plato ſpeaks of the migration of a human ſoul into a brute, is intended allegorically, and is to be underſtood only of the manners, affections, and habits, degenerated into a beaſtly nature by vice. Serranus, though he allows ſome force to this interpretation, yet inclines rather to underſtand the metempſychoſis of a reſurrection.

Pythagoras is ſaid to have borrowed the notion of a metempſychoſis from the Egyptians; others ſay, from the ancient Brachmans. It is ſtill retained among the Banians and other idolaters of India and China; and makes the principal foundation of their religion. So extremely are they bigotted to it, that they not only forbear eating any thing that has life, but many of them even refuſe to defend themſelves from wild beaſts. They burn no wood, leſt ſome little animalcule ſhould be in it; and are ſo very charitable, that they will redeem from the hands of ſtrangers any animals that they find ready to be killed. See Pythagoreans.

METEMPTOSIS (from μετα *poſt*, and πιπτω *cado* "I fall,") a term in chronology, expreſſing the ſolar equation, neceſſary to prevent the new moon from happening a day too late. By which it ſtands contradiſtinguiſhed from *proemptoſis*, which ſignifies the lunar equation, neceſſary to prevent the new moon from happening a day too ſoon.

The new moons running a little backwards, that is, coming a day too ſoon at the end of 312 years and a half; by the proemptoſis, a day is added every 300 years, and another every 2400 years: on the other hand, by the metemptoſis, a biſſextile is ſuppreſſed each 134 years; that is, three times in 400 years. Theſe alterations are never made but at the end of each century; that period being very remarkable, and rendering the practice of the calendar eaſy.

There are three rules for making this addition or ſuppreſſion of the biſſextile day, and, by conſequence, for changing the index of the epacts. 1. When there is a metemptoſis without a proemptoſis, the next following, or lower index, muſt be taken. 2. When there is a proemptoſis without a metemptoſis, the next preceding or ſuperior index is to be taken. 3. When there are both a metemptoſis and a proemptoſis, or when there is neither the one nor the other, the ſame index is preſerved. Thus, in 1600, we had D: in 1700, by reaſon of the metemptoſis, C was taken: in 1800, there was both a proemptoſis and a metemptoſis; ſo the ſame index was retained. In 1900, there will be a metemptoſis again, when B will be taken; which will be preſerved in 2000, becauſe there will then be neither the one nor the other. This is as far as we need compute for it: But Clavius has calculated a cycle of 301,800 years; at the end of which period, the ſame indices return in the ſame order. See Epact.

METEOR, (by the Greeks called μετεωρα, q. d. *ſublima* or "high raiſed;" by the Latins *impreſſiones* as making ſigns or impreſſions in the air), commonly denotes any bodies in the air that are of a tranſitory nature. Hence it is extended to the phenomena of hail, rain, ſnow, thunder, &c.; but is moſt commonly confined to thoſe unuſual and fiery appearances named *falling ſtars*, *ignes fatui*, *auroræ boreales*, &c. See Meteorology.

METEOROLITE. This term is derived from the Greek μετεωρα, a *meteor*, and λιθος, a *ſtone*; and denotes a ſtony ſubſtance, exhibiting peculiar characters, and whoſe deſcent to the earth is uſually accompanied by the appearance and exploſion of a fire-ball.

Luminous meteors have, in all ages, been obſerved in the atmoſphere. It is alſo well known that their diſappearance has frequently been attended with a loud noiſe; but that they ſhould moreover terminate in the fall of one or more ſolid bodies to the earth's ſurface, is a poſition ſo repugnant to our ordinary conceptions of the tenor of phyſical events, that we cannot admit it as a fact on ſlight or ſcanty evidence. With due deference, however, to ſome philoſophers of name, we are not prepared to aſſert, that it implies impoſſibility. For who has explored the higher regions of the atmoſphere? or who knows what may take place beyond its precincts? If a ſolid reſult from the combination of two aeriform ſubſtances, as muriatic acid and ammoniacal gaſes; if oxygen, the properties of which are moſt familiar to us in the ſtate of gas, can undergo fixation, and if fluids can paſs into cryſtalline forms, is it too bold to preſume, that the ſame, or ſimilar proceſſes, effected in the grand laboratory of the atmoſphere, may be within the range of poſſible occurrences? At all events, the ſame Being who called into exiſtence thoſe ſublime and countleſs maſſes of matter which revolve in ſpace, may, to ſerve purpoſes unknown to us, create bodies of dimenſions infinitely ſmaller, and deſtined to impinge on ſome planetary orb. The reaſoning of an angel may not convince us, that a part is greater than the whole, or that the value of two and two is equivalent to ſix; but a very ordinary logician may prove to our ſatisfaction, that the contact of particles of matter in portions of ſpace which lie beyond our globe, is no chimerical ſuppoſition. Every thing around us proclaims, that matter is ſubject to inceſſant change. New forms and new modifications are ever ſpringing into being: and can we doubt, that the ſame particles, as they may happen to be affected or influenced by various circumſtances, may exiſt in the ſtate of gas, of aqueous vapour, or of a concrete maſs?

Again, it ſurely will not be ſeriouſly maintained, that, from the rarity of a phenomenon, we are warranted to infer its nonexiſtence. The appearance of a comet is a rare, but not a fictitious, occurrence. Nay, we may ſafely advance a ſtep farther, and aſſert, without fear of confutation, that the exiſtence of a phenomenon, if otherwiſe well atteſted, cannot be diſproved by our inability to explain it. How multiplied, in fact, are the ſubjects, even of our daily and hourly obſervation, which we cannot ſatiſfactorily expound? We cannot ſay why a ſmall ſeed ſhould gradually unfold into a large tree, why flame ſhould produce heat, why the hand ſhould act in immediate ſubſerviency to the will, or why a contuſion of the brain ſhould induce ſtupor, alienation of mind, or death. It is one thing to prove a fact, and it is another to account for it.

From theſe premiſes it follows in courſe, that we are not entitled to reject the exiſtence of meteoric ſtones, provided it be eſtabliſhed by valid teſtimony. Should the hiſtorical evidence, on a fair and diſpaſſionate review, be deemed concluſive, we may afterwards examine the theories which have been propoſed for the ſolution of the appearance.

From the Scriptures of the Old Teſtament we are not aware that any paſſage can be cited in direct corroboration of the deſcent of ſtones from the atmoſphere. The ingenious and fanciful Mr Edward King, indeed, in his "Remarks concerning ſtones ſaid to have fallen from the clouds, both in theſe days, and in ancient times," adverts to the 13th verſe of the 18th Pſalm.—"The Lord alſo thundered out of heaven, and the Higheſt gave his thunder: hail-ſtones and *coals of fire*." This laſt expreſſion has, no doubt, been conjectured to denote real hard bodies, in a ſtate of ignition; and the term *ανθρακες*, employed by the cautious Seventy, rather favours ſuch an interpretation. The ſame expreſſion, however, occurs in the preceding verſe, without admitting this interpretation; and the phraſe ſeems to be only a figurative mode of deſcribing lightning. In the ſober latitudes of the north, and even in colloquial language, we talk of *balls of fire* and *thunderbolts*, without any reference to ſolid matter. Mr King likewiſe quotes the 11th verſe of the 10th chapter of Joſhua.—"And it came to paſs, as they fled from before Iſrael, and were in the going down to Beth-horon, that the Lord caſt down *great ſtones* from heaven upon them unto Azekah, and they died: they were more which died with hail-ſtones, than they whom the children of Iſrael ſlew with the ſword." Here, the expreſſion, *great ſtones*, is leſs equivocal than *coals of fire;* yet the context hardly allows us to doubt, that the great ſtones were really hail-ſtones, or rather, perhaps, lumps of ice, conſolidated in the atmoſphere, ſuch as occaſionally fall in hot countries, and ſuch as alarmed the whole of Paris and its neighbourhood in 1788. At any rate, the ſlaughter of the Canaanites is repreſented as reſulting from the ſpecial interpoſition of divine power; and the conſideration of miracles is irrelevant to our preſent purpoſe.

If from ſacred, we turn to the early period of profane hiſtory, we ſhall find the annals of public events very copiouſly interſperſed with notices of ſtrange appearances, many of which may be ſafely aſcribed to the aſcendancy which ſuperſtition long obtained over the human mind. The ſcepticiſm of the learned is, however, ſometimes not leſs injudicious and indiſcriminate than the credulity of the ſavage; and he who ſhould reſolve every extraordinary event, which is recorded by the writers of Greece and Rome, into a "cunningly deviſed fable," would not be leſs reprehenſible for want of candour, than the untutored ruſtic, who yields his aſſent to every alledged miracle, is to be taxed with want of diſcernment.

Although theſe general poſitions can ſcarcely admit of diſpute, it becomes extremely difficult, after a lapſe of many ages, and in the collation of marvellous records, to ſeparate truth from falſehood. In our attempts to proſecute this analytical proceſs, we may ſometimes advance a certain length with perfect ſecurity, without being able to trace uniformly the preciſe lines of demarcation. Thus, in regard to the topic of our preſent diſcuſſion, we know, that in various periods of the world the vulgar have aſcribed a celeſtial origin to ſtones of a peculiar configuration, as to certain modifications of pyrites, to belemnites, orthoceratites, &c. which the ſubſequent obſervations of naturaliſts have proved to be of mineral formation, and to the heads of arrows and ſharpened flints, which have been faſhioned by the hand of man, and which, accordingly we are authorized to exclude from the ex-terreſtrial catalogue. But when ſubſtances diſſimilar from theſe, and coinciding in any one character or circumſtance with modern ſpecimens of atmoſpheric ſtone, are reported by the ancients to have fallen from the clouds, the diſtance of ages and the lameneſs of the documents may powerfully affect our appreciation of the reputed evidence.

When, therefore, we ſhortly touch on a few of the many inſtances which might be quoted from the annals of antiquity, we mean not to vouch for the truth even of theſe particular inſtances; but merely to admit their probability, and the weight which the mention of them may be conſidered to add to that of ſubſequent and recent narrations.

Through the miſt of fable which envelopes the hiſtory of the *bætuli*, we diſcern ſome characters which correſpond with thoſe of meteorolites. Thus, in the *Λιθικα*, a poem faſely aſcribed to Orpheus, the *σιδηριτης*, which M. Falconet properly claſſes with the bætuli, is ſaid to be *rough*, *heavy*, and *black*. Damaſcius, in an extract of his life of Iſidorus, preſerved by Photius, relates that the bætuli fell on Mount Libanus, in *a globe of fire.* A fragment of Sanchoniathon, preſerved in Euſebius, (Præpar. Evangel. i. 10.), moreover informs us, that theſe ſtones were fabricated by the god *Uranus* (or *Heaven*), one of whoſe four ſons was named *Bætul.* May not this mythological genealogy be regarded as merely emblematical of their deſcent from the upper regions of the atmoſphere? In the ſame chapter we are told that Aſtarte found a *ſtar* which had *fallen from heaven*, and honoured it with conſecration in the city of Tyre. The ſtone denominated "the mother of the gods," if we can believe Appian, Herodian, and Marcellinus, *fell from heaven.* Ariſtodemus, cited by the Greek ſcholiaſt on Pindar, aſſerts that it *fell encircled by fire*, on a hill, at the feet of the Theban bard. It is ſaid to have been of a *black* colour, and of an *irregular* ſhape. Herodian (lib. v.) expreſsly declares, that the Phœnicians had no ſtatue of the ſun, poliſhed by the hand; but only a certain ſtone, circular below, and terminated acutely above, in the form of a cone, of a *black* colour, and that, according to report, it *fell from heaven*, and was regarded as the image of the ſun.

Among various inſtances which might be ſelected from Livy, is that of a ſhower of ſtones on Mount Alba, in the reign of Tullus Hoſtilius, or about ſix hundred and fifty-two years before the birth of Chriſt. When the ſenate were told, that it had *rained ſtones*, they doubted the fact, and deputed commiſſioners to inquire into the particulars. They were then aſſured, that ſtones had really fallen, *haud aliter quam quum grandinem venti glomeratam in terras agunt.* On this occaſion, the hiſtorian mentions, that ſimilar events were celebrated by a feſtival of nine days. *Manſit ſolemne, ut quandocumque idem prodigium nuntiaretur, feriæ per novem dies agerentur.*

But one of the moſt remarkable caſes which occurs in the records of antiquity, is that which is mentioned in the 58th chapter of the ſecond book of Pliny's Natural Hiſtory, of a large ſtone which fell near Egoſpotamos, in Thrace, in the ſecond year of the ſeventy-eighth Olympiad, or, according to our chronology, about four hundred and ſixty-ſeven years before the Chriſtian era. Pliny aſſures us, that this extraordinary maſs was ſtill ſhewn in his day; and that it was as large as a cart, and of a *burnt colour*. The Greeks pretended that it had *fallen from the ſun*, and that Anaxagoras had predicted the day of its arrival on the earth's ſurface. According to Plutarch, in the life of Lyſander, the inhabitants of the Cherſoneſus held the Thracian ſtone in great veneration, and exhibited it as a public ſhow. His account of its firſt appearance is chiefly extracted from the relation of Daimachus of Platææ, and may be thus tranſlated. "During ſeventy-five ſucceſſive days before the ſtone fell, a large fiery body, like a cloud of flame, was obſerved in the heavens, not fixed to one point, but wandering about with a broken, irregular motion. By its violent agitation, ſeveral fiery fragments were forced from it, impelled in various directions, and darted with the velocity and brightneſs of ſo many ſhooting ſtars. After this body had fallen on the Cherſoneſus, and the people had aſſembled to examine it, they could find no inflammable matter, nor the ſlighteſt trace of combuſtion, but a real ſtone, which, though large, by no means correſponded to the dimenſions of the flaming globe which they had ſeen in the ſky, but ſeemed to be only a piece detached from it." Daimachus, it is true, may, on this occaſion, have given way to his reputed love of the marvellous; and we can eaſily believe that the *ſeventy five continuous days* are either an error of the copyiſt, or an original exaggeration; yet, from the marked coincidence of ſome of the circumſtances with thoſe more fully detailed in the ſequel, there ariſes the preſumption that a meteorolite really fell at the place and period above aſſigned.

From this period, till near the cloſe of the fifteenth century, any hiſtorical notices which we have been enabled to collect, are ſo vague and ſcanty, that, in this abridged view of the ſubject, we may paſs them over in ſilence.

Profeſſor Bantenſchoen, of the central ſchool of Colmar, firſt directed the attention of naturaliſts to ſome of the old chronicles, which commemorate with much *naivete*, and in the true ſpirit of the times, the fall of the celebrated ſtone of Enſiſheim. The following account accompanied this very ſingular maſs, when it was ſuſpended in the church.

"In the year of the Lord 1492, on Wedneſday, which was Martinmas eve, the 7th of November, there happened a ſingular miracle: for, between eleven o'clock and noon, there was a loud peal of thunder, and a prolonged confuſed noiſe, which was heard to a great diſtance, and a ſtone fell from the air, in the juriſdiction of Enſiſheim, which weighed 260 pounds, and the confuſed noiſe was, moreover, much louder than here. There a child ſaw it ſtrike on a field, ſituated in the upper juriſdiction, towards the Rhine and Inn, near the diſtrict of Giſgard, which was ſown with wheat, and did it no harm, except that it made a hole there: and then they conveyed it from that ſpot; and many pieces were broken from it, which the landvogt forbade. They, therefore, cauſed it to be placed in the church, with the intention of ſuſpending it as a miracle; and many people came hither to ſee this ſtone. So there were remarkable converſations about this ſtone: but the learned ſaid, that they knew not what it was; for it was beyond the ordinary courſe of nature, that ſuch a large maſs ſhould ſmite the earth from the height of the air; but that it was really a miracle of God; for, before that time, never any thing was heard like it, nor ſeen, nor deſcribed. When the people found that ſtone, it had entered into the earth, to the depth of a man's ſtature, which every body explained to be the will of God, that it ſhould be found, and the noiſe of it was heard at Lucerne, at Villing, and in many other places, ſo loud, that it was believed that houſes had been overturned: And as the king (Maximilian) was here, the Monday after St Catherine's day, of the ſame year, his royal excellence ordered the ſtone which had fallen to be brought to the caſtle, and after having converſed a long time about it with the noblemen, he ſaid the people of Enſiſheim ſhould take it, and order it to be hung up in the church, and not allow any body to take any thing from it. However, his excellency took two pieces of it, of which he kept one, and ſent the other to the duke Sigiſmund of Auſtria; and they ſpoke a great deal about this ſtone, which they ſuſpended in the choir, where it ſtill is; and a great many people came to ſee it."

Trithemius, in his Hirſaugienſian Annals, employs language to this effect.—"In the ſame year, on the 7th day of November, in the village of Suntgaw, near the townlet of Enſiſheim, not far from Baſil, a city of Germany, a ſtone, called a thunder-ſtone, of a prodigious ſize, for we know from eye-witneſſes that it weighed 255 pounds, fell from the heavens. Its fall was ſo violent, that it broke into two pieces. The moſt conſiderable is ſtill exhibited at the door of the church of Enſiſheim, ſuſpended by an iron chain, as a proof of the fact which we have mentioned, and to preſerve it in the public recollection."—We learn alſo from Paul Lang that there aroſe a furious ſtorm on the 7th of November 1492, and that while the thunder roared, and the heavens appeared all on fire, a ſtone of enormous ſize fell near Enſiſheim. "Its form was that of the Greek delta, with a triangular point. They ſtill ſhow it at Enſiſheim as an aſtoniſhing phenomenon."

It is worthy of obſervation, that theſe chroniclers lived at the period which they aſſign to the deſcent of the ſtone; and that, though their names are haſtening to oblivion, Trithemius yielded to few of his contemporaries in labour and learning; while Lang, a German Benedictine as he was, travelled in ſearch of hiſtorical monuments, arraigned the licence of the catholic clergy, and applauded the independence of Luther and Melancthon.

Of the Enſiſheim ſtone, which has been tranſported to the national library at Colmar, and which, notwithſtanding various *dilapidations*, ſtill weighs 150 pounds, ſome intereſting ſpecimens may now be ſeen in the cabinets of the curious. Robert Ferguſon, Eſq. younger of Raith, has, in the moſt polite and obliging manner, gratified us with the ſight of a ſmall fragment, which belongs to his valuable collection of minerals at Raith houſe in Fifeſhire, Scotland.

We are fully aware, that M. Barthold has laboured to convince his readers (Journal de Phyſique, Ventoſe, year 8.) that the far-famed maſs of Enſiſheim is merely argillo-ferrugineous, of ſecondary formation, detached from an adjacent mountain, and conveyed to the ſpot on which it was found by ſome torrent or land-flood. In this opinion, we might partially acquieſce, did not the artleſſneſs of contemporary and concurring records militate againſt it, and had not the more accurate analyſis of Vauquelin detected the ſame conſtituent parts as in the other ſtony and metalline ſubſtances denominated meteoric. "It is certainly compoſed of ſilica," obſerves this celebrated chemiſt, "of magneſia, of iron, of nickel, of ſulphur, and of a ſmall quantity of lime.—Particular trials have convinced me of the preſence of ſulphur and nickel in the grains of malleable iron, and in the pyrites, though in different proportions. This ſtone, then, in every reſpect, reſembles others which have fallen from the atmoſphere."

In the Commentary of Surius, a Carthuſian monk of Cologne, mention is made of a ſhower of large ſtones in Lombardy, in 1510. Theſe ſtones were harder than flint, and ſmelled of ſulphur. The heavieſt weighed 120 pounds.—The ſame event is more particularly related by Cardan, in his work intitled *de Rerum Varietate* (lib. xiv. c. 72) According to this author, near the river Adda, not far from Milan, and at five o'clock in the evening, about 1120 ſtones fell from the air, one of them weighing 120 pounds and another 60 pounds. Many were preſented to the French governor, and his deputy. At three o'clock P. M. the ſky appeared as if in a general blaze; and the paſſage, though ſomewhat ambiguous, would lead us to infer, that the meteor was viſible for two hours. Like many of the learned and unlearned of his day, Cardan inſtantly connects the extraordinary appearance with the political tranſactions of his diſtrict.

We next paſs to an intereſting extract from the memoirs of the emperor Jehangire, written in Perſian, by himſelf, and tranſlated by Colonel Kirkpatrick,

"*A. H.* 1030, *or* 16th *year of the reign*.—The following is among the extraordinary occurrences of this period.

"Early on the 30th of Furverdeen of the preſent year (1620), and in the eaſtern quarter of the heavens, there aroſe in one of the villages of the purgunnah of Jalindher, ſuch a great and tremendous noiſe, as had nearly, by its dreadful nature, deprived the inhabitants of the place of their ſenſes. During this noiſe, a luminous body was obſerved to fall from above, on the earth, ſuggeſting to the beholders the idea that the firmament was raining fire. In a ſhort time, the noiſe having ſubſided, and the inhabitants having recovered from their alarm, a courier was diſpatched to *Mahommed Syeed*, the aumil of the aforeſaid purgunnah, to advertiſe him of this event. The aumil, inſtantly mounting his horſe, proceeded to the ſpot. Here he perceived the earth, to the extent of a dozen of yards in length and breadth, to be burned to ſuch a degree, that not the leaſt trace of verdure, or a blade of graſs remained; nor had the heat yet ſubſided entirely.

"*Mahommed Syeed* hereupon directed the aforeſaid ſpace of ground to be dug up; when the deeper it was dug, the greater was the heat of it found to be. At length a lump of iron made its appearance, the heat of which was ſo violent, that one might have ſuppoſed it to have been taken from a furnace. After ſome time it became cold: when the aumil conveyed it to his own habitation, from whence he afterwards diſpatched it in a ſealed bag to court.

"Here I had this ſubſtance weighed in my preſence. Its weight was 160 tolahs (A). I committed it to a ſkilful artiſan, with orders to make of it a ſabre, a knife, and a dagger. The workman reported, that the ſubſtance was not malleable, but ſhivered into pieces under the hammer.

"Upon this I ordered it to be mixed with other iron. Conformably to my orders, three parts of the *iron of lightning* (B) were mixed with one part of common iron; and from the mixture were made two ſabres, one knife, and one dagger."

Our limits will not permit us to give the whole of the extract, nor the remarks of the Right Hon. Charles Greville and Colonel Kirkpatrick, which were read before the Royal Society of London, on the 27th January, 1803. We feel, however, no heſitation in attaching to this document ſomething very nearly approaching to direct evidence of the fact in queſtion.

The celebrated Gaſſendi relates, that, on the 27th of November, 1627, about 10 o'clock A. M. during a very clear ſky, he ſaw a flaming ſtone, of the apparent diameter of four feet, fall on Mount *Vaiſion*, an eminence ſituated between the ſmall towns of Perne and Guillaumes, in Provence. This ſtone was ſurrounded by a luminous circle of different colours, nearly reſembling the rainbow, and its fall was accompanied with a noiſe like the diſcharge of artillery. It weighed 59 pounds; and its ſpecific gravity was to that of common marble as 14 to 11. It was of a dark metallic colour, and extremely hard. Though it was not ſubjected to chemical analyſis, and is not now to be found, the circumſtances which have been ſtated by the philoſopher are ſufficiently

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(A) A tolah is about 180 grains, Troy weight.

(B) This expreſſion is equivalent to our term *thunder-bolt*.

ſufficiently minute to operate on the conviction of thoſe who are willing to be convinced.

From a curious book printed at Paris in 1672, and now become very ſcarce, entitled *Converſations tirées de l'Académie de M. l'Abbé Bourdelot, contenant diverſes recherches et obſervations phyſiques, par le Sieur Legallois*, we make the enſuing extract.

“A member preſents a fragment of two ſtones which fell near Verona, one of which weighed 300, and the other 200 pounds. Theſe ſtones,” ſays he, “fell during the night, when the weather was perfectly mild and ſerene. They ſeemed to be all on fire, and came from above, but in a ſlanting direction, and with a tremendous noiſe. This prodigy terribly alarmed 300 or 400 eye-witneſſes, who were at a loſs what to think of it. Theſe ſtones fell with ſuch rapidity, that they formed a ditch, in which after the noiſe had ceaſed, the ſpectators ventured to approach them, and examine them more cloſely. They then ſent them to Verona, where they were depoſited in the Academy, and that learned body ſent fragments of them to different places.” That which accompanied the above intimation was of a yellowiſh hue, very eaſily pulverized, and ſmelled of ſulphur.—In the courſe of examining one of theſe ſtones, M. Laugier, profeſſor of pharmacy at Paris, has recently detected the preſence of chrome, by means of the cauſtic alkali.—The date of the Verona phenomena, if we have been correctly informed, is 1663.

In the Bornian collection there is a ſubſtance which is deſignated *Ferrum retractorium, granulis nitentibus, matrice vireſcenti immixtis* (*Ferrum virens Lin.*), *cujus fragmenta ab unius ad viginti uſque librarum pondus, cortice nigro ſcoriaceo circumdata, ad Plann, prope Tabor, circuli Bechinenſis Bohemiæ, paſſim reperiuntur.* The following note is ſubjoined. (*Quæ fragmenta 3 Julii anni 1753, inter tonitrua, è cœlo pluiſſe creduliores quidam aſſerunt.*) The expreſſion *creduliores quidam*, it may be alledged, at once deſtroys the evidence of this memorandum. It deſerves, however, to be noted, that, in regard to our preſent ſubject, what was formerly accounted the credulity of the vulgar, may now, on ſeveral occaſions, be conſtrued into probability, if not into matter of fact; and that Mr Greville has found the identical fragment to have the ſame compoſition with other meteoric ſtones. Hence, we are compelled either to admit its ex-terreſtrial origin, or the exiſtence of a ſubſtance, originally belonging to the earth, and yet agreeing in character with thoſe deemed atmoſpheric. The former part of the alternative is perfectly conſonant with well-authenticated facts; whereas of the latter, we are not warranted to pronounce, that a ſingle caſe has hitherto been eſtabliſhed to the ſatisfaction of any chemiſt or mineralogiſt.

But we have now to turn our attention to a report of M. de la Lande, inſerted in the Hiſtorical Almanack of Breſſe, for 1756.

In the month of September, 1753, about one o'clock P. M. when the weather was very hot, and very ſerene, without the leaſt appearance of a cloud, a very loud noiſe, like the diſcharge of two or three cannons, was heard within the circumference of ſix leagues, but was of very ſhort duration. This noiſe was loudeſt in the neighbourhood of Pont-de-Veſle; and at Liponas, a village three leagues from the laſt-mentioned place, it was even accompanied with a hiſſing, like that of a cracker. On the ſame evening there were found at Liponas and at Pin, two blackiſh maſſes, of a form nearly circular, but very uneven, which had fallen on ploughed ground, and ſunk, by their own weight, to half a foot below the ſurface. One of them weighed about twenty pounds; and a fragment of one of them weighing 11½lb. was preſerved in the cabinet of M. Varenne de Beoſt, at Dijon. The baſis of theſe maſſes reſembled a grayiſh whinſtone, and was very refractory; and ſome ferrugineous particles were diſſeminated in grains, filaments, or minute maſſes, through the ſubſtance of the ſtone, eſpecially in its fiſſures. This iron, when ſubjected to a red heat, became obedient to the magnet. The black coating on the ſurface, M. de la Lande aſcribes to fuſion, induced by violent heat. This gentleman's acknowledged reſpectability and accuracy of obſervation, combined with the circumſtances which he has adduced, circumſtances, too, which, if miſtated, lay ſo open to public inveſtigation, powerfully plead in favour of his teſtimony.

On the 15th of September 1760, according to the abbé Bachelay, about half paſt four o'clock P. M. there appeared near the chateau de Chevabrie, in the neighbourhood of Lucé, a ſmall town of the province of Maine, a ſtormy cloud, from which proceeded a loud peal of thunder, like the diſcharge of cannon, and followed by a noiſe which was miſtaken by ſeveral people for the lowing of oxen. This ſound was heard over a ſpace of about two leagues and a half, but unaccompanied by any perceptible flame. The reapers in the pariſh of Perigué, about three leagues from Lucé, on hearing the ſame noiſe, looked up, and ſaw an opake body, which deſcribed a curve, and fell on ſoft turf, on the high road from Mons, near which they were at work. They all quickly ran up to it, and found a ſort of ſtone, nearly half of which was buried in the earth, and the whole ſo hot that it could not be touched. At firſt they ran away in a panic; but on returning to the ſpot ſome time after, they found the ſtone preciſely in the ſame ſituation, and ſufficiently cooled to admit of being handled, and narrowly examined. It weighed ſeven ounces and a half, and was of a triangular form, preſenting, as it were, three rounded horns, one of which, at the moment of the fall had entered into the ground, and was of a gray or aſh colour, while the reſt, which was expoſed to the air, was very black. When the abbé preſented this ſtone to the academy, that body appointed three of its number, namely, Meſſieurs Lavoiſier, Fougeroux, and Cadet, to examine and analyſe it. This taſk they performed with more care and accuracy than M. de la Lande had done on the preceding occaſion; but their trial was confined to an integral part of the whole, conſidered as a homogeneous ſubſtance, in place of being repeated on each of the conſtituent parts. The ſubſtance was of a pale cinereous hue, ſpeckled with an infinite number of ſmall and ſhining metallic points, viſible through a magnifying glaſs. That part of the outer ſurface which remained above ground was incruſted with a thin black coating, which ſeemed to have undergone fuſion, and which gave a few ſparks when ſtruck with ſteel. The ſpecific gravity of the maſs was 3535.—Two other ſtones, nearly of the ſame characters, the one reported to have fallen at Aire, in Artois, and the other in the Cotentin, in Normandy, were preſented to the academy in the courſe of the ſame year by M. Gurſon de Boyaval, honorary lieutenant-general of the bailliage of Aire, and the younger M. Morand. According to the academical report, theſe three ſtones, when compared, preſented no difference to the eye, were of the ſame colour, and nearly of the ſame grain, exhibiting metallic and pyritous particles, and covered with a black and ferrugineous incruſtation. Although the coincidence of facts and circumſtances, in three places ſo remote from one another, did not convince the academy that theſe ſtones had been conveyed to the earth by lightning, yet it induced them to invite naturaliſts to proſecute the examination of the ſubject.

On the 20th of November 1768, a ſtone fell at Mauerkircken near the Inn, in Bavaria, that weighed 38lb. was of a triangular form, and only eight inches in thickneſs. Its fall was accompanied by a hiſſing noiſe, and great darkneſs in the atmoſphere. This meteorolite penetrated two feet and a half into the ſoil. Part of it is now in the muſeum of the right honourable Charles Greville, and a fragment may be ſeen in Mr Ferguſon's collection quoted above.

The next remarkable caſe on record occurred on the 20th of Auguſt 1789, at Barbotan, near Roquefort, in the *Landes* of Bordeaux, and is thus related by Citizen Lomet, who was known to ſeveral members of the inſtitute, and happened to be at Agen when the meteor appeared.

“ It was a very bright fire-ball, luminous as the ſun, of the ſize of an ordinary balloon, and, after inſpiring the inhabitants with conſternation, burſt and diſappeared. A few days after, ſome peaſants brought ſtones, which they ſaid fell from the meteor; but the philoſophers to whom they offered them laughed at their aſſertions as fabulous. The peaſants would have now more reaſon to laugh at the philoſophers.”—One of theſe ſtones broke through the roof of a cottage, and killed a herdſman and ſome cattle. Vauquelin, who received a *proces-verbal* of the circumſtances, alſo examined one of the ſpecimens. The fragment procured by Mr Ferguſon has viſibly all the characters of a genuine meteorolite.

A much more remarkable phenomenon, however, of the ſame deſcription, occurred near Agen, on the 24th of July 1790. An inhabitant of St Severe communicates the following particulars to M. Darcet the chemiſt, who was then reſident at Paris.

“ Our towns-people were yeſterday very much alarmed. About a quarter paſt nine o'clock, in the evening, there ſuddenly appeared in the air a fire-ball, dragging a long train, which diffuſed a very vivid light over the horizon. This meteor ſoon diſappeared, and ſeemed to fall at one hundred paces from us. It was quickly followed by an exploſion louder than that of cannon or of thunder. Every body dreaded being buried under the ruins of his houſe, which ſeemed to give way from the concuſſion. The ſame phenomenon was ſeen, and the report heard, in the neighbouring towns, as Mont de Marſan, Tartas, and Dax. The weather in other reſpects was very calm, without a breath of wind or a cloud, and the moon ſhone in all her brightneſs.”

M. Darcet's brother, a clergyman in that part of the country, ſent him a ſmall ſtone, which was picked up on the morning after the exploſion, and the hiſtory of which he was ſcrupulouſly anxious to inveſtigate. Being ſatisfied with reſpect to all the particulars, he at length diſpatched it to Paris, accompanied with ſome curious remarks. “ When theſe ſtones fell,” ſays he, “ they had not their preſent degree of hardneſs. Some of them fell on ſtraw, bits of which ſtuck to the ſtones, and incorporated with them. I have ſeen one in this predicament. It is at preſent at la Baſtide; but I cannot perſuade the owner to part with it * * *. Thoſe which fell on the houſes produced a noiſe, not like that of ſtones, but rather of a ſubſtance which had not yet acquired compactneſs.”

We ſubjoin the *proces-verbal*—a ſimple but authentic document.

“ In the year one thouſand ſeven hundred and ninety, and the 30th day of the month of Auguſt, we, the Sieur Jean Duby, mayor, and Louis Maullon, procurator of the commune of the municipality of La Grange de Juillac, and Jean Darmite, reſident in the pariſh of La Grange de Juillac, certify in truth and verity, that, on Saturday the 24th of July laſt, between nine and ten o'clock in the evening, there paſſed a great fire, and after it we heard in the air a very loud and extraordinary noiſe; and, about two minutes after, there fell ſtones from heaven, but fortunately there fell only a very few, and they fell about ten paces from one another in ſome places, and in others nearer, and finally, in ſome other places, farther, and falling, moſt of them, of the weight of about half a quarter of a pound each; ſome of about half a pound, like that found in our pariſh of La Grange; and on the borders of the pariſh of Creon, they were found of a pound weight; and in falling they ſeemed not to be inflamed, but very hard and black without, and within of the colour of ſteel; and, thank God, they occaſioned no harm to the people, nor the trees, but only to ſome trees which were broken on the houſes; and moſt of them fell gently, and others fell quickly, with a hiſſing noiſe; and ſome were found which had entered into the earth, but very few. In witneſs whereof we have written and ſigned theſe preſents. (Signed) DUBY, Mayor—DARMITE.”

Monſieur Baudin mentions, that, as M. Carris of Barbotan and he were walking in the court of the caſtle of Mormes about half paſt nine o'clock, in the evening of the 24th of July 1790, when the air was perfectly calm, and the ſky cloudleſs, they found themſelves ſuddenly ſurrounded by a pale clear light, which obſcured that of the moon, though the latter was nearly full. On looking up, they obſerved, almoſt in their zenith, a fire-ball of a larger apparent diameter than that of the moon, dragging a tail, which ſeemed to be five or ſix times longer than the diameter of its body, and which gradually tapered to a point, the latter approaching to blood-red, though the reſt of the meteor was of a pale white. This luminous body proceeded with great velocity from ſouth to north, and in two ſeconds ſplit into portions of conſiderable ſize, like the fragment of a burſting bomb. Theſe fragments became extinguiſhed in the air, and ſome of them, as they fell, aſſumed that deep red colour, which had been obſerved at the point of the tail. Two or three minutes after M. Baudin and his friend heard a dreadful exploſion, like the ſimultaneous firing of ſeveral pieces of ordnance; but they were not ſenſible of any tremulous motion under their feet, though the concuſſion of the atmoſphere ſhook the windows in their frames, and threw down kitchen utenſils from their ſhelves. When theſe gentlemen removed to the garden, the noiſe ſtill continued, and ſeemed to be directly over their heads. Some time after it had ceaſed, they heard a hollow ſound rolling, in echoes, for fifty miles, along the chain of the Pyrenees, and at the end of about four minutes gradually dying away in diſtance. At the ſame time, a ſtrong ſulphureous odour was diffuſed in the atmoſphere. The interval which occurred between the diſruption of the meteor, and the loud report, induced M. Baudin to conjecture, that this fireball muſt have been at leaſt eight miles from the earth's ſurface, and that it fell about four miles from Mormes. "The latter part of my conjecture, ſays he, was ſoon confirmed by an account which we received of a great many ſtones having fallen from the atmoſphere at Juillac and in the neighbourhood of Barbotan." It appears, indeed, from the concurring teſtimony of intelligent perſons worthy of credit, that the meteor really exploded at a little diſtance from Juillac, and that its fragments were found lying in an almoſt circular ſpace, of nearly two miles in diameter. Some of them weighed eighteen or twenty, and a few, it is alleged, even fifty pounds. M. de Carris procured one of 18 lbs. which he tranſmitted to the Pariſian Academy of Sciences. That examined by M. Baudin was ſmall, but heavy in proportion to its ſize, black on the outſide, grayiſh within, and interſperſed with many minute, ſhining, metallic particles. Theſe laſt circumſtances perfectly accord with the fragment of a Barbotan ſtone preſerved in Mr Ferguſon's collection.

In one of his letters to Profeſſor St Amand, M. Goyon d'Arzas remarks, that theſe ſtones, though generally ſmooth on the outſide, preſented ſome longitudinal cracks, or fiſſures, while their interior parts exhibited ſymptoms of metallic veins, eſpecially of a ferrugineous complexion. When yet red-hot, and ſcattered in various directions, they formed that magnificent fire-work, that ſhower of flame, which enlightened the horizon over a large tract of country; for this extraordinary meteor was ſeen at Bayonne, Auch, Pau, Tarbes, and even at Bordeaux and Toulouſe. At the laſt mentioned place it excited little attention, on account of its great diſtance, and its appearing only a little brighter than a ſhooting ſtar. It, moreover, deſerves to be noted, that the meteorolites in queſtion were found on a bare moor, of an extremely thin ſoil, on which no ſuch ſtones, or indeed ſtones of any deſcription, had been obſerved in the memory of man. They who are ſolicitous of additional information on this part of our ſubject, may conſult N^{os}. 23 and 24 of the *Journal des Sciences Utiles* of Montpelier, for 1790, and the *Decade Philoſophique* for February 1796.

When all the circumſtances of the caſe are duly conſidered, we need not be ſurpriſed, that they ſhould produce conviction on the minds of many men of ſcience, who, till then, poſſeſſed "an evil heart of unbelief." M. de St Amand ingenuouſly confeſſed to M. Pictet of Geneva, that he had treated this novel topic with unmerited contempt, and that the evidence deduced from the ſimilar characters of the ſtones ſhould not be raſhly rejected. The learned and the unlearned of the diſtrict in which the phenomenon is ſtated to have occurred, atteſt its exiſtence; the profeſſor of natural hiſtory in the central ſchool of Agen renounces his former ſcepticiſm; Vauquelin analyſes a ſpecimen, and finds it to contain the ſame chemical ſubſtances as other meteorolites, and in nearly the ſame proportions; and ſhall we be ſo unreaſonable as to withhold our aſſent, merely becauſe we have not *ocular demonſtration* of the alledged particulars?

Our chronological ſeries of caſes has now brought us to the fall of ſeveral meteorolites near Sienna, the particulars of which, as reported by the late earl of Briſtol and Sir William Hamilton, are recorded in the firſt part of the Philoſophical Tranſactions for 1795 (page 103). Mr King, likewiſe in the tract which we have already quoted, communicates ſome intereſting circumſtances relative to this phenomenon, chiefly extracted from an account of it publiſhed by Profeſſor Soldani. While we refer our readers to theſe details, we cannot omit mentioning that, in regard to aſpect and compoſition, the Sienna ſtones are perfectly analogous to others already noticed, and very different from any that occur in Tuſcany. As the meteor from which they were diſcharged appeared on the morning after a violent eruption of Veſuvius, they were at firſt ſuppoſed to be volcanic, till cool reflection and examination betrayed the extravagance of ſuch a hypotheſis. The preciſe number of ſtones which were collected on this occaſion is not ſpecified, but many of them were ſmall, weighing from a quarter of an ounce to two ounces. A pretty entire ſpecimen occurs in Mr Ferguſon's collection.—The date of the Sienna meteor is the 16th of June, 1794.

On the 13th of December of the following year, about three o'clock in the afternoon, another of theſe ſingular ſtones, weighing 56 pounds, fell near the country houſe of Captain Topham, in Yorkſhire. The captain's report, which is inſerted in the Gentleman's Magazine for 1796, is diſtinct and ſatisfactory; while the chemical examination of the maſs, detailed in Mr Howard's paper, in the Philoſophical Tranſactions for 1802, affords a ſtill more deciſive proof of its atmoſpheric origin. M. de Drée, alſo, found it to correſpond exactly in aſpect and character, with fragments of meteor ſtones from Benares and Ville-franche. The original maſs is in the poſſeſſion of Mr Sowerby author of Engliſh Botany, &c. It is larger than a man's head.

Mr Southey, in his letters from Spain and Portugal, tranſcribes the authenticated relation of another inſtance of the deſcent of a ſtone from the clouds on the 19th of February 1796. But we paſs to ſome of the moſt important details relative to the ſtone which is affirmed to have fallen near Ville-franche, in the department of the Rhone, on the 12th of March, 1798. When it was tranſmitted to Profeſſor Sage, member of the National Inſtitute, he conſidered it at firſt, as only a pyritous and magnetical ore of iron, although it bore no reſemblance to any known ſpecies of ore of that metal, ſince it contained nickel, ſilica, magneſia, and native iron, which ſhone like ſteel when poliſhed. "It is of an aſh gray colour, ſays M. Sage, granulated and ſpeckled with gray, ſhining, and pyritous metallic points. One of its ſurfaces is covered with a dingy black enamel, about the third of a line in thickneſs. This ſtone acts very powerfully on the magnetic needle. When the ſenator Chaſſet tranſmitted it to me, it

Meteorolite.

was accompanied with an hiſtorical notice of ſimilar import with that which M. Delievre, of Ville-franche, who ſaw and deſcribed the phenomenon on the ſpot."

At ſix o'clock in the evening, a round body, which diffuſed the moſt vivid light, was obſerved in the vicinity of Ville-franche, moving weſtward, and producing a hiſſing, like that of a bomb which traverſes the air. This luminous body, which was ſeen at the ſame time at Lyons and on Mont-Cenis, marked its path by a red track of fire, and exploded, about 200 toiſes from the earth, with a tremendous report and concuſſion. One of the flaming fragments fell on the vineyard of Peter Crepier, an inhabitant of Sales. On the ſpot where this portion of the meteor was ſeen to fall, and in a freſh opening of about 20 inches in depth, and 18 in width, was found a black maſs, 15 inches in diameter, and rounded on one ſide.

An account of the ſame meteor was publiſhed in the Journal de Phyſique, for Floreal, year 11, by M. de Drée. From his minute and deliberate inveſtigation, it appears that the fire-ball had ſcarcely fixed the attention of the inhabitants of the Sales and of the adjacent villages, when its rapid approach, accompanied by a terrible whizzing noiſe, like that of an irregular hollow body, traverſing the air with unuſual velocity, inſpired the whole commune with alarm, eſpecially when they obſerved it paſſing over their heads, at an inconſiderable elevation. It left behind a long train of light, and emitted, with an almoſt unceaſing crackling, ſmall vivid flames, like little ſtars. Its fall was remarked, at the diſtance of only 50 paces, by three labourers, one of whom, named Mortillard, let fall his coat and bundle of ſticks that he might run the faſter, while the other two, Chardon and Lapoces, fled with equal precipitation to Sales, where the alarm had become general.—Theſe three witneſſes atteſt the aſtoniſhing rapidity of the meteor's motion, and the hiſſing which proceeded from the ſpot where it fell. So terrified was Crepier at the exploſion, that he locked himſelf up with his family, firſt in his cellar, and then in his private apartment, nor ventured abroad till next morning, when, in the company of M. Blandel, Chardon, Lapoces, and many others, he repaired to the opening which had been made by the fire-ball. At the bottom of this opening, which was 18 inches deep, including the entire thickneſs of the mould, they found a large black maſs, of an irregularly ovoid form, having a fanciful reſemblance to a calf's head. Though no longer hot, it ſmelled of gun-powder and was cracked in ſeveral places. When the obſervers broke it, and diſcovered nothing but ſtone, indifference ſucceeded to curioſity, and they coolly aſcribed its appearance to cauſes more or leſs whimſical and ſupernatural.

The original weight of this ſtone was about twenty pounds. Its black vitrified ſurface gave fire with ſteel. Its interior was hard, earthy, aſh coloured, of a granular texture, preſenting different ſubſtances ſcattered through it, namely, iron in grains, from the ſmalleſt ſize to a line or even more in diameter, ſomewhat malleable, but harder and whiter than forged iron; white pyrites, both lamellated and granular, and in colour approaching to nickel; ſome gray globules, which ſeemed to preſent the characters of trapp, and a very few and ſmall particles of ſteatites, inclining to an olive hue. On account of its heterogeneous compoſition, its ſpecific gravity could not be eaſily aſcertained. One hundred parts of the maſs gave, according to Vauquelin, 46 of ſilica, 38 oxide of iron, 15 magneſia, 2 nickel, and 2 lime. The exceſs of this reſult was aſcribed to the abſorption of oxygen by the native iron during the proceſs. A ſmall ſpecimen of this maſs belongs to Mr Ferguſon's collection.

Meteorolite.

On the 19th of December 1798, about eight o'clock in the evening, the inhabitants of Benares and its neighbourhood obſerved in the heavens a very luminous meteor, in the form of a large ball of fire, which exploded with a loud noiſe, and from which a number of ſtones were precipitated near Krakhut, a village about fourteen miles from the city of Benares. Mr Davis, the judge and magiſtrate of the diſtrict, affirmed that its brilliancy equalled the brighteſt moonlight. Both he and Mr Erſkine, the aſſiſtant collector, were induced to ſend perſons in whom they could confide to the ſpot where this ſhower of ſtones was aſſerted to have taken place, and thus obtained additional evidence of the phenomenon, and ſeveral of the ſtones, which had penetrated about ſix inches into fields recently watered. Mr Maclane, a gentleman who reſided near Krakhut, preſented Mr Howard with part of a ſtone, which had been brought to him the morning after its deſcent, by the watchman who was on duty at his houſe, and through the roof of whoſe hut it had paſſed, and buried itſelf ſeveral inches in the floor, which was of conſolidated earth. Before it was broken, it muſt have weighed upwards of two pounds.

At the time that this meteor appeared, the ſky was perfectly ſerene; not the ſmalleſt veſtige of a cloud had been ſeen ſince the 11th of the month, nor was any obſerved for many days after.

" Of theſe ſtones (ſays Mr Howard,) I have ſeen eight nearly perfect, beſides parts of ſeveral others, which had been broken by the poſſeſſors, to diſtribute among their friends. The form of the more perfect ones appeared to be that of an irregular cube, rounded off at the edges; but the angles were to be obſerved on moſt of them. They were of various ſizes, from about three to upwards of four inches in their largeſt diameter; one of them, meaſuring four inches and a quarter, weighed two pounds twelve ounces. In appearance they were exactly ſimilar; externally they were covered with a hard black coat, or incruſtation, which in ſome parts had the appearance of varniſh or bitumen; and on moſt of them were fractures, which, from their being covered with a matter ſimilar to that of the coat, ſeemed to have been made in the fall, by the ſtones ſtriking againſt each other, and to have paſſed through ſome medium, probably an intenſe heat, previous to their reaching the earth. Internally they conſiſted of a number of ſmall ſpherical bodies, of a ſlate colour, imbedded in a whitiſh gritty ſubſtance, interſperſed with bright ſhining ſpiculæ, of a metallic or pyritical nature. The ſpherical bodies were much harder than the reſt of the ſtone: the white gritty part readily crumbled, on being rubbed with a hard body; and, on being broken, a quantity attached itſelf to the magnet, but more particularly the outſide coat or cruſt, which appeared almoſt wholly attractable by it."

Here we are furniſhed with another circumſtantial and authenticated narrative, by individuals above the rank of ſuſpicion, and who were prompted ſolely by motives of curioſity, to examine with due deliberation the particulars which they have reported.

The hiſtory of the extraordinary ſhower of ſtones which fell near l'Aigle, in Normandy, on the 26th of April 1803, firſt appeared in the enſuing artleſs letter, addreſſed by M. Marais, an inhabitant of the place, to his friend in Paris.

' *At l'Aigle, the 13th Floréal, year* 11.

" An aſtoniſhing miracle has juſt occurred in our diſtrict. Here it is, without alteration, addition, or diminution. It is certain, that it is the truth itſelf.

" On Friday laſt, 6th Floréal (26th April), between one and two o'clock in the afternoon, we were rouſed by a murmuring noiſe like thunder. On going out we were ſurpriſed to ſee the ſky pretty clear, with the exception of ſome ſmall clouds. We took it for the noiſe of a carriage, or of fire in the neighbourhood. We were then in the meadow, to examine whence the noiſe proceeded, when we obſerved all the inhabitants of the Pont de Pierre at their windows, and in gardens, inquiring concerning a cloud, which paſſed in the direction of from ſouth to north, and from which the noiſe iſſued, although that cloud preſented nothing extraordinary in its appearance. But great was our aſtoniſhment when we learned, that many and large ſtones had fallen from it, ſome of them weighing ten, eleven, and even ſeventeen pounds, in the ſpace between the houſe of the Buat family (half a league to the north-north-eaſt of l'Aigle) and Glos, paſſing by St Nicolas, St Pierre, &c. which ſtruck us at firſt as a fable, but which was afterwards found to be true.

" The following is the explanation given of this extraordinary event by all who witneſſed it.

" They heard a noiſe like that of a cannon, then a double report ſtill louder than the preceding, followed by a rumbling noiſe, which laſted about ten minutes, the ſame which we alſo heard, accompanied with hiſſings, cauſed by theſe ſtones, which were counteracted in their fall by the different currents of air, which is very natural in the caſe of ſuch a ſudden expanſion. Nothing more was heard; but it is remarkable, that previouſly to the exploſion, the domeſtic fowls were alarmed, and the cows bellowed in an unuſual manner. All the country-folks were much diſmayed, eſpecially the women, who believed that the end of the world was at hand. A labourer at la Sapée fell proſtrate on the ground, exclaiming, 'Good God! is it poſſible that thou canſt make me periſh thus? Pardon, I beſeech thee, all the faults I have committed,' &c. The moſt trifling objects, in fact, might create alarm, for it is not improbable, that hiſtory offers no example of ſuch a ſhower of ſtones as this. The piece which I ſend was detached from a large one, weighing eleven pounds, which was found between the houſe of the Buats and le Fertey. It is ſaid, that a collector of curioſities purchaſed one of ſeventeen pounds weight, that he might ſend it to Paris. Every body in this part of the country is deſirous of poſſeſſing a whole ſtone, or a fragment of one, as an object of curioſity. The largeſt were darted with ſuch violence that they entered at leaſt a foot into the earth. They are black on the outſide, and grayiſh, as you ſee, within, ſeeming to contain ſome ſpecies of metal and nitre. If you know before us of what ingredients they are compoſed, you will inform us. One fell near M. Bois de la Ville, who lives near Glos. He was much afraid, and took ſhelter under a tree. He has found a great number of them of different ſizes, in his court-yard, his wheat fields, &c. without reckoning all thoſe which the peaſants have found elſewhere. Numberleſs ſtories, more or leſs abſurd, have been circulated among the people. You know that our country is fertile in ſuch tales. Couſin Moutardier ſends one of theſe ſtones to Mademoiſelle Hébert; and he is not leſs eager than we are, to know how theſe ſubſtances can be compreſſed and petrified in the air. Do try to explain the proceſs.

" The perſon who gave me the largeſt ſtone which I ſend to you, went to take it at the moment that it fell, but it was ſo hot that it burned him. Several of his neighbours ſhared the ſame fate in attempting to lift it.

" The elder Buat has juſt arrived, and deſires us to add, that a fire-ball was obſerved to hover over the meadow. Perhaps it was wild-fire."

At the ſitting of the inſtitute, on the 9th of May, Fourcroy read a letter, addreſſed from l'Aigle to Vauquelin, and which ſufficiently corroborates the preceding ſtatements. But we paſs to the ſubſtance of M. Biot's letter, addreſſed to the miniſter of the interior, and publiſhed in the *Journal des Débats*, (14th Thermidor, year 11.). The writer, who is advantageouſly known for his ſcientific attainments, was deputed by government to repair to the ſpot, and collect all the authentic facts. The contents of his letter have been ſince expanded into the form of a memoir, which manifeſts the caution and good ſenſe which guided his inquiries, and which, we are ſurpriſed to learn, has not appeared in an Engliſh tranſlation.

M. Biot left Paris on the 25th of June, and in place of proceeding directly to l'Aigle, went firſt to Alençon, which lies fifteen leagues to the weſt-ſouth-weſt of it. He was informed on his way, that a globe of fire had been obſerved moving towards the north, and that its appearance was followed by a violent exploſion. From Alençon he journeyed through various villages to l'Aigle, being directed in his progreſs by the accounts of the inhabitants, who had all heard the exploſion on the day and at the hour ſpecified. Almoſt all the inhabitants of twenty hamlets, ſcattered over an extent of upwards of two leagues ſquare affirmed that they were eye-witneſſes of a dreadful ſhower of ſtones which was darted from the meteor. The following is his ſummary of the whole evidence.

" On Tueſday, 6th Floréal, year 11. about one o'clock, P. M the weather being ſerene, there was obſerved from Caen, Pont d'Audemer, and the environs of Alençon, Falaiſe, and Verneuil, a fiery globe, of a very brilliant ſplendor, and which moved in the atmoſphere with great rapidity. Some moments after, there was heard at l'Aigle, and in the environs of that town, in the extent of more than thirty leagues in every direction, a violent exploſion, which laſted five or ſix minutes. At firſt there were three or four reports, like thoſe of cannon, followed by a kind of diſcharge which reſembled the firing of muſketry; after which there was heard a dreadful rumbling like the beating of a drum. The air was calm, and the ſky ſerene, except a few clouds, ſuch as are frequently obſerved.

" This noiſe proceeded from a ſmall cloud which had a rectangular form, the largeſt ſide being in a direction from eaſt to weſt. It appeared motionleſs all the time that the phenomenon laſted; but the vapours of which it was compoſed, were projected momentarily from different ſides, by the effect of the ſucceſſive exploſions. This cloud was about half a league to the north-north-weſt of the town of l'Aigle. It was at a great elevation in the atmoſphere, for the inhabitants of two hamlets, a league diſtant from each other, ſaw it at the ſame time above their heads. In the whole canton over which this cloud was ſuſpended, there was heard a hiſſing noiſe like that of a ſtone diſcharged from a ſling, and a great many mineral maſſes exactly ſimilar to thoſe diſtinguiſhed by the name of *meteor-ſtones* were ſeen to fall.

" The diſtrict in which theſe maſſes were projected, forms an elliptical extent of about two leagues and a half in length, and nearly one in breadth, the greateſt dimenſion being in a direction from ſouth-eaſt to north-weſt, forming a declination of about 22 degrees. This direction, which the meteor muſt have followed, is exactly that of the magnetic meridian, which is a remarkable reſult. The greateſt of theſe ſtones fell at the ſouth-eaſtern extremity of the large axis of the ellipſe, the middle-ſized in the centre, and the ſmaller at the other extremity. Hence it appears that the largeſt fell firſt, as might naturally be ſuppoſed. The largeſt of all thoſe that fell weighs ſeventeen pounds and a half. The ſmalleſt which I have ſeen weighs about two *gros* (a thouſandth part of the laſt), The number of all thoſe which fell is certainly above two or three thouſand."

As we cannot make room for an analyſis of M. Biot's more extended communication, we ſhall be contented to ſelect only two facts.

The *curé* of St Michael declared, that he obſerved one of the ſtones fall, with a hiſſing noiſe, at the feet of his niece, in the court-yard of his parſonage, and that it rebounded upwards of a foot from the pavement. He inſtantly requeſted his niece to fetch it to him; but as ſhe was too much alarmed, a woman who happened alſo to be on the ſpot, took it up; and it was found in every reſpect to reſemble the others.

As one *Piche*, a wire-manufacturer belonging to the village of *Armées*, was working with his men in the open air, a ſtone grazed his arm, and fell at his feet; but it was ſo hot, that, on attempting to take it up, he inſtantly let it fall again.

He who compares the various accounts of the l'Aigle meteor, with a critical eye, may detect ſome apparent contradictions, which, however, on reflection, are found to be ſtrictly conformable to truth. Thus, according to ſome, the meteor had a rapid motion, others believed it ſtationary; ſome ſaw a very luminous ball of fire, others only an ordinary cloud. Spectators, in fact, viewed it in different poſitions with reſpect to its direction. They who happened to be in its line of march, would ſee it ſtationary, for the ſame reaſon, that we fancy a ſhip under full ſail to be motionleſs, when we are placed in its wake, or when we view it from the harbour to which it is approaching in a ſtraight line. They, on the other hand, who had a ſide view of the meteor, would reckon its progreſs the more rapid, in proportion as their poſition approached to a right angle with its line of paſſage. They, again, who ſaw it from behind, as the inhabitants of l'Aigle, would perceive only the cloud of vapour, which it left in its train, and which, in the dark, would figure like a blazing tail, in the ſame manner as the ſmoke of a volcano appears black during the day and red at might. Laſtly, they who were placed in front of the meteor, would reckon it ſtationary, but brilliant and cloudleſs.

It deſerves to be remarked, that the l'Aigle ſtones were very friable for ſome days after their deſcent, that they gradually acquired hardneſs, and that after they had loſt the ſulphureous odour on their ſurface, they ſtill retained it in their ſubſtances, as was found by breaking them. Profeſſor Sage ſubmitted them to ſeveral comparative trials with thoſe of Ville-franche; and, though the l'Aigle ſpecimens preſent ſome globules of the ſize of a ſmall coriander ſeed, of a darker gray than the maſs, and not attractable by the magnet, yet, in reſpect of granular texture and general aſpect, the coincidence was ſo ſtriking as to lead one to ſuppoſe that they were all parts of the ſame maſs.

The l'Aigle ſtones, according to Fourcroy, are generally irregular, polygonal, often cuboid, ſometimes ſubcuneiform, and exceedingly various in their diameter and weight. All are covered with a black gravelly cruſt, conſiſting of a fuſed matter, and filled with ſmall agglutinated grains of iron. The greater part of them are broken at the corners, either by their ſhock againſt each other, or by falling on hard bodies. The internal parts reſemble thoſe of all the ſtones analyzed by Meſſrs. Howard and Vauquelin, being gray, a little varied in their ſhades, granulated, and as it were ſcaly, ſplit in many parts, and filled with brilliant metallic points, exactly of the ſame aſpect as thoſe of other ſtones of a like deſcription. The proportions of their conſtituent materials are ſtated as nearly, 54 ſilex, 36 oxidated iron, 9 magneſia, 3 nickel, 2 ſulphur, and 1 lime, the five per cent. of increaſe ariſing from the oxidation of the metals produced by the analyſis.

Of the two ſpecimens which M. Biot preſented to the celebrated Patrin, one was leſs compact, and of a lighter gray than the other, and likewiſe preſented ſmall patches of a ruſt colour. When immerſed in water, it gave a hiſſing ſound, like the humming of a fly, which is held by one wing. As it began to dry, it was obſerved to be marked by curvilinear and parallel layers. The more compact ſpecimens, when moiſtened, preſented no ſuch appearances, but aſſumed the aſpect of a gray porphyry, with a baſe of trap, mottled with ſmall white ſpots, and ſpeckled with metallic points.

Two fine ſpecimens of the l'Aigle ſtone, one of them nearly entire, may be ſeen in Mr Ferguſon's collection, which we have already repeatedly quoted.

Previouſly to the exploſion of the 26th of April 1803, no meteorolites had been found by the inhabitants of the l'Aigle diſtrict, nor in the mineralogical collections of the department; nor the ſlighteſt mention of them made in the geological documents of this portion of Normandy; the mines, founderies, and forges, had produced nothing ſimilar, in the form of droſs or ore, nor had the country exhibited any trace of volcanoes.

canoes. The meteor at once appears, and a multitude of ſtones of the peculiar character noted above are ſeen ſcattered on a determined ſpace of ground, in a manner, and accompanied with circumſtances, which could not formerly have eſcaped obſervation. Let us likewiſe reflect, that the young and the old, ſimple peaſants dwelling at a diſtance from one another, ſagacious and rational workmen, reſpectable eccleſiaſtics, young ſoldiers devoid of timidity, individuals, in ſhort, of various manners, profeſſions, and opinions, united by no common ties, all agree in atteſting a fact, which contributed neither directly nor indirectly to promote their own intereſt, and they all aſſign the manifeſtation of this fact to the ſame day and hour. They, moreover, point to exiſting veſtiges of the deſcent of ſolid ſubſtances, and they declare, in terms unſuſceptible of miſconſtruction or ambiguity, that they ſaw the maſſes in queſtion roll down on roofs, break branches of trees, rebound from the pavement, and produce ſmoke where they fell. Theſe recitals, and theſe veſtiges, are limited to a tract of territory which has been accurately defined; while beyond the precincts of this tract, not a ſingle particle of a meteorolite has been found, nor a ſingle individual who pretends that he ſaw ſtone fall.

Having now, we preſume, advanced ample and ſatisfactory evidence of the exiſtence of meteorolites, we ſhall forbear to enlarge this article by dwelling on inſtances of inferior notoriety to thoſe which we have recounted, and ſhall merely note the dates of ſubſequent examples.

On the 4th of July 1803, a fire-ball ſtruck the White Bull Inn at Eaſt-Norton, and left behind it ſeveral meteoric fragments.—On the 13th of December of the ſame year, a ſimilar phenomenon occurred at the village of St Nicholas, in Bavaria.—At Poſſil, near Glaſgow in Scotland, a meteor-ſtone fell, with a loud and hiſſing noiſe, on the 5th April 1804.—The next inſtance which we have to mention occurred near Apt, in the department of Vaucluſe, on the 6th of October of the ſame year; and the laſt which has come to our knowledge happened at half paſt five o'clock, in the evening of the 15th March 1806, near Alais in Languedoc.

It ſeems reaſonable, however, to ſuppoſe, that the fall of meteoric ſubſtances takes place more frequently than is commonly ſuppoſed, ſince ſeveral foreign collections of foſſils contain ſpecimens of reputed celeſtial origin, and exhibiting the genuine atmoſpheric phyſiognomy. It is likewiſe worthy of remark, that many relations of the phenomenon may have ſunk into oblivion, from the contempt with which they were heard by the learned, and that, on a fair computation of chances, meteors may have ſometimes exploded on deſert tracts of land, and ſtill more frequently over the pathleſs expanſe of the waters.

That ſome of the relations to which we have alluded are vague and unſatisfactory, cannot be denied, but the circumſtantial teſtimony conveyed by others is more pointed and poſitive; and the whole maſs of hiſtorical proof, eſpecially when combined with the argument deduced from the identity of the phyſical and chemical conſtitution of the ſtones, appears to us to be altogether irreſiſtible.

In the courſe of our inquiry into this novel and intereſting ſubject, we have aſcertained a variety of circumſtances which render it highly probable, if not indubitable, that thoſe detached maſſes of native iron, whoſe hiſtory has ſo often ſtaggered and perplexed the geologiſt, are only modifications of meteoric depoſitions. The Tartars, for example, aſcribe the deſcent of the Siberian maſs deſcribed by Chladni, Pallas, Patrin, &c. to a period that is loſt in the remoteneſs of antiquity; and while tradition thus favours our hypotheſis, the analogy which is obviouſly obſervable in point of texture and chemical characters with thoſe of other ſolid bodies, whoſe fall is no longer queſtioned, ſtrengthens tradition. According to the diſcoveries of Prouſt and Klaproth, native iron, reputed meteoric, differs from that which occurs in a foſſil ſtate by the preſence of nickel. The former of theſe celebrated analyſts obtained 50 grains of ſulphate of nickel from 100 of the South American maſs, and his reſults are corroborated by Mr Howard and the Count de Bournon.

Of the two pieces of Siberian iron poſſeſſed by Mr Greville, one, which was tranſmitted by Dr Pallas, weighs ſeveral pounds; and another preſents a cellular and ramified texture, analogous to that of ſome very light and porous volcanic ſcoriæ. When attentively examined, there may be perceived in it not only empty cells, but alſo impreſſions or cavities of greater or leſs depth, and in ſome of which there remains a tranſparent ſubſtance, of a yellowiſh green colour. The iron itſelf is very malleable; and may be eaſily cut with a knife, or flattened under the hammer. The ſpecific gravity is 6487, which is obviouſly inferior to that of unforged iron that has undergone fuſion, and may be partly owing to the oxidizement of the ſurface of the iron, and partly to the many minute cavities in its ſubſtance, which are often rendered viſible by fracture, and which have their ſurface alſo oxidized. The fracture is ſhining and ſilvery, like that of white caſt iron; but its grain is much ſmoother and finer; and it is much more malleable when cold. The heavier ſpecimen is more ſolid and compact, exhibiting no cavities or pores, though its ſurface is ramified and cellular. So blended and incorporated is its compact part with the yellowiſh-green ſubſtance mentioned above, that if the whole of the latter could be ſubtracted, the remainder would conſiſt of iron in the metallic ſtate, and would diſplay the ſame cellular appearance as the preceding ſpecimen, or as the ſuperficial portion of that now deſcribed. This ſtony part of the compoſition uſually aſſumes the appearance of ſmall nodules, generally of an irregular ſhape, but ſometimes nearly globular, with a ſmooth, ſhining, and glaſſy ſurface. This ſubſtance, which is always more or leſs tranſparent, is hard enough to cut glaſs, but makes no impreſſion on quartz. It becomes electric by friction, is very refractory, and varies in ſpecific gravity from 3263 to 3300. Of all ſubſtances hitherto known, it approaches moſt to the peridot, or Wernerian chryſolite, which yielded to Klaproth nearly the ſame reſults which this ſubſtance did to Howard. In the maſs of iron, it is liable to decompoſition, changing to an opake white, and crumbling into a gritty dry powder, when lightly preſſed or ſqueezed between the fingers.—"I cannot help obſerving (ſays the count de Bournon), that there appears to exiſt a very intereſting analogy between theſe tranſparent nodules and the globules I deſcribed as making part of the ſtones ſaid to have fallen on the earth. This analogy, though not a very ſtrong one, may lead us to ſuppoſe, that the two ſubſtances are ſimilar in their nature, but that the globules are leſs pure, and contain a greater quantity of iron."

The native iron from Bohemia is compact, like the large ſpecimen from Siberia, in Mr Greville's collection, and like it contains nodules, but not ſo numerous. They are beſides quite opake, and very much reſemble the globules in atmoſpheric ſtones. This iron contains nearly five per cent. of nickel. Between five and ſix per cent. of the ſame metal ſeems to exiſt in a piece of native iron brought from Senegal.

Though our limits will not permit us to dwell with minuteneſs on the phyſical and chemical characters of meteorolites, we ſhall ſhortly ſtate thoſe which the count de Bournon found to appertain to the ſpecimens from Benares, and which may ſerve as no unfair ſtandard of the aſpect and compoſition of the others.

Like all of the ſame origin which were ſubjected to the count's examination, the Benares ſtones are covered over the whole extent of their ſurface, with a thin cruſt, of a deep black colour, ſprinkled over with ſmall aſperities, which make it feel ſomewhat like ſhagreen or fiſh ſkin. Their fracture exhibits a grayiſh aſh colour, and a granulated texture, like that of coarſe grit-ſtone. By help of a lens, they are perceived to be compoſed of four different ſubſtances. One of theſe occurs in great abundance, in the form of ſmall bodies, ſome of which are perfectly globular, others rather elongated or elliptical, and all of various ſizes, from that of a ſmall pin's head to that of a pea, or nearly ſo. Theſe ſmall globules are uſually gray, ſometimes inclining much to brown, and always opake; they are eaſily broken in any direction, have a conchoidal fracture, and a fine, ſmooth, compact grain, with a ſlight degree of luſtre, approaching to enamel; laſtly, they can deſtroy the poliſh of glaſs without being able to cut it, and ſparkle faintly when ſtruck with ſteel. Another of theſe ſubſtances is martial pyrites, of an indeterminate form, and reddiſh yellow colour, ſlightly verging to the nickel tint, or to that of artificial pyrites; of a ſomewhat looſely granulated texture, and irregularly diſtinguiſhed in the maſs, being black when reduced to powder, and not attractible by the magnet. The third of theſe ſubſtances conſiſts of ſmall particles of iron, in a perfectly metallic ſtate, ſo that they may be eaſily flattened or extended under the hammer. Though in a much ſmaller proportion than the pyrites juſt mentioned, they impart the magnetic attraction to the ſtone. When a piece of the latter was pulverized, and the particles of iron ſeparated from it as accurately as poſſible, by means of a magnet, they appeared to compoſe about 200 parts of the weight of the ſtone. Theſe three ſubſtances are united by means of a fourth, which is nearly of an earthy conſiſtency, and of a whitiſh gray colour.—The black cruſt, or outward coating, though of very inconſiderable thickneſs, emits bright ſparks when ſtruck with ſteel, may be broken by the hammer, and ſeems to poſſeſs the ſame properties with the black oxide of iron, though, like the ſubſtance of the ſtone, it is occaſionally intermixed with ſmall particles of iron in the metallic ſtate. Theſe are eaſily diſtinguiſhed, by paſſing a file over the cruſt, which reveals their luſtre. The ſpecific gravity of the Benares ſtones is 3352. None of them, when breathed on, emit the argillaceous odour.

In conſequence of various experiments, M. Sage infers that meteorolites are compoſed of native iron, ſulphuret of nickel, quartz or ſilica, alumina, and magneſia; that the proportions of iron and nickel vary; that the quartz ſeems to form at leaſt the half of the ſtone, the alumina and magneſia the ſixth, and the ſulphur the 30th part. Theſe general reſults pretty nearly accord with the more ſpecial reports of Howard and Vauquelin, except that the latter makes no mention of alumina, the exiſtence of which in atmoſpheric ſtones is by no means diſtinctly aſcertained.

We ſhall only beg leave to add, on this part of our ſubject, that Laugier, an ingenious chemiſt, by employing the cauſtic alkali, has detected a ſmall portion of chrome. The reſults of his experiments, which are ſtated in the 58th volume of the *Annales de Chimie*, are 1ſt, That the five ſtones from Verona, Barbotan, Enſiſheim, l'Aigle, and the neighbourhood of Apt, beſides the principles already recognized, contain about one per cent. of chrome. 2dly, That it is very probable, that all meteorolites contain this principle, ſince they all reſemble one another in their phyſical and chemical properties, and have all, apparently, the ſame origin; and, 3dly, That in many caſes, the perfection of chemical analyſis requires, that the ſame ſubſtance ſhould be treated both by acids and alkalies, ſince experience has ſhown, that a principle which eluded the former method, has been revealed by the latter.

Having now, as we apprehend, ſufficiently eſtabliſhed the exiſtence and nature of meteorolites, we hope our readers will excuſe us from enlarging on the various cauſes which have been aſſigned for their origin, as theſe ſeem to lie beyond the reach of our preſent ſtate of knowledge. After a candid and patient review of the principal theories, we conceive that they are at beſt gratuitous, and that moſt of them are open to many and formidable objections.

The *terreſtrial* hypotheſes, we believe, begin already to be generally abandoned, as untenable. Until the phenomenon of exploding meteors had been diſtinctly obſerved and recorded, Lemery and others could maintain, with ſome degree of plauſibility, that lightning might tear up the ground, and convert ſoil into a compact maſs. But the appearances of a thunder ſtorm and of a fire-ball are now aſcertained to differ in various important reſpects. Spectators worthy of credit have ſeen the latter terminate in the fall of ſolid bodies; and the compoſition of theſe ſolid bodies has been found to differ from that of all the known foſſil ſubſtances on the ſurface of the globe. It is in vain, then, to allege, that they are formed on the ground by common lightning, which has often produced very extraordinary effects, but which never generated thouſands of ſtones in fine calm weather. The ſuppoſition, that ſuch ſtones have been projected from ſome of our volcanoes, is hardly leſs conceivable. The aſhes which accompany a violent eruption of Ætna or Veſuvius have, from their levity, been carried to a very conſiderable diſtance; but we are totally unacquainted with any projectile force which could dart ſolid maſſes many hundred miles, through ſuch a denſe medium as the atmoſphere. The compact lavas of burning mountains are never found remote from the ſcene of their formation, and none of them preſent the characters and aſpect of the ſtones which we have deſcribed. M. Bory de St Vincent, indeed, in his *Voyage dans les quatre Principales Iſles des Mers d'Afrique*, very pompouſly expounds a doctrine, which, in our opinion, carries its confutation along with it. According to this writer, meteorolites were projected from immenſe depths, in an early ſtage of the earth's exiſtence, when ignivomous mountains were endued with propelling forces ſufficient to drive maſſes of matter into the regions of ſpace, where they were conſtrained to obey, for ages, the combined laws of impulſe and gravitation, until, in the progreſs of time, their ſpiral revolutions at length terminated on the ſurface of their native earth. Before we can adopt ſuch an extravagant hypotheſis, we muſt be convinced, that at one period of the hiſtory of our globe, the agency of ſubterraneous fire was adequate to communicate planetary motion to ſplinters of rock, without heaving up the rocks themſelves, and that the rotatory movement, though once eſtabliſhed, muſt gradually diminiſh and ceaſe. The demonſtration of theſe poſitions is ſurely not leſs arduous than the explanation of the phenomenon which they are intended to ſolve.

Of thoſe who contend for the *atmoſpherical* formation of meteorolites, ſcarcely any two agree in regard to the manner by which ſuch formation is effected. Patrin, who is ſolicitous to extend and illuſtrate his darling theory of volcanoes, labours at great length to maintain the exiſtence of a regular circulation of gaſeous fluids between the primitive ſchiſtoſe ſtrata of the globe, and its ſurrounding atmoſphere, and, from this fancied circulation, which he flatters himſelf he has *demonſtrated*, he deduces, quite at his eaſe, the occaſional ignition and concretion of portions of theſe fluids in the higher regions of the air. This ingenious mineralogiſt and geologiſt is ſo extremely tenacious of theſe ideas that we ſhall not attempt to diſturb his ſelf complacency; but he will excuſe us if we refuſe our aſſent to reſults which reſt on imaginary foundations. The celebrated Muſchenbroeck, in one part of his writings, aſcribes the deſcent of ſtones from the air to earthquakes and volcanic eruptions, an opinion which later obſervations have diſproved. In other paſſages, however, he ſeems to incline to a modification of the atmoſpherical hypotheſes, and endeavours to trace the origin of ſhooting ſtars to an accumulation of the volatile matters which are ſuſpended in the air. It is extremely probable, that ſhooting ſtars and fiery meteors have an intimate relation to one another, if they are not identical appearances; but it is certain that the former move at a much greater diſtance from our earth than fireballs, and only occaſion a tranſient luminous appearance in their paſſage through the upper regions of the atmoſphere. Perhaps they are analogous to thoſe teleſcopic ſparks of light which were obſerved by M. Schröter. Muſchenbroeck, however, adopts the vulgar notion of their falling to the earth, and ſeems to confound their reſidue with *tremella noſtoc*. M. Salverte has given extenſion to the theory of formation from vapours, by having recourſe to the agency of hydrogen gas. According to him, in conſequence of the decompoſition of water, which is conſtantly going on at the ſurface of the earth, immenſe quantities of hydrogen gas are continually riſing into the atmoſphere, and aſcending to its higher regions. As this gas is capable of diſſolving metals, it carries along with it a portion of iron and nickel. During thunder ſtorms this gas is kindled by electricity; the metals are depoſited, reduced, melted, and vitrified; in other words, meteors are produced and ſtones formed. This hypotheſis is ſcarcely more ſatisfactory than the others. It does not account for the preſence of magneſia and ſilica, nor does it explain why the ſtones are always compoſed of the ſame materials. Beſides, the exiſtence of hydrogen gas in the atmoſphere has not been proved, far leſs that it forms a ſeparate atmoſphere, which is contrary to all experience; and it is well known, that a little hydrogen, mixed with a large portion of atmoſpheric air, cannot be fired by electricity. In general, we may obſerve, that if the origin of meteorolites be really atmoſpherical, the matters of which they are compoſed muſt have exiſted in one of two ſtates; namely, in very attenuated particles or concretions of the matters themſelves volatilized and held in ſolution in the air, or only in the *elements* of theſe matters. In the firſt caſe, when abandoned by their menſtruum to their reciprocal tendencies, they would unite by aggregation only; in the ſecond by chemical combination. Now, we can hardly ſuppoſe that diſengagement of light and violent detonation ſhould reſult from the mere affinity of aggregation, whereas they are ſtrictly ſymptomatic of the affinity of compoſition. This, and various other conſiderations which might be ſtated, if we could make room for them, induce us to regard the doctrine of combination as the moſt plauſible. M. Izarn, who has publiſhed a treatiſe on *Atmoſpheric Lithology*, has entered into a tedious and ſomewhat obſcure expoſition of his own theory, founded on this principle. We ſhall give the ſummary, as nearly as we can, in his own words.

"Gaſeous ſubſtances, arranged in ſpherical maſſes in the upper regions of the air, being admitted, the various agitations of the atmoſphere ſhould naturally waft ſome of theſe maſſes from their inſulating medium into one capable of combining with them. If the combination begins, the diſengagement of light is explained. In proportion as the combination advances, the ſpecific gravities are changed; and, conſequently, a change of place will commence, and that in the quarter which preſents leaſt reſiſtance, or where the medium is moſt rarefied, in courſe rather towards the ſouth than the north. Hence, moſt fire-balls are obſerved to move from north to ſouth, or from north-eaſt to ſouth-weſt. Motion being once impreſſed, the maſs traverſes other media, capable of ſupplying new principles, which ſtill increaſing the weight, determine the curve; and when at length the principles which are at work, and which iſſue in all directions, have attained the requiſite proportion for extinguiſhing the elements in the birth of the compound, the grand operation is announced by the exploſion, and the product takes its place among the ſolids."—That the ſtones in queſtion are produced by chemical combination in the higher regions of the atmoſphere, and that they are thus formed from their own elements, are ſuppoſitions fully as probable as any that have been advanced on the ſubject; but whether the union of their parts be effected in the manner detailed by M. Izarn, we are unable to determine, both becauſe we are uncertain if we perfectly comprehend his meaning, and becauſe our range of data is as yet too circumſcribed, to warrant any ſpecific or deciſive concluſions.

A much bolder theory has been ſuggeſted, and its *poſſibility* demonſtrated by the celebrated French aſtronomer, La Place, who ſhews, that meteorolites *may be* the products of lunar volcanoes. As this romantic view of the ſubject has obtained the ſuffrages of ſome men of ſcience, and has excited the ridicule of others, we ſhall preſent the reaſoning on which it is founded in the popular and perſpicuous language of Dr Hutton of Woolwich.

" As the attraction of gravitation extends through the whole planetary ſyſtem, a body placed at the ſurface of the moon is affected chiefly by two forces, one drawing it toward the centre of the earth, and another drawing it toward that of the moon. The latter of theſe forces, however, near the moon's ſurface, is incomparably the greater. But, as we recede from the moon, and approach toward the earth, this force decreaſes, while the other augments; till at laſt a point of ſtation is found between the two planets, where theſe forces are exactly equal, ſo that a body placed there muſt remain at reſt; but if it be removed ſtill nearer to the earth, then this planet would have the ſuperior attraction, and the body muſt fall towards it. If a body then be projected from the moon towards the earth, with a force ſufficient to carry it beyond the point of equal attraction, it muſt neceſſarily fall on the earth. Such then is the idea of the manner in which the bodies muſt be made to paſs from the moon to the earth, if that can be done, the *poſſibility* of which is now neceſſary to be conſidered.

" Now, ſuppoſing a maſs to be projected from the moon, in a direct line towards the earth, by a volcano, or by the production of ſteam by ſubterranean heat; and ſuppoſing for the preſent theſe two planets to remain at reſt; then it has been demonſtrated, on the Newtonian eſtimation of the moon's maſs, that a force projecting the body with a velocity of 12,000 feet in a ſecond, would be ſufficient to carry it beyond the point of equal attraction. But this eſtimate of the moon's maſs is now allowed to be much above the truth; and on M. la Place's calculation, it appears that a force of little more than half the above power would be ſufficient to produce the effect, that is, a force capable of projecting a body with a velocity of leſs than a mile and a half per ſecond. But we have known cannon balls projected by the force of gunpowder, with a velocity of 2500 feet per ſecond or upwards, that is, about half a mile. It follows, therefore, that a projectile force, communicating a velocity about three times that of a cannon ball, would be ſufficient to throw the body from the moon beyond the point of equal attraction, and cauſe it to reach the earth. Now there can be little doubt that a force equal to that is exerted by volcanoes on the earth, as well as by the production of ſteam by ſubterranean heat, when we conſider the huge maſſes of rock, ſo many times larger than cannon balls, thrown on ſuch occaſions to heights alſo ſo much greater. We may eaſily imagine, too, ſuch cauſe of motion to exiſt in the moon as well as in the earth, and that in a ſuperior degree, if we may judge from the ſuppoſed ſymptoms of volcanoes recently obſerved in the moon by the powerful tubes of Dr Herſchel; and ſtill more, if we conſider that all projections from the earth ſuffer an enormous reſiſtance and diminution, by the denſe atmoſphere of this planet; while it has been rendered probable, from optical conſiderations, that the moon has little or no atmoſphere at all, to give any ſuch reſiſtance to projectiles.

" Thus then we are fully authorized in concluding, that the caſe of *poſſibility* is completely made out; that a known power exiſts in nature, capable of producing the foregoing effect, of detaching a maſs of matter from the moon, and transferring it to the earth in the form of a flaming meteor, or burning ſtone; at the ſame time we are utterly ignorant of any other proceſs in nature by which the ſame phenomenon can be produced. Having thus diſcovered a way in which it is poſſible to produce thoſe appearances, we ſhall now endeavour to ſhow, from all the concomitant circumſtances, that theſe accord exceedingly well with the natural effects of the ſuppoſed cauſe, and thence give it a very high degree of *probability*.

" This important deſideratum will perhaps be beſt attained, by examining the conſequences of a ſubſtance ſuppoſed to be projected by a volcano from the moon into the ſphere of the earth's ſuperior attraction; and then comparing thoſe with the known and viſible phenomena of the blazing meteors or burning ſtones that fall through the air on the earth. And if in this compariſon a ſtriking coincidence or reſemblance ſhall always or moſtly be found, it will be difficult for the human mind to reſiſt the perſuaſion that the aſſumed cauſe involves a degree of probability but little ſhort of certainty itſelf. Now the chief phenomena attending theſe blazing meteors or burning ſtones, are theſe: 1. That they appear or blaze out ſuddenly. 2. That they move with a ſurpriſing rapid motion, nearly horizontal, but a little inclined downwards. 3. That they move in ſeveral different directions with reſpect to the points of the compaſs. 4. That in their flight they yield a loud whizzing ſound. 5. That they commonly burſt with a violent exploſion and report. 6. That they fall on the earth with great force in a ſloping direction. 7. That they are very hot at firſt, remain hot a conſiderable time, and exhibit viſible tokens of fuſion on their ſurface. 8. That the fallen ſtony maſſes have all the ſame external appearance and contexture, as well as internally the ſame nature and compoſition. 9. That they are totally different from all our terreſtrial bodies, both natural and artificial.

" Now theſe phenomena will naturally compare with the circumſtances of a ſubſtance projected by a lunar volcano, and in the order in which they are here enumerated. And firſt, with reſpect to the leading circumſtance, that of a ſudden blazing meteoric appearance, which is not that of a ſmall bright ſpark, firſt ſeen at an immenſe diſtance, and then gradually increaſing with the diminution of its diſtance. And this circumſtance appears very naturally to reſult from the aſſumed cauſe. For, the body being projected from a lunar volcano, may well be ſuppoſed in an ignited ſtate, like inflamed matter thrown up by our terreſtrial volcanoes, which paſſing through the comparatively vacuum, in the ſpace between the moon and the earth's ſenſible atmoſphere, it will probably enter the ſuperior parts of this atmoſphere with but little diminution of its original

nal heat; from which circumſtance, united with that of its violent motion, this being 10 or 12 times that of a cannon ball, and through a part of the atmoſphere probably conſiſting chiefly of the inflammable gas riſing from the earth to the top of the atmoſphere, the body may well be ſuppoſed to be ſuddenly inflamed, as the natural effect of theſe circumſtances; indeed it would be ſurpriſing if it did not. From whence it appears that the ſudden inflammation of the body, on entering the earth's atmoſphere, is exactly what might be expected to happen.

“ 2. To trace the body through the earth's atmoſphere; we are to obſerve that it enters the top of it with the great velocity acquired by deſcending from the point of equal attraction, which is ſuch as would carry the body to the earth's ſurface in a very few additional ſeconds of time if it met with no obſtruction. But as it enters deeper in the atmoſphere, it meets with ſtill more and more reſiſtance from the increaſing denſity of the air, by which the great velocity of ſix miles per ſecond muſt ſoon be greatly reduced to one that will be uniform, and only a ſmall part of its former great velocity. This remaining part of its motion will be various in different bodies, being more or leſs as the body is larger or ſmaller, and as it is more or leſs ſpecifically heavy; but, for a particular inſtance, if the body were a globe of 12 inches diameter, and of the ſame gravity as the atmoſpheric ſtones, the motion would decreaſe ſo as to be little more than a quarter of a mile per ſecond of perpendicular deſcent. Now while the body is thus deſcending, the earth itſelf is affected by a twofold motion, both the diurnal and the annual one, with both of which the deſcent of the body is to be compounded. The earth's motion of rotation at the equator is about 17 miles in a minute, or two-ſevenths of a mile in a ſecond; but in the middle latitudes of Europe little more than the half of that, or little above half a quarter of a mile in a ſecond; and if we compound this motion with that of the deſcending body, as in mechanics, this may cauſe the body to appear to deſcend obliquely, though but a little, the motion being nearer the perpendicular than the horizontal direction. But the other motion of the earth, or that in its annual courſe, is about 20 miles in a ſecond, which is 80 times greater than the perpendicular deſcent in the inſtance above-mentioned; ſo that, if this motion be compounded with the deſcending one of the body, it muſt neceſſarily give it the appearance of a very rapid motion, in a direction nearly parallel to the horizon, but a little declining downwards. A circumſtance which exactly agrees with the appearances of theſe meteoric bodies, as ſtated in the ſecond article of the enumerated phenomena.

“ 3. Again, with regard to the apparent direction of the body; this will evidently be various, being that compounded of the body's deſcent and the direction of the earth's annual motion at the time of the fall, which is itſelf various in the different ſeaſons of the year, according to the direction of the ſeveral points of the ecliptic to the earth's meridian or axis. Uſually, however, from the great exceſs of the earth's motion above that of the falling body, the direction of this muſt appear to be nearly oppoſite to that of the former. And in fact this exactly agrees with a remark made by Dr Halley, in his account of the meteors in his paper above given, where he ſays that the direction of the meteor's motion was exactly oppoſite to that of the earth in her orbit. And if this ſhall generally be found to be the caſe, it will prove a powerful confirmation of this theory of the lunar ſubſtances. Unfortunately, however, the obſervations on this point are very few, and moſtly inaccurate; the angle or direction of the fallen ſtones has not been recorded; and that of the flying meteor commonly miſtaken, all the various obſervers giving it a different courſe, ſome even directly the reverſe of others. In future, it will be very adviſable that the obſervers of fallen ſtones, obſerve and record the direction or bearing of the perforation made by the body in the earth, which will give us perhaps the courſe of the path nearer than any other obſervation.

“ 4. In the flight of theſe meteoric ſtones, it is commonly obſerved, that they yield a loud whizzing ſound. Indeed it would be ſurpriſing if they did not. For if the like ſound be given by the ſmooth and regularly formed cannon ball, and heard at a conſiderable diſtance, how exceedingly great muſt be that of a body ſo much larger, which is of an irregular form and ſurface too, and ſtriking the air with 50 or 100 times the velocity.

“ 5. That they commonly burſt and fly in pieces in their rapid flight, is a circumſtance exceedingly likely to happen, both from the violent ſtate of fuſion on their ſurface, and from the extreme rapidity of their motion through the air. If a grinding ſtone, from its quick rotation, be ſometimes burſt and fly in pieces, and if the ſame thing happen to cannon balls when made of ſtone and diſcharged with conſiderable velocity, merely by the friction and reſiſtance of the air; how much more is the ſame to be expected to happen to the atmoſpheric ſtones, moving with more than 50 times the velocity, and when their ſurface may well be ſuppoſed to be partly looſened or diſſolved by the extremity of the heat there.

“ 6. That the ſtones ſtrike the ground with a great force, and penetrate to a conſiderable depth, as is uſually obſerved, is a circumſtance only to be expected from the extreme rapidity of their motion, and their great weight, when we conſider that a cannon ball, or a mortar ſhell, will often bury itſelf many inches, or even ſome feet in the earth.

“ 7. That theſe ſtones, when ſoon ſought after and found, are hot, and exhibit the marks of recent fuſion, are alſo the natural conſequences of the extreme degree of inflammation in which their ſurface had been put during their flight through the air.

“ 8. That theſe ſtony maſſes have all the ſame external appearance and contexture, as well as internally the ſame nature and compoſition, are circumſtances that ſtrongly point out an identity of origin, whatever may be the cauſe to which they owe ſo generally uniform a conformation. And when it is conſidered,

“ 9. That in thoſe reſpects they differ totally from all terreſtrial compoſitions hitherto known or diſcovered, they lead the mind ſtrongly to aſcribe them to ſome other origin than the earth we inhabit; and none ſo likely as coming from our neighbouring planet.

“ Upon the whole then (continues Dr Hutton), it

Meteorolite.

appears highly probable, that the flaming meteors, and the burning ſtones, that fall on the earth, are one and the ſame thing. It alſo appears impoſſible, or in the extremeſt degree improbable, to aſcribe theſe either to a formation in the ſuperior parts of the atmoſphere, or to the eruptions of terreſtrial volcanoes, or to the generation by lightning ſtriking the earth. But, on the other hand, that it is poſſible for ſuch maſſes to be projected from the moon ſo as to reach the earth; and that all the phenomena of theſe meteors or falling ſtones, having a ſurpriſing conformity with the circumſtances of maſſes that may be expelled from the moon by natural cauſes, unite in forming a body of ſtrong evidence, that this is in all probability and actually the caſe.

M. Poiſſon, an ingenious French mathematician, has ſhown by an algebraical calculation, the poſſibility of a projectile reaching our planet from the moon. His calculation, however, which may be found in the work of Izarn, quoted above, (p. 238. et ſeq.) proceeds on the ſuppoſition that our ſatellite has no atmoſphere, or next to none. There are, no doubt, appearances which ſeem to favour this ſuppoſition, but they do not amount to poſitive proof of the fact. Even could the latter be eſtabliſhed, the combuſtion of a volcano, without the preſence of atmoſpheric air, would remain to be explained. But, granting this difficulty too to be ſurmounted, there are other circumſtances which we cannot eaſily reconcile to the lunar hypotheſis. The occaſional arrival of fragments of lava on the earth's ſurface, would argue, on a fair computation of chances, ſuch a copious diſcharge of volcanic matters, that the moon, by this time, would conſiſt of hardly any thing elſe. Again, if we may be allowed to reaſon from analogy, the volcanic productions of the moon ſhould exhibit varieties of aſpect and compoſition like thoſe with which we are acquainted, and not a definite and preciſe number of the ſame ingredients. We may alſo remark, that the ſoft and incoherent ſtate of ſeveral of the recent ſpecimens of meteorolites can ill accord with their ſuppoſed paſſage through any conſiderable portion of ſpace; and that the l'Aigle phenomenon, which is ſo diſtinctly recorded, evidently ſuggeſts the notion of inſtantaneous formation in the atmoſphere. And, though this view of the ſubject may be regarded by ſome as inexplicable, we cannot conceive that it is more ſo than the doctrine of cryſtallization, or than many of the reſults of chemical combination, whoſe exiſtence it is impoſſible to deny. Theſe and other arguments may, we apprehend, be fairly urged againſt any theory which attempts to explain the hiſtory of meteors by the agency of lunar volcanoes.

The hypotheſis of Dr Chladni, which likewiſe boaſts of its advocates, though ſtill more extravagant than the preceding, deſerves to be ſtated. As earthy, metallic, and other particles form the principal component parts of our planet, among which iron is the prevailing part, other planetary bodies, he affirms, may conſiſt of ſimilar, or, perhaps, the ſame component parts, though combined and modified in a very different manner. There may alſo be denſe matters accumulated in ſmaller maſſes, without being in immediate connexion with the larger planetary bodies, diſperſed throughout infinite ſpace, and which, being impelled either by ſome projecting power or attraction, continue to move until they approach the earth, or ſome other body; when, being overcome by attractive force, they immediately fall down. By their exceeding great velocity, ſtill increaſed by the attraction of the earth and the violent friction in the atmoſphere, a ſtrong electricity and heat muſt neceſſarily be excited, by which means they are reduced to a flaming and melted condition, and great quantities of vapour and different kinds of gaſes are thus diſengaged, which diſtend the liquid maſs to a monſtrous ſize, till, by a ſtill farther expanſion of theſe elaſtic fluids, they muſt at length diſplode. That portions of coſmical matter are allowed to revolve in ſpace, and to terminate their career on the ſurface of a planet, is a poſition too gratuitous and vague, to be readily admitted, but the belief of which involves no principle of atheiſm or impiety, as ſome of Dr Chladni's antagoniſts have very unhandſomely inſinuated. If worlds diſappear and others ſpring into exiſtence, a ſportive imagination may be permitted to indulge in the innocent ſuppoſition, that fragments of their materials are detached from their fractured maſſes, and obey thoſe laws of attraction which ſeem to extend their influence to the remoteſt corners of the univerſe.

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Such of our readers as are ſolicitous of obtaining more ample information on the ſubject of this article, may conſult *Izarn's Lithologie Atmoſpherique*; *Biot's Relation d'un Voyage fait dans le departement de l'Orne, pour conſtater la réalité d'un Météore obſervé à l'Aigle*; *Böttiger's Obſervations on the Accounts given by ancient authors of Stones ſaid to have fallen from the Clouds*; *Fulda's Memoir on Fire-balls*; *Cavallo's Elements of Natural Philoſophy*; *Klaproth on Meteoric Stones*; *Soldani's Account of the Tuſcan Meteor*; *Chladni's Treatiſe on the Siberian Maſs of Iron*; *Mr Edward King's Remarks concerning Stones ſaid to have fallen from the Clouds*; and ſeveral of the more recent tranſactions of learned ſocieties and periodical ſcientific communications, as thoſe of the Royal Society of London, of the Inſtitute at Paris, the Journal de Phyſique, Annales de Chimie, Bibliotheque Britannique, Decade Philoſophique, Journal des Mines, Philoſophical Magazine, Nicholſon's Journal, &c. &c.

METEOROLOGICAL, ſomething belonging to meteors.

Meteorological Journal, is a table recording the daily ſtate of the air, exhibited by the barometer, thermometer, hygrometer, anemometer, and other meteorological inſtruments. We have many journals of this kind, kept at the houſe of the Royal Society, and by different obſervers in other places, in the Philoſophical Tranſactions, the Memoirs of the Academy of Sciences, and ſimilar publications.

METEOROLOGY.

INTRODUCTION.

1 Object of meteorology.

METEOROLOGY is that part of natural ſcience which treats of the changes that take place in our atmoſphere, as they are perceptible to our ſenſes, or as they are indicated by certain inſtruments which the ingenuity of man or accident has diſcovered to anſwer that purpoſe. In as far as it deſcribes the phenomena produced by ſuch changes, meteorology is a department of natural hiſtory; but in its attempts to account for the appearances, it is almoſt entirely dependent on NATURAL PHILOSOPHY and CHEMISTRY.

2 Its connection with chemiſtry.

The connection of METEOROLOGY with CHEMISTRY is ſufficiently evident to thoſe who take only a ſuperficial view of the ſubject, though it has only of late attracted the notice of philoſophers. That the air is ſometimes hotter and ſometimes colder than uſual; that it is at one time much rarefied, and at another greatly condenſed; now uncommonly dry, and now ſurcharged with moiſture—are circumſtances that daily meet the ſenſes of the moſt caſual obſerver, as they are circumſtances that powerfully, and often unpleaſantly, arreſt his attention. That theſe changes are the reſult of decompoſitions and combinations that are continually going on in the atmoſphere, and of new modifications of its component principles, is manifeſt to him who is acquainted merely with the firſt elements of modern chemiſtry.

3 Indeed to modern chemiſtry this ſcience is indebted for the progreſs it has made within the laſt 50 years; a period which may be conſidered as the ſecond epoch of meteorology. In fact, this ſcience is ſtill in its infancy; but from the ardour with which it is now cultivated, from the abilities of the philoſophers who are engaged in the ſtudy, and from the progreſs that is daily making in the kindred ſciences, we may reaſonably look forward to a period, at no great diſtance, when it ſhall pleaſe the great Author of nature to unveil many of thoſe wonders which are now involved in darkneſs and obſcurity, and permit us to controul the jarring elements, as he has allowed us to exerciſe dominion over the beaſts of the earth, the fowls of the air, and the fiſhes of the ſea.

4 Means of improving meteorology.

A late ingenious writer on the climate of Britain has ſuggeſted ſome uſeful hints for the improvement of meteorology, which we ſhall here extract. "With this view, our firſt ſtep muſt be *that* recommended by Mr Kirwan and others, to eſtabliſh correſponding ſocieties in different parts of the world; theſe ſocieties muſt be furniſhed with ſimilar apparatus, equally adjuſted, and graduated in their conſtruction, for making obſervations on the weather. In our own iſland it will be neceſſary to procure regiſters, carefully kept, from the different parts of the ſea-coaſt, and from thoſe parts of the country ſituated in the interior. The various ſtates of the barometer, thermometer, hygrometer, and electroſcope, ſhould be carefully noted; with the variations and the degrees of wind, as well as the diurnal and nocturnal aſpect of the heavens diſcriminately marked; the appearance of the ſky; and in familiar language, ſuch as might be underſtood by the reſpective and diſtant obſervers; for inſtance, whether the ſun is totally or partially obſcured by vapour;—whether the clouds are mottled, or fleaky;—whether they aſſume the appearance of horizontal ſtreaks, or appear in radii apparently from a centre—or in maſſes of denſe vapour—or looſe and fleecy—or thoſe familiarly known by the name of *mare-tail* clouds—with any other new or accuſtomed phenomena. The common terms *fair*, *cloudy*, or *wet*, are inſufficient for forming a judgement of the weather; as the term fair is generally at preſent expreſſed only in oppoſition to *rain*, without diſtinguiſhing whether the atmoſphere is obſcure, dull, or bright. The appearance of the ſtratum of air on the earth's ſurface, *that is, the ſpace between the clouds and the earth*, ſhould be always accurately deſcribed. Is there a blue haze, white miſt, and denſe fog? or is the air tranſparent? which is the caſe when diſtant objects appear more than commonly diſtinct and near to the eye of the obſerver: the temperature of the ocean at *full tide* ſhould be frequently aſcertained, as it will be found to have conſiderable influence in theſe reſpects on an inſular country. By the remarks of obſervers, ſtationed in various parts of our coaſts, we ſhould ſoon be enabled to diſcover when vapour is wafted in from the ſea, or generated by the aqueous and vegetable ſurface of our iſland. During a north-weſt wind, which is frequently attended with ſtorms of hail and rain, and uſually experienced in the ſpring, an obſerver ſtationed on the coaſt of Sligo in Ireland, or Denbighſhire in Wales, might aſcertain whether the diſpoſition of the atmoſphere to ſtorm and cloud came in with the air from the Atlantic ocean, or was generated by the vapours of our own iſland. It would be deſirable alſo again, that the temperature and blue hazy appearance of the atmoſphere during the north-eaſt winds, ſo common in May and June, ſhould be noticed by obſervers on the north eaſt coaſt, in the counties of York, Lincoln, Eſſex and Kent; and by others, on the oppoſite weſtern coaſts of Pembroke, Devon, and Cornwall, ſo as to determine what changes in temperature this wind undergoes in its paſſage over the iſland; and whether or not the degree of haze increaſes or diminiſhes by its progreſs from either quarter; and whether the vapour is more or leſs diſpoſed to produce ſtorms?

By ſuch comparative obſervations on the coaſt, conjoined with thoſe made by others in the central parts of the kingdom, we might rapidly proceed in meteorological ſcience, or, as it is commonly called, a knowledge of the weather. The obſervations made in the interior of the country would enable us at all times to trace the origin and progreſs of ſtorms: in ſituations where tillage or paſturage is moſt attended to, the effects of ſpring froſts and blights ſhould be particularly noticed, as well as the firſt appearance of the aphis and coccus, the caterpillar and larvæ of other inſects, on fruit trees, and particularly thoſe peculiar to the *hop plantations*. The firſt opening of the vernal foliage on trees and hedges in the ſpring, ſhould likewiſe be remarked, and compared with the ſtarting up graſs on the highly manured paſtures in the neighbourhood of towns, and on thoſe alſo aſſiſted with manure, as well as the natural herbage on the commons and waſtes. Some attention ſhould be paid to the effects of thunder ſtorms, in deſtroying the aphis and other deſtructive inſects, the peſt of fruit and hop plantations; and the firſt appearance of the mildew or ruſt on wheat ſhould be particularly obſerved, and remarks made to aſcertain, whether or not the moiſture, which occaſions the diſeaſe in its commencement was attended with wind and rain, or a cloſe damp ſtate of the air. The different kinds of ſoil, where the crops, from the diſeaſe, ſuffered moſt, ſhould be noticed, and the ſituation of the land for ventilation, with the height of the fences, ſize of incloſures, and vicinity to coppices, trees, or hedge-rows *."

* *Williams on the Climate of Britain.*

5 Importance of the ſcience. The importance of the ſtudy of meteorology requires little elucidation. In climates where the ſucceſſion of ſeaſons is nearly ſtated and regular, where the periods of parching drought or deluging torrents, of the tempeſtuous hurricane or the refreſhing breeze, are fixed and aſcertained, mankind has little to do, but expect the dreaded changes, and provide againſt their devaſtations; but in countries like our own, where all the viciſſitudes of ſeaſons may take place in the courſe of a few hours, it is of the higheſt conſequence to inveſtigate the nature of the change, and the circumſtances that precede or accompany it. To the farmer, the mariner, the traveller, the phyſician, meteorology is in ſome meaſure a ſtudy of neceſſity; to the philoſopher it is a ſtudy of intereſt and delight; and to the obſerver of nature it affords objects of grandeur and ſublimity not to be found in any other department of his favourite ſcience. Surely nothing can contribute more to elevate the mind of man, to raiſe it "from nature up to nature's God," than the contemplation of the ſweeping whirlwind, the dazzling lightning, or the awful thunder.

Our limits will not admit of our entering into a hiſtorical detail of the progreſs of meteorology; but it may be proper in this place to enumerate the principal writers on this ſcience both in our own country and on the continent.

6 Writers on meteorology. In this country, we may reckon Dr Kirwan, (in his "Eſtimate of the Temperature of different Climates," his "Eſſay on the Variations of the Atmoſphere," and in the "Iriſh Tranſactions"), Mr John Dalton (chiefly in the "Mancheſter Memoirs"), Col. Capper (in his "Obſervations on the Winds and Monſoons"), Mr Williams (in his "Climate of Great Britain"), and Mr Luke Howard (in the Philoſophical Magazine), as the principal cultivators of meteorological knowledge; and on the continent, the names of Cotte ("*Traite de Meteorologie*," and *Journal de Phyſique)*, Sauſſure ("*Eſſai ſur l'Hygrometrie*," and *Voyage aux Alpes*"), De Luc (A) ("*Recherches ſur les Modifications de l'Atmoſphere*", *Idees ſur la Meteorologie*," and other works), and Lamarck (See *Journ. de Phyſ.* paſſim) ſtand moſt conſpicuous in this branch of natural ſcience.

7 In conſidering the ſubject of meteorology, we may properly divide it into ſeven general heads: 1. of the changes which take place in the gravity of the air; 2. of the changes of the temperature of the air; 3. of the changes produced by evaporation and rain; 4. of the changes produced by winds; 5. of atmoſpherical electricity; 6. of meteors or thoſe viſible phenomena accompanied with light, which take place in the atmoſphere or near the ſurface of the earth; and 7. the application of the principles of meteorology to the uſeful purpoſes of life. Of theſe heads, the fifth has been already fully conſidered under ELECTRICITY, and much of the ſixth has been exhauſted under METEOROLITE. The remaining circumſtances will form the ſubjects of the following chapters.

CHAP. I. *Of the Changes which take place in the Gravity of the Air.*

MANY of the facts relating to this part of our ſubject have been already anticipated under the article BAROMETER, and ſeveral circumſtances fall to be conſidered more properly under PNEUMATICS than in this place. We ſhall here confine ourſelves to a general view of the changes in the gravity of the atmoſphere, as indicated by the barometer, in various ſituations on or near the ſurface of the earth, and briefly examine the concluſions that may be drawn from them.

8 Mercury ſtands higheſt at the level of the ſea. The moſt general fact indicated by the barometer is, that this inſtrument ſhews us the weight of a column of air

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(A) In again mentioning the name of a philoſopher ſo reſpectable as M. de Luc, we embrace the firſt opportunity of doing him juſtice, and of vindicating his character againſt an unfortunate miſconception of the late Profeſſor Robiſon, a miſtake which we have inadvertently contributed to diſſeminate, by quoting Dr Robiſon's ſtatement in our account of Dr Black, where M. de Luc is accuſed of having arrogated to himſelf Dr Black's diſcovery of *latent heat.*

M. de Luc's vindication of himſelf (as printed in the 12th number of the Edinburgh Review) is before the public. We owe it to candour and juſtice to acknowledge our conviction that Dr Robiſon was too haſty in his aſſertion, and that M. de Luc, ſo far from arrogating to himſelf the doctrine of *latent heat*, has, in various parts of his numerous writings, expreſsly mentioned Dr Black as the author of that doctrine. This will appear from the following citations. In his "Introduction à la Phyſique terreſtre," p. 102, M. de Luc thus expreſſes himſelf. "Ne connoiſſant point le *feu latent*, dans la vapeur à toute temperature, *dont la premiere decouverte eſt due au* Dr Black, &c. Again, p. 232 of the ſame work. "Ce qui developpoit l'idée de *chaleur latente par laquelle le Dr Black avoit deſigné ce phénoméne*,"—and at p. 385, "Le Dr Black ayant découvert qu'une certaine quantité de chaleur diſparoit quand la vapeur de l'eau bouillante ſe forme, *nomma ce phénoméne chaleur latente* dans la vapeur."

We truſt that theſe quotations, with M. de Luc's own juſtification of himſelf above referred to, will be ſufficient to exculpate him from the charge of *literary felony* ſo warmly brought againſt him by Profeſſor Robiſon; and we have no doubt the Profeſſor himſelf, were he ſtill alive, would under ſuch evidence retract his accuſation.

air whoſe baſe is equal to the diameter of the mercury in the tube, and whoſe height is equal to the extent of the atmoſphere above the place of obſervation. As the height of this column muſt vary in different ſituations, and muſt, *cæteris paribus*, be greateſt, at the level of the ſea, the mercury in the tube will, under the ſame circumſtances, ſtand higheſt in ſuch a ſituation.

9 Medium height 30 inches.

The medium height of the barometer at the level of the ſea is 30 inches, as has been found by obſervations in the Britiſh channel, and in the Mediterranean ſea, at the temperatures of 55° and 60°; on the coaſt of Peru at the temperature of 84°, and in latitude 80°. As we aſcend above the ſurface of the earth, the medium height of the mercury diminiſhes; and ſome late obſervations made in balloons at a conſiderable diſtance above the tops of the higheſt mountains, have ſhewn that in the higher regions of the air, the column of mercury is very conſiderably ſhortened. This fact, as we have ſeen (ſee BAROMETER), has been uſefully applied to the meaſuring of heights and depths that cannot be aſcertained by the uſual geometrical methods. As the abſolute gravity of the atmoſphere is conſtantly varying, even in the ſame place, the column of air preſſing on the ſurface of the mercury without the tube, muſt preſs with more or leſs force, in proportion as theſe changes are greater; and hence the barometer points out theſe variations, falling when the atmoſphere is lighter, and riſing when it is heavier than uſual. For an account of the obſervations that were made on the riſe and fall of the barometer by the earlier philoſophers, and the attempts which were made by them to explain theſe phenomena, ſee BAROMETER.

It will be of advantage here to conſider the variations of the barometer, as they take place in different ſituations, in order, if poſſible, to point out the cauſe by which theſe variations are produced, as this cauſe muſt have conſiderable influence on the changes of the weather.

10 Variation of the barometer between the tropics very ſmall.

It is found, that between the tropics the variations of the barometer are exceedingly ſmall, and it is remarkable, that in that part of the world it does not deſcend above half as much for every 200 feet of elevation as it does beyond the tropics *. In the torrid zone, too, the barometer is elevated about $\frac{2}{3}$ of a line twice every day; and this elevation happens at the ſame time with the tides of the ſea †.

As the latitude advances towards the poles, the range of the barometer gradually increaſes, till at laſt it amounts to two or three inches. This gradual increaſe will appear from the following table.

Table of the Range of the Barometer.

Latitude.		Places.	Range of the Barometer.	
			Greateſt.	Annual.
0°		Peru	0.20 *	
22	23′	Calcutta	0.77 †	
40	55	Naples	1.00 ‡	
51	8	Dover	2.47 §	1.80
53	13	Middlewick	3.00 §	1.94
53	23	Liverpool	2.89 ‖	1.96
59	56	Peterſburgh	3.45 **	2.77

There is, however, ſome exception to this general rule, as in North America the range of the barometer is much leſs than in the correſponding European latitudes.

The range of the barometer is greater at the level of the ſea than on mountains, and in the ſame degree of latitude the extent of the range is in the inverſe ratio of the height of the place above the level of the ſea.

It appears probable that the barometer has a tendency to riſe during the day from morning to evening, and that this tendency is greateſt between 2 and 9 P. M. the greateſt elevation being at this laſt period. The elevation at 2 differs from that at 9 by $\frac{4}{12}$, while that at 2 differs from the morning elevation only by $\frac{1}{12}$; and that in certain climates the greateſt elevation takes place at 2 o'clock *.

11

The range of the barometer is greater in winter than in ſummer, as appears from ſome obſervations made at Kendal during five years; the mean range from October to March being 7.982, and that from April to September being only 5.447 †.

When the atmoſphere is ſerene and ſettled the mercury is generally high; and in calm weather, when it is inclined to rain, the mercury is low. On the approach of high winds it ſinks, as it does with a ſoutherly wind, but riſes very high on the approach of eaſterly and northerly winds. It is found, however, that at Calcutta the mercury is higheſt with north-weſterly and northerly, and loweſt with ſouth-eaſterly winds.

The mercury ſuddenly falls on the approach of tempeſts, and during their continuance undergoes great oſcillations.

To theſe general facts that have been obſerved on the riſe and fall of the barometer, we ſhall annex the following axioms by M. Cotte.

12 Cotte's axioms on the barometer.

1. The greateſt changes of the barometer commonly take place during clear weather, with a north wind; and the ſmall riſings during cloudy, rainy, or windy weather, with a ſouth, or nearly ſouth wind.

2. The ſtate of the mercury changes more in the winter than in the ſummer months; ſo that its greateſt riſing and falling takes place in winter; but its mean elevation is greater in ſummer than in winter.

3. The changes of the ſtate of the barometer are nearly null at the equator, and become greater the more one removes from it towards the poles.

4. They are more conſiderable in valleys than on mountains.

5. The more variable the wind, the more changeable the ſtate of the barometer.

6. It is lower at midnight and noon than at other periods of the day; its greateſt daily height is towards evening.

7. Between 10 at night and 2 in the morning, and alſo in the day, the riſing and falling of the mercury are leſs; the contrary is the caſe between 6 and 10 in the morning and evening.

8. Between 2 and 6 in the morning and evening it riſes as often as it falls; but in ſuch a manner that it oftener riſes about that time in the winter months, and falls oftener in the ſummer months.

9. The oſcillations are leſs in ſummer, greater in winter, and very great at the equinoxes.

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* *Jour. de Phyſ.* 1790, p. 268.

† *Ibid.*

* *Kirw. Iriſh Tranſ.* vol. iii. 47.

† *Aſiatic Reſearches*, vol. ii. Appendix.

‡ *Mancheſt. Mem.* vol. iv.

§ *Edin. Tranſ.* vol. ii.

‖ *Tranſ. Philadelph.* vol. ii.

** *Edin. Tranſ.* vol. ii. p. 229.

* *Jour. de Phyſ.* 1790.

† *Mancheſt. Mem.* vol. iv. p. 547.

10. They are greater alſo in the daytime than during the night.

11. The higher the ſun riſes above the horizon, the leſs are the oſcillations; they increaſe as he approaches the weſtern ſide of the horizon, and are exceedingly great when he comes oppoſite to the eaſtern part of the horizon.

12. They are, to a certain degree, independent of the changes of temperature.

13. The mercury generally riſes between the new and the full moon, and falls between the latter and the new moon.

14. It riſes more in the apogee than the perigee; it uſually riſes between the northern luniſtice and the ſouthern, and falls between the ſouthern luniſtice and the northern.

15. In general, a compariſon of the variations of the mercury with the poſitions of the moon gives nothing certain; the reſults of N° 13. and 14. are the moſt conſtant.

16. In the neighbourhood of Paris the barometer never continues 24 hours without changing.

17. The barometers in the weſtern diſtricts riſe and fall ſooner than thoſe in the more eaſtern.

18. When the ſun paſſes the meridian, the mercury, if falling, continues to fall, and its fall is often haſtened.

19. When the mercury at the ſame period is riſing, it falls, remains ſtationary, or riſes more ſlowly.

20. When the mercury, under the ſame circumſtances, is ſtationary, it falls, unleſs before or after it becomes ſtationary, it has been in the act of riſing.

21. The above changes commonly take place between 11 in the morning and 1 in the afternoon, but oftener before than after noon.

22. Before high tides there is almoſt always a great fall of the mercury; this takes place oftener at the full than the new moon.

Such is a general view of the variations in the gravity of the air, as far as they have been obſerved by the barometer; and we ſhall now endeavour to give ſome plauſible theory of them.

13 Atmoſphere forms two inclined planes meeting at the equator.

It is evident that the denſity of the atmoſphere is leaſt at the equator, and greateſt at the poles; for at the equator the centrifugal force, the diſtance from the centre of the earth, and the heat (all of which tend to diminiſh the denſity of the air), are at their maximum, while at the poles they are at their minimum. The mean height of the barometer at the level of the ſea, all over the globe, is 30 inches; the weight of the atmoſphere, therefore, is the ſame all over the globe. This weight depends on the denſity and height of the air; where the denſity is greateſt, its height muſt be leaſt; and on the contrary, where its denſity is leaſt, its height muſt be greateſt. The height of the atmoſphere, therefore, muſt be greateſt at the equator, and leaſt at the poles; and it muſt decreaſe gradually between the equator and the poles, ſo that its upper ſurface will reſemble two inclined planes, meeting above the equator their higheſt part *.

During ſummer, when the ſun is in our hemiſphere, the mean heat between the equator and the pole does not differ ſo much as in winter. Hence the rarity of the atmoſphere at the pole, and conſequently its height, will be increaſed. The upper ſurface of the atmoſphere, therefore, in the northern hemiſphere, will be leſs inclined; while that of the ſouthern hemiſphere, from contrary cauſes, will be much more inclined. The reverſe will take place during our winter.

The denſity of the atmoſphere depends in a great meaſure on the preſſure of the ſuperincumbent column, and therefore decreaſes according to the height, as the preſſure of the ſuperincumbent column conſtantly decreaſes. But the denſity of the atmoſphere in the torrid zone will not decreaſe ſo faſt as in the temperate and frigid zones, becauſe its column is larger, and becauſe there is a greater proportion of air in the higher part of this column. This accounts for the obſervation of Mr Caſſon, that the barometer ſinks only half as much for every 200 feet of elevation in the torrid as in the temperate zones. The denſity of the atmoſphere at the equator, therefore, though at the ſurface of the earth it is leſs, muſt at a certain height equal, and at a ſtill greater muſt exceed, the denſity of the atmoſphere in the temperate zones and at the poles.

14 Why the mercury is higheſt in winter in northern latitudes.

We ſhall preſently endeavour to prove, that a quantity of air is conſtantly aſcending at the equator, and that part of it at leaſt reaches and continues in the higher parts of the atmoſphere. From the fluidity of air, it is evident that it cannot accumulate above the equator, but muſt roll down the inclined plane which the upper ſurface of the atmoſphere aſſumes towards the poles. As the ſurface of the atmoſphere of the northern hemiſphere is more inclined during our winter than that of the ſouthern hemiſphere, a greater quantity of the equatorial current of air muſt flow over upon the northern than upon the ſouthern hemiſphere; ſo that the quantity of our atmoſphere will be greater during winter than that of the ſouthern hemiſphere; but during ſummer the reverſe will take place. Hence the greateſt mercurial heights take place during winter, and the range of the barometer is leſs in ſummer than in winter.

The denſity of the atmoſphere is in a great meaſure regulated by the heat of the place; wherever the cold is greateſt, there the denſity of the atmoſphere will be greateſt, and its column ſhorteſt. High countries, and ranges of lofty mountains, the tops of which are covered with ſnow the greateſt part of the year, muſt be much colder than other places ſituated in the ſame degree of latitude, and conſequently the column of air over them much ſhorter. The current of ſuperior air will linger and accumulate over theſe places in its paſſage towards the poles, and thus occaſion an irregularity in its motion, which will produce a ſimilar irregularity in the barometer. Such accumulations will be formed over the north-weſtern parts of Aſia, and over North America; hence the barometer uſually ſtands higher, and varies leſs there, than in Europe. Accumulations alſo are formed upon the Pyrenees, the Alps, the mountains of Africa, Turkey in Europe, Tartary, and Tibet. When theſe accumulations have gone on for ſome time, the denſity of the air becomes too great to be balanced by the ſurrounding atmoſphere; it ruſhes down on the neighbouring countries, and produces cold winds which raiſe the barometer. Hence the riſe of the barometer which generally attends north-eaſt winds in Europe, as they proceed from accumulations in the north-weſt of Aſia, or about the pole; hence, too, the north-weſt wind from the mountains of Tibet raiſes the barometer at Calcutta.

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* Iriſh. Tranſ. vol. ii. p. 43, &c.

Gravity of the Air.

We ſhall preſently endeavour to ſhew, that conſiderable quantities of air are occaſionally deſtroyed in the north polar regions. When this happens, the atmoſphere to the ſouth ruſhes in to ſupply the deficiency. Hence ſouth-weſt winds take place, and the barometer falls.

As the mean heat of our hemiſphere differs in different years, the denſity of the atmoſphere, and conſequently the quantity of equatorial air which flows towards the poles, muſt alſo be variable. Does this range correſpond to the mean annual heat; that is to ſay, Is the range greateſt when the heat is leaſt, and leaſt when the heat is greateſt? In ſome years greater accumulations than uſual take place in the mountainous parts in the ſouth of Europe and Aſia, owing, perhaps, to earlier falls of ſnow, or to the rays of the ſun having been excluded by long-continued fogs. When this takes place, the atmoſphere in the polar regions will be proportionably lighter. Hence the prevalence of ſoutherly winds during ſome winters more than others.

As the heat in the torrid zone never differs much, the denſity, and conſequently the height, of the atmoſphere, will not vary much. Hence the range of the barometer within the tropics is comparatively ſmall; and it increaſes gradually as we approach the poles, becauſe the difference of the temperature, and conſequently of the denſity, of the atmoſphere, increaſes with the latitude.

The diurnal elevation of the barometer in the torrid zone correſponding to the tides, obſerved by Mr Caſſon and others, muſt be owing to the influence of the moon on the atmoſphere. This influence, notwithſtanding the ingenious attempts of D'Alembert and ſeveral other philoſophers, ſeems altogether inadequate to account for the various phenomena of the winds. It is not ſo eaſy to account for the tendency which the barometer has to riſe as the day advances. Perhaps it may be accounted for by the additional quantity of vapour added to the atmoſphere, which, by increaſing the quantity of the atmoſphere, may poſſibly be adequate to produce the effect.

The falls of the barometer which precede, and the oſcillations which accompany, violent ſtorms and hurricanes, ſhew us that theſe phenomena are produced by very great rarefactions, or perhaps deſtructions of air, in particular parts of the atmoſphere. The falls of the barometer, too, that accompany winds proceed from the ſame cauſe. The obſervation made by Mr Copland, that a high barometer is accompanied by a temperature above the mean, will be eaſily accounted for by every one acquainted with Dr Black's theory of latent heat. The higher the mercury ſtands, the denſer the atmoſphere muſt be; and the denſer it becomes, the more latent heat it muſt give out. It is well known that air evolves heat when condenſed artificially. The falling of the barometer, which generally precedes rain, remains ſtill to be accounted for; but we know too little about the cauſes by which rain is produced, to be able to account for it in a ſatisfactory manner.

It has been for ſome time ſuſpected that the variation of the barometer is affected by the changes of the moon. The theory of lunar influence has been diſcuſſed on the continent chiefly by Lamarck and Cotte, (ſee Journal de Phyſique, *paſſim*); and in this country by Mr Luke Howard. Mr Howard's ſuſpicions of this influence on the barometer were firſt conceived, in conſequence of the printed charts, of which he made uſe in keeping a regiſter of the barometer, having the phaſes of the moon marked on them, and of his obſerving a remarkable coincidence between theſe and certain ſtates of the mercury. This coincidence conſiſts in the depreſſion of the barometrical line on the approach of the new and full moon, and its elevation on that of the quarters. In above 30 out of the 50 lunar weeks in the year 1798, the barometer was found to have changed its general direction once in each week, in ſuch a manner as to be either riſing or at its *maximum*, for the week preceding and following, about the time of each quarter; and to be either falling or at its *minimum*, for the two weeks, about the new and full. It is remarkable, that the point of greateſt depreſſion during the year, viz. to 28.67, was found about 12 hours after the new moon on the 8th of November; and that at its greateſt and extraordinary elevation to 30.89, on the 7th of February, at the time of the laſt quarter. Moreover, this coincidence appeared to take place moſt regularly in fair and moderate weather; and, in general, when the barometer fell, during the interval between the new or full moon and the quarters, an evident perturbation in the atmoſphere accompanied; of which may be inſtanced February 15. to 23. when the barometer, after an uncommon riſe, continued to fall rapidly after the new moon, with ſevere cold, which ended ſuddenly in ſtormy and wet weather; again, June 14. to 20. when two weeks of fair weather ended in a thunder ſtorm. In the greater part of December the uſual coincidence diſappeared, and the converſe took place; the barometer being low at the quarter and high at the full, amidſt continual alternations of rain, froſt, and ſnow, and, for part of the time, high winds. On the two days preceding the laſt quarter, the barometer roſe rapidly, and rain followed.

Gravity of the Air.

On the whole, Mr Howard thought there appeared ſufficient ground, on the evidence of the year 1798, to ſuppoſe that the gravity of our atmoſphere, as indicated by the barometer, may be ſubject to certain periodical changes, effected by a cauſe more ſteady and regular than either change of temperature, currents, or ſolution and precipitation of water, to which he believes the whole variation has been heretofore attributed.

The mean of the regiſter at large appeared to be 29.89, whence it appears that the depreſſion at the new and full moon either amounted to more, on the whole, than the elevations at the quarters, or that they fell out nearer to the time. He was quite ſatisfied, in paſſing through this regiſter, that if he had allowed himſelf to chooſe the higher rotations about the quarters, and the lower about the new and full, with a latitude of 24 or 36 hours, it would have made the reſults as much more favourable to his concluſions as in her former caſe.

Now, to omit the conſideration of other proofs for the preſent, it appeared to him evident, that the atmoſphere is ſubject to a periodical change of gravity, whereby the barometer, on a mean of ten years, is depreſſed at leaſt one-tenth of an inch while the moon is paſſing from the quarters to the full and new; and elevated, in the ſame proportion, during the return to the quarter. To what cauſes ſhall we attribute this periodical change, other than the attraction of the ſun and moon for the matter compoſing the atmoſphere?

The atmoſphere is a gravitating fluid, differing, in a

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Temperature of the Air.

phyſical ſenſe, from the water, chiefly in poſſeſſing leſs gravity; and it is demonſtrated *à priori* on the principles of the Newtonian philoſophy, that it ought to have its tides as well as the ocean, although in a degree as much leſs perceptible as is its gravity.

He ſuppoſes, therefore, that the joint attractions of the ſun and moon at the new moon, and the attraction of the moon predominating over the ſun's weaker attraction at the full, tend to depreſs the barometer, by taking off from the gravity of the atmoſphere, as they produce a high tide in the waters, by taking off from their gravity; and, again, that the attraction of the moon being diminiſhed by that of the ſun at her quarters, this diminution tends to make a high barometer, together with a low tide, by permitting each fluid to preſs with additional gravity upon the earth *.

Chap. II. *Of the Changes which take place in the Temperature of the Air.*

It is obvious to the moſt careleſs obſerver, that the temperature of the air varies conſiderably even in the ſame place, and at the ſame ſeaſon. This conſtant variation muſt be attributed to the reflected rays of the ſun, which communicate heat from the ſurface of the earth to the ſurrounding atmoſphere. As from this cauſe the heat of thoſe places which are ſo ſituated as to be moſt warmed by the ſun's rays is always greateſt, and as this temperature varies in every place with the ſeaſon of the year, and diminiſhes according to the height of the air above the ſurface; and as the earth at the equator is expoſed to the moſt perpendicular rays of the ſun, the earth is there hotteſt, and its heat diminiſhes gradually from the equator to the poles. Of courſe, the temperature of the air muſt vary in the ſame manner, being hotteſt over the equator, and diminiſhing in temperature towards the poles, where it is coldeſt. Though it it hotteſt at the equator, its heat, as in all other ſituations, gradually diminiſhes there, as we aſcend above the ſurface of the earth.

Temperature of the Air.

Though there is a conſiderable difference in every part of the world between the temperature of the atmoſphere in ſummer and in winter; though in the ſame ſeaſon the temperature of almoſt every day, and even every hour, differs from that which precedes and follows it; though the heat varies continually in the moſt irregular and ſeemingly capricious manner—ſtill there is a certain mean temperature in every climate, which the atmoſphere has always a tendency to obſerve, and which it neither exceeds nor comes ſhort of beyond a certain number of degrees. What this temperature is, may be known by taking the mean of tables of obſervations kept for a number of years; and our knowledge of it muſt be the more accurate the greater the number of obſervations is.

15 Mean annual temperature greateſt at the equator.

The mean annual temperature is greateſt at the equator (or at leaſt a degree or two on the north ſide of it), and it diminiſhes gradually towards the poles, where it is leaſt. This diminution takes place in arithmetical progreſſion, or, to ſpeak more properly, the annual temperatures of all the latitudes are arithmetical means between the mean annual temperature of the equator and that of the pole. This was firſt aſcertained by Mr Meyer; and Dr Kirwan improving on Meyer's hint, has calculated in the following table the mean annual temperature of every latitude between the equator and the pole. It muſt be remarked, however, that this table is calculated only for a particular part of the earth's ſurface, viz. that part of the Atlantic ocean which lies between the 80° of northern, and the 45° of ſouthern latitude, extending weſtward as far as the Gulf ſtream, and to within a few leagues of the coaſt of America, and for all that part of the Pacific ocean that reaches from 45° of north latitude to 40° of ſouth latitude, and extending between the 20th and 275th degree of longitude eaſt from London. This part of the ocean is called by Dr Kirwan the ſtandard, and was beſt ſuited to his purpoſe, as the reſt of the ocean is ſubject to irregularities, which will be noticed preſently (D).

Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.	Lat.	Temper.
90	31.	77	33.7	64	41.2	51	52.4	38	63.9	25	74.5	12	81.7
89	31.04	76	34.1	63	41.9	50	52.9	37	64.8	24	75.4	11	82.0
88	31.10	75	34.5	62	42.7	49	53.8	36	65.7	23	75.9	10	82.3
87	31.14	74	35.0	61	43.5	48	54.7	35	66.6	22	76.5	9	82.7
86	31.2	73	35.5	60	44.3	47	55.6	34	67.4	21	77.2	8	82.9
85	31.4	72	36.0	59	45.09	46	56.4	33	68.3	20	77.8	7	83.2
84	31.5	71	36.6	58	45.8	45	57.5	32	69.1	19	78.3	6	83.4
83	31.7	70	37.2	57	46.7	44	58.4	31	69.9	18	78.9	5	83.6
82	32.0	69	37.8	56	47.5	43	59.4	30	70.7	17	79.4	0	84.0
81	32.2	68	38.4	55	48.4	42	60.3	29	71.5	16	79.9		
80	32.6	67	39.1	54	49.2	41	61.2	28	72.3	15	80.4		
79	32.9	66	39.7	53	50.2	40	62.0	27	72.8	14	80.8		
78	33.2	65	40.4	52	51.1	39	63.0	26	73.8	13	81.3		

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* Phil. Mag. vol. vii. p. 355.

(D) In calculating this table, Dr Kirwan proceeded on the following principle. Let the mean annual heat at the equator be m and at the pole $m-n$; put ϕ for any other latitude; the mean annual temperature of that latitude will be $m-n \times \text{ſin.}\ \phi^2$. If, therefore, the temperature of any two latitudes be known, the value of m and n may be found. Now, the temperature of north latitude 40° has been found by the beſt obſervations to be 62.1°,

and

Dr Kirwan has alſo calculated in the following table the mean monthly temperature of the ſame ſtandard (E).

Latit.	80°	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°	69°	68°	67°	66°	65°	64°	63°	62°
Jan.	22.	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	27.5	28.	28.	28.	29.	30.	31.
Feb.	23.	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	28.5	29.	30.	31.	32.	33.
March	27.	27.5	28.	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	35.	36.	37.	38.
April	32.6	32.9	33.2	33.7	34.1	34.5	35.	35.5	36.	36.6	37.2	37.8	38.4	39.1	39.7	40.4	41.2	41.9	42.7
May	36.5	36.5	37.	37.5	38.	38.5	39.	39.5	40.	40.5	41.	41.5	42.	42.5	43.	44.	45.	46.	47.
June	51.	51.	51.5	52.	52.	52.	52.5	53.	53.5	54.	54.	54.5	54.5	54.5	55.	55.	55.5	55.5	56.
July	50.	50.	50.5	51.	51.	51.	51.5	52.	52.5	53.	53.5	53.5	53.5	54.	54.5	54.5	55.	55.	55.5
Aug.	39.5	40.	41.	41.5	42.	42.5	43.	43.5	44.	44.5	45.	45.5	46.	47.	48.	48.5	49.	50.	51.
Sept.	33.5	34.	34.5	35.	35.5	36.	36.5	37.	38.	38.5	39.	39.5	40.	41.	42.	43.	44.	45.	46.
Oct.	28.5	29.	29.5	30.	30.5	31.	31.5	32.	32.5	33.	33.5	34.	34.	35.	36.	37.	37.5	38.	39.
Nov.	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.5	29.	30.	31.	32.	32.5	33.	34.
Dec.	22.5	23.	23.5	24.	24.5	25.	25.5	26.	26.5	27.	27.5	28.	28.	29.	30.	30.5	31.	31.	32.

Latit.	61°	60°	59°	58°	57°	56°	55°	54°	53°	52°	51°	50°	49°	48°	47°	46°	45°	44°	43°
Jan.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	42.5	43.5	43.	42.5	44.	44.5	45.	45.5
Feb.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	44.5	44.5	45.	45.5	46.	46.5	47.	48.
March	39.	40.	41.	42.	43.	44.6	45.	46.	48.	49.	50.	50.5	51.	52.5	53.	53.5	54.5	55.5	56.5
April	43.5	44.3	45.09	45.8	46.7	47.5	48.4	49.2	50.2	51.1	52.4	52.9	53.8	54.7	55.6	56.4	57.5	58.4	59.4
May	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	58.5	59.	60.	61.	62.	63.	64.	65.
June	56.	56.	56.5	57.	57.	57.5	58.	58.5	59.	59.	60.	61.	62.	63.	64.	65.	66.	67.	68.
July	55.5	56.	56.5	57.	57.5	58.	59.	60.	61.	62.	63.	63.5	64.	65.	66.	67.	68.	69.	69.5
Aug.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.5	64.	65.	66.	67.	68.	69.	69.5
Sept.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.5	59.	60.	61.	62.	63.	64.	66.
Oct.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.	50.	50.5	51.	52.	53.	54.	55.	56.	57.
Nov.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.5	46.	46.5	47.	48.	49.	50.	51.	52.	53.
Dec.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	44.	44.5	45.	46.	47.	48.	49.	50.	51.

Latit.	42°	41°	40°	39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	29°	28°	27°	26°	25°	24°
Jan.	46.	46.5	49.5	51.	52.	53.5	55.	56.5	59.5	63.	63.	63.	63.5	63.5	63.5	64.	64.5	65.5	67.
Feb.	49.	50.	53.	56.5	58.	60.	61.	62.	63.	64.5	66.	67.	68.5	68.5	69.5	69.5	70.5	71.	72.
March	58.5	59.5	60.	60.5	61.	62.	63.	64.	65.	66.5	67.5	68.5	69.5	71.	72.	72.5	73.	73.5	74.5
April	60.3	61.2	62.1	63.	63.9	64.8	65.7	66.6	67.4	68.3	69.1	69.9	70.7	71.5	72.3	72.8	73.8	74.5	75.4
May	66.	67.	68.	69.	70.	70.5	71.	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	77.5	78.
June	69.	70.	70.5	71.	71.	71.	71.5	71.5	72.	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
July	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
Aug.	70.	70.	71.	71.	72.	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.5	75.5	76.	76.5	78.	78.5
Sept.	68.	69.5	70.5	71.	71.5	72.	72.5	72.5	72.5	72.5	73.	73.	73.5	74.	75.5	76.	76.5	77.5	78.
Oct.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.5	68.5	69.5	70.5	71.	72.5	72.5	73.	73.5	74.5
Nov.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.	64.5	65.5	66.5	68.	69.	69.5	71.5	72.	73.5
Dec.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.5	63.5	64.5	66.	67.	67.5	68.5	69.5	70.

Latit.

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and that of latitude 50°, 52.9°. The ſquare of the ſine of 40° is nearly 0.419, and the ſquare of the ſine of 50° is nearly 0.586. Therefore,

$$m—0.41\ n=62.1, \text{ and}$$
$$m—0.58\ n=52.9\text{; therefore,}$$
$$62.1+0.41\ n=52.9+058\ n,$$

as each of them, from the two firſt equations, is equal to m. From this laſt equation the value of n is found to be nearly 53; and m is nearly equal to 84. The mean temperature of the equator, therefore, is 84°, and that of the pole 31°. To find the mean temperature for every other latitude we have only to find 88 arithmetical means between 84 and 31.

(E) In calculating the table of mean monthly temperature, Dr Kirwan proceeded on the following principles. The mean temperature of April ſeems to approach very nearly to the mean temperature of the whole year, and as far as heat depends on the action of the ſolar rays, the mean heat of each month may be conſidered as proportional

tional

Latit.	23°	22°	21°	20°	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°
Jan.	68.	69.	71.	72.	72.5	73.	73.5	74.	74.5	75.	76.	76.5	77.	77.5
Feb.	72.	72.5	74.	75.	76.	76.5	77.	77.5	78.	78.5	79.	79.5	79.8	80.
March	75.	75.5	76.	77.	77.5	78.	78.5	79.	79.5	80.	80.8	81.	81.5	81.8
April	75.9	76.5	77.2	77.8	78.3	78.9	79.4	79.9	80.4	80.8	81.3	81.7	82.	82.3
May	78.5	79.5	80.	80.5	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.	84.3
June	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
July	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
Aug.	79.	79.5	80.	80.5	81.5	82.	82.5	83.	83.5	83.8	84.	84.3	84.6	84.8
Sept.	78.5	79.	79.5	80.	81.	81.5	82.	82.5	83.	83.	83.5	84.	84.3	84.6
Oct.	75.	75.5	77.	78.	79.	80.	81.	81.5	82.	82.5	83.	83.5	83.8	84.
Nov.	74.	74.5	75.	75.5	76.	77.	78.	78.5	79.	79.5	80.	80.5	80.8	81.
Dec.	71.	71.5	72.	72.5	73.	74.	75.	75.5	76.	76.5	77.	77.5	78.	78.5

16 It appears from the above table that January is the coldeſt month in every latitude; that July is the warmeſt month in all latitudes above 48°; that in lower latitudes Auguſt is generally the warmeſt month; that the difference between the hotteſt and coldeſt months increaſes according to the diſtance of the place from the equator. All habitable latitudes are found to enjoy a medium heat of 60° for at leaſt 2 months, which is a very favourable circumſtance, as probably no corn could be produced under a lower medium temperature. The temperatures within 10° of the poles differ very little, nor do they differ much within 10° of the equator. Hence it was unneceſſary to note theſe latitudes in the table. The temperatures of different years vary but little near the equator, but this difference increaſes more and more as the latitudes approach the poles.

17 Temperature decreaſes as we aſcend in the air.

It is well known that the temperature of the atmoſphere gradually diminiſhes according to the height of the place above the level of the ſea. It was found by Dr Hutton of Edinburgh, that a thermometer kept on the top of Arthur's ſeat, a height of about 800 feet, uſually ſtood 3° lower than one kept at the foot of this hill; and Bouguer obſerved that on the top of Pinchincha, a height of about 15564 feet, a thermometer ſtood 54° lower than it did at the level of the ſea in the ſame latitude.

We are indebted to Dr Kirwan for a very ingenious method of determining the rate of the diminution in the temperature in particular caſes, having the temperature of the ſurface of the earth given. The temperature of the atmoſphere conſtantly diminiſhing as we riſe above the level of the ſea, we muſt at a certain height arrive at a point where a perpetual congelation takes place. This point muſt vary in height according to the latitude, being higheſt at the equator, and coming gradually nearer the earth as we approach the poles; it muſt vary alſo with the ſeaſon, being higheſt in ſummer, and loweſt in winter.

18 Term of perpetual congelation.

The cold on the top of Pinchincha was found by M. Bouguer to extend from 7° to 9° below the freezing point every morning juſt before ſunriſe; hence he concluded that between the tropics the medium height of the term of congelation (where it freezes at ſome part of the day all the year round) ſhould be fixed at 15577 feet above the level of the ſea; but in latitude 28°, and during the ſummer, at 13440 feet. If we take the difference between the temperature at the equator, and the freezing point, this difference will bear the ſame proportion to the term of congelation at the equator, that the difference between the medium temperature at any other latitude and the freezing point bears to the term of congelation at that latitude. Suppoſe the medium heat at the equator to be 84°, the difference between which and 32° is 52°; and ſuppoſe the medium heat of latitude 28° to be 72$\frac{3}{10}$°, the difference between which and 32° is 40$\frac{2}{10}$°. Then by the following proportion, 52° : 15577 = 40$\frac{3}{10}$: 12.72° gives us the term of congelation at 28°. In this way Dr Kirwan proceeded in calculating the following table.

Lat.

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tional to the mean altitude of the ſine, or rather to the ſine of that altitude. If, therefore, we have the mean heat of April, and the ſine of the ſun's altitude given, the mean heat of May be found by the following proportion:

As the ſine of the ſun's mean altitude in April : the mean heat of April = the ſine of the ſun's mean altitude in May : mean heat of May.

In the ſame manner the mean heat of June, July, and Auguſt may be found; but for the temperature of the ſucceeding months we muſt take into conſideration another circumſtance, ſince the above rule would make the temperature of theſe months too low, as it does not take in the heat derived from the earth, which is nearly equal to the mean annual temperature. The real mean heats of theſe months muſt be conſidered as an arithmetical mean between the aſtronomical and terreſtrial heats. Thus, for latitude 51°, the aſtronomical heat of September being 44.6°, and the mean annual heat 52.4°, the real heat of September ought to be $\frac{44.6+52.4}{2}=48.5$. Dr Kirwan, however, after going through a tedious calculation, found the reſults to correſpond ſo little with actual obſervation, that he drew up the table partly from calculating from principles, and partly from an examination of ſeveral ſea journals.

Lat.	Mean height of the term of congelation, in feet.	Lat.	Mean height of the term of congelation, in feet.
0°	15577	45°	7658
5	15457	50	6260
10	15067	55	4912
15	14498	60	3684
20	13719	65	2516
25	13030	70	1557
30	11592	75	748
35	10664	80	120
40	9016		

This laſt height of 120 feet M. Bouguer called the lower term of congelation. He alſo diſtinguiſhed another term of congelation above which no viſible vapour riſes, and this he called the upper term of congelation. This line is conſidered by Kirwan as much leſs variable during the ſummer months than the lower line, and it has therefore been adopted by him to determine the rate of diminution in the temperature as we aſcend into the atmoſphere. He has calculated its height for every degree of north latitude in the following table.

N. Lat.	Feet.	N. Lat.	Feet.	N. Lat.	Feet.	N. Lat.	Feet.
0	28000	26	22906	48	12245	70	4413
5	27784	27	22389	49	11750	71	4354
6	27644	28	21872	50	11253	72	4295
7	27504	29	21355	51	10124	73	4236
8	27364	30	20838	52	8965	74	4177
9	27224	31	20492	53	7806	75	4119
10	27084	32	20146	54	6647	76	4067
11	26880	33	19800	55	5617	77	4015
12	26676	34	19454	56	5533	78	3963
13	26472	35	19169	57	5439	79	3911
14	26268	36	18577	58	5345	80	3861
15	26061	37	17985	59	5251	81	3815
16	25781	38	17393	60	5148	82	3769
17	25501	39	16801	61	5068	83	3723
18	25221	40	16207	62	4989	84	3677
19	24941	41	15712	63	4910	85	3631
20	24661	42	15217	64	4831	86	3592
21	24404	43	14722	65	4752	87	3553
22	24147	44	14227	66	4684	88	3514
23	23890	45	13730	67	4616	89	3475
24	23633	46	13235	68	4548	90	3432
25	23423	47	12740	69	4480		(F)

19 Temperature of the air above the earth owing to the conducting power of the air.

From the modes of eſtimating the diminution of temperature now given, which agree extremely well with obſervation, we find that the temperature diminiſhes in arithmetical progreſſion, and hence we infer that the temperature of the air at a diſtance from the earth is owing to the conducting power of the air, and not to the aſcent of hot air from the ſurface of the earth.

It is however found that in winter the upper ſtrata of the air are often warmer than the lower; and this ſuperior heat, almoſt conſtantly obſerved in winter, is attributed by Dr Kirwan to a current of warm air from the equator, rolling towards the north pole during our winter *.

20 Temperature of the North Pacific ocean.

We have now given the general method of finding the medium annual temperature all over the globe; but there are ſeveral exceptions to our general inferences which muſt be particularly mentioned.

That part of the Pacific ocean which lies between north latitude 52° and 66° is no broader at its northern extremity than 42 miles, and at its ſouthern extremity its breadth ſcarcely exceeds 1300 miles: it is reaſonable to ſuppoſe, therefore, that its temperature will be conſiderably influenced by the ſurrounding land, which conſiſts of ranges of mountains, covered a great part of the year with ſnow; and there are beſides a great many high, and conſequently cold, iſlands ſcattered through it. For theſe reaſons Dr Kirwan concludes, that its temperature is at leaſt 4° or 5° below the ſtandard. But we are not yet furniſhed with a ſufficient number of obſervations to determine this with accuracy.

21 Of the ſouthern hemiſphere.

It is the general opinion, that the ſouthern hemiſphere beyond the 40° of latitude is conſiderably colder than the correſponding parts of the northern hemiſphere. See America.

22 Of ſmall ſeas.

Small ſeas ſurrounded with land, at leaſt in temperate and cold climates, are generally warmer in ſummer and colder in winter than the ſtandard ocean, becauſe they are much influenced by the temperature of the land. The gulf of Bothnia, for inſtance, is for the moſt part frozen in winter; but in ſummer it is ſometimes heated to 70°, a degree of heat never to be found in the oppoſite part of the Atlantic. The German ſea is above 3° colder in winter, and 5° warmer in ſummer, than the Atlantic. The Mediterranean ſea is, for the greater part of its extent, warmer both in ſummer and winter than the Atlantic, which therefore flows into it. The Black ſea is colder than the Mediterranean, and flows into it.

The eaſtern parts of North America are much colder than the oppoſite coaſt of Europe, and fall ſhort of the

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* *Iriſh Tranſ.* vol. viii. p. 375.

(F) Dr Kirwan has given us the following rule for aſcertaining the temperature at any required height, ſuppoſing we know the temperature of the ſurface of the earth.

For the temperature obſerved at the ſurface of the earth, put m; for the given height h, and t for the height of the upper term of congelation at the given latitude; then $\frac{m-32}{\frac{t}{100}-1}$ = the diminution of temperature for every 100 feet of elevation; or it is the common difference of the terms of the progreſſion required. Let this common difference thus found be denoted by c; then $c \times \frac{h}{100}$ gives us the whole diminution of temperature from the ſurface of the earth to the given height. Let this diminution be denoted by d, then $m-d$ is obviouſly ſtandard by about 10° or 12°, as appears from American meteorological tables. The cauſes of this remarkable difference are many. The higheſt part of North America lies between 40° and 50° of north latitude, and 100° and 110° of longitude weſt from London, for there the greateſt rivers originate. The very height, therefore, makes this ſpot colder than it would otherwiſe be. It is covered with immenſe foreſts, and abounds with large ſwamps and moraſſes, which render it incapable of receiving any great degree of heat; ſo that the rigour of winter is much leſs tempered by the heat of the earth than in the old continent. To the eaſt lie a number of very large lakes, and farther north, Hudſon's bay; about 50 miles on the ſouth of which there is a range of mountains which prevent its receiving any heat from that quarter. This bay is bounded on the eaſt by the mountainous country of Labrador and by a number of iſlands. Hence the coldneſs of the north-weſt winds and the lowneſs of the temperature. But as the cultivated parts of North America are now much warmer than formerly, there is reaſon to expect that the climate will become ſtill milder when the country is better cleared of woods, though perhaps it will never equal the temperature of the old continent.

23
Of iſlands.

Iſlands are warmer than continents in the ſame degree of latitude; and countries lying to the windward of extenſive mountains or foreſts are warmer than thoſe lying to the leeward. Stones or ſand have a leſs capacity for heat than earth has, which is always ſomewhat moiſt; they heat or cool, therefore, more rapidly and to a greater degree. Hence the violent heat of Arabia and Africa, and the intenſe cold of Terra del Fuego. Living vegetables alter their temperature very ſlowly, but their evaporation is great; and if they be tall and cloſe, as in foreſts, they exclude the ſun's rays from the earth, and ſhelter the winter ſnow from the wind and the ſun. Woody countries, therefore, are much colder than thoſe which are cultivated.

We ſhall conclude this chapter with a ſeries of meteorological axioms reſpecting the temperature of the air, by M. Cotte.

24
Cotte's axioms reſpecting temperature.

1. The extreme degrees of heat are almoſt every where the ſame; this, however, is not the caſe in regard to the extreme degrees of cold.
2. The thermometer riſes to its extreme height oftener in the temperate zones than in the torrid zone.
3. It changes very little between the tropics; its variations, like thoſe of the barometer, are greater the more one proceeds from the equator towards the poles.
4. It riſes higher in the plains than on mountains.
5. It does not fall ſo much in the neighbourhood of the ſea as in inland parts.
6. The wind has no influence on its motions.
7. Moiſture has a peculiar influence on it, if followed by a wind which diſperſes it.
8. The greateſt heat, and the greateſt cold, take place about ſix weeks after the northern or ſouthern ſolſtice.
9. The thermometer changes more in ſummer than in winter.
10. The coldeſt period of the day is before ſunriſe.
11. The greateſt heat in the ſun and the ſhade ſeldom takes place on the ſame day.
12. The heat decreaſes with far more rapidity from September and October, than it increaſed from July to September.
13. It is not true, that a very cold winter is the prognoſtic of a very hot ſummer.

CHAP. III. *Of the Changes which take place in the Air with reſpect to Evaporation and Rain.*

25
Qualities of vapour.

There ſeems no reaſon to doubt that water exiſts in the atmoſphere in an intermediate ſtate between that of a fluid and that of abſolute ſteam. This is the ſtate of vapour, of the qualities of which it is proper that we ſhould here take a general view.

We are indebted to the experiments of Sauſſure and de Luc for much of our knowledge of the qualities of vapour. It is an elaſtic inviſible fluid like common air, but lighter; being to common air, according to Sauſſure, as 10 to 14, or, according to Kirwan, as 10 to 12; it cannot paſs beyond a certain maximum of denſity, otherwiſe the particles of water which compoſe it unite together, and form ſmall, hollow, viſible veſicles, called *veſicular vapour;* which is of the ſame ſpecific gravity with atmoſpherical air. It is of this vapour that clouds and fogs are compoſed. This maximum increaſes with the temperature; and at the heat of boiling water is ſo great, that ſteam can reſiſt the whole preſſure of the air, and exiſt in the atmoſphere in any quantity.

After what has been ſtated under CHEMISTRY with reſpect to the nature and properties of vapour, we have nothing here to add on that ſubject, except to give the reſult of obſervations that have been made on the ſtate of vapour in the atmoſphere.

26
Evaporation confined to the ſurface.

It is found that the evaporation of water into the air is confined entirely to the ſurface, and hence it is always proportional to the ſurface expoſed to the action of the air. Accordingly, obſervation ſhows that in maritime countries, and in marſhy ſituations, in the neighbourhood of lakes, rivers, &c. the evaporation is much greater than in inland countries, and dry ſituations.

27
Proportional to the temperature of the air.

It is found that evaporation is greateſt in hot weather; whence it muſt depend, in ſome degree, on the tempera-

ture

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the temperature required. An example will make this rule ſufficiently obvious. In latitude 56° the heat below being 54°; required the temperature of the air at the height of 803 feet?

$$\text{Here } m=54,\ t=5533,\ \frac{m-32}{\frac{t}{100}-1}=\frac{22}{54\cdot33}=0404=c, \text{ and } c\times\frac{h}{100}=0.404\times8.03=3.24=d, \text{ and } m-d=$$

$54-3.24=50.75$. Hence we ſee that the temperature of the air at the height of 803 feet above the ſurface is 50°.75.

Evaporation and Rain.

ture of the air. This was aſcertained by Mr Dalton from actual experiments, the reſult of which was, that the quantity evaporated per minute from a given ſurface of water at a given temperature, is to the quantity evaporated from the ſurface at 212°, as the force of vapour at the given temperature is to the force of vapour at 212°. By means of the table expreſſing the force of vapour at various temperatures given under CHEMISTRY, p. 468, we may diſcover by the above rule the quantity of water at a given temperature loſt by evaporation.

There are ſeveral circumſtances that affect the quantity of vapour riſing from water, even at the ſame temperature. Thus, we find that evaporation is leaſt in calm weather, increaſes when there is wind, and is greater in proportion as the wind is ſtronger. This evidently ariſes from the agitation of the water, by which a new ſurface is perpetually expoſed to the action of the air.

We ſhall here inſert a table by Mr Dalton, expreſſing the quantity of vapour raiſed in various atmoſpheric temperatures, from a circular ſurface ſix inches in diameter.

Temperature.	Force of vapour in inches.	Evaporating force in grains.			Temperature.	Force of vapour in inches.	Evaporating force in grains.		
212°	30	120	154	189	212°	30	120	154	189
20°	.129	.52	.67	.82	53°	.415	1.66	2.13	2.61
21	.134	.54	.69	.85	54	.429	1.71	2.20	2.69
22	.139	.56	.71	.88	55	.443	1.77	2.28	2.78
23	.144	.58	.73	.91	56	.458	1.83	2.35	2.88
24	.150	.60	.77	.94	57	.474	1.90	2.43	2.98
25	.156	.62	.79	.97	58	.490	1.96	2.52	3.08
26	.162	.65	.82	1.02	59	.507	2.03	2.61	3.19
27	.168	.67	.86	1.05	60	.524	2.10	2.70	3.30
28	.174	.70	.90	1.10	61	.542	2.17	2.79	3.41
29	.180	.72	.93	1.13	62	.560	2.24	2.88	3.52
30	.186	.74	.95	1.17	63	.578	2.31	2.97	3.63
31	.193	.77	.99	1.21	64	.597	2.39	3.07	3.76
32	.200	.80	1.03	1.26	65	.616	2.46	3.16	3.87
33	.207	.83	1.07	1.30	66	.635	2.54	3.27	3.99
34	.214	.86	1.11	1.35	67	.655	2.62	3.37	4.12
35	.221	.89	1.14	1.39	68	.676	2.70	3.47	4.24
36	.229	.92	1.18	1.45	69	.698	2 79	3.59	4.38
37	.237	.95	1.22	1.49	70	.721	2.88	3.70	4.53
38	.245	.98	1.26	1.54	71	.745	2.98	3.83	4.68
39	.254	1.02	1.31	1.60	72	.770	3.08	3.96	4.84
40	.263	1.05	1.35	1.65	73	.796	3.18	4.09	5.00
41	.273	1.09	1.40	1.71	74	.823	3.29	4.23	5.17
42	.283	1.13	1.45	1.78	75	.851	3.40	4.37	5.34
43	.294	1.18	1.51	1.85	76	.880	3.52	4.52	5.53
44	.305	1.22	1.57	1.92	77	.910	3.65	4.68	5.72
45	.316	1.26	1.62	1.99	78	.940	3.76	4.83	5.91
46	.327	1.31	1.68	2.06	79	.971	3.88	4.99	6.10
47	.339	1.36	1.75	2.13	80	1.00	4.00	5.14	6.29
48	.351	1.40	1.80	2.20	81	1.04	4.16	5.35	6.54
49	.363	1.45	1.86	2.28	82	1.07	4.28	5.50	6.73
50	.375	1.50	1.92	2.36	83	1.10	4.40	5.66	6.91
51	.388	1.55	1.99	2.44	84	1.14	4.56	5.86	7.17
52	.401	1.60	2.06	2.51	85	1.17	4.68	6.07	7.46

The firſt column of the above table expreſſes the temperature; the ſecond, the correſponding force of vapour; the other three columns give the number of grains of water that would be evaporated from a ſurface of ſix inches in diameter in the reſpective temperatures, on the ſuppoſition of there being previouſly no aqueous vapour in the atmoſphere. Theſe columns preſent the extremes and the mean of evaporation likely to be noticed, or nearly ſuch; for the firſt is calculated upon the ſuppoſition of 35 grains loſs per minute from the veſſel of three inches and a quarter in diameter; the ſecond 45, and the third 55 grains per minute.

As yet we have ſtated only the degree of evaporation that would take place under various circumſtances, provided that the atmoſphere were, at the time, entirely free from moiſture; but as this can ſcarcely happen, it becomes neceſſary to aſcertain the rate of evaporation when qualified by the vapour already exiſting in the atmoſphere. This is readily done by firſt finding the force of the vapour already in the atmoſphere, as above directed, and ſubtracting it from the force of vapour at the given temperature. The remainder is the actual force of evaporation, from which, by the laſt table, we find the required rate of evaporation. Suppoſe, for inſtance, it be required to know the rate of evaporation at the temperature of 59°. From the laſt table we ſee that the force of vapour at 59° is about 0.5 or $\frac{1}{60}$ its force at 212°. Now, ſuppoſe that by trials we find the force of the vapour which already exiſts in the atmoſphere to be 0.25 or $\frac{1}{120}=\frac{1}{2}$ of $\frac{1}{60}$. Subtracting the latter from the former, we have for a remainder 0.25 = the force of evaporation required, which is therefore juſt the half of what it would be if the atmoſphere were entirely free from vapour.

The force of vapour exiſting in the atmoſphere is ſcarcely ever equal to the force of vapour of the temperature of the atmoſphere. Hence evaporation may, with a few exceptions, be conſidered as going on without intermiſſion. Attempts have been made to aſcertain the quantity of evaporation that takes place in the courſe of a year; but the inveſtigation of this problem is ſo difficult, that theſe attempts have ſucceeded only in obtaining approximations towards the truth. Mr Dobſon of Liverpool, from a courſe of experiments made in 1772, 1773, 1774, and 1775, concludes that the mean annual evaporation from the ſurface of water, amounted to 36.78 inches. The proportions for each month are as follows.

	Inches.		Inches.
January	1.50	July	5.11
February	1.77	Auguſt	5.01
March	2.64	September	3.18
April	3.30	October	2.51
May	4.34	November	1.51
June	4.41	December	1.49

The experiments of Mr Dalton ſhew that the evaporation from the ſurface of water in a very dry and hot ſummer day, was rather more than two tenths of an inch.

Several experiments have been made on the quantity of evaporation from land, eſpecially by Mr Williams in America, and Dr Watſon, Mr Dalton and Mr Hoyle in Britain.

Mr Williams's experiments appear to ſhew that the evaporation from the ſurface of ſuch land as is covered with trees and other vegetables is about one third greater than the evaporation from the ſurface of water, though much reliance is not laid on theſe experiments.

28 Evaporation from land.

From an experiment made by Dr Watſon during ſummer, when the earth had been parched by a month's drought, it appeared that 1600 gallons of water were evaporated from a ſingle acre in 12 hours *. Dr Watſon's experiment, however, was of a nature that did not admit of great preciſion.

29 Experiments by Dalton and Hoyle.

The experiments made by Mr Dalton and Mr Hoyle in the years 1796, 1797, and 1798, are the moſt exact that have been made on this ſubject, and we ſhall therefore conſider them more at large. They were made with the following apparatus. Having procured a cylindrical veſſel made of tin plate, three feet deep and ten inches in diameter, they inſerted into it two pipes directed downwards, ſo that water might paſs through them into two bottles. One pipe was fixed near the bottom of the veſſel, and the other about an inch from the top. The veſſel was filled up for a few inches with gravel and ſand, and all the reſt with good freſh ſoil. It was then put into a hole in the ground, and the ſpace around filled up with earth except on one ſide, for the convenience of putting bottles to the two pipes; then ſome water was poured on the earth to ſadden it, and all that would drain off was ſuffered to eſcape. Hence the earth may be conſidered as ſaturated with moiſture. The ſoil was kept for ſome weeks above the level of the upper pipe, but after that it was conſtantly allowed to be a little below it, thus preventing any water from running off through that pipe. The top of the ſoil for the firſt year was bare; but for the two laſt years it was covered with graſs like other turf. The apparatus being thus prepared, a correct regiſter was kept of the quantity of rain water which ran off from the ſurface of the earth by the upper pipe, as long as that was below the earth, and alſo of the quantity of water which paſſed through the three feet of earth, and ran off by the lower pipe; and a rain gauge of an equal diameter with the cylinder was kept near it, for the purpoſe of meaſuring the quantity of rain which fell in any correſponding time. Then, by ſubtracting the quantity of water which paſſed through the pipes from that in the rain gauge, the remainder was conſidered as equal to the quantity evaporated from the ſurface of the earth in the cylinder. The mean annual reſult of theſe experiments is ſhewn in the following table.

30 Reſult.

	Water through the two pipes.			Mean.	Mean Rain.	Mean Evap.
	1796. Inch.	1797. Inch.	1798. Inch.	Inch.	Inch.	Inch.
January	1.897—	.680—	1.774+	1.450+	2.458	1.008
February	1.778—	.918—	1.122	1.273	1.801	.528
March	.431—	.070—	.335	.279	.902	.623
April	.220—	.295—	.180	.232	1.717	1.485
May	2.027—	2.443+	.010	1.493+	4.177	2.684
June	.171—	.726	—	.299 -	2.483	2.184
July	.153—	.025	—	.059	4.154	4.095
Auguſt	—	—	.504	.168	3.554	3.386
September	—	.976	—	.325	3.279	2.954
October	—	.680	—	.227	2.899	2.672
November	—	1.044	1.594	.879	2.934	2.055
December	.200	3.077	1.878+	1.718+	3.202	1.484
	6.877—	10.934—	7.379	8.402	33.560	25.158
Rain	30.629—	38.791—	31.259			
Evap.	23.725—	27.857—	23.862			

It

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* *Watſon's Chemical Eſſays*, vol. iii. 54.

It appears from theſe experiments, that at Mancheſter the mean annual evaporation of water is above 25 inches; and if we add to this with Mr Dalton 5 inches for the dew which falls, the whole quantity evaporated in a year will be 30 inches. On the whole, we may perhaps eſtimate the mean annual evaporation from the whole ſurface of the globe at 35 inches from every ſquare inch of ſurface, making the whole water annually evaporated over the whole globe equal to 94,450 cubic miles.

31
Mean annual evaporation over the globe.

Were this prodigious maſs of water all to ſubſiſt in the atmoſphere at once, it would increaſe its maſs by about $\frac{1}{12}$, and raiſe the barometer nearly 3 inches. But this never happens, no day paſſes without rain in ſome part of the earth; ſo that part of the evaporated water is continually precipitated again. Indeed it would be impoſſible for the whole of the evaporated water to ſubſiſt in the atmoſphere at once, at leaſt in the ſtate of vapour.

The higher regions of the atmoſphere contain leſs vapour than the ſtrata near the ſurface of the earth. This was obſerved both by M. de Sauſſure and M. de Luc.

32

At ſome height above the tops of mountains the atmoſphere is probably ſtill drier, for it was obſerved by Sauſſure, that on the tops of mountains the moiſture of the air was rather leſs during the night than the day. And there can be little doubt that every ſtratum of air deſcends a little lower during the night than it was during the day, owing to the cooling and condenſing of the ſtratum neareſt the earth. Vapours, however, muſt aſcend very high, for we ſee clouds forming far above the tops of the higheſt mountains.

Rain never begins to fall while the air is tranſparent; the inviſible vapours firſt paſs their maximum, and are changed into veſicular vapours; clouds are formed, and theſe clouds gradually diſſolve in rain. Clouds, however, are not formed in all parts of the horizon at once; the formation begins in one particular ſpot, while the reſt of the air remains clear as before; this cloud rapidly increaſes till it overſpreads the whole horizon, and then the rain begins.

33
Clouds always form at ſome height.

It is remarkable, that though the greateſt quantity of vapour exiſts in the lower ſtrata of the atmoſphere, clouds never begin to form there, but always at ſome conſiderable height. It is remarkable too, that the part of the atmoſphere at which they form has not arrived at the point of extreme moiſture, nor near that point, even a moment before their formation. They are not formed then becauſe a greater quantity of vapour had got into the atmoſphere than could remain there without paſſing its maximum. It is ſtill more remarkable, that when clouds are formed, the temperature of the ſpot in which they are formed is not always lowered, though this may ſometimes be the caſe. On the contrary, the heat of the clouds themſelves is ſometimes greater than that of the ſurrounding air*. Nor is the formation of clouds owing to the capacity of air for combining with moiſture being leſſened by cold; ſo far from that, we often ſee clouds which had remained in the atmoſphere during the heat of the day, diſappear in the night, after the heat of the air was diminiſhed.

34
The formation of clouds and rain as yet unexplained.

The formation of clouds and rain cannot be accounted for by a ſingle principle with which we are acquainted. It is neither owing to the ſaturation of the atmoſphere, nor the diminution of the heat; nor the mixture of airs of different temperatures, as Dr Hutton ſuppoſes: for clouds are often formed without any wind at all either above or below them; and even if this mixture conſtantly took place, the precipitation, inſtead of accounting for rain, would be almoſt imperceptible.

It is a very remarkable fact, that evaporation often goes on for a month together in hot weather without any rain. This ſometimes happens in this country; it happens every year in the torrid zone. Thus at Calcutta, during January 1785, it never rained at all; the mean of the thermometer for the whole month was $66\frac{1}{2}$°; there was no high wind, and indeed during great part of the month little wind at all.

The quantity of water evaporated during ſuch a drought muſt be very great; yet the moiſture of the air, inſtead of being increaſed, is conſtantly diminiſhing, and at laſt diſappears almoſt entirely. For the dew, which is at firſt copious, diminiſhes every night; and if Dr Watſon's experiment formerly mentioned be attended to, it will not be objected that the quantity of evaporation is alſo very much diminiſhed. Of the very dry ſtate to which the atmoſphere is reduced during long droughts, the violent thunder-ſtorms with which they often conclude is a very deciſive proof. Now what becomes of all this moiſture? It is not accumulated in the atmoſphere above the country from which it was evaporated, otherwiſe the whole atmoſphere would in a much leſs period than a month be perfectly ſaturated with moiſture. If it be carried up daily through the different ſtrata of the atmoſphere, and wafted to other regions by ſuperior currents of air, how is it poſſible to account for the different electrical ſtate of the clouds ſituated between different ſtrata, which often produces the moſt violent thunder-ſtorms? They could not have remained in the lower ſtrata of the atmoſphere, and been daily carried off by winds to other countries; for there are often no winds at all during ſeveral days to perform this office; nor in that caſe would the dews diminiſh, nor could their preſence fail to be indicated by the hygrometer.

It is impoſſible for us to account for this remarkable fact upon any principle with which we are acquainted. The water can neither remain in the atmoſphere, nor paſs through it in the ſtate of vapour. It muſt therefore aſſume ſome other form; but what that form is, or how it aſſumes it, we know not. There are, therefore, two ſteps of the proceſs which takes place between evaporation and rain, with which we are entirely unacquainted; firſt, the ſtate of the vapour after it enters into the atmoſphere, and ſecond, the cauſe by which it is made to lay aſide the new form which it aſſumed, return to its ſtate of vapour, and deſcend in form of rain. Several theories have been contrived to account for this phenomenon, but they are all untenable on the preſent known laws of chemical action.

The mean annual quantity of rain is greateſt at the equator, and decreaſes gradually as we approach the poles. Thus at Granada, Antilles, 12° N. Lat. it is 126 inches.

Cape François, St Domingo	19°	46′	120
Calcutta	22	23	81
Rome	41	54	39
England	33	0	32
Peterſburgh	59	16	16

On

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* *De Luc la Meteorol.* vol. ii. 100.

Evaporation and Rain.

On the contrary, the number of rainy days is ſmalleſt at the equator, and increaſes in proportion to the diſtance from it. From N. Lat. 12° to 43° the mean number of rainy days is 78; from 43° to 46° the mean number is 103; from 46° to 50° it is 134; from 51° to 60°, 161 days.

35
Rainy days often more numerous in winter.

The number of rainy days is often greater in winter than in ſummer; but the quantity of rain is greater in ſummer than in winter. At Peterſburgh, the number of rainy or ſnowy days during winter is 84, and the quantity which falls is only about 5 inches; during ſummer the number of rainy days is nearly the ſame, but the quantity which falls is about 11 inches.

More rain falls in mountainous countries than in plains. Among the Andes it is ſaid to rain almoſt perpetually, while in Egypt it ſcarcely ever rains at all. If a rain-gauge be placed on the ground, and another at ſome height perpendicularly above it, more rain will be collected into the lower than into the higher; a proof that the quantity of rain increaſes as it deſcends, owing perhaps to the drops attracting vapour during their paſſage through the lower ſtrata of the atmoſphere where the greateſt quantity reſides. This, however, is not always the caſe, as Mr Copland of Dumfries diſcovered in the courſe of his experiments. He obſerved alſo, that when the quantity of rain collected in the lower gage was greateſt, the rain commonly continued for ſome time; and that the greateſt quantity was collected in the higher gage only either at the end of great rains, or during rains which did not laſt long. Theſe obſervations are important, and may, if followed out, give us new knowledge of the cauſes of rain. They ſeem to ſhow, that during rain the atmoſphere is ſomehow or other brought into a ſtate which induces it to part with its moiſture; and that the rain continues as long as this ſtate continues. Were a ſufficient number of obſervations made on this ſubject in different places, and were the atmoſphere carefully analyſed during dry weather, during rain, and immediately after rain, we might ſoon perhaps diſcover the true theory of rain.

36
More rain falls in the day than in the night.

Rain falls in all ſeaſons of the year, at all times of the day, and during the night as well as the day; though, according to M. Toaldo, a greater quantity falls during the day than the night. The cauſe of rain, then, whatever it may be, muſt be ſomething which operates at all times and ſeaſons. Rain falls alſo during the continuance of every wind, but ofteneſt when the wind blows from the ſouth. Falls of rain often happen likewiſe during perfect calms.

37
Mean annual quantity of rain in Great Britain.

It appears from a paper publiſhed by M. Cotte in the *Journal de Phyſique* for October 1791, containing the mean quantity of rain falling at 147 places, ſituated between N. Lat. 11° and 60°, deduced from tables kept at theſe places, that the mean annual quantity of rain falling in all theſe places is 34.7 inches. Let us ſuppoſe then (which cannot be very far from the truth), that the mean annual quantity of rain for the whole is 34 inches. The ſuperficies of the globe conſiſts of 170,981,012 ſquare miles, or 686,401,498,471,475,200 ſquare inches. The quantity of rain therefore falling annually will amount to 23,337,650,812,030,156,800 cubic inches, or ſomewhat more than 91,751 cubic miles of water. This is 16,191 cubic miles of water leſs than the quantity of water evaporated. It ſeems probable therefore, if the imperfection of our data warrant any concluſion, that ſome of the vapour is actually decompoſed in the atmoſphere, and converted into oxygen and hydrogen gas.

The dry land amounts to 52,745,253 ſquare miles; the quantity of rain falling on it annually therefore will amount to 30,960 cubic miles. The quantity of water running annually into the ſea is 13,140 cubic miles; a quantity of water equal to which muſt be ſupplied by evaporation from the ſea, otherwiſe the land would ſoon be completely drained of its moiſture.

The quantity of rain falling annually in Great Britain may be ſeen from the following table.

Years of obſervation.	Places.	Rain in Inches.
3	Dover -	37.52
5	Ware, Hertfordſhire	23.6
8	London - -	17.5
8	Kimbolton -	23.9
45	Lyndon - -	22.21
5	Chatſworth, Derbyſhire	27.865
8	Mancheſter - -	43.1
18	Liverpool - -	34.41
7	Lancaſter - -	40.3
5	Kendal - -	61.223
14	Dumfries - -	36.127
10	Branxholm, 44 miles S. W. of Berwick - -	31.26
5	Langholm -	36.73
5	Dalkeith - -	25.124
20	Glaſgow - -	31.
8	Hawkhill - -	28.966
	Mean	32.532

Mr Dalton has eſtimated the quantity of rain that falls in England at 21 inches; but as no account is taken of what falls in Wales and Scotland, this eſtimate probably falls much ſhort of the real annual quantity. In this country it generally rains leſs in March than in November, in the proportion at a medium of 7 to 12. It generally rains leſs in April than October, in the proportion of 1 to 2 nearly at a medium. It generally rains leſs in May than September; the chances that it does ſo are at leaſt at 4 to 3: but when it rains plentifully in May, it generally rains but little in September; and when it rains one inch or leſs in May, it rains plentifully in September.

The degree of moiſture that is preſent in the atmoſphere at any given time, is meaſured by the hygrometer. Under the article HYGROMETER we have amply deſcribed ſeveral of the moſt important inſtruments of that kind; but there is one hygrometer, viz. that of Mr Leſlie, which remains to be deſcribed in this place. Figures of the inſtrument are given in Plate CCLXXVI. fig. 13, 14.

38
Leſlie's hygrometer.

The principal part of the inſtrument is compoſed of two glaſs tubes terminated by hollow balls, one tranſparent and the other opaque. The tubes are ſelected, as regular as poſſible, from 4 to 8 inches long, and about $\frac{1}{16}$ of an inch thick, or as ſlender as thoſe employed for thermometers, but with a much wider bore. This, in one tube, muſt be from $\frac{1}{40}$ to the $\frac{1}{90}$ of an inch in diameter, and an exact calibre, at leaſt not differing by $\frac{1}{50}$ between both its extremities. To the end of it a ſmall piece of black enamel is attached, and blown into an opaque ball, from 4 to $\frac{1}{10}$ of an inch diameter. The correſponding tube may have its bore of the ſame, or rather a greater width, but its uniformity is not at all eſſential. Near the extremity it is ſwelled out into a thin cylinder, almoſt $\frac{1}{10}$ of an inch wide, and from $\frac{3}{10}$ to $\frac{6}{10}$ long; the inner cavity only being enlarged, without altering the exterior regularity of the tube. The ſhort bit of glaſs where this cylinder terminates, is now blown into a thin pellucid ball, as nearly of the ſize of the former as the eye can judge. The exact equality of the balls would be unattainable, and fortunately the theory of the inſtrument does not require it. When a dark and a bright object are viewed together, the latter, from an optical deception, appears always larger than the reality; and for this reaſon, ſays Mr Leſlie, I prefer making the clear ball a ſlight degree ſmaller than the black one. In the mean time a coloured liquor is prepared by diſſolving carmine in concentrated ſulphuric acid, in a phial with a ground ſtopper, taking care to avoid heat, as by this the colouring-matter would be charred, and the beauty of the liquor deſtroyed.

The tubes are now cut to nearly equal lengths, and the end of each ſwelled out a little, to facilitate their junction. Cloſe to the black ball, the tube is bent by the flame of a candle into a ſhoulder, ſuch, that the root of the ball ſhall come into a line with the inner edge of the tube. This ball, being then warmed, the end of the tube is dipt into the acid liquor, and as much of it allowed to riſe and flow into the cavity, as may be gueſſed ſufficient to fill both tubes, excepting the cylinder. The two tubes are then, by the help of a blow-pipe, ſolidly joined together in one ſtraight piece, without having any knot or protuberance. About half an inch from the joining, and nearer the cylinder, it is gently bent round by the flame of a candle, till the clear ball is brought to touch the tube $\frac{1}{4}$ inch directly below the black one. The inſtrument is now to be graduated; and the ſcale choſen by Mr Leſlie is that which correſponds to the centigrade thermometer. Mr Leſlie thus deſcribes the mode of graduating the inſtrument.—The inſtrument is held in an oblique poſition, that the coloured liquor may collect at the bottom of the black ball, into which a few minute portions of air muſt, from time to time, be forced over, by heating the oppoſite ball with the hand. In this way, the interpoſed liquid will gradually be made to deſcend into the tube, and aſſume its proper place; and it ſhould remain for a week or two in an inclined poſition, to let every particle drain out of the black ball. If any trace of fluid collects in rings within the bore, they are eaſily diſpelled with a little dexterity and manipulation, which, though it would be difficult to deſcribe, is moſt readily learnt and practiſed. The ſmall cavity at the joining facilitates the rectification, by affording the means of ſending a globule of air in either direction. In fixing the zero of the ſcale, Mr Leſlie ſet the inſtrument in a remote corner of the room, or partly cloſed the window-ſhutters. When completely adjuſted, the top of the coloured liquor, if held upright, ſhould ſtand nearly oppoſite to the middle of the cylindrical reſervoir.

In this ſtate of preparation, the inſtrument is ready for being graduated. The clear ball and the contiguous part of the parallel tube are therefore covered with two or three folds of thin bibulous paper, moiſtened with pure water, to make it act as a hygrometer; and there is attached to the ſame tube a temporary ſcale, by means of a ſoft cement compoſed of bees-wax and roſin. A flat round piece of wood being provided with four or five pillars that ſcrew into it, the inſtrument is fixed to one of them in an erect poſition, and on each ſide is diſpoſed a fine correſponding thermometer, inverted, and at the ſame height, the one having its bulb covered with wet bibulous paper. Then half a yard of flannel is dried as much as poſſible without ſingeing, before a good fire, and rolling it up like a ſleeve, it is lapped looſly round the lower part of the pillars, and the whole is incloſed under a large bell-glaſs. The flannel powerfully abſorbs moiſture from the confined air, and creates an artificial dryneſs of 80 or 100 degrees. In the ſpace of a quarter or half an hour, the full effect is produced, and the quantities being noted at two or three ſeparate times, the mean reſults are adopted. The deſcent, meaſured by the temporary ſcale, being then augmented in the proportion of ten to the difference of the two thermometers, will give the length that correſponds to 100°. After the ſtandard inſtrument is conſtructed, others are thence graduated with the utmoſt eaſe; the firſt being planted in the centre, and the reſt, with their temporary ſcales, ſtuck to the encircling pillars. For greater accuracy, the obſervation ſhould be made in a room without a fire, or a ſcreen ought to be interpoſed between the fire and the apparatus.

The ſlips of ivory intended for the ſcales are divided into equal parts, and ſhould contain from 100° to 150°. The edges are filed down and chamfered, to fit eaſily between the parallel tubes; and they are ſecured in their place by a ſtrong ſolution of iſinglaſs. The lower ball and its annexed cylinder, are covered with thin ſilk of the ſame colour as the upper ball, and a few threads are likewiſe lapped about that part of the tube which it touches. The inſtrument is laſtly cemented into a piece of wood, either end of which admits a cylindrical caſe that ſerves equally to protect or to hold it. On other occaſions, the hygrometer is inſerted into the ſocket of a round bottom-piece where it ſtands vertical.

The above deſcription refers particularly to fig. 14. Fig. 13. differs from this, only in having the balls of an equal height, and bended in oppoſite directions, which Mr Leſlie conſiders as more convenient for ſome purpoſes to which the inſtrument is applied, to be mentioned hereafter, but which renders the inſtrument leſs portable.

39
Theory of the inſtrument.

The action of this hygrometer depends on the following principle; *That the cold produced by evaporation will accurately denote the degree of dryneſs of the air, or its diſtance from the point of ſaturation.* To diſcover the dryneſs or humidity of the air, therefore, we have only to find the change of temperature induced in a body of water inſulated, or expoſed on all ſides to evaporation. The ſteps which led Mr Leſlie from theſe ſimple principles to the conſtruction of the preſent ingenious inſtrument, are detailed by him in a paper publiſhed in Nicholſon's Journal for January 1800, to which we muſt refer our readers for the particulars, contenting ourſelves with the following ſummary view.

If two thermometers be filled with any expanſible fluid, and having the bulb of the one wet and the other dry, they will, by their difference, denote the ſtate of the air in reſpect to humidity. Mr Leſlie's object was to combine two ſuch inſtruments, ſo that they ſhould indicate merely their difference of temperature; and this object he has completely attained by the preſent inſtrument. In ordinary caſes, the intermediate liquor would continue ſtationary; for the air in both balls having the ſame temperature, and conſequently the ſame elaſticity, the oppoſite preſſures would preciſely counteract each other; but if, from the action of the external air on the moiſtened ſurface, one ball became colder, it is manifeſt the liquor would be puſhed towards it by the ſuperior elaſticity of the air included in the other ball, ſo as to mark, by the ſpace of its approach, the depreſſion of temperature induced by evaporation.

This inſtrument does not merely point out the dryneſs of the air; it enables us to determine the *abſolute quantity* of moiſture which it is capable of imbibing; for the converſion of water into ſteam is found to conſume 524° of the centigrade diviſion; and evaporation, analogous in its effects, may be preſumed to occaſion the ſame waſte of heat. If, therefore, air had the ſame capacity as water, for each degree of the hygrometer it would depoſit as much heat as it would abſtract by diſſolving the $\frac{1}{5240}$ part of its weight of humidity. But the capacity of air is to that of water as 11 to ſix, and conſequently it would require in that proportion a greater evaporation to produce the ſame effect. We may hence conclude, that, for each hygrometric degree, the air would require $\frac{11}{6} \times \frac{1}{5240}$ or $\frac{1}{2858}$ part by weight of water to effect ſaturation.

Strictly ſpeaking, the degrees marked by this hygrometer do not meaſure the dryneſs of the air at its actual temperature, but only its ſtate of dryneſs when cooled down to the ſtandard of the wet ball. The law, however, being known of the diſſolving power of air as affected by heat, it is eaſy, from the diſpoſition of the air with reſpect to humidity at one temperature to derive that at any other. It will ſuffice to mention the reſult of a number of careful experiments:—Suppoſing air at the freezing point to be capable of holding 50 parts of moiſture; at 10° centigrade, it will hold 100; at 20°, 200; at 30°, 400; thus doubling at each increaſe of 10°. Hence a table may be conſtructed by which theſe converſions will be eaſily made.

To omit nothing that tends to elucidate the theory of the inſtrument, we muſt obſerve that the air in its contact with the humid ſurface is not abſolutely cooled to the ſame temperature; the air and water really meet each other at an intermediate point determined by their compounded denſity and capacity. Conſequently the indications of the hygrometer ought to be augmented by the $\frac{1}{464}$ part, or $\frac{11}{6} + \frac{1}{850}$. But this quantity is too ſmall in any caſe to be regarded.

CHAP. IV. *Of the Changes produced in the Air by Winds.*

40 In conſidering the ſubject of winds, we ſhall firſt briefly detail their natural hiſtory, ſo far as it has not been already anticipated, and ſhall then endeavour to trace the laws by which they are regulated, or explain the manner in which their varieties are produced. As the direction of the winds is of the greateſt conſequence, eſpecially in a commercial view, we ſhall firſt point out the direction of the moſt prevalent winds in various quarters of the world.

41 Trade-winds. Between the tropics the winds are the moſt regular. In thoſe parts of the Pacific and Atlantic oceans which lie neareſt the equator, there is a regular wind during the whole year called the *trade-wind.* On the north ſide of the equator it blows from the north-eaſt, varying frequently a point or two towards the north or eaſt; and on the ſouth ſide of it, from the ſouth-eaſt, changing ſometimes in the ſame manner towards the ſouth or eaſt. The ſpace included between the ſecond and fifth degrees of north latitude is the internal limit of theſe two winds. There the winds can neither be ſaid to blow from the north nor the ſouth; calms and violent ſtorms are frequent. This ſpace varies a little in latitude as the ſun approaches either of the tropics. In the Atlantic ocean the trade winds extend farther north on the American than on the African coaſt; and as we advance weſtward, they become gradually more eaſterly, and decreaſe in ſtrength. Their force diminiſhes likewiſe as we approach their utmoſt boundaries. It has been remarked alſo, that as the ſun approaches the tropic of cancer, the ſouth-eaſt winds become gradually more ſoutherly, and the north-eaſt winds more eaſterly: exactly the contrary takes place when the ſun is approaching the tropic of capricorn.

42 Monſoons. The trade-wind blows conſtantly in the Indian ocean from 10° ſouth latitude to near 30°; but to the northward of this the winds change every ſix months, and blow directly oppoſite to their former courſe. Theſe regular winds are called *monſoons*, from the Malay word *mooſſin*, which ſignifies a ſeaſon. When they ſhift their direction, variable winds and violent ſtorms ſucceed, which laſt for a month, and frequently longer; and during that time it is dangerous for veſſels to continue at ſea.

The monſoons in the Indian ocean may be reduced to two; one on the north and another on the ſouth ſide of the equator; which extend from Africa to the longitude of New Holland and the eaſt coaſt of China, and which ſuffer partial changes in particular places from the ſituation and inflection of the neighbouring countries.

Between 3° and 10° of ſouth latitude the ſouth-eaſt trade-wind continues from April to October; but during the reſt of the year the wind blows from the north-weſt. Between Sumatra and New Holland this monſoon blows from the ſouth during our ſummer months, approaching gradually to the ſouth-eaſt as we advance towards the coaſt of New Holland; it changes about the end of September, and continues in the oppoſite direction till April. Between Africa and Madagaſcar its direction is influenced by the coaſt; for it blows from the north-eaſt from October to April, and during the reſt of the year from the ſouth-weſt.

43 Direction of the trade-winds throughout the year.

Over all the Indian ocean to the northward of the third degree of ſouth latitude, the north-eaſt trade-wind blows from October to April, and a ſouth-weſt wind from April to October. From Borneo, along the coaſt of Malacca, and as far as China, this monſoon in ſummer blows nearly from the ſouth, and in winter from the north by eaſt. Near the coaſt of Africa, between Mozambique and Cape Guardafeu, the winds are irregular during the whole year, owing to the different monſoons which ſurround that particular place.—Monſoons are likewiſe regular in the Red ſea; between April and October they blow from the north-weſt, and during the other months from the ſouth-eaſt, keeping conſtantly parallel to the coaſt of Arabia.

44 Of monſoons.

Monſoons are not altogether confined to the Indian ocean; on the coaſt of Brazil, between Cape St Auguſtine and the iſland of St Catharine, the wind blows between September and April from the eaſt or north-eaſt, and between April and September from the ſouth-weſt. The bay of Panama is the only place on the weſt ſide of a great continent where the wind ſhifts regularly at different ſeaſons: there it is eaſterly between September and March; but between March and September it blows chiefly from the ſouth and ſouth-weſt.

Such in general is the direction of the winds in the torrid zone all over the Atlantic, Pacific, and Indian oceans; but they are ſubject to particular exceptions, which we ſhall now endeavour to enumerate. On the coaſt of Africa, from Cape Bayador to Cape Verde, the winds are generally north-weſt; from thence to the iſland of St Thomas near the equator they blow almoſt perpendicular to the ſhore, bending gradually as we advance ſouthwards, firſt to the weſt and then to the ſouth-weſt. On the coaſt of New Spain likewiſe, from California to the bay of Panama, the winds blow almoſt conſtantly from the weſt or ſouth-weſt, except during May, June, and July, when land-winds prevail, called by the Spaniards *Popogayos*. On the coaſt of Chili and Peru, from 20° to 30° ſouth latitude, to the equator, and on the parallel coaſt of Africa, the wind blows during the whole year from the ſouth, varying according to the direction of the land towards which it inclines, and extending much farther out to ſea on the American than the African coaſt. The trade-winds are alſo interrupted ſometimes by weſterly winds in the bay of Campeachy and the bay of Honduras.

As to the countries between the tropics, we are too little acquainted with them to be able to give a ſatisfactory hiſtory of their winds,

45 Of ſea and land breezes.

In all maritime countries between the tropics, of any extent, the wind blows during a certain number of hours every day from the ſea, and during a certain number towards the ſea from the land; theſe winds are called the *ſea and land breezes*. The ſea breeze generally ſets in about 10 in the forenoon, and blows till ſix in the evening; at ſeven the land breeze begins and continues till eight in the morning, when it dies away. During ſummer the ſea breeze is very perceptible on all the coaſts of the Mediterranean ſea, and even ſometimes as far north as Norway.

In the iſland of St Lewis on the coaſt of Africa, in 16° north latitude, and 16° weſt longitude, the wind during the rainy ſeaſon, which laſts from the middle of July to the middle of October, is generally between the ſouth and the eaſt: during the reſt of the year it is for the moſt part eaſt or north-eaſt in the morning; but as the ſun riſes, the wind approaches gradually towards the north, till about noon it gets to the weſt of north, and is called a *ſea breeze*. Sometimes it ſhifts to the eaſt as the ſun deſcends, and continues there during the whole night. In February, March, April, May and June, it blows almoſt conſtantly between the north and weſt. In the iſland of Bulama, which likewiſe lies on the weſt coaſt of Africa, in 11° north latitude, the wind during nine months of the year blows from the ſouth-weſt; but in November and December, a very cold wind blows from the north-eaſt.

In the kingdom of Bornou, which lies between 16° and 20° north latitude, the warm ſeaſon is introduced about the middle of April by ſultry winds from the ſouth-eaſt, which bring along with them a deluge of rain. In Fezzan, in 25° north latitude, and 35° eaſt longitude, the wind from May to Auguſt blows from the eaſt ſouth-eaſt, or ſouth-weſt, and is intenſely hot.

46 Winds in Abyſſinia.

In Abyſſinia the winds generally blow from the weſt, north-weſt, north, and north-eaſt. During the months of June, July, Auguſt, September and October, the north and north-eaſt winds blow almoſt conſtantly, eſpecially in the morning and evening; and during the reſt of the year they are much more frequent than any other winds.

47 At Calcutta.

At Calcutta, in the province of Bengal, the wind blows during January and February from the ſouth-weſt and ſouth; in March, April, and May from the ſouth; in June, July, Auguſt and September, from the ſouth and ſouth-eaſt; in October, November, and December, from the north-weſt. At Madras the moſt frequent winds are the north and north-eaſt.—At Tivoli in St Domingo, and the iſles des Vaches, the wind blows ofteneſt from the ſouth and ſouth-eaſt. From theſe facts it appears, that in moſt tropical countries with which we are acquainted, the wind generally blows from the neareſt ocean, except during the coldeſt months, when it blows towards it.

48 In the temperate zones.

In the temperate zones the direction of the wind is by no means ſo regular as between the tropics. Even in the ſame degree of latitude, we find them often blowing in different directions at the ſame time, while their changes are often ſo ſudden and capricious, that to account for them has been hitherto found impoſſible. When winds are violent and continue long, they generally extend over a large tract of country; and this is more certainly the caſe when they blow from the north-eaſt, than from any other points. By the multiplication and compariſon of meteorological tables, ſome regular connection between the changes of the atmoſphere in different places may in time be obſerved, which will at laſt lead to a ſatisfactory theory of the winds. It is from ſuch tables chiefly that the following facts have been collected.

49 In Virginia.

In Virginia, the prevailing winds are between the *ſouth weſt*, *weſt*, *north*, and *north-weſt*; the moſt frequent is the *ſouth-weſt*, which blows more conſtantly in June, July, and Auguſt, than at any other ſeaſon. The north-weſt winds blow moſt conſtantly in November, December, January, and February. At Ipſwich in New England, the prevailing winds are alſo between the ſouth-weſt, weſt, north, and north-eaſt; the moſt frequent is the north weſt. But at Cambridge, in the ſame province, the moſt frequent wind is the ſouth-eaſt. The predominant winds at New York are the north and weſt. In Nova Scotia north-weſt winds blow for three-fourths of the year. The ſame wind blows moſt frequently at Montreal in Canada, but at Quebec the wind generally follows the direction of the river St Lawrence, blowing either from the north-eaſt or ſouth-weſt. At Hudſon's bay weſterly winds blow for three-fourths of the year; the north-weſt wind occaſions the greateſt cold; but the north and north-eaſt are the vehicles of ſnow.

It appears from theſe facts, that weſterly winds are moſt frequent over the whole eaſtern coaſt of North America; that in the ſouthern provinces ſouth-weſt winds predominate, and that the north-weſt become gradually more frequent as we approach the frigid zone.

50
In Egypt.

In Egypt, during part of May, and during June, July, Auguſt, and September, the wind blows almoſt conſtantly from the *north*, varying ſometimes in June to the weſt, and in July to the weſt and the eaſt; during part of September, and in October and November, the winds are variable, but blow more regularly from the eaſt than any other quarter; in December, January, and February, they blow from the north, north-weſt, and weſt; towards the end of February they change to the ſouth, in which quarter they continue till near the end of March; during the laſt days of March and in April they blow from the ſouth-eaſt, ſouth, and ſouth-weſt, and at laſt from the eaſt; and in this direction they continue during a part of May.

51
In the Mediterranean.

In the Mediterranean the wind blows nearly three-fourths of the year from the north; about the equinoxes there is always an eaſterly wind in that ſea, which is generally more conſtant in ſpring than in autumn. Theſe obſervations do not apply to the gut of Gibraltar, where there are ſeldom any winds except the eaſt and the weſt. At Baſtia, in the iſland of Corſica, the prevailing wind is the ſouth-weſt.

52
In Syria.

In Syria the north wind blows from the autumnal equinox to November; during December, January, and February, the winds blow from the weſt and ſouth-weſt; in March they blow from the ſouth, in May from the eaſt, and in June from the north. From this month to the autumnal equinox the wind changes gradually as the ſun approaches the equator; firſt to the eaſt, then to the ſouth, and laſtly to the weſt. At Bagdad the moſt frequent winds are the ſouth-weſt and north-weſt; at Pekin, the north and the ſouth; at Kamtſchatka, on the north-eaſt coaſt of Aſia, the prevailing winds blow from the weſt.

53
In Italy.

In Italy the prevailing winds differ conſiderably according to the ſituation of the places where the obſervations have been made. At Rome and Padua they are northerly, at Milan eaſterly. All that we have been able to learn reſpecting Spain and Portugal is, that on the weſt coaſt of theſe countries the weſt is by far the moſt common wind, particularly in ſummer; and that at Madrid the wind is north-eaſt for the greateſt part of the ſummer, blowing almoſt conſtantly from the Pyrenean mountains. At Berne in Switzerland, the prevailing winds are the north and weſt; at St Gothard, the north-eaſt; at Lauſanne the north-weſt and ſouth-weſt.

54
Reſult of M. Cotte's obſervations on the direction of the winds in France.

M. Cotte has given us the reſult of obſervations made at 86 different places of France, from which it appears, that along the whole ſouth coaſt of that empire the wind blows moſt frequently from the north, north-weſt, and north-eaſt: on the weſt coaſt, from the weſt, ſouth-weſt, and north-weſt; and on the north coaſt from the ſouth-weſt. That in the interior parts of France the ſouth weſt wind blows moſt frequently in 18 places; the weſt wind in 14; the north in 13; the ſouth in 6; the north-eaſt in 4; the ſouth eaſt in 2; the eaſt and north-weſt each of them in one. On the weſt coaſt of the Netherlands, as far north as Rotterdam, the prevailing winds are probably the ſouth-weſt; at leaſt this is the caſe at Dunkirk and Rotterdam. It is probable alſo, that along the reſt of this coaſt, from the Hague to Hamburgh, the prevailing winds are the north-weſt, at leaſt theſe winds are moſt frequent at the Hague and at Franeker. The prevailing wind at Delft is the ſouth-eaſt, and at Breda the north and the eaſt.

55
Direction of the winds in Germany.

In Germany the eaſt wind is moſt frequent at Gottingen, Munich, Weiſſemburg, Duſſeldorff, Saganum, Erford, and at Buda in Hungary; the ſouth-eaſt at Prague and Wirtſburg; the north-eaſt at Ratiſbon, and the weſt at Manheim and Berlin.

56
At London.

From an average of 10 years of the regiſter kept by order of the Royal Society, it appears, that at London the winds blow in the following order:

Winds.	*Days.*	*Winds.*	*Days.*
South-weſt	112	South-eaſt	32
North-eaſt	58	Eaſt	26
North-weſt	50	South	18
Weſt	53	North	16

It appears from the ſame regiſter, that the ſouth-weſt wind blows at an average more frequently than any other wind during every month of the year, and that it blows longeſt in July and Auguſt; that the north-eaſt blows moſt conſtantly during January, March, April, May, and June, and moſt ſeldom during February, July, September, and December; and that the north-weſt wind blows oftener from November to March, and more ſeldom during September and October, than any other months. The ſouth-weſt winds are alſo moſt frequent at Briſtol, and next to them are the north-eaſt.

57
Table of winds at Lancaſter.

The following table of the winds at Lancaſter has been drawn up from a regiſter kept for ſeven years at that place.

Winds.	*Days.*	*Winds.*	*Days.*
South-weſt	92	South-eaſt	35
North-eaſt	67	North	30
South	51	North-weſt	26
Weſt	41	Eaſt	17

58
At Dumfries.

The following table is an abſtract of nine years obſervations made at Dumfries by Mr Copland.

Winds.	*Days.*	*Winds.*	*Days.*
South	82½	North	36½
Weſt	69	North-weſt	25½
Eaſt	68	South-eaſt	18½
South-weſt	50½	North-eaſt	14½

The

59
At Cambuſlang.

The following table is an abſtract of ſeven years obſervations, made by Dr Meek at Cambuſlang, near Glaſgow.

Winds.	*Days.*	*Winds.*	*Days.*
South-weſt	174	North-eaſt	104
North-weſt	40	South-eaſt	47

It appears from the regiſter from which this table was extracted, that the north-eaſt wind blows much more frequently in April, May, and June, and the ſouth-weſt in July, Auguſt, and September, than at any other period. We learn from the Statiſtical Account of Scotland, that the ſouth-weſt is by far the moſt frequent wind all over that kingdom, eſpecially on the weſt coaſt. At Saltcoats in Ayrſhire, for inſtance, it blows three fourths of the year; and along the whole coaſt of Murray on the north-eaſt ſide of Scotland, it blows for two-thirds of the year. Eaſt winds are common over all Great Britain during April and May; but their influence is felt moſt ſeverely on the eaſtern coaſt.

The following table exhibits a view of the number of days during which the weſterly and eaſterly winds blow in a year, at different parts of the iſland. Under the term weſterly are included the north-weſt, weſt, ſouth-weſt, and ſouth; the term eaſterly is taken in the ſame latitude.

Years of obſervation.	Places.	Wind.	
		Weſterly	Eaſterly.
10	London	233	132
7	Lancaſter	216	149
51	Liverpool	190	175
9	Dumfries	227.5	137.5
10	Branxholm	232	133
7	Cambuſlang	214	151
8	Hawkhill near Edin.	229.5	135.5
	Medium	220.3	144.7

60
Direction of the winds in Ireland.

In Ireland the ſouth-weſt and weſt are the grand trade-winds, blowing moſt in ſummer, autumn, and winter, and leaſt in ſpring. The north-eaſt blows moſt in ſpring, and nearly double to what it does in autumn and winter. The ſouth-weſt and north-weſt are nearly equal, and are moſt frequent after the ſouth-weſt and weſt.

61
At Copenhagen, and in Ruſſia.

At Copenhagen the prevailing winds are the eaſt and ſouth-eaſt; at Stockholm, the weſt and north. In Ruſſia, from an average of a regiſter of 16 years, the winds blow from November to April in the following order.

	W.	N.W.	E.	S.W.	S.	N.E.	N.	S.E.
Days	45	26	23	22	20	19	14	12

And during the other ſix months,

	W.	N.W.	E.	S.W.	S.	N.E.	N.	S.E.
Days	27	27	19	24	22	15	32	18

The weſt wind blows during the whole year 72 days; the north-weſt 53, the ſouth-weſt and north 46 days each. During ſummer it is calm for 41 days, and during winter for 21. In Norway the moſt frequent winds are the ſouth, the ſouth-weſt and ſouth eaſt. The wind at Bergen is ſeldom directly weſt, but generally ſouth-weſt or ſouth-eaſt; a north-weſt, and eſpecially a north-eaſt wind, are but little known there.

From the whole of theſe facts, it appears that the moſt frequent winds on the ſouth coaſts of Europe are the north, the north-eaſt and north-weſt, and on the weſtern coaſt the ſouth-weſt; that in the interior parts which lie moſt contiguous to the Atlantic ocean, ſouth-weſt winds are alſo moſt frequent; but that eaſterly winds prevail in Germany. Weſterly winds are alſo moſt frequent on the north-eaſt coaſt of Aſia.

It is probable that the winds are more conſtant in the ſouth temperate zone, which is in a great meaſure covered with water, than in the north temperate zones, where their direction muſt be frequently interrupted and altered by mountains and other cauſes.

62
Main winds at the Cape of Good Hope.

M. de la Bailie, who was ſent thither by the French king to make aſtronomical obſervations, informs us, that at the Cape of Good Hope the main winds are the ſouth-eaſt and north-weſt; that other winds ſeldom laſt longer than a few hours; and that the eaſt and north-eaſt winds blow very ſeldom. The ſouth-eaſt wind blows in moſt months of the year, but chiefly from October to April; the north-weſt prevails during the other ſix months, bringing along with it rain, and tempeſts, and hurricanes. Between the Cape of Good Hope and New Holland the winds are commonly weſterly, and blow in the following order: north-weſt, ſouth-weſt, weſt, north.

63
In the Pacific ocean.

In the great South ſea, from latitude 30° to 40° ſouth, the ſouth eaſt trade-wind blows moſt frequently, eſpecially when the ſun approaches the tropic of Capricorn; the wind next to it in frequency is the north-weſt, and next to that is the ſouth-weſt.

Thus it appears that the trade-winds ſometimes extend farther into the ſouth temperate zone than their uſual limits, particularly during ſummer; that beyond their influence the winds are commonly weſterly, and that they blow in the following order: north-weſt, ſouth-weſt, weſt.

64
Theory of the winds.

We have now conſidered pretty much at large the direction of the winds in different parts of the earth's ſurface. Another very curious part of the hiſtory of the winds relates to their violence, and the effects with which they are attended, or to the hiſtory of hurricanes, whirlwinds, tornadoes, &c. Of ſome of theſe we have already treated under the articles HURRICANE and HARMATTAN; and the confined limits of this article oblige us to refer our readers for more particulars to Capper's Obſervations on the Winds and Monſoons.

65
Velocity of the winds almoſt infinitely various.

As to the velocity of the wind, its variations are almoſt infinite, from the gentleſt breeze, to the hurricane which tears up trees and blows down houſes. Our moſt violent winds take place when neither the heat nor the cold is greateſt; violent winds generally extend over a large tract of country, and they are accompanied with ſudden and great falls in the mercury of the barometer. The wind is ſometimes very violent at a diſtance from the earth, while it is quite calm at its ſurface. On one occaſion Lunardi went at the rate of 70 miles an hour in his balloon, though it was quite calm at Edinburgh when he aſcended, and continued ſo during his whole voyage.

66 Velocity of the winds. A pretty good idea of the velocity of the wind, under different circumſtances, may be formed from the following table, which was drawn up by Mr Smeaton.

Miles per Hour.	Feet per Second.	Perpendicular force on one ſquare foot, in Avoirdupois pounds and Paris.	
1	1.47	.005	Hardly perceptible.
2	2.93	.020	Juſt perceptible.
3	4.4	.044	
4	5.87	.079	Gently pleaſant.
5	7.33	.123	
10	14.67	.492	Pleaſant, briſk.
15	22.	1.107	
20	29.34	1.968	Very briſk.
25	36.67	3.075	
30	44.01	4.429	High wind.
35	51.34	6.027	
40	58.68	7.873	Very high wind.
45	66.01	9.963	
50	73.35	12.300	Storm or tempeſt.
60	88.02	17.715	Great ſtorm.
80	117.36	31.490	Hurricane.
100	146.7	49.200	Hurricane that tears up trees and carries buildings before it.

For the means of aſcertaining the velocity of the winds, ſee ANEMOMETER and ANEMOSCOPE.

We ſhall now endeavour to explain the phenomena that we have been deſcribing, or to form a plauſible theory of the winds.

The atmoſphere is a fluid ſurrounding the earth, and extending to an unknown height. Now all fluids tend invariably to a level: if a quantity of water be taken out of any part of a veſſel, the ſurrounding water will immediately flow in to ſupply its place, and the ſurface will become level as before; or if an additional quantity of water be poured into any part of the veſſel, it will not remain there, but diffuſe itſelf equally over the whole. Such exactly would be the caſe with the atmoſphere. Whatever therefore deſtroys the equilibrium of this fluid, either by increaſing or diminiſhing its bulk in any particular place, muſt at the ſame time occaſion a wind.

67 Air, beſides its qualities in common with other fluids, is alſo capable of being dilated and compreſſed. Suppoſe a veſſel filled with air: if half the quantity which it contains be drawn out by means of an air-pump, the remainder will ſtill fill the veſſel completely; or if twice or three times the original quantity be forced in by a condenſer, the veſſel will ſtill be capable of holding it.

Rarefied air is lighter, and condenſed air heavier than common air. When fluids of unequal ſpecific gravities are mixed together, the heavier always deſcend and the lighter aſcend. Were quickſilver, water, and oil, thrown into the ſame veſſel together, the quickſilver would uniformly occupy the bottom; the water the middle, and the oil the top. Were water to be thrown into a veſſel of oil, it would immediately deſcend, becauſe it is heavier than oil. Exactly the ſame thing takes place in the atmoſphere. Were a quantity of air, for inſtance, to be ſuddenly condenſed at a diſtance from the ſurface of the earth, being now heavier than before, it would deſcend till it came to air of its own denſity; or, were a portion of the atmoſphere at the ſurface of the earth to be ſuddenly rarefied, being now lighter than the ſurrounding air, it would immediately aſcend.

68 Cauſe of the trade-winds. If a bladder half filled with air be expoſed to the heat of a fire, the air within will ſoon expand, and diſtend the bladder; if it be now removed to a cold place, it will ſoon become flaccid as before. This ſhews that heat rarefies, and that cold condenſes air. The ſurface of the torrid zone is much more heated by the rays of the ſun than the frozen or temperate zones, becauſe the rays fall upon it much more perpendicularly. This heat is communicated to the air near the ſurface of the torrid zone, which being thereby rarefied, aſcends, and its place is ſupplied by colder air, which ruſhes in from the north and ſouth.

The diurnal motion of the earth is greateſt at the equator, and diminiſhes gradually as we approach the poles, where it ceaſes altogether. Every ſpot of the earth's ſurface at the equator moves at the rate of 15 geographical miles in a minute; at 40° of latitude it moves at about 11 miles and a half in a minute, and at the 30° at nearly 13 miles. The atmoſphere, by moving continually round along with the earth, has acquired the ſame degree of motion, ſo that thoſe parts of it which are above the equator move faſter than thoſe which are at a diſtance. Were a portion of the atmoſphere to be tranſported in an inſtant from latitude 30° to the equator, it would not immediately acquire the velocity of the equator; the eminences of the earth, therefore, would ſtrike againſt it, and it would aſſume the appearance of an eaſt wind. This is the caſe in a ſmaller degree with the air that flows towards the equator, to ſupply the place of the rarefied air which is continually aſcending; and this, when combined with its real motion from north to ſouth, muſt cauſe it to aſſume the appearance of a north-eaſterly wind on this ſide the equator, and of a ſouth-eaſterly beyond it.

The motion weſtward occaſioned by this difference in celerity alone, would be very ſmall; but it is increaſed by another circumſtance. Since the rarefaction of the air in the torrid zone is owing to the heat derived from the contiguous earth, and ſince this heat is owing to the perpendicular rays of the ſun, thoſe parts muſt be hotteſt where the ſun is actually vertical; and conſequently the air above them muſt be moſt rarefied; the contiguous parts of the atmoſphere will therefore be drawn moſt forcibly to that particular ſpot. Now, ſince the diurnal motion of the earth is from eaſt to weſt, this hotteſt ſpot will be continually ſhifting weſtwards, and this will occaſion a current of the atmoſphere in that direction. That this cauſe really operates, appears from a circumſtance already mentioned: When the ſun approaches either of the tropics, the trade-wind on the ſame ſide of the equator aſſumes a more eaſterly direction, evidently from the cauſe here mentioned, while the oppoſite trade-wind being deprived of this additional impulſe, blows in a direction more perpendicular to the equator.

69 What increaſes the weſterly direction of the trade-wind. The weſterly direction of the trade wind is ſtill farther increaſed by another cauſe. Since the attraction of the ſun and moon produces ſo remarkable an

effect upon the ocean, we cannot but ſuppoſe that an effect equally great, at leaſt, is produced upon the atmoſphere. Indeed as the atmoſphere is nearer the moon than the ſea is, the effects produced by attraction upon it ought to be greater. When we add to this the elaſticity of the air, or that diſpoſition which it has to dilate itſelf when freed from any of its preſſure, we cannot but conclude, that the tides in the atmoſphere are conſiderable. Now ſince the apparent diurnal motion of the moon is from eaſt to weſt, the tides muſt follow it in the ſame manner, and conſequently produce a conſtant motion in the atmoſphere from eaſt to weſt. This reaſoning is confirmed by the obſervations of ſeveral philoſophers, particularly of M. Caſſon, that in the torrid zone the barometer is always two-thirds of a line higher twice every 24 hours than during the reſt of the day; and that the time of this riſe always correſponds with the tides of the ſea; a proof that it proceeds from the ſame cauſe.

All theſe different cauſes probably combine in the production of the trade-winds; and from their being ſometimes united, and ſometimes diſtinct or oppoſite, ariſe all thoſe little irregularities which take place in the direction and force of the trade-winds.

Since the great cauſe of theſe winds is the rarefaction of the atmoſphere by the heat of the ſun, its aſcenſion and the conſequent ruſhing in of colder air from the north and ſouth, the internal boundary of the trade-winds muſt be that parallel of the torrid zone which is hotteſt, becauſe there the aſcenſion of the rarefied air muſt take place. Now ſince the ſun does not remain ſtationary, but is conſtantly ſhifting from one tropic to the other, we ought naturally to expect that this boundary would vary together with its exciting cauſe; that therefore, when the ſun is perpendicular to the tropic of Cancer, the north-eaſt trade-wind would extend no farther ſouth than north latitude 23° 30′; that the ſouth-eaſt wind would extend as far north; and that, when the ſun was in the tropic of Capricorn, the very contrary would take place. We have ſeen, however, that though this boundary be ſubject to conſiderable changes from this very cauſe, it may in general be conſidered as fixed between the ſecond and fifth degrees of north latitude.

Though the ſun be perpendicular to each of the tropics during part of the year, he is for one half of it at a conſiderable diſtance, ſo that the heat which they acquire, while he is preſent, is more than loſt during his abſence. But the ſun is perpendicular to the equator twice in a year, and never farther diſtant from it than 23½°; being therefore twice every year as much heated, and never ſo much cooled as the tropics, its mean heat muſt be greater, and the atmoſphere in conſequence generally moſt rarefied at that place. Why then, it will be aſked, is not the equator the boundary of the two trade-winds? To ſpeak more accurately than we have hitherto done, the internal limit of theſe winds muſt be that parallel where the mean heat of the earth is greateſt. This would be the equator, were it not for a reaſon that ſhall now be explained.

It has been ſhewn by aſtronomers, that the orbit of the earth is an ellipſis, and that the ſun is placed in one of the foci. Were this orbit to be divided into two parts by a ſtraight line perpendicular to the tranſverſe axis, and paſſing through the centre of the ſun, one of theſe parts would be leſs than the other; and the earth during its paſſage through the ſmall part of its orbit, would conſtantly be nearer the ſun than while it moved through the other portion. The celerity of the earth's motion in any part of its orbit is always proportioned to its diſtance from the ſun; the nearer it is to the ſun it moves the faſter; the farther diſtant, the ſlower. The earth paſſes over the ſmaller portion of its orbit during our winter, which muſt therefore be ſhorter than our ſummer, both on account of this part of the orbit being ſmaller than the other, and on account of the increaſed celerity of the earth's motion. The difference, according to Caſſini, is 7 days, 23 hours, 53 minutes. While it is winter in the northern, it is ſummer in the ſouthern hemiſphere; wherefore the ſummer in the ſouthern hemiſphere muſt be juſt as much ſhorter than the winter, as our winter is ſhorter than our ſummer. The difference, therefore, between the length of the ſummer in the two hemiſpheres is almoſt 16 days. The ſummer in the northern hemiſphere conſiſts of 190½ days, while in the ſouthern it conſiſts only of 174½. They are to one another nearly in the proportion of 14 to 12.8; and the heat of the two hemiſpheres may probably have nearly the ſame proportion to one another. The internal limit of the trade-winds ought to be that parallel where the mean heat of the globe is greateſt; this would be the equator, if both hemiſpheres were equally hot; but ſince the northern hemiſphere is the hotteſt, that parallel ought to be ſituated ſomewhere in it; and ſince the difference between the heat of the two hemiſpheres is not great, the parallel ought not to be ſo far diſtant from the equator.

The trade-wind would blow regularly round the whole globe if the torrid zone were all covered with water. If the Indian ocean were not bounded by land on the north, it would blow there in the ſame manner as it does in the Atlantic and Pacific oceans. The rays of light paſs through a tranſparent body without communicating any, or at leaſt but a ſmall degree of heat. If a piece of wood be incloſed in a glaſs veſſel, and the focus of a burning-glaſs directed upon it, the wood will burn to aſhes, while the glaſs through which all the rays paſſed is not even heated. When an opaque body is expoſed to the ſun's rays, it is heated in proportion to its opacity. If the bulb of a thermometer be expoſed to the ſun, the mercury will not riſe ſo high as it would do if this bulb were painted black. Land is much more opaque than water; it becomes therefore much warmer when both are equally expoſed to the influence of the ſun. For this reaſon, when the ſun approaches the tropic of Cancer, India, China, and the adjacent countries, become much hotter than the ocean which waſhes their ſouthern coaſts. The air over them becomes rarefied, and aſcends, while colder air ruſhes in from the Indian ocean to ſupply its place. As this current of air moves from the equator northward, it muſt, for a reaſon already explained, aſſume the appearance of a ſouth-weſt wind; and this tendency eaſtward is increaſed by the ſituation of the countries to which it flows. This is the cauſe of the ſouth-weſt monſoon, which blows during ſummer in the northern parts of the Indian ocean. Between Borneo and the coaſt of China, its direction is almoſt due north, becauſe the country to which the current is directed lies rather to the weſt of north; a circumſtance which counteracts its greater velocity.

In winter, when the ſun is on the ſouth ſide of the equator, theſe countries become cool, and the north-eaſt trade-wind reſumes its courſe, which, had it not been for the interference of theſe countries, would have continued the whole year.

As the ſun approaches the tropic of Capricorn, it becomes almoſt perpendicular to New Holland; that continent is heated in its turn, the air over it is rarefied, and colder air ruſhes in from the north and weſt to ſupply its place. This is the cauſe of the north-weſt monſoon, which blows from October to April, from 3° to 10° ſouth latitude. Near Sumatra its direction is regulated by the coaſt: this is the caſe alſo between Africa and Madagaſcar.

The ſame cauſe which occaſions the monſoons, gives riſe to the winds which blow on the weſt coaſts of Africa and America. The air above the land is hotter and rarer, and conſequently lighter than the air above the ſea; the ſea air, therefore, flows in, and forces the lighter land atmoſphere to aſcend.

The ſame thing will account for the phenomena of the ſea and land breezes. During the day, the cool air of the ſea, loaded with vapours, flows in upon the land, and takes the place of the rarefied land air. As the ſun declines, the rarefaction of the land air is diminiſhed; thus an equilibrium is reſtored. As the ſea is not ſo much heated during the day as the land, neither is it ſo much cooled during the night, becauſe it is conſtantly expoſing a new ſurface to the atmoſphere. As the night approaches, therefore, the cooler and denſer air of the hills (for where there are no hills there are no ſea and land breezes) falls down upon the plains, and preſſing upon the now comparatively lighter air of the ſea, cauſes the land breeze.

The rarefied air which aſcends between 2° and 5° north latitude, has been ſhewn to be the principal cauſe of the trade-winds. As this air aſcends, it muſt become gradually colder, and conſequently heavier; it would therefore deſcend again if it were not buoyed up by the conſtant aſcent of new rarefied air. It muſt therefore ſpread itſelf to the north and ſouth, and gradually mix in its paſſage with the lower air; and the greater part of it probably does not reach far beyond 30°, which is the external limit of the trade-wind. Thus there is a conſtant circulation of the atmoſphere in the torrid zone; it aſcends near the equator, diffuſes itſelf toward the north and ſouth, deſcends gradually as it approaches 30°, and, returning again towards the equator, performs the ſame circuit. It has been the opinion of the greater part of thoſe who have conſidered this ſubject, that the whole of the rarefied air which aſcends near the equator, advances towards the poles and deſcends there. But if this were the caſe, a conſtant wind would blow from both poles towards the equator, and the trade-winds would extend over the whole earth; for otherwiſe the aſcent of air in the torrid zone would very ſoon ceaſe. A little reflection muſt convince us that it cannot be true. Rarefied air differs in nothing from the common air, except in containing a greater quantity of heat. As it aſcends, it gradually loſes this ſuperfluous heat. What then ſhould hinder it from deſcending, and mixing with the atmoſphere below? That there is a conſtant current of ſuperior air, however, towards the poles, cannot be doubted; but it conſiſts principally of hydrogen gas. We ſhall immediately attempt to aſſign the reaſon why its accumulation at the pole is not always attended with a north wind.

If the attraction of the moon and the diurnal motion of the ſun have any effect upon the atmoſphere, and that they have ſome effect can hardly be diſputed, there muſt be a real motion of the air weſtwards within the limits of the trade-winds. When this body of air reaches America, its further paſſage weſtwards is ſtopt by the mountains which extend from one extremity of that continent to the other. From the momentum of this air, when it ſtrikes againſt the ſides of theſe mountains, and from its elaſticity, it muſt acquire from them a conſiderable velocity, in a direction contrary to the firſt, and would therefore return eaſtwards again if this were not prevented by the trade-winds. It muſt therefore ruſh forwards in that direction where it meets with the leaſt reſiſtance; that is, towards the north and ſouth. As air is nearly a perfectly elaſtic body, when it ſtrikes againſt the ſides of the American mountains, its velocity will not be perceptibly diminiſhed, though its direction be changed. Continuing to move, therefore, with the velocity of the equator, when it arrives at the temperate zones it will aſſume the appearance of a north-eaſt or ſouth-eaſt wind. To this is to be aſcribed the frequency of ſouth-weſt winds over the Atlantic ocean and weſtern parts of Europe. Whether theſe winds are equally frequent in the northern Pacific ocean, we have not been able to aſcertain; but it is probable that the mountains in Aſia produce the ſame effect as thoſe in America.

It is not impoſſible that another circumſtance may alſo contribute to the production of theſe winds. The oxygen, which is rather heavier than common air, may mix with the atmoſphere; but the hydrogen (a cubic foot of which weighs only 41.41 grains, while a cubic foot of oxygen weighs 593.32 grains) may aſcend to the higher regions of the atmoſphere.

By what means the decompoſition is accompliſhed (if it takes place at all) we cannot tell. There are probably a thouſand cauſes in nature of which we are entirely ignorant. Whether heat and light, when long applied to vapours, may not be able to decompound them, by uniting with the hydrogen, which ſeems to have a greater attraction for heat than oxygen has, or whether the electrical fluid may not be capable of producing this effect, are queſtions which future obſervations and experiments muſt determine. Dr Franklin filled a glaſs tube with water, and paſſed an electrical ſhock through it; the tube was broken in pieces, and the whole water diſappeared. He repeated the experiment with ink inſtead of water, and placed the tube upon white paper: the ſame effects followed, and the ink, though it diſappeared completely, left no ſtain on the paper. Whether the water in theſe caſes was decompoſed or not, it is impoſſible to ſay; but the ſuppoſition that it was, is not improbable. An experiment might eaſily be contrived to determine the point.

This decompoſition would account for the frequency of ſouth-weſt winds, particularly in ſummer; for this new air is furniſhed to ſupply the place of that which is forced northwards by the cauſes already explained.

Perhaps it may be a confirmation of this conjecture, that the ſouth-weſt winds generally extend over a greater tract of country than moſt other winds which blow in the temperate zones. What has been ſaid of ſouth-weſt winds holds equally with regard to north-weſt winds in the ſouth temperate zone.

After ſouth-weſt winds have blown for ſome time, a great quantity of air will be accumulated at the pole, at leaſt if they extend over all the northern hemiſphere; and it appears, from comparing the tables kept by ſome of our late navigators in the northern Pacific ocean with ſimilar tables kept in this iſland, that this is ſometimes the caſe ſo far as relates to the Atlantic and Pacific oceans. When this accumulation becomes great, it muſt, from the nature of fluids, and from the elaſticity of the air, preſs with a conſiderable and increaſing force on the advancing air; ſo that in time it becomes ſtronger than the ſouth-weſt wind. This will occaſion at firſt a calm, and afterwards a north wind, which will become gradually eaſterly as it advances ſouthwards, from its not aſſuming immediately the velocity of the earth. The maſs of the atmoſphere will be increaſed in all thoſe places over which this north-eaſt wind blows; this is confirmed by the almoſt conſtant riſe of the barometer during a north-eaſt wind.

Whatever tends to increaſe the bulk of the atmoſphere near the pole, muſt tend alſo to increaſe the frequency of north-eaſt winds; and if there be any ſeaſon when this increaſe takes place more particularly, that ſeaſon will be moſt liable to theſe winds. During winter the northern parts of Europe are covered with ſnow, which is melted in the beginning of ſummer, when the heat of the ſun becomes more powerful. Great quantities of vapour are during that time raiſed, which will augment both the bulk and weight of the atmoſphere, eſpecially if the conjecture about the converſion of vapour into air has any foundation. Hence north-eaſt winds are moſt prevalent during May and June.

But it will be ſaid, if this hypotheſis were true, the ſouth-weſt and north-eaſt winds ought to blow alternately, and continue each of them for a ſtated time; whereas the ſouth-weſt wind blows ſometimes longer and ſometimes ſhorter, neither is it always followed by a north-eaſt wind.

If the conjecture about the decompoſition of vapour in the torrid zone be true, the hydrogen which formed a part of it will aſcend from its lightneſs, and form a ſtratum above the atmoſpherical air, and gradually extend itſelf, as additional hydrogen riſes, towards the north and ſouth, till at laſt it reaches the poles. The lightneſs of hydrogen is owing to the great quantity of heat which it contains; as it approaches the poles it muſt loſe a great part of this heat, and may in conſequence become heavy enough to mix with the atmoſphere below. Oxygen makes a part of the atmoſphere; and its proportion near the poles may ſometimes be greater than ordinary, on account of the additional quantity brought thither from the torrid zone. Mr Cavendiſh mixed oxygen and hydrogen together in a glaſs jar; and upon making an electrical ſpark paſs through them, they immediately combined and formed water.

That there is electric matter at the poles, cannot be doubted. The abbé Chappe informs us, that he ſaw thunder and lightning much more frequently at Toboſki and other parts of Siberia, than in any other part of the world. In the north of Europe, the air, during very cold weather, is exceedingly electric; ſparks can be drawn from a perſon's hands and face, by combing his hair, or even powdering him with a puff. Æpinus was an eye-witneſs to this fact, and to ſtill more aſtoniſhing proofs of the electricity of the atmoſphere during great colds.

May not the appearance of the aurora borealis be owing to the union of oxygen and hydrogen by the intervention of the electric fluid? That it is an electrical phenomenon, at leaſt, can hardly be doubted. Artificial electricity is much ſtrengthened during an aurora, as M. Volta and Mr Canton have obſerved; and the magnetic needle moves with the ſame irregularity during an aurora that has been obſerved in other electrical phenomena. This fact we learn from Bergman and De la Lande. Many philoſophers have attempted to demonſtrate, that auroræ boreales are beyond the earth's atmoſphere; but the very different reſults of their calculations evidently prove that they were not poſſeſſed of ſufficient data.

If this conjecture be true, part of the atmoſphere near the poles muſt at times be converted into water. This would account for the long continuance of ſouth-weſt winds at particular times; when they do ſo, a decompoſition of the atmoſphere is going on at the pole. It would render this conjecture more probable, if the barometer fell always when a ſouth-weſt wind continues long.

70 South-weſt winds very common after auroræ boreales.

If this hypotheſis be true, a ſouth-weſt wind ought always to blow after auroræ boreales; and we are informed by Mr Winn, that this is actually the caſe. This he found never to fail in 23 inſtances. He obſerved alſo, that when the aurora was bright, the gale came on within 24 hours, but did not laſt long; but if it was faint and dull, the gale was longer in beginning, and leſs violent, but it continued longer. This looks like a confirmation of our conjecture. Bright auroræ are probably nearer than thoſe which are dull. Now, if the aurora borealis be attended with a decompoſition of a quantity of air, that part of the atmoſphere which is neareſt muſt firſt ruſh in to ſupply the diſtant parts. Juſt as if a hole were bored in the end of a long veſſel filled with water, the water neareſt the hole would flow out immediately, and it would be ſome time before the water at the other end of the veſſel began to move. The nearer we are to the place of precipitation, the ſooner will we feel the ſouth-weſt wind. It ought therefore to begin ſooner after a bright aurora, becauſe it is nearer than a dull and faint one. Precipitations of the atmoſphere at a diſtance from the pole cannot be ſo great as thoſe which take place near it; becauſe the cold will not be ſufficient to condenſe ſo great a quantity of hydrogen; ſouth-weſt winds, therefore, ought not to laſt ſo long after bright as after dull auroræ. Winds are more violent after bright auroræ, becauſe they are nearer the place of precipitation; juſt as the water near the hole of the veſſel runs ſwifter than that which is at a conſiderable diſtance.

71 Probable cauſes of ſouth-weſt winds.

If theſe conjectures have any foundation in nature, there are two ſources of ſouth-weſt winds; the firſt has its origin in the trade-winds, the ſecond in precipitations of the atmoſphere near the pole. When they originate from the firſt cauſe, they will blow in countries farther ſouth for ſome time before they are felt in thoſe which are farther north; but the contrary will take place when they are owing to the ſecond cauſe. In this laſt caſe, too, the barometer will ſink conſiderably; and it actually does ſo conſtantly after auroræ, as we are informed by Mr Madiſon, who paid particular attention to this ſubject. By keeping accurate meteorological tables in different latitudes, it might eaſily be diſcovered whether theſe conſequences be true, and of courſe whether the above conjectures be well or ill grounded.

72 Winds commonly begin at the place towards which they blow.

It appears that winds generally commence at that point towards which they blow; and hence they muſt ariſe from a rarefaction and conſequent diſplacing of the air in ſome particular place, by the action of heat, or ſome other cauſe. Perhaps, according to the idea of Mr Williams, this cauſe may be an increaſed precipitation of the ſuperior ſtrata of air, rendered unuſually denſe from its being ſurcharged with moiſture in the place where the wind begins to blow, or from an increaſed evaporation from a humid ſurface in the oppoſite direction.

Hurricanes are conſtantly preceded by a great depreſſion of the thermometer; and in theſe caſes the wind often ſeems to blow from every direction towards the quarter where this fall of the barometer is obſerved.

Violent winds from the north-eaſt have repeatedly been obſerved to begin at the quarter towards which they blow. In 1740 Dr Franklin was prevented from obſerving an eclipſe of the moon at Philadelphia by a north-eaſt ſtorm, which came on about ſeven o'clock in the evening. He was ſurpriſed to find afterwards that it had not come on at Boſton till near 11 o'clock; and, upon comparing all the accounts which he received from the ſeveral colonies of the beginning of this and other ſtorms of the ſame kind, he found it to be always an hour later the farther north-eaſt, for every 100 miles. "From hence (ſays he) I formed an idea of the courſe of the ſtorm, which I will explain by a familiar inſtance. I ſuppoſe a long canal of water ſtopped at the end by a gate. The water is at reſt till the gate is opened; then it begins to move out through the gate, and the water next the gate is firſt in motion, and moves on towards the gate, and ſo on ſucceſſively, till the water at the head of the canal is in motion, which it is laſt of all. In this caſe the water moves indeed towards the gate; but the ſucceſſive times of beginning the motion are in the contrary way, viz. from the gate back to the head of the canal. Thus to produce a north-eaſt ſtorm, I ſuppoſe ſome great rarefaction of the air in or near the gulf of Mexico; the air riſing thence has its place ſupplied by the next more northern, cooler, and therefore denſer and heavier air; a ſucceſſive current is formed, to which our coaſt and inland mountains give a north eaſt direction."

Several inſtances of a ſimilar kind have occurred. In 1802, Dr Mitchell obſerved a ſtorm which began at Charleſtown on the 21ſt of February, at two o'clock P. M. but was not obſerved at Waſhington, ſeveral hundred miles to the north-eaſt, till five o'clock; at New York till 10, nor at Albany till daybreak of the following morning. Hence it appears that it muſt have moved at the rate of 1100 miles in 11 hours, or 100 miles an hour.

A remarkable ſtorm of this kind, in which the wind was eaſterly, and attended with a heavy fall of ſnow, was obſerved in Scotland on the 8th of February 1799; but the motion of the wind was much ſlower. It began to ſnow at Falkirk on the 7th of February at ſix in the evening, but at Edinburgh not till one o'clock A. M. on the 8th; and the ſnow was not obſerved at Dunbar till ſeven hours after. The ſtorm continued 11 hours, during which time it did not travel more than 100 miles.

Currents of air from the poles naturally aſſume a north eaſt direction as they advance ſouthwards, becauſe their diurnal motion becomes leſs than that of the earth. Various circumſtances, however, may change this direction, and cauſe them to become north, or even north-weſt winds. The ſouth-weſt winds themſelves may often prove ſufficient for this; and violent rains, or great heat, by leſſening or rarefying the atmoſphere in any country, will produce the ſame effect in countries to the weſtwards, when north winds happen to be blowing.

In North America, the north-weſt winds become gradually more frequent as we advance northwards. The eaſt coaſt of this continent, where the obſervations were made from which this concluſion was drawn, is alone cultivated; the reſt of the country is covered with wood. Now cultivated countries are generally conſidered as warmer than thoſe which are uncultivated, though Mr Williams is of a different opinion; and on this circumſtance founds his hypotheſis of the climate of Britain being much deteriorated during the laſt 50 years. The air, therefore, in the interior parts of the country ſhould be conſtantly colder than the eaſt coaſt. This difference will ſcarcely be perceptible in the ſouthern parts, becauſe there the influence of the ſun is very powerful; but it will become gradually greater as we advance northwards, becauſe the influence of the ſun diminiſhes, and the continent becomes broader. Hence north-weſt winds ought to become more frequent upon the eaſt coaſt as we advance northwards; and they will probably ceaſe to blow ſo often as ſoon as the whole continent of North America becomes cultivated.

73 Different currents often appear in the atmoſphere at the ſame time.

There is one curious circumſtance which deſerves attention. One current of air is often obſerved to blow at the ſurface of the earth, while a current in the contrary direction is flowing in a ſuperior part of the atmoſphere. Dr Thomſon on one occaſion obſerved three currents of this kind blowing all at the ſame time in contrary directions. It has been affirmed that changes of weather commonly commence in the upper ſtrata, and that they are gradually extended by the current of air that commences above, proceeding towards the lower parts of the atmoſphere.

74 Partial winds.

Beſides theſe more general winds, there are others which extend only over a very ſmall part of the earth. Theſe originate from many different cauſes. The atmoſphere is principally compoſed of three different kinds of air, oxygen, azote, and carbonic acid, to which may be added water. Great quantities of each of theſe ingredients are conſtantly changing their aërial form, and combining with various ſubſtances; or they are ſeparating from other bodies, aſſuming the form of air, and mixing with the atmoſphere. Partial deficiences, therefore, and partial accumulations, muſt be continually

ally taking place in different parts of the atmoſphere, which will occaſion winds varying in direction, violence, and continuance, according to the ſuddenneſs and the quantity of air deſtroyed or produced. Beſides theſe, there are many other ingredients conſtantly mixing with the atmoſphere, and many partial cauſes of condenſation and rarefaction in particular places. To theſe, and probably to other cauſes hitherto unknown, are to be aſcribed all thoſe winds which blow in any place beſides the general ones already explained; and which, as they depend on cauſes hitherto at leaſt reckoned contingent, will probably for ever prevent uniformity and regularity in the winds. All theſe cauſes, however, may, and probably will, be diſcovered: the circumſtances in which they will take place, and the effects they will produce, may be known; and whenever this is the caſe, the winds of any place may in ſome meaſure be reduced to calculation.

CHAP. V. *Of Meteors.*

75 Meteors. THE principal luminous phenomena denominated meteors, have been fully conſidered under ATMOSPHERIC ELECTRICITY. Thoſe meteors that burſt in the air, and are followed by the falling of ſtones or other mineral ſubſtances, have been fully deſcribed and accounted for under METEOROLITE. We have here only to notice briefly the meteors called *falling ſtars*, and *ignes fatui*.

76 Falling ſtar. The falling or ſhooting ſtar is a very common phenomenon, and takes place more eſpecially at thoſe ſeaſons and in thoſe ſituations where the aurora borealis is moſt frequently obſerved. Indeed they are conſidered by moſt philoſophers as modifications of the ſame phenomenon, and depending on the ſame cauſe. We have ſeen good reaſon to conclude that the aurora borealis is an electrical meteor; and if the falling ſtar is ſo nearly allied to the aurora as is ſuppoſed, it muſt alſo be produced by electricity. Mr G. Morgan ſeems to have no doubt of the electrical nature of this meteor, and remarks that if what appears as an undulating flaſh in the aurora, could be concentrated, or confined within ſmaller dimenſions, it would probably aſſume the appearance of a falling ſtar. He founds this opinion chiefly on the following experiment.

Into a tube 48 inches long, and ¼ inch diameter, Mr Morgan conveyed as much air, as under the common preſſure of the atmoſphere, would fill two inches in length of the ſame tube. (The tube we preſume was previouſly exhauſted of air.) One extremity of the tube he connected with the ground by means of good conductors, and faſtened to the other a metallic ball. Through the tube thus filled with rarefied air, he ſent electric ſparks of different magnitudes, by bringing the ball within the ſtriking diſtance of different fixed conductors. When the ſparks were ſmall, a flaſh like that of the aurora borealis, ſeemed to fill the whole tube; but when the ſpark was what might be made to ſtrike through 10 inches in the open air, it appeared to ſtrike through the whole length of the tube, with all the brilliancy and ſtraightneſs of a falling ſtar. If, however, he extracted part of the air out of the tube, by the air-pump, he could never make the electric fluid aſſume any form excepting that of a flaſh; but by exchanging the tube for another with a thermometrical ball, and treating it in the ſame manner as the preceding, the flaſh never appeared, but the fluid in its paſſage aſſumed all the brilliancy of a falling ſtar.

It is eaſy to trace the ſimilarity of circumſtances that take place in this experiment, and in the natural phenomenon of the falling ſtar. Both take place in rarefied air; both are remarkable for the brightneſs of their light, and for the ſtraightneſs of their direction. That falling ſtars are frequently, if not always, the concentration of an aurora borealis, may be inferred from their being the conſtant attendants of a very electrical ſtate of the atmoſphere; and from their frequent appearance near that portion of the heavens which is illumined by the northern lights at the time of their appearance.

Mr Morgan was riding towards Norwich late at night, when to the north-eaſt of the town he beheld a fine conical ſtream of the aurora borealis. The whole body every now and then flaſhed, as if an additional quantity of electric fluid were thrown into it, and nearly at the ſame inſtant he perceived what is vulgarly called a falling ſtar, darting from its ſummit. This appearance he obſerved twice ſucceſſively.

77 Ignis fatuus. The *ignis fatuus*, or *will-with-the-wiſp*, that appears ſo often in boggy, marſhy and damp ſituations, decoying the unwary traveller, and terrifying the ſuperſtitious vulgar, ſeems to be rather of a phoſphoric than an electric nature, ſimilar to the light which is emitted by ſtale fiſh, rotten wood, and other putreſcent ſubſtances. Sir Iſaac Newton defined it to be a vapour ſhining without heat.

A remarkable *ignis fatuus* was obſerved by Mr Derham, in ſome boggy ground, between two rocky hills. He was ſo fortunate as to be able to approach it within two or three yards. It moved with a briſk and deſultory motion about a dead thiſtle, till a ſlight agitation of the air, occaſioned, as he ſuppoſed, by his near approach to it, occaſioned it to jump to another place; and as he approached, it kept flying before him. He was near enough to ſatisfy himſelf, that it could not be the ſhining of glow-worms or other inſects—it was one uniform body of light.

M. Beccaria mentions two of theſe luminous appearances, which were frequently obſerved in the neighbourhood of Bologna, and which emitted a light equal to that of an ordinary faggot. Their motions were unequal, ſometimes riſing, and ſometimes ſinking towards the earth; ſometimes totally diſappearing, though in general they continued hovering about ſix feet from the ground. They differed in ſize and figure; and indeed, the form of each was fluctuating, ſometimes floating like waves, and dropping ſparks of fire. He was aſſured there was not a dark night in the whole year in which they did not appear; nor was their appearance at all affected by the weather, whether cold or hot, ſnow or rain. They have been known to change their colour from red to yellow; and generally grew fainter as any perſon approached, vaniſhing entirely when the obſerver came very near to them, and appearing again at ſome diſtance.

Dr Shaw alſo deſcribes a ſingular *ignis fatuus*, which he ſaw in the Holy Land. It was ſometimes globular, or in the form of the flame of a candle; and immediately afterwards ſpread itſelf ſo much, as to involve the whole company in a pale inoffenſive light, and then was obſerved to contract itſelf again, and ſuddenly diſappear. In leſs than a minute, however, it would become viſible as before, and run along from one place to another; or would expand itſelf over more than three acres of the adjacent mountains. The atmoſphere at this time was thick and hazy.

All theſe luminous appearances are probably owing to the extrication of hydrogen gas ſo ſlightly impregnated with phoſphorus as to continue emitting a faint light, without producing that brilliant flaſh which follows the ſudden extrication into the air, of the common phoſphorated hydrogen gas obtained in the uſual chemical experiment of throwing phoſphuret of lime into water.

CHAP. VI. *Of the Application of Meteorology to Prognoſticating the Weather.*

It has ever been a principal object among mankind, to foretel the changes of weather that are likely to follow particular appearances in the ſky, among the heavenly bodies, &c.; and it has been often alleged, that in this reſpect the philoſopher is far behind the huſbandman and the ſhepherd. Were the former, however, to add to his ſcientific reſearches the obſervations to which the latter are indebted for their judgement of the weather, he would ſoon be far ſuperior to them in this reſpect.

79 Kirwan's concluſions on the weather.

Dr Kirwan has lately endeavoured to diſcover probable rules for prognoſticating the weather in different ſeaſons, as far as regards this climate, from tables of obſervation alone; and from comparing a number of theſe obſervations made in England, from 1677 to 1789, he found,

1. That when there has been no ſtorm before or after the vernal equinox, the enſuing ſummer is generally *dry*, at leaſt five times in ſix.

2. That when a ſtorm happens from an eaſterly point, either on the 19th, 20th, or 21ſt of May, the ſucceeding ſummer is generally *dry* four times in five.

3. That when a ſtorm ariſes on the 26th, 27th, or 29th of May (and not before), in any point, the ſucceeding ſummer is generally *dry* four times in five.

4. If there be a ſtorm at ſouth-weſt or weſt-ſouth-weſt on the 19th, 20th, 21ſt, or 22d of March, the ſucceeding ſummer is generally *wet* five times in ſix.

In this country winters and ſprings, if dry, are moſt commonly cold; if moiſt, warm: on the contrary, dry ſummers and autumns are uſually *hot*, and moiſt ſummers cold. So that if we know the moiſtneſs or dryneſs of a ſeaſon, we can judge pretty accurately of its temperature.

From a table of the weather kept by Dr Rutty, in Dublin, for 41 years, Dr Kirwan endeavoured to calculate the probabilities of particular ſeaſons being followed by others. Though his rules relate chiefly to the climate of Ireland, yet as probably there is not much difference between that iſland and Britain, in the general appearance of the ſeaſons, we ſhall mention his concluſions here.

In 41 years there were ſix wet ſprings, 22 dry, and 13 variable; 20 wet ſummers, 16 dry, and five variable; 11 wet autumns, 11 dry, and 19 variable. A ſeaſon according to Dr Kirwan, is counted *wet*, when it contains two wet months. In general, the quantity of rain which falls in dry ſeaſons is leſs than five inches; in wet ſeaſons more. Variable ſeaſons are thoſe in which there falls between 30 and 36 pounds, a pound being equal to .157637 of an inch.

80 Probable ſucceſſion of ſeaſons.

The order in which the different ſeaſons ſucceeded each other, was as in the following table.

				Times	Probability.
A dry ſpring	Has been followed by a	dry	Summer	11	$\frac{11}{22}$
		wet		8	$\frac{8}{22}$
		variable		3	$\frac{3}{22}$
A wet ſpring		dry		0	0
		wet		5	$\frac{5}{6}$
		variable		1	$\frac{1}{6}$
A variable ſpring		dry		5	$\frac{5}{13}$
		wet		7	$\frac{7}{13}$
		variable		1	$\frac{1}{13}$
A dry ſummer		dry	Autumn	5	$\frac{5}{16}$
		wet		5	$\frac{5}{16}$
		variable		6	$\frac{6}{16}$
A wet ſummer		dry		5	$\frac{5}{20}$
		wet		3	$\frac{3}{20}$
		variable		12	$\frac{12}{20}$
A variable ſummer		dry		1	$\frac{1}{5}$
		wet		3	$\frac{3}{5}$
		variable		1	$\frac{1}{5}$
A dry ſpring and dry ſummer		dry		3	$\frac{3}{11}$
		wet		4	$\frac{4}{11}$
		variable		4	$\frac{4}{11}$
A dry ſpring and wet ſummer		dry		2	$\frac{2}{8}$
		wet		0	0
		variable		6	$\frac{6}{8}$
A wet ſpring and dry ſummer		dry		0	0
		wet		0	0
		variable		0	0
A wet ſpring and wet ſummer		dry		2	$\frac{2}{5}$
		wet		1	$\frac{1}{5}$
		variable		2	$\frac{2}{5}$
A wet ſpring and variable ſummer		dry		1	$\frac{1}{1}$
		wet		0	0
		variable		0	0
A dry ſpring and variable ſummer		dry		0	0
		wet		2	$\frac{2}{3}$
		variable		1	$\frac{1}{3}$
A variable ſpring and dry ſummer		dry		2	$\frac{2}{4}$
		wet		0	0
		variable		2	$\frac{2}{4}$
A variable ſpring and wet ſummer		dry		1	$\frac{1}{7}$
		wet		1	$\frac{1}{7}$
		variable		5	$\frac{5}{7}$
A variable ſpring and variable ſummer		dry		0	0
		wet		1	$\frac{1}{1}$
		variable		0	0

81 Rules for prognoſticating the weather.

Hence Dr Kirwan deduced the probability of the kind of ſeaſons which would follow others. This probability is expreſſed in the laſt column of the table, and is to be underſtood in this manner. The probability that a dry ſummer will follow a dry ſpring is $\frac{11}{22}$; that a wet ſummer will follow a dry ſpring, $\frac{8}{22}$; that a variable ſummer will follow a dry ſpring, $\frac{3}{22}$, and ſo on.

This method of Dr Kirwan, if there is ſuch a connexion between the different ſeaſons that a particular kind of weather in one has a tendency to produce a particular kind of weather in the next, as it is reaſonable to expect from theory, may in time, by multiplying obſervations, come to a great degree of accuracy, and may at laſt, perhaps, lead to that great deſideratum, a rational theory of the weather. As we wiſh to throw as much light as poſſible on this important ſubject, we ſhall add to theſe a few maxims, the truth of which has either been confirmed by long obſervation, or which the knowledge we have already acquired of the cauſes of the weather has eſtabliſhed on tolerably good grounds.

1. A moiſt autumn with a mild winter is generally followed by a cold and dry ſpring, which greatly retards vegetation. Such was the year 1741.

2. If the ſummer be remarkably rainy, it is probable that the enſuing winter will be ſevere; for the unuſual evaporation will have carried off the heat of the earth. Wet ſummers are generally attended with an unuſual quantity of ſeed on the white thorn and dog-roſe-buſhes. Hence the unuſual fruitfulneſs of theſe ſhrubs is a ſign of a ſevere winter.

3. The appearance of cranes and birds of paſſage early in autumn announces a very ſevere winter; for it is a ſign it has already begun in the northern countries.

4. When it rains plentifully in May, it will rain but little in September, and *vice verſa*.

5. When the wind is ſouth-weſt during ſummer or autumn, and the temperature of the air unuſually cold for the ſeaſon, both to the feeling and the thermometer, with a low barometer, much rain is to be expected.

6. Violent temperatures, as ſtorms or great rains, produce a ſort of criſis in the atmoſphere, which produces a conſtant temperature, good or bad, for ſome months.

7. A rainy winter predicts a ſteril year: a ſevere autumn announces a windy winter.

To the above we ſhall add the following maxims, drawn from obſervation, and with theſe ſhall conclude this article.—82 Signs of rain from birds. Sea and freſh water-fowls, ſuch as cormorants, ſea-gulls, muir-hens, &c. flying from ſea, or the freſh waters, to land, ſhew bad weather at hand: land fowls flying to waters, and theſe ſhaking, waſhing, and noiſy, eſpecially in the evening, denote the ſame; geeſe, ducks, cats, &c. picking, ſhaking, waſhing, and noiſy; rooks and crows in flocks, and ſuddenly diſappearing; pyes and jays in flocks, and very noiſy; the raven or hooded-crow crying in the morning, with an interruption in their notes, or crows being very clamorous at even; the heron, bittern, and ſwallow flying low; birds forſaking their meat and flying to their neſts; poultry going to rooſt, or pigeons to their dove-houſe; tame fowls grubbing in the duſt, and clapping their wings; ſmall birds ſeeming to duck and waſh in the ſand; the late and early crowing of the cock, and clapping his wings; the early ſinging of wood-larks; the early chirping of ſparrows; the early note of the chaffinch near houſes; the dull appearance of robin-redbreaſt near houſes; peacocks and owls unuſually clamorous.

83 Wind from birds. Sea and freſh-water fowls gathering in flocks to the banks, and there ſporting, eſpecially in the morning; wild-geeſe flying high, and in flocks, and directing their courſe eaſtward; coots reſtleſs and clamorous; the hoopoe loud in his note; the king's-fiſher taking to land; rooks darting or ſhooting in the air; or ſporting on the banks of freſh waters; and laſtly, the appearance of the maleſigie at ſea, is a certain forerunner of violent winds, and (early in the morning) denotes horrible tempeſts at hand.

84 Fair weather from birds. Halcyons, ſea-ducks, &c. leaving the land and flocking to the ſea; kites, herons, bitterns, and ſwallows flying high and loud in their notes; lapwings reſtleſs and clamorous; ſparrows after ſunriſe reſtleſs and noiſy; ravens, hawks, and keſtrils (in the morning), loud in their notes; robin-redbreaſt mounted high, and loud in his ſong; larks ſoaring high, and loud in their ſongs; owls hooting with an eaſy and clear note; bats appearing early in the evening.

85 Rain from beaſts. Aſſes braying more frequently than uſual; hogs playing, ſcattering their food, or carrying ſtraw in their mouths; oxen ſnuffing the air, looking to the ſouth, while lying on their ſides, or licking their hoofs; cattle gaſping for air at noon; calves running violently and gamboling; deer, ſheep, or goats, leaping, fighting, or puſhing; cats waſhing their face and ears; dogs eagerly ſcraping up earth; foxes barking, or wolves howling; moles throwing up earth more than uſual; rats and mice more reſtleſs than uſual; a grumbling noiſe in the belly of hounds.

86 Rain from inſects. Worms crawling out of the earth in great abundance; ſpiders falling from their webs; flies dull and reſtleſs; ants haſtening to their neſts; bees haſtening home, and keeping cloſe in their hives; frogs and toads drawing nigh to houſes; frogs croaking from ditches; toads crying on eminences; gnats ſinging more than uſual; but, if gnats play in the open air, or if hornets, waſps, and glow-worms appear plentifully in the evening, or if ſpiders webs are ſeen in the air, or on the graſs, or trees, theſe do all denote fair and warm weather at hand.

87 Rain from the ſun. Sun riſing dim or wateriſh; riſing red with blackiſh beams mixed along with his rays; riſing in a muſty or muddy colour; riſing red and turning blackiſh; ſetting under a thick cloud; ſetting with a red ſky in the eaſt.

N. B. Sudden rains never laſt long; but when the air grows thick by degrees, and the ſun, moon, and ſtars ſhine dimmer and dimmer, then it is like to rain ſix hours uſually.

88 Wind from the ſun. Sun riſing pale and ſetting red, with an iris; riſing large in ſurface; riſing with a red ſky in the north; ſetting of a bloody colour; ſetting pale, with one or more dark circles, or accompanied with red ſtreaks; ſeeming concave or hollow; ſeeming divided, great ſtorms; parhelia, or mock ſuns, never appear, but are followed by tempeſts.

89 Fair weather from the ſun. Sun riſing clear, having ſet clear the night before; riſing while the clouds about him are driving to the weſt; riſing with an iris around him; and that iris wearing away equally on all ſides, then expect fair and ſettled weather; riſing clear and not hot; ſetting in red clouds, according to the old obſervation:

The evening red and morning gray,
Is the ſure ſign of a fair day.

90 Rain from the moon. Moon pale in colour, rain; horns blunt at firſt riſing, rain; horns blunt, at or within two or three days after the change, denotes rain for that quarter; an iris with a ſouth wind, rain next day; wind ſouth third night after change, rain next day; the wind ſouth, and the moon not ſeen before the fourth night, rain moſt of that month; full moon in April, new and full moon in Auguſt, for moſt part bring rain; mock moons are the forerunners of great rains, land floods, and inundations.

91 Wind from the moon. Moon ſeeming greatly enlarged; appearing of a red colour; horns ſharp and blackiſh; if included with a clear and ruddy iris; if the iris be double or ſeem to be broken in parts, tempeſts.

N. B. On the new moon, the wind for the moſt part changes.

When the moon, at four days old, has her horns ſharp, ſhe foretels a tempeſt at ſea, unleſs ſhe has a circle about her, and that too entire, becauſe, by that ſhe ſhews that it is not like to be bad weather, till it is full moon.

92 Fair weather from the moon. Moon ſeeming to exhibit bright ſpots; a clear iris with full moon; horns ſharp fourth day, fair till full; horns blunt at firſt riſing, or within two or three days after change, denotes rain for that quarter; but fair weather the other three quarters; moon clear three days after change and before full, always denotes fair weather. After every change and full, rains for the moſt part, ſucceeded by fair ſettled weather; moon clear and bright, always fair weather.

93 Weather from the ſtars. Stars ſeeming large, dull, and pale of colour, rain; or when their twinkling is not perceptible, or if encompaſſed with an iris. In ſummer, when the wind is at eaſt, and ſtars ſeem greater than uſual, then expect ſudden rain; ſtars appearing great in number, yet clear and bright, ſeeming to ſhoot or dart, denote fair weather in ſummer, and in winter froſt.

94 Rain from the clouds. In cloudy weather, when the wind falls, rain follows; clouds growing bigger, or ſeeming like rocks or towers ſettling on tops of mountains; coming from the ſouth, or often changing their courſe; many in number at north-weſt in the even; being black in colour from the eaſt, rain at night; but out of the weſt, rain next day; being like fleece of wool, from the eaſt, rain for two or three days; lying like ridges about mid day in the ſouth-weſt, ſhews great ſtorms both of wind and rain to be nigh.

95 Wind from the clouds. Clouds flying to and fro; appearing ſuddenly from the ſouth or weſt; appearing red, or accompanied with redneſs in the air, eſpecially in the morning; being of a leadiſh colour in the north-weſt; ſingle clouds denote wind from whence they come; but if at ſunſet, clouds appear with golden edges, or diminiſh in bulk, or ſmall clouds ſink low, or draw againſt the wind, or appear ſmall, white, and ſcattered in the north-weſt (ſuch as are vulgarly called mackerel) when the ſun is high, theſe are ſigns of fair weather.

N. B. It is often obſerved, that though the mackerel ſky denotes fair weather for that day, yet for the moſt part, rain follows in a day or two after.

96 Rain from a rainbow. After a long drought, the rainbow denotes ſudden and heavy rains; if green be the predominant colour, it denotes rain, but if red, wind with rain; if the clouds grow darker, rain; if the bow ſeems broken, violent ſtorms; if appearing at noon, much rain; if in the weſt great rain, with thunder.

N. B. It is obſerved, that if the laſt week in February, and the firſt fortnight of March, be moſtly rainy, and attended with frequent appearances of the bow, a wet ſpring and ſummer may be expected.

97 Fair weather from the rainbow. The rainbow appearing after rains, denotes fair weather at hand, if the colours grow lighter, fair; if the bow ſuddenly diſappears, fair; if the bow appear in the morning, it is the ſign of ſmall rains, followed by fair weather; and if appearing at night, fair weather; if appearing in the eaſt in the evening, fair; if the bow appear double, it denotes fair weather at preſent but rain in a few days; if in autumn, it continues fair for two days after the appearance of the aurora borealis, expect fair weather for at leaſt eight days more.

98 Rain from miſts. If miſts be attracted to the tops of hills then expect rain in a day or two; if, in dry weather, they be obſerved to aſcend more than uſual, then expect ſudden rain; miſts in the new moon foreſhew rain in the old; miſts alſo in the old moon denote rain to happen in the new; a miſty white ſcare, in a clear ſky in the ſouth-eaſt, is always a forerunner of rain.

99 Fair weather from miſts. If miſts diſſipate quickly, or deſcend after rain, it is a ſure ſign of fair weather; a general miſt before ſunriſing near the full moon, denotes fair weather for about a fortnight running. If after ſunſet or before ſunriſe, a white miſt ariſe from the waters and meads, it denotes warm and fair weather next day. A miſty dew on the inſide of glaſs windows ſhews fair weather for that day.

100 Rain from inanimate bodies. Wood ſwelling, or ſtones ſeeming to ſweat; lute or viol ſtrings breaking; printed canvas or paſted maps relaxing; ſalt becoming moiſt; rivers ſinking, or floods ſuddenly abating; remarkable halo about the candle; great dryneſs of the earth; pools ſeeming troubled or muddy; yellow ſcum on the ſurface of ſtagnant waters; dandelion or pimpernel ſhutting up; trefoil ſwelling in ſtalk, while the leaves bow down.

N. B. A dry ſpring is always attended with a rainy winter.

101 Wind from inanimate bodies. Wind ſhifting to the oppoſite point; ſea calm, with a murmuring noiſe; a murmuring noiſe from the woods and rocks when the air is calm; leaves and feathers ſeeming much agitated; tides high when the thermometer is high; trembling or flexuous burning of flames; coal burning white with a murmuring noiſe; thunder in the morning with a clear ſky; thunder from the north.

N. B. Whenſoever the wind begins to ſhift, it will not reſt till it come to the oppoſite point; and if the wind be in the north, it will be cold; if in the north-eaſt colder; if in the ſouth; it brings rain; but if in the ſouth-weſt more rain.

102 Signs of rain ceaſing. The ſudden cloſing of gaps in the earth; the remarkable riſing of ſprings or rivers; if the rain begins an hour or two before ſunriſe it is like to be fair ere noon; but if an hour or two after ſunriſe; it for the moſt part happens to continue all day and then to ceaſe; when it begins to rain from the ſouth with a high wind for two or three hours, and that the wind falls, and it ſtill continues raining, it is then like to continue for 12 hours or more, and then to ceaſe.

N. B. Theſe long rains ſeldom hold above 24 hours, or happen above once a year.

103 Of wind ceaſing. A haſty ſhower after raging winds is a ſure ſign of the ſtorm being near an end. If the water ruckles and frequent bubbles ariſe, or if the halcyon or king's-fiſher attempts the ſea while the ſtorm laſts, or moles come out of their holes, or ſparrows chirp merrily, theſe are all certain ſigns of the ſtorm ceaſing.

Both ſea and freſh water fiſhes by their frequent riſing and fluttering on the ſurface of the water, foretel the ſtorm nigh over, but eſpecially dolphins ſpouting up water in a ſtorm foretel a calm.

N. B. Let the wind be in what quarter it will, upon the new moon, it preſently changes.

104 Signs of hail. Clouds white, inclining to yellow, and moving heavily though the wind be high, is a ſure ſign of hail; if the eaſtern ſky before ſunriſe be pale, and refracted rays appear in thick clouds, then expect great ſtorms of hail: white clouds in ſummer are a ſign of hail, but in winter they denote ſnow, eſpecially when we perceive the air to be a little warm; in ſpring or winter, when clouds appear of blueiſh white, and expand much, expect ſmall hail or drizzling, which properly is no other than frozen miſts.

105 Signs of thunder. Meteors ſhooting in the ſummer's evening, or chops and clefts in the earth, when the weather is ſultry, always foretel thunder is nigh; in ſummer or harveſt, when the wind has been ſouth two or three days, and the thermometer high, and clouds riſe with great white tops like towers, as if one were upon the top of another, and joined with black on the nether ſide, expect rain and thunder ſuddenly; if two ſuch clouds ariſe, one on either hand, it is then time to look for ſhelter, as the thunder is very nigh.

N. B. It is obſerved that it thunders moſt with a ſouth wind and leaſt with an eaſt.

106 Signs of cold and froſty weather. Sea-pyes, ſtarlings, fieldfares, with other migratory birds, appearing early, denote a cold ſeaſon to enſue; the early appearance of ſmall birds in flocks, and of robin-redbreaſts near houſes; ſun in harveſt ſetting in a miſt or broader than uſual; moon bright, with ſharp horns, after change; wind ſhifting to the eaſt or north after change; ſky full of twinkling ſtars; ſmall clouds hovering low in the north; ſnow falling ſmall, while clouds appear on heaps like rocks.

N. B. Froſts in autumn are always ſucceeded with rain.

107 Signs of thaw. Snow falling in large flakes while the wind is at ſouth; cracks appearing in the ice; ſun looking wateriſh; the moon's horns blunted; ſtars looking dull; wind turning to the ſouth; wind extremely ſhifting. It is alſo obſerved, that, if October and November be froſt and ſnow, January and February are like to be open and mild.

108 Signs of drought. Fair weather for a week together, while the wind is all that time in the ſouth, is, for the moſt part, followed by a great drought; if February be for moſt rainy, ſpring and ſummer quarters are like to be ſo too; but if it happen to be altogether fair, then expect a drought to follow; if lightning follow after 24 hours of dry and fair weather, drought will follow, but if within 24 hours, expect great rains.

109 Signs of a hard winter. A moiſt and cold ſummer, and mild autumn, are ſure ſigns of a hard and ſevere winter: ſtore of hips and haws denote the ſame; the hazel-tree flowering is ever obſerved to foretel the ſame; acorns found without any inſect is a ſure prognoſtic of a hard winter.

110 Signs of peſtilential ſeaſons. A dry and cold winter with a ſoutherly wind; a very rainy ſpring, ſickneſs in ſummer; if ſummer be dry with the wind northerly, great ſickneſs is like to follow; great heats in ſpring time without winds; roots having a luſcious taſte, while the wind has been long ſoutherly without rain; and laſtly, great quantities of ſtinking atoms, inſects or animals, as flies, frogs, ſnakes, locuſts, &c.

111 Experiments with the leech. Incloſe the leech worm in an eight ounce phial glaſs, three fourths filled with water, covered with a bit of linen; let the water be changed once a week in ſummer, and once a fortnight in winter.

If the leech lies motionleſs at the bottom in a ſpiral form, fair weather; if crept to the top, rain; if reſtleſs, wind; if very reſtleſs, and without the water, thunder; if in winter at bottom, froſt; but if in the winter it pitches its dwelling on the mouth of the phial, ſnow. See HELMINTHOLOGY (F).

112 Signs of the weather from the barometer. In calm weather, when the air is inclined to rain, the mercury is low; but when tending to fair, it will riſe; in very hot weather when falling, it foreſhews thunder; if riſing in winter, froſt; but if falling in froſt, thaw; if riſing in a continued froſt, ſnow; if foul weather quickly on its falling, ſoon over; if fair weather quickly on its riſing, ſoon over; alſo if riſing high in foul weather, and ſo continuing for two or three days, before the foul weather is over, then expect a continuance of fair weather; but, if in fair weather the mercury fall low, and ſo continue for two or three days, then expect much rain, and probably high winds.

N. B. In an eaſt wind, the mercury always riſes and falls loweſt before great winds. *

It was intended to inſert in this article a ſummary view of the opinions of Toaldo, Cotte, and Lamarck, reſpecting the influence of the moon in producing changes in our atmoſphere; but peculiar circumſtances render it neceſſary to poſtpone this view till we come to the article MOON.

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* *Nicholſon's Journal*, Feb. 1804, p. 149.

(F) In compliance with the writer of this paper, we have retained this paſſage on the leech; though, as we ſtated, when treating of the *Hirudo medicinalis*, in HELMINTHOLOGY, we are very ſceptical reſpecting the *weather-judging* faculties of that worm.

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Meteoromancy || Methodiſts.

METEOROMANCY, a ſpecies of divination by meteors, principally by lightning and thunder. This method of divination paſſed from the Tuſcans to the Romans, with whom, as Seneca informs us, it was held in high eſteem.

METESSIB, an officer of the eaſtern nations, who has the care and overſight of all the public weights and meaſures, and ſees that things are made juſtly according to them.

METHEGLIN, a ſpecies of mead; one of the moſt pleaſant and general drinks which the northern parts of Europe afford, and much uſed among the ancient inhabitants: (See MEAD). The word is Welſh, *meddyglin*, where it ſignifies the ſame.—There are divers ways of making it; one of the beſt whereof follows: Put as much new honey, naturally running from the comb, into ſpring water, as that when the honey is thoroughly diſſolved an egg will not ſink to the bottom, but be juſt ſuſpended in it; boil this liquor for an hour or more, till ſuch time as the egg ſwim above the liquor about the breadth of a groat; when very cool, next morning it may be barrelled up; adding to each 15 gallons an ounce of ginger, as much of mace and cloves, and half as much cinnamon, all groſsly pounded; a ſpoonful of yeaſt may be alſo added at the bung hole to promote the fermentation. When it has done working, it may be cloſely ſtopped up; and after it has ſtood a month, it ſhould be drawn off into bottles.

METHOD, the arrangement of our ideas in ſuch a regular order, that their mutual connexion and dependence may be readily comprehended. See LOGIC, Part iv.

METHODISTS, in eccleſiaſtical hiſtory, is a denomination applied to different ſects, both Papiſts and Proteſtants.

Methodiſts.

I. The *Popiſh Methodiſts* were thoſe polemical doctors, of whom the moſt eminent aroſe in France towards the middle of the 17th century, in oppoſition to the Huguenots or Proteſtants. Thoſe Methodiſts, from their different manner of treating the controverſy with their opponents, may be divided into two claſſes. The one may comprehend thoſe doctors, whoſe method of diſputing with the Proteſtants was diſingenuous and unreaſonable, and who followed the examples of thoſe military chiefs, who ſhut up their troops in intrenchments and ſtrong holds, in order to cover them from the attacks of the enemy. Of this number were the Jeſuit Veron, who required the Proteſtants to prove the tenets of their church by plain paſſages of ſcripture, without being allowed the liberty of illuſtrating thoſe paſſages, reaſoning upon them, or drawing any concluſions from them; Nihuſius, an apoſtate from the Proteſtant religion; the two Walenburgs, and others, who confined themſelves to the buſineſs of anſwering objections and repelling attacks; and Cardinal Richelieu, who confined the whole controverſy to the ſingle article of the divine inſtitution and authority of the church. The Methodiſts of the ſecond claſs were of opinion, that the moſt expedient manner of reducing the Proteſtants to ſilence, was not to attack them by piecemeal, but to overwhelm them at once, by the weight of ſome general principle or preſumption, ſome univerſal argument, which comprehended or might be applied to all the points conteſted between the two churches: thus imitating the conduct of thoſe military leaders who, inſtead of ſpending their time and ſtrength in ſieges and ſkirmiſhes, endeavoured to put an end to the war by a general and deciſive action. Theſe polemics reſted the defence of Popery upon preſcription; the wicked lives of Proteſtant princes who had left the church of Rome; the crime of religious ſchiſm; the variety of opinions among Proteſtants with regard to doctrine and diſcipline;

pline; and the uniformity of the tenets and worſhip of the church of Rome. To this claſs belong Nicolle the Janſeniſt doctor, the famous Boſſuet, &c.

II. The *Proteſtant Methodiſts* form a very conſiderable body in this country. The ſect was founded in the year 1729 by one Mr Morgan and Mr John Weſley. In the month of November that year, the latter being then fellow of Lincoln college, began to ſpend ſome evenings in reading the Greek New Teſtament, along with Charles Weſley ſtudent, Mr Morgan commoner of Chriſt church, and Mr Kirkham of Merton college. Next year two or three of the pupils of Mr John Weſley, and one pupil of Mr Charles Weſley, obtained leave to attend theſe meetings. Two years after they were joined by Mr Ingham of Queen's college, Mr Broughton of Exeter, and Mr James Hervey; and in 1735 they were joined by the celebrated Mr Whitefield, then in his 18th year.

At this time it is ſaid that the whole kingdom of England was tending faſt to infidelity. "It is come (ſays Biſhop Butler), I know not how, to be taken for granted by many perſons, that Chriſtianity is not ſo much as a ſubject of inquiry, but that it is now at length diſcovered to be fictitious; and accordingly they treat it as if in the preſent age this were an agreement among all people of diſcernment, and nothing remained but to ſet it up as a principal ſubject of mirth and ridicule, as it were by way of repriſals, for its having ſo long interrupted the pleaſures of the world." The Methodiſts are ſaid, with great probability, to have been very inſtrumental in ſtemming this torrent. They obtained their name from the exact regularity of their lives; which gave occaſion to a young gentleman of Chriſt church to ſay, "Here is a new ſet of *Methodiſts* ſprung up;" alluding to a ſect of ancient phyſicians which went by that name. This extreme regularity, however, ſoon brought a charge againſt them, perhaps not altogether without foundation, of being too ſcrupulous, and carrying their ſanctity to too great a height. In particular it was urged, that they laid too much ſtreſs upon the rubrics and canons of the church, inſiſted too much on obſerving the rules of the univerſity, and took the ſcriptures in too literal a ſenſe; and to the name of *Methodiſts* two others were quickly added, viz. thoſe of *Sacramentarians* and the *Godly Club*.

The principal perſon in this club while in its infancy appears to have been Mr Morgan, and next to him Mr John Weſley. They viſited the ſick, and inſtituted a fund for the relief of the poor; and the better to accompliſh their benevolent deſigns, Mr Weſley abridged himſelf of all his ſuperfluities, and even of ſome of the neceſſaries of life; and by propoſing the ſcheme to ſome gentleman, they quickly increaſed their funds to 80l. *per annum.* This, which one ſhould have thought would have been attended with praiſe inſtead of cenſure, quickly drew upon them a kind of perſecution; ſome of the ſeniors of the univerſity began to interfere, and it was reported "that the college cenſors were going to blow up the Godly Club*." They found themſelves, however, patroniſed and encouraged by ſome men eminent for their learning and virtue; ſo that the ſociety ſtill continued, though they had ſuffered a ſevere loſs in 1730 in the death of Mr Morgan, who had indeed been the founder of it. In the month of October 1735, John and Charles Weſley, Mr Ingham, and Mr Delamotte ſon to a merchant in London, embarked for Georgia along with Mr Oglethorpe, afterwards General Oglethorpe. The deſign of this voyage was to preach the goſpel to the Indians. By this time, however, it appears that Mr Weſley had embraced ſuch notions as may without the leaſt breach of charity be accounted fanatical. Thus in a letter to his brother Samuel, he conjures him to baniſh from his ſchool "the claſſics with their poiſon, and to introduce inſtead of them ſuch Chriſtian authors as would work together with him in "building up his flock in the knowledge and love of God."

During the voyage ſuch a profuſion of worſhip was obſerved, as we cannot help thinking ſavoured more of a Phariſaical than Chriſtian behaviour; an account of which, as a ſimilar ſtrictneſs would certainly be inculcated upon the diſciples, and conſequently muſt give a juſt idea of the principles of the early Methodiſts, we ſhall here tranſcribe from Mr Weſley's life. "From four in the morning till five, each of us uſed private prayer; from five to ſeven we read the Bible together, carefully comparing it (that we might not lean to our own underſtandings) with the writings of the earlieſt ages; at ſeven we breakfaſted; at eight were the public prayers; from nine to twelve learned the languages and inſtructed the children; at twelve we met to give an account to one another what we had done ſince our laſt meeting, and what we deſigned to do before our next; at one we dined; the time from dinner to four we ſpent in reading to thoſe of whom each of us had taken charge, or in ſpeaking to them ſeparately as need required; at four were the evening prayers, when either the ſecond leſſon was explained (as it always was in the morning), or the children were catechiſed and inſtructed before the congregation; from five to ſix we again uſed private prayer; from ſix to ſeven I read in our cabin to two or three of the paſſengers, of whom there were about 80 Engliſh on board, and each of my brethern to a few more in theirs; at ſeven I joined with the Germans in their public ſervice, while Mr Ingham was reading between decks to as many as deſired to hear; at eight we met again, to inſtruct and exhort one another; between nine and ten we went to bed, when neither the roaring of the ſea nor the motion of the ſhip could take away the refreſhing ſleep which God gave us."

As they proceeded in their paſſage, this auſterity inſtead of being diminiſhed was increaſed. Mr Weſley diſcontinued the uſe of wine and fleſh; confining himſelf to vegetables, chiefly rice and biſcuit. He ate no ſupper; and his bed having been made wet by the ſea, he lay upon the floor, and ſlept ſoundly till morning. In his Journal he ſays, "I believe I ſhall not find it needful to go to bed, *as it is called*, any more;" but whether this was really done or not, we cannot ſay.

The miſſionaries, after their arrival, were at firſt very favourably received, but in a ſhort time loſt the affections of the people entirely. This was owing to the behaviour of Mr Weſley himſelf, who appeared not only capricious but frequently deſpotic. He particularly gave offence by inſiſting upon the baptiſm of children by immerſion; and his exceſſive auſterity with regard to himſelf did not tend to give his hearers any favourable opinion either of the ſuperior ſanctity or wiſdom of their teacher. At laſt, on account of a difference with Mr Cauſton the ſtorekeeper and chief magiſtrate of Savannah which ended in a law-ſuit, he was obliged to return to England.

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* See *Weſley's Life*, p. 105.

Thus the cauſe of Methodiſm ſeemed to be entirely loſt in Georgia. But Mr Weſley was ſoon ſucceeded by a more popular and ſucceſsful champion, viz. Mr George Whitefield; who having ſpent his time during the voyage in converting the ſoldiers with whom he ſailed, arrived at Savannah in Georgia on the 7th of May 1738. Here he was received by Mr Delamotte, was joined by ſeveral of Mr Weſley's hearers, and became intimate with ſome other miniſters. Mr Ingham had made ſome progreſs in converting a few runaway Creek Indians, who had a ſettlement about four miles from Savannah; but being obliged to return to England in a few months, this deſign was fruſtrated, and the Indians in a few years ſeparated. During the ſhort time that Mr Whitefield reſided at Savannah, he became extremely popular; and indeed the inſtances of his ſucceſs in the way of making converts are very ſurpriſing. However, he was obliged to return to England in the autumn of that year, that he might receive prieſts orders. On his return to America in October 1739, he landed at Philadelphia, and inſtantly began his ſpiritual labours as in other places; being attended with aſtoniſhing ſucceſs not only there but wherever he went. Paſſing through the colonies of Virginia, Maryland, North and South Carolina, the number of converts continually increaſed; but on his arrival at Savannah, he found the colony almoſt deſerted. He now reſumed the ſcheme he had formerly projected of building an Orphan-houſe; and for this he made the firſt collection at Charleſtown in South Carolina, amounting to about 70l. ſterling. His zeal in the cauſe of religion, or of the colony, were not, however, ſufficient to procure him the favour of thoſe in power. On his return to Philadelphia, after a ſhort ſtay at Savannah, the churches were denied him; but he was made ample amends by the ſucceſs which attended his field preachings and private efforts. Religious ſocieties were everywhere ſet up, and many were converted with ſymptoms of enthuſiaſm, different according to their various tempers and conſtitutions. During this excurſion, he was ſo ſucceſsful in his collection for the Orphan-houſe, that on his return to Savannah he brought along with him money and proviſions to the value of 500l. ſterling.

The ſucceſs in Georgia was now greater than ever; but the many charities which it was neceſſary to ſupply, rendered it neceſſary in a ſhort time for him to undertake another journey to Charleſtown. Here his principles met with the greateſt oppoſition. He had loſt the favour of the commiſſary by his field-preaching, and was denied the ſacrament. The oppoſition, however, was altogether fruitleſs; the number of converts increaſed wherever he went, and he now undertook a voyage to New England. In this place alſo the eſtabliſhed clergy were his enemies; but the uſual ſucceſs attended his other endeavours, and procured 500l. more for the uſe of the orphans in Georgia.

From the year 1741 to 1743 America was deprived of Mr Whitefield's preaching, he having ſpent that interval in England; but in 1744 he again ſet out for the weſtern continent. The remarkable ſucceſs which had hitherto attended his labours now ſtirred up many opponents; and theſe had met with the greater ſucceſs, as none of the Methodiſt preachers whom he had left were poſſeſſed of ſuch abilities either to gain the favour of thoſe who heard them, or to defend their doctrines againſt objections. Mr Whitefield's ſucceſs, however, was the ſame as before: he even found means to inſpire the military claſs with ſuch ſentiments of devotion, that Colonel Pepperell could not undertake his expedition againſt Louiſbourg without firſt conſulting Mr Whitefield; and great numbers of New-Englanders went volunteers, confident of victory, in conſequence of the diſcourſes of their teacher.

From the continent of America Mr Whitefield took a voyage to the Bermudas iſlands; and here, as everywhere elſe, he met with the moſt ſurpriſing ſucceſs. Here alſo collections were made for the Orphan-houſe in Savannah, which were tranſmitted to that place.

Suppoſing it to be better for his cauſe to viſit different countries, than to take up a permanent reſidence in one, Mr Whitefield left Bermudas in a few months, and did not return to America till 1751, when the Orphan-houſe was found to be in a very flouriſhing ſituation. After a ſhort ſtay, he ſet ſail again for Britain. Here he remained two years, and then ſet out on another viſit to America, landing at Charleſtown on the 27th of May 1754. His preſence conſtantly revived the ſpirits and cauſe of his party, and added to their numbers wherever he went. Next year he returned to England; but after labouring in the uſual manner, and meeting with the uſual ſucceſs there till the year 1763, he ſet ſail again for America, and arrived at Virginia in the latter end of Auguſt. He now viſited all the colonies, and found that great progreſs had been made in converting the Indians. On his arrival at Georgia, matters were found in a very flouriſhing ſituation, and he received the thanks of the governor and principal people for the great benefit he had been to the colony; which ſhows, that the ſtories which had been ſo induſtriouſly propagated, concerning the avarice of him and other Methodiſt preachers, were, partly at leaſt, unfounded. In 1765 he returned to England; and in 1769 made his ſeventh and laſt voyage to America, landing at Charleſtown on the 30th of November the ſame year. He was ſtill attended with the ſame ſucceſs; and indeed it is impoſſible to read, without admiration, an account of the efforts made by himſelf and Mr Weſley, to propagate their tenets in the different parts of the world.

For a very conſiderable time Mr Whitefield was the only Methodiſt who paid any attention to America; and in that country he was more popular than even in Europe. Towards the end of his life, ſeveral Methodiſts having emigrated from Britain, formed diſtinct ſocieties in New York and Philadelphia. Theſe quickly increaſed in number; and, about the time that the war with Britain began, their numbers amounted to about 3000 in Virginia, Maryland, New York, and Pennſylvania. They would probably have increaſed much more, had it not been for the imprudence of ſome of their preachers, who introduced politics into their diſcourſes, and thus rendered themſelves obnoxious to the people among whom they lived. Among thoſe who hurt the cauſe in this manner was Mr Weſley himſelf, who, by writing a piece entitled *A Calm Addreſs to the American Colonies*, would in all probability have ruined it, had not a gentlemen, with whom he was connected, deſtroyed or ſent back to England the whole impreſſion as ſoon as it arrived in America, ſo that its exiſtence was ſcarce known in that continent. At the concluſion of the war, Dr Coke, who in 1776 had left a curacy in England in order to join Mr Weſley, paid a viſit to his friends in America; though it had been imagined that a total ſeparation had taken place between the American and European Methodiſts. This breach was, however, made up by a manœuvre of Mr Weſley; for no ſooner had the Americans obtained their independence, than he, who had hitherto branded them with the name of *rebels*, ſent a congratulatory letter on their freedom from the "State and the Hierarchy," and exhorting them to "ſtand faſt in that liberty with which God had ſo ſtrangely made them free." To ſhow his zeal in their ſervice ſtill farther, he gave ordination, by laying on of hands, to ſeveral preachers who were to embark for America, and conſecrated Dr Coke one of the biſhops of the Methodiſt Epiſcopal church in that country. He extracted alſo from the liturgy of the Engliſh church one for the American Methodiſts, taking particular care to expunge every expreſſion that had a particular reſpect to the regal authority.

Such proceedings in one who had formerly profeſſed ſuch extraordinary attachment to the Engliſh church, could not but require an apology; and this was accordingly made in a paſtoral letter tranſmitted to the American ſocieties, and addreſſed "to Dr Coke, Mr Aſtbury, and our brethren in North America." In this letter he makes the following defence of his conduct. "Lord King's account of the primitive church convinced me, many years ago, that biſhops and preſbyters are the ſame order, and conſequently have the ſame right to ordain. For many years I have been importuned, from time to time, to exerciſe this right, by ordaining part of our travelling preachers. But I have ſtill refuſed, not only for the ſake of peace, but becauſe I was determined, as little as poſſible, to violate the eſtabliſhed order of the national church to which I belonged. But the caſe is widely different between England and North America. Here there are biſhops who have a legal juriſdiction; in America there are none, neither any pariſh miniſters: ſo that for ſome hundred miles together, there is none either to baptize, or to adminiſter the Lord's ſupper. Here, therefore, my ſcruples are at an end; and I conceive myſelf at full liberty, as I violate no order, and invade no man's right, by appointing and ſending labourers into the harveſt. It has indeed been propoſed to deſire the Engliſh biſhops to ordain part of our preachers for America; but to this I object. 1. I deſired the biſhop of London to ordain only one, but could not prevail. 2. If they conſented, we know the ſlowneſs of their proceedings; but the matter admits of no delay. 3. If they would ordain them now, they would likewiſe expect to govern them; and how grievouſly would that entangle us. 4. As our American brethren are now totally diſentangled, both from the ſtate and the Engliſh hierarchy, we dare not entangle them again either with the one or the other. They are now at full liberty ſimply to follow the ſcripture and the primitive church; and we judge it beſt, that they ſhould ſtand faſt in that liberty wherewith God has ſo ſtrangely made them free."

Dr Coke, on the conſecration of Mr Aſtbury to the office of a biſhop, made another apology. "The church of England (ſays he), of which the ſociety of Methodiſts in general have till lately profeſſed themſelves a part, did for many years groan in America under grievances of the heavieſt kind. Subjected to a hierarchy which weighs every thing in the ſcale of politics, its moſt important intereſts were repeatedly ſacrificed to the ſuppoſed advantages of England. The churches were in general filled with the paraſites and bottle-companions of the rich and great. The humble and moſt importunate entreaties of the oppreſſed flocks, yea the repreſentations of a general aſſembly itſelf, were contemned and deſpiſed. Every thing ſacred muſt bow down at the feet of a party; the holineſs and happineſs of mankind be ſacrificed to their views; and the drunkard, the fornicator, and the extortioner, triumphed over bleeding Zion, becauſe they were faithful abettors of the ruling powers. The memorable revolution has ſtruck off theſe intolerable fetters, and broken the antichriſtian union which before ſubſiſted between church and ſtate. And had there been no other advantage ariſing from that glorious epoch, this itſelf, I believe, would have made ample compenſation for all the calamities of the war; one happy conſequence of which was the expulſion of moſt of thoſe hirelings, who "ate the fat, and clothed themſelves with the wool, but ſtrengthened not the diſeaſed," &c. The parochial churches in general being hereby vacant, our people were deprived of the ſacraments through the greateſt part of theſe ſtates, and continue ſo ſtill. What method can we take in ſo critical a juncture? God has given us ſufficient reſources in ourſelves; and, after mature deliberation, we believe that we are called to draw them forth.

"But what right have you to ordain?" The ſame right as moſt of the churches in Chriſtendom; our ordination, in its loweſt view, being equal to any of the preſbyterian, as originating with three preſbyters of the church of England. "But what right have you to exerciſe the epiſcopal office?" To me the moſt manifeſt and clear. God has been pleaſed to raiſe up, by Mr Weſley, in America and Europe, a numerous ſociety well known by the name of *Methodiſts*. The whole body have invariably eſteemed this man as their chief paſtor under Chriſt. He has conſtantly appointed all their religious officers from the higheſt to the loweſt, by himſelf or his delegate. And we are fully perſuaded there is no church office which he judges expedient for the welfare of the people intruſted to his charge, but, as eſſential to his ſtation, he has power to ordain. "But, do not you break the ſucceſſion?" The uninterrupted ſucceſſion of biſhops is a point that has long been given up by the moſt able Proteſtant defenders of epiſcopacy. Biſhop Hoadley himſelf, in his celebrated controverſy with Dr Calamy, allows it to be unneceſſary. His words are, 'To the 13th queſtion I anſwer, that I think not an uninterrupted line of ſucceſſion of regularly ordained biſhops neceſſary.' He alſo grants the authenticity of the anecdote given us by St Jerome, which informs us, that the church of Alexandria had no regular ſucceſſion from the time of St Mark the evangeliſt, the firſt biſhop of that church, to the time of Dionyſius, a ſpace of 200 years; but the college of preſbyters, on the death of a biſhop, elected another in his ſtead. We are alſo informed, from the epiſtle of St Clement to the Corinthians, written ſoon after the death of St Paul, a writer whoſe works are next in precedence to the canon of ſcripture, and probably written by immediate inſpiration, that the church of Corinth was then governed only by a college of preſbyters. And from the epiſtle of Polycarp to the church of Philippi, written in 116, we alſo find that the Chriſtian Philippians were then governed only by a college of preſbyters. So that the primitive Chriſtians were ſo far from eſteeming the regular ſucceſſion as eſſential to the conſtitution of a Chriſtian church, that, in ſome inſtances, epiſcopacy itſelf was wholly omitted.

Such was the defence urged by Mr Weſley for this extraordinary aſſumption of epiſcopal powers: a conduct, however, of which he afterwards repented, as tending to make a final ſeparation betwixt his followers and the church of England. Yet it does not appear that this had any bad effect on the minds of his American brethren; for Dr Coke, on his arrival on the weſtern continent, found the ſocieties numerous and flouriſhing. His firſt efforts were directed againſt the ſlave trade; and not only the abolition of that traffic, but the releaſe of all thoſe who were actually ſlaves at the time, ſeem to have been his favourite objects. By interfering in this matter, however, perhaps with too much zeal, he involved himſelf in danger. Some riots took place, and a lady offered the mob 50 guineas if they would give the Doctor 100 laſhes. This piece of diſcipline would have been inflicted, had it not been for the interpoſition of a ſturdy colonel; and the Doctor had not only the ſatisfaction of eſcaping the intended puniſhment, but of ſeeing his doctrine ſo far attended to, that ſome ſlaves were emancipated.

Mr Hanſon, in his Memoirs of Mr Weſley, obſerves, that "the coloniſts, in the infancy of Methodiſm, conducted themſelves with more propriety than the Engliſh. There was little or no perſecution, nor any thing like a riot, except in one or two inſtances which have been mentioned as the conſequence of the animadverſions on ſlavery; and even theſe were productive of no miſchief. Not a creature was materially injured; no bones were broken, nor any lives loſt; which was not the caſe in this country. Here many thouſands of innocent people were ſubjected to the groſſeſt indignities, and ſeveral were eventually ſacrificed to the fury of their perſecutors.

"While we commend the Americans for their behaviour in oppoſition to the brutality of Engliſh mobs, it may be proper to inquire into the ſources of this diſtinction. Something of this may have ariſen from ſimilarity of ſentiment. The Americans, from the firſt beginnings of colonization, had been accuſtomed to the doctrines of the old puritans and nonconformiſts, which in many reſpects have a near affinity to the Methodiſtic tenets. The origin of Methodiſm in America was ſeldom, if ever, attended, either under the diſcourſes of Mr Whitefield's or Mr Weſley's preachers, with thoſe ridiculous effects with which it was accompanied in theſe kingdoms. Moſt of the preachers, who went over to the continent, having laboured for ſome years in Europe previous to their having croſſed the water, had exhauſted their wildfire; ſo that their diſcourſes were more ſcriptural and rational than thoſe of the primitive Methodiſts. Another reaſon may be found in the education of the Americans. As a people, they are better cultivated than the body of the Engliſh; they are chiefly compoſed of merchants and a reſpectable yeomanry: and there is but a ſmall proportion of that claſs, ſo ſuperabundant here, which we diſtinguiſh by the name of *mob*.

"The only exception we have heard, to their exemption from the extravagancies which in this country marked the infancy of Methodiſm, is a cuſtom they have introduced in Maryland and Virginia. Frequently, at the concluſion of a ſermon, the whole congregation begin to pray and to praiſe God aloud. The uproar which this muſt create may eaſily be conceived. Some we are told, are great admirers of this ſpecies of enthuſiaſm, in which every man is his own miniſter, and one ſings and another prays, with the moſt diſcordant devotion. But we will not dignify ſuch indecency with ſuch a name. Its proper appellation is *fanaticiſm*. We hope, that, for the future, religion will never appear in this country under ſo odious a form; and greatly is it to be lamented, that, among the friends of Chriſtianity, any ſuch abſurdities ſhould ariſe, to furniſh infidels with occaſions of triumph."

Our author informs us, that the occupation of the Methodiſt preachers in America was very laborious. In the courſe of the day they frequently rode 20 or 30 miles, preaching twice or thrice, and ſometimes to conſiderable congregations. Notwithſtanding this labour, however, few or none of them ever thought of returning to Britain. Several reaſons may be aſſigned for the pleaſure they took in this laborious exerciſe. "Their excurſions (ſays Mr Hanſon) through immenſe foreſts abounding in trees of all ſorts and ſizes, were often highly romantic. Innumerable rivers and falls of water; villas opening to the view, in contraſt with the uncultivated wild; deer now ſhooting acroſs the road, and now ſcouring through the woods, while the eye was frequently relieved by the appearance of orchards and plantations, and the houſes of gentlemen and farmers peeping through the trees; formed a ſcenery ſo various and pictureſque, as to produce a variety of reflection, and preſent, we will not ſay to a philoſophic eye, but to the mind of every reaſonable creature, the moſt ſublime and agreeable images.

"Their worſhip partook of the general ſimplicity. It was frequently conducted in the open air. The woods reſounded to the voice of the preacher, or to the ſinging of his numerous congregations; while their horſes, faſtened to the trees, formed a ſingular addition to the ſolemnity. It was indeed a ſtriking picture; and might naturally impreſs the mind with a retroſpect of the antediluvian days, when the hills and valleys re-echoed the patriarchal devotions, and a Seth or an Enoch, in the ſhadow of a projecting rock, or beneath the foliage of ſome venerable oak, delivered his primeval lectures, and was a "preacher of righteouſneſs to the people."

The American hoſpitality is ſuppoſed by Mr Hanſon to have been another reaſon for the aſſiduity of the Methodiſt teachers, as well as the conſciouſneſs of being well employed, and the ſatisfaction reſulting from conſiderations of public utility. As many of the preachers were men of fervent piety, this reflection would have its full weight; and the inſtruction of the ignorant and the reformation of the profligate would be conſidered as the beſt recompenſe of their labours. Spreading themſelves through the continent, they took in Nova Scotia, Georgia, with the principal places in both Carolinas, Virginia, Maryland, Delaware, Pennſylvania, New Jerſey, and New York; numbering upwards of 43,000 members of their ſociety, excluſive of about 80 itinerants, and a conſiderable number of local preachers, who took no circuits, but aſſiſted occaſionally in the neighbourhood of their reſpective reſidence.

The large and expenſive buildings which the coloniſts have erected for public worſhip, almoſt exceed credibility; and ſeveral colleges are founded for the inſtruction of youth. How far the propoſed plan of uniting genuine religion and extenſive learning will be carried into execution, time only can diſcover. It muſt materially depend on the character of the preſidents and tutors, and the proviſion that ſhall be made for their ſupport. Men of real erudition will never be procured at low ſalaries; and it is in vain to attempt eſtabliſhments of this ſort without a liberal proviſion for the profeſſors in every branch of ſcience. Two of theſe places are called *Cokeſbury* and *Weſley Colleges*. How they are endowed, or whether they propoſe to obtain authority to confer degrees, we are not informed. But perhaps they are rather ſchools than colleges; which indeed is a circumſtance to be wiſhed, as good grammar ſchools are of the utmoſt ſervice to the progreſs of literature.

The great ſucceſs which attended the Methodiſt preachers in America naturally determined Mr Weſley to try the Weſt India iſlands. The Moravians had already attempted to eſtabliſh their principles in ſome of theſe iſlands; and in 1786 ſome preachers were ſent from the Methodiſts in England to the Weſt Indies. In many of theſe they met with ſucceſs. Societies were formed in Barbadoes, St Vincent's, Dominica, St Chriſtopher's, Nevis, Antigua, St Euſtatius, Tortola, and St Croix, amounting in all to near 5000 perſons. At this time the whole number of Methodiſts in America and the Weſt Indies amounted to about 48,302. Theſe ſocieties conſiſted both of whites and blacks: on the continent they were moſtly whites, but in the iſlands negroes. "But it is to be obſerved (ſays Mr Hanſon) that the ſubjection of the negroes, and the obedience in which they are trained, muſt inculcate a docility peculiarly favourable to the purpoſes of a miſſion." Some of the miſſionaries went alſo to St Vincent's, where they met with ſome ſucceſs, and have eſtabliſhed ſome ſchools, in which their children are carefully inſtructed in the principles of religion.

"In January 1789 (ſays our author), Dr Coke paid a viſit to Jamaica, and gave them ſeveral ſermons. As he made but a ſhort ſtay, it could hardly be conſidered as a fair trial. Should a miſſion be eſtabliſhed here, as well as in the other iſlands, which will probably be the caſe, it is hoped it will be the means of correcting one vice at leaſt, and that is duelling; a ſavage relict of Gothic barbarity, by which all the iſlands have for many years been diſtinguiſhed. Perhaps too it will give ſome check to the ſpirit of luxury and diſſipation; and teach the planters, if it be found impracticable to emancipate their ſlaves, at leaſt to treat them with humanity."

It has been debated among the leading men of the Methodiſtical profeſſion, whether the cauſe might not be ſerved by ſending miſſionaries to the Eaſt Indies and to Africa; but theſe projects were dropped, as there was no invitation, nor any proſpect of ſucceſs if it had been adopted. A miſſion has been formed to the new ſettlement called *Kentucky*, on the confines of the Indian territories, near the Miſſiſſippi. The danger of the miſſionaries at the time they undertook this ſervice was certainly very great; yet ſuch was their zeal for the cauſe, that they voluntarily offered themſelves: but we are not yet informed what ſucceſs they have met with.

While Methodiſm was thus making rapid progreſs in America, its teachers were equally indefatigable in Britain. A moſt remarkable particular, however, occurs with regard to Mr Weſley himſelf; for though he had gone to Georgia, as has been already related, to convert the Indians to Chriſtianity, yet on his return to England in 1738, he took it into his head that he, their teacher, was not yet converted: the reaſon was, that he had not the faith of aſſurance. This, however, was not long wanting. He arrived in England on the firſt day of February, and was bleſt with the aſſurance on the ſixth of March following. This was immediately announced to the public; and the conſequence, if we may believe him, was, that God then began to work by his miniſtry, which he had not done before. Being joined by one Kinchin, a fellow of Corpus, they travelled to Mancheſter, Holms Chapel, Newcaſtle in Staffordſhire, and other places, where they preached, exhorted, and converſed on religious ſubjects, in public houſes, ſtables, &c. ſometimes meeting with ſucceſs and ſometimes not. During this peregrination Mr Weſley certainly diſplayed a great deal of ſuperſtition, which we muſt undoubtedly ſuppoſe to have been communicated to his hearers, and to have cauſed them act on many occaſions in a very ridiculous manner. An inſtance follows:—"The next day (ſays he), March 11th, we dined at Birmingham, and, ſoon after we left it, were reproved for our negligence there (in letting thoſe who attended us go without either exhortation or inſtruction) by a ſevere ſhower of hail!" About the latter end of March or beginning of April he and his companion began to pray *extempore*, leaving off entirely the forms of the church of England, to which he had formerly been ſo devoted. The doctrine of inſtantaneous converſion, which his imagination had ſuggeſted to him as a work performed on himſelf, was greedily received by ſome of his hearers; and all the converts to the new doctrine confirmed themſelves, and contributed greatly to perſuade others, by declarations of their *experiences*, as they called them: however

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ever, though a knowledge of the ſaving aſſurance had been given on March 6th, he does not date his converſion ſooner than May 24th of the ſame year.

This new doctrine of an inſtantaneous, and in fact miraculous impulſe, though greatly reliſhed by the enthuſiaſtical part of the ſociety, was very much diſliked by others, particularly Mr Charles Weſley his brother, who warned him of the miſchief he was doing; though he himſelf was ſoon converted, and, what is very aſtoniſhing, two days before John Weſley himſelf. The particulars related of theſe miraculous converſions are truly diſgraceful, and could not but bring into contempt the ſociety which conſiſted of ſuch enthuſiaſts. "Many (ſays Mr Hanſon) are repreſented as falling ſuddenly to the ground, in horror and agony not to be conceived, and riſing again with equal expreſſions of peace and conſolation."—Their converſions were uſually attended with theſe violent ſymptoms; and, for ſeveral years, few meetings occurred where Mr Weſley preſided, without one or more inſtances of the ſame kind. It was not poſſible that ſuch tranſactions ſhould paſs without notice. The confuſion that too often prevailed, the emotions of the perſons affected, and the exultations of the reſt, which were ſeverally animadverted upon, gave great and general offence. Many inſiſted, that it muſt either be occaſioned by the heat of the rooms, and the agitation of the animal ſpirits under diſcourſes of the moſt alarming nature; or that it was mere artifice and hypocriſy.

In the mean time, two of the ſons of a Mrs Hutton in London, happening to become converts to the new doctrine, this lady was ſo much offended, that ſhe wrote to Mr Samuel Weſley, informing him, that ſhe was of opinion his brother John had loſt his ſenſes; and requeſting, that the next time he came to his houſe, he, Mr Samuel, would either confine or convert him. All that could be done, however, to prevent the progreſs of the new doctrine was inſufficient; and the firſt Methodiſt ſociety was formed in London on the firſt of May 1738, when about 50 agreed to meet together once a-week, for free converſation, begun and ended with ſinging and prayer.

All this time, however, it ſeems that the converſion of Mr Weſley was far from being ſo complete as that of many of his hearers. He had preached and converted others, while he himſelf was abſolutely unconverted. The knowledge of the true ſaving faith was only revealed to him on the 6th of March, and he did not experience its power till the 24th of May; and even after this, his doubts and fears were ſtill ſo great, that on the 13th of June he undertook a voyage to Germany, where, in the company of Count Zinzendorff, his faith ſeems to have been thoroughly confirmed.

On Mr Weſley's return, September 16th, 1738, he applied himſelf with the greateſt aſſiduity and ſucceſs to the propagation of his doctrine. Multitudes of converts were made in various parts of the kingdom; and the reproaches poured upon him by his opponents, ſeemed to have rendered his zeal more fervent if poſſible than before. It is remarkable, however, that ſome of his old friends were now ſo much offended with his conduct or his principles, that they abſolutely refuſed to keep company with him. His original plan ſeems to have been, to make an union of clergymen, and diſſeminate his principles by their means. But in this he ſucceeded ſo ill, that in a letter written in 1742, he wiſhed for a clerical aſſiſtant, were he only in deacons orders: but adds, "I know of none ſuch, who is willing to caſt in his lot with us; and I ſcarce expect I ſhall, becauſe I know how faſt they are rivetted in the ſervice of the devil and the world before they leave the univerſity."—Finding at laſt that nothing could be done with them, he was obliged to have recourſe to lay preachers; and eaſily ſelected thoſe who appeared to have the greateſt talents for prayer and exhortation in the private meetings appointed for that purpoſe. Thus he at once raiſed himſelf to be the head of a ſect; as the lay preachers willingly yielded obedience to him who had the advantages of ſuperior learning and abilities, and was beſides in orders as a clergyman; and this obedience he did not fail on every occaſion to exact.

If his doctrine had formerly given offence to the eſtabliſhed clergy, the appointment of lay preachers was reckoned much worſe; and their being appointed without any form of ordination whatever, which almoſt all of them were, ſubjected them to contempt and reproach, which their want of learning, and very often of natural abilities, did not contribute to remove. Thus finding the churches ſhut againſt him and his followers, he was obliged to preach in the fields, and made his firſt eſſay in this way on the ſecond of April 1739, in the neighbourhood of Briſtol; Mr Whitefield having ſet him an example the day before.

The ſucceſs of thoſe ignorant and itinerant preachers, with their abſurd and uncharitable diſcourſes and behaviour, ſo provoked their adverſaries, that a perſecution was ſoon commenced againſt them. Mr Weſley himſelf was calumniated in the harſheſt manner, being ſometimes ſaid to be a Jeſuit, ſometimes an illiterate enthuſiaſt, as the people took it into their heads. Many pretended to anſwer him in writing, without being able to do ſo: the conſequence was, that their deficiency of argument was ſupplied by invective, and the moſt ſcandalous performances made their appearance. Some of the Engliſh clergy ſo far forgot themſelves as to inſtigate the mob againſt them, and the moſt cruel outrages were committed upon them in various places. For ſome time the perſecuted party adhered to the doctrines of paſſive obedience and nonreſiſtance, which their inhuman adverſaries did not fail to take the advantage of.—The leſs they were oppoſed, the more inſolent they became. The Methodiſts were frequently in danger of their lives. Men, women with child, and even children, were knocked down and abuſed with the ſame undiſtinguiſhing fury. Houſes were ſtripped of their furniture, vaſt quantities of furniture carried off, featherbeds cut in pieces and ſtrewed over the ſtreets, ſeveral reputable people were forced into the army, &c. To the diſgrace of magiſtracy alſo it was found, that when application was made to the juſtices of the peace, redreſs was commonly denied; nor was a ſtop put to theſe ſhameful proceedings without a royal mandate for the purpoſe.

From the year 1738 to 1747 Mr Weſley and his itinerants were employed in various parts of England, In 1747 he went over to Dublin, where a ſociety had been formed by one Mr Williams a clergyman.—Here they proved ſo ſucceſsful, notwithſtanding the number of Papiſts, and the violence of their other opponents, that in 1750 they had erected meeting-houſes in every part of the kingdom, and had formed 29 circuits, which employed 67 itinerants, beſides a conſiderable number of local preachers. An invitation was given to Mr Weſley, in 1751, to viſit Scotland, by an officer in quarters at Muſſelburgh. He accordingly took a journey thither the ſame year; but left the place, after preaching in it once or twice. In 1753 he returned to Scotland, and viſited Glaſgow. Societies were at length formed in that city, as well as at Edinburgh, Dundee, Aberdeen, Inverneſs, and a few other places: but his ſucceſs was by no means equal to what it had been in other parts; for in 1790 the number of circuits in Scotland was no more than eight, which were ſupplied by 20 itinerants.

Mr Whitefield, the other great labourer in the vineyard, was equally indefatigable, and probably more ſucceſsful than Mr Weſley. Before entering into orders, he had formed a ſociety of religious perſons at Glouceſter: here he preached his firſt ſermon on the Neceſſity and Benefit of Religious Society; here he became extremely popular, as well as at Briſtol and London, while preparing to ſet ſail for Georgia for the firſt time; and in all places to which he came, large collections were made for the poor. He maintained the ſame doctrine with Mr Weſley as to the new birth; which likewiſe gave offence to the clergy when delivered by him, as it had done with Mr Weſley. In the various intervals of his voyages to America, he employed himſelf with the very ſame aſſiduity in Britain and in Ireland, which we have already taken notice of in the weſtern continent. His ſucceſs was everywhere prodigious. In 1741 he was invited to Scotland, and preached his firſt ſermon there at Dunfermline. From thence he went to Edinburgh, and preached in ſeveral of the eſtabliſhed churches, but differed with Meſſrs Ralph and Ebenezer Erſkine; ſo that he, as well as Mr Weſley, proved unſucceſsful in forming a coalition with any other religious party. In the private way, however, his ſucceſs was very conſiderable, at Edinburgh, Glaſgow, Aberdeen, Dundee, and other places. In 1742 he paid a ſecond viſit to Scotland, and a third one in 1748. In 1751 he viſited Ireland for the firſt time; and preached to great multitudes, without being moleſted, even in places where others had been mobbed. From thence he returned to Scotland the ſame year, and ſpeaks in very favourable terms of the attention the people there paid to their Bibles. In 1752 and 1753 he again viſited the ſame kingdom, and the laſt time diſtinguiſhed himſelf by preaching againſt the playhouſe in Glaſgow. In 1756 he returned; and by his animated diſcourſes at Edinburgh againſt Popery and arbitrary power, was owned to have contributed very much to the increaſe of courage and loyalty in this country. Next year he again viſited the Scottiſh capital during the time that the General Aſſembly ſat, and his ſermons were attended by ſeveral of the members. At Glaſgow he made a large collection for the poor of that city, and from thence took a voyage to Ireland. He was received with the uſual affection by the lower claſſes of Proteſtants; but the Popiſh rabble, exaſperated at his ſucceſs, almoſt murdered him with ſtones. After paſſing through a great part of Ireland, viſiting England and Wales, he paid another viſit to Scotland, where four clergymen now lent him their pulpits. His laſt viſit was in the ſummer of 1758, when his congregations were as large as ever; and it is to his endeavours principally that we are to aſcribe the great number of Methodiſt ſocieties now exiſting in Scotland.

Hiſtory of Methodiſm, &c.

With regard to the religious principles of the Methodiſts, we cannot enter into any particular detail; neither indeed are there any doctrines peculiar to all included under that name, except the ſingle one of univerſal redemption. In March 1741, Mr Whitefield being returned to England, entirely ſeparated from Mr Weſley and his friends, "becauſe he did not hold the decrees."—Here was the firſt breach, which warm men perſuaded Mr Whitefield to make, merely for a difference of opinion. Thoſe indeed who believed univerſal redemption, had no deſire at all to ſeparate: but thoſe who held particular redemption, would not hear of any accommodation, being determined to have no fellowſhip with men that "were in ſuch dangerous errors." So there were now two ſorts of Methodiſts ſo called; thoſe for particular, and thoſe for general, redemption.

Not many years paſſed, before William Cudworth and James Relly ſeparated from Mr Whitefield.—Theſe were properly Antinomians, abſolute avowed enemies to the law of God, which they never preached or profeſſed to preach, but termed all *legaliſts* who did. With them, preaching the law was an abomination. They had nothing to do with the law. They would preach Chriſt, as they called it; but without one word either of holineſs or good works. Yet theſe were ſtill denominated *Methodiſts*, although differing from Mr Whitefield both in judgement and practice, abundantly more than Mr Whitefield did from Mr Weſley.

In the mean time, Mr Venn and Mr Romaine began to be ſpoken of: and not long after Mr Madan and Mr Berridge, with a few other clergymen, who, although they had no connexion with each other, yet preaching ſalvation by faith, and endeavouring to live accordingly, to be Bible Chriſtians, were ſoon included in the general name of *Methodiſts*. And ſo indeed were all others who preached ſalvation by faith, and appeared more ſerious than their neighbours. Some of theſe were quite regular in their manner of preaching: ſome were quite irregular, (though not by choice; but neceſſity was laid upon them, they muſt preach irregularly, or not at all): and others were between both; regular in moſt, though not in all particulars.

In 1762, George Bell and a few other perſons began to ſpeak great words. In the latter end of the year they foretold that the world would be at an end on the 28th of February. Mr Weſley, with whom they were then connected, withſtood them both in public and private. This they would not endure: ſo, in January and February 1763, they ſeparated from him, under the care of Mr Maxfield, one of Mr Weſley's preachers. But ſtill Mr Maxfield and his adherents, Methodiſts.

rents, even the wildeſt enthuſiaſts among them, go under the general name of *Methodiſts*, and ſo bring a ſcandal upon thoſe with whom they have no connexion.

At preſent, thoſe who remain with Mr Weſley are moſtly Church of England men. They love her articles, her homilies, her liturgy, her diſcipline, and unwillingly vary from it in any inſtance. Mean time, all who preach among them declare, *we are all by nature children of wrath*, but *by grace we are ſaved through faith:* ſaved from both the guilt and from the power of ſin. They endeavour to live according to what they preach, to be plain Bible Chriſtians; and they meet together at convenient times, to encourage one another therein. They tenderly love many that are Calviniſts, though they do not love their opinions. Yea, they love the Antinomians themſelves; but it is with a love of compaſſion only, for they hate their doctrines with a perfect hatred; they abhor them as they do hell fire: being convinced nothing can ſo effectually deſtroy all faith, all holineſs, and all good works.

We ſhall conclude this article with the words of Mr Hanſon, which muſt certainly be accounted juſt, whatever objections may be made to ſome parts of the principles or behaviour of the Methodiſts. "If they poſſeſs not much knowledge, which, however, we do not know to be the caſe, it is at leaſt certain, they are not deficient in zeal: and without any paſſionate deſire to imitate their example, we may at leaſt commend their endeavours for the general good. Every good man will contemplate with pleaſure the operation of the ſpirit of reformation, whether foreign or domeſtic; and will rejoice in every attempt to propagate Chriſtianity in the barbarous parts of the world. An attempt which, if in any tolerable degree ſucceſsful, will do infinitely more for their civilization and happineſs, than all the united energies of thoſe boaſted benefactors of mankind, the philoſophic infidels."

The minutes of the laſt conference of the Methodiſts held at Leeds in Auguſt, 1806, repreſent the numbers of that ſociety to be as follows:

In Great Britain, - -	110,803
In Ireland, - -	23,773
Gibraltar, - -	40
Nova Scotia, New Brunſwick, and Newfoundland, - -	1,418
Weſt Indies, whites 1775, coloured people 13,165, - -	14,940
United States, whites 95,628, coloured people 24,316, - -	119,945
Total,	270,919

Methodists (*Methodici*), in the hiſtory of medicine, a ſect of ancient phyſicians, who reduced the whole art of healing to a few common principles or appearances. The Methodiſts were the followers of Theſſalus; whence they were alſo called *Theſſalici*. They were ſtrenuouſly oppoſed by Galen in ſeveral of his writings; who ſcrupled not to aſſert, that the methodical hereſy ruined every thing that was good in the art. According to Quincy, the *Methodiſts* (*Methodici*) are thoſe phyſicians who adhere to the doctrine of Galen, and the ſchools; and who cure with bleeding, purges, &c. duly applied according to the ſymptoms, circumſtances, &c. in oppoſition to empirics and chemiſts, who uſe violent medicines, and pretended ſecrets or noſtrums.

Methuſelah
||
Metre.

METHUSELAH, the ſon of Enoch and father of Lamech, was born in the year of the world 687, begat Lamech in 874, and died in 1656, being the very year of the deluge, at the age of 969, which is the greateſt age that has been attained to by any mortal man upon earth (Gen. v. 21, 22, &c.) According to the text of the ſeptuagint, Methuſelah muſt have lived 14 years after the deluge; and according to other copies, he died ſix years before it: but it is generally agreed on, that theſe copies, as well as the ſeptuagint, are corrupted in this place.

METHYMNA, in *Ancient Geography*, a town of the iſland of Leſbos. It was the ſecond city of the iſland in greatneſs, population, and opulence. Its territory was fruitful, and the wines it produced excellent. It was the native place of Theophraſtus, and of Arion the muſician. When the whole iſland of Leſbos revolted from the power of the Athenians, Methymna alone remained firm to its ancient allies.

METŒCI, a name given by the Athenians to ſuch as had their fixed habitations in Attica, though foreigners by birth. The *metœci* were admitted by the council of Areopagus, and entered in the public regiſter. They differed both from the πολιται and ξενοι; becauſe the *politæ* or "citizens" were freemen of Athens, and the *xeni* or "ſtrangers" had lodgings only for a ſhort time; whereas the *metœci*, though not freemen of Athens, conſtantly reſided upon the ſpot whither they had removed.

METONYMY, in *Rhetoric*, is a trope in which one name is put for another, on account of the near relation there is between them. See Oratory, N° 51.

METOPE, in *Architecture*, is the interval or ſquare ſpace between the triglyphs of the Doric frieze, which among the ancients uſed to be painted or adorned with carved work, repreſenting the heads of oxen or utenſils uſed in ſacrifices.

METOPOSCOPY, the pretended art of knowing a perſon's diſpoſitions and manners by viewing the traces and lines in the face. Ciro Spontoni, who has written expreſsly on metopoſcopy, ſays, that ſeven lines are examined in the forehead, and that each line is conſidered as having its particular planet: the firſt is the line of Saturn, the ſecond of Jupiter, the third of Mars, &c. Metopoſcopy is only a branch of phyſiognomy, which founds its conjectures on all the parts of the body.

METRE, μετρια, in *Poetry*, a ſyſtem of feet of a juſt length.

The different metres in poetry, are the different manners of ordering and combining the quantities, or the long and ſhort ſyllables; thus hexameter, pentameter, iambic, ſapphic verſes, &c. conſiſt of different metres or meaſures. See Hexameter.

In Engliſh verſes, the metres 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, meaſure, by forming ſpondees, &c. of different feet. See Poetry.

METRETES, a Grecian meaſure, containing ſomething more than nine Engliſh gallons. See Measure.

METRICAL verses, are thoſe conſiſting of a determinate number of long and ſhort ſyllables; as thoſe of the Greek and Latin poets.—Capellus obſerves, that the genius of the Hebrew language is incompatible with metrical poetry.

METROCOMIA (from μητηρ *mother*, and κωμη *town* or *village*), a term in the ancient church-hiſtory, ſignifying "a borough or village that had other villages under its juriſdiction."—What a metropolis was among cities, a *metracomia* was among country towns. The ancient *metrocomiæ* had each its choriepiſcopus or rural dean, and here was his ſee or reſidence. See Metropolis and Choriepiscopus.

METRONOMII, the name given by the Athenians to five officers in the city and ten in the *Piræus*, whoſe duty it was to inſpect all ſorts of meaſures except thoſe of corn. The *Piræus* was the greateſt mart in Attica.

METROPOLIS (from μητηρ *mother*, and πολις *city*), the capital of a country or province; or the principal city, and as it were mother of all the reſt.

The term metropolis is alſo applied to archiepiſcopal churches, and ſometimes to the principal or mother-church of a city. The Roman empire having been divided into 13 dioceſes and 120 provinces, each dioceſe and each province had its metropolis or capital city, where the proconſul had his reſidence. To this civil diviſion the eccleſiaſtical was afterwards adapted, and the biſhop of the capital city had the direction of affairs, and the pre-eminence over all the biſhops of the province. His reſidence in the metropolis gave him the title of *metropolitan*. This erection of metropolitans is referred to the end of the third century, and was confirmed by the council of Nice. A metropolitan has the privilege of ordaining his ſuffragans; and appeals from ſentences paſſed by the ſuffragans are preferred to the metropolitan.

Metropolis, in *Ancient Geography*, a town of Acarnania, a little to the ſouth of Stratos.—Another, of Lydia; ſituated between Colophon and Priene, near the Cayſter.—A third, of Phrygia; ſacred to the mother of the gods, who was here worſhipped.—A fourth Metropolis of Eſtiotis, a diſtrict in Theſſaly, to the eaſt of Gomphi, and the laſt town of that diſtrict. *Metropolitæ*, the people.

METULUM, in *Ancient Geography*, a conſiderable city of Liburnia, at the ſiege of which Octavius Cæſar was wounded. Said to be the metropolis, and ſituated on two eminences, interſected by a valley (Appian.) Now generally thought to be *Metling* in Carniola. E. Long. 16. N. Lat. 46. 5.

METZ, an ancient, large, and ſtrong town of France, and capital of the territory of Meſſin, with a citadel and a biſhop's ſee, whoſe biſhop uſed to hold the title of a prince of the empire. The cathedral church is one of the fineſt in Europe, and the ſquare called *Coſlin* and the houſe of the governor are worth ſeeing. The Jews live in a part of the town by themſelves, where they have a ſynagogue. The ſweetmeats they make here are in high eſteem. It is ſeated at the confluence of the rivers Moſelle and Seille. E. Long. 6. 16. N. Lat. 49. 7.

MEVANIA, in *Ancient Geography*, a town of the Ciſapennine Umbria; ſeated at the confluence of the Tina and Clitumnus, on the Via Flaminia, famous for its herds of white cattle brought up there for ſacrifice; the white colour ſaid to be owing to the waters of the Clitumnus (Virgil). Mevania was the country of Propertius. *Mevenates* the people. Now ſaid to be *Bevagna*, in the territory of the Pope.

MEURSIUS, John, a learned and laborious writer, was born at Loſdun, near the Hague, in 1579. He early diſcovered a fondneſs for polite literature and the ſciences; and went to ſtudy law at Orleans with the ſon of Barneveldt, whom he accompanied in his travels. In 1610 he was made profeſſor of hiſtory at Leyden, and afterwards Greek profeſſor. In the following year, the magiſtrates of the United Provinces proved how high their opinion was of his abilities, by fixing on him to write the hiſtory of his country. Meurſius married in the year 1612. His wife, Anna Catherina Bilberbeccia, deſcended from a very ancient and noble family in Angermond a city of Pomerania, poſſeſſed many amiable qualities, and rendered his domeſtic life remarkably happy, while he diſcharged the duties of his profeſſorſhip with an aſſiduity equal to his abilities. At the ſame time the republic of letters did not loſe the advantages to be derived from his labours; for during the fourteen years of his reſidence at Leyden, the works which he publiſhed were more numerous than thoſe which had been preſented to the world by the whole body of profeſſors from the original foundation of the univerſity in 1575.

Meurſius's writings had now ſpread his reputation in every part of Europe; nor was the fame of his diligence and talents as a profeſſor leſs known. In ſo high a rank, indeed, did he ſtand among his literary contemporaries, that Chriſtian IV. king of Denmark conferred on him the place of hiſtoriographer royal, and invited him to undertake the profeſſorſhip of hiſtory and politics in the academy of Sora, which was founded by King Frederick II. although the revival of its honours and dignities may be dated from this period, when it ſeemed to be again founded under the auſpices of Chriſtian IV. Meurſius and his family left Leyden in the year 1635. On his arrival at Sora, he was received with the moſt friendly tokens of regard by his majeſty and the Daniſh nobility, and more particularly by Chancellor Roſenkrantz, on whom he has beſtowed very ample praiſes in one of his letters. Here he reſided, equally beloved and admired, for above twelve years. His pupils were not very numerous, but his exertions never relaxed. Thoſe hours likewiſe which were not devoted to the duties of his profeſſorſhip, he employed in reviſing the works of the ancients and in philological diſquiſitions.

His health did not ſuffer by the intenſeneſs of application, till in the year 1638 he had a violent attack of the ſtone, from which diſorder he had ſuffered ſeverely. In a letter to Voſſius he thus deſcribes his melancholy condition: "The ſtate of my health during the whole of the laſt winter has been truly deplorable. My ſufferings from the ſtone have been really dreadful. I have voided ſo many, that the repeated diſcharges brought on a wound which emitted blood for above four months. I was next attacked by a tertian fever, which increaſed conſtantly, and produced an univerſal laſſitude of body, a dejection of ſpirits, and a total loſs of appetite. But, thank heaven, I have now in ſome meaſure recovered my ſtrength, and gotten the better of theſe complaints." He recovered from this attack; but in the following year the diſorder returned with redoubled violence, and brought on a conſumption which terminated his exiſtence on the 20th day of September 1639. He left behind him a ſon who was named after him, and one daughter.

So mild were the diſpoſitions of Meurſius, that in all his writings he conſtantly avoided literary diſputes. He was ſometimes unavoidably drawn into them; but conſtantly endeavoured to promote a reconciliation rather than widen any breach, by his replies to the attacks of his adverſaries. In his friendſhips he was firm and affectionate. Of his domeſtic life, whatever is known has been gathered from his letters. The ſame eaſy tranquillity ſeems to have attended him in every ſituation. In his family he was particularly fortunate. In his ſon, to whom he gave his own name, he ſeemed to behold his own youth renewed. The ſame application, the ſame eagerneſs in the purſuit of knowledge, marked the conduct of this promiſing young man; who did not long ſurvive his father, but died ſoon after he had recommended himſelf to the notice of the learned world by his publications. They were only three in number; but diſplayed ſo much ſolid learning, that they have been aſſigned to the father, John Meurſius, by l'Abbé Beughem and others. This miſtake was occaſioned as much by the ſimilitude of their names, as by the nature of their works, and their manner of treating philological ſubjects.

His works may be divided into four claſſes, of which each might form a ſeparate volume if they were ever to be republiſhed. Meurſius himſelf indeed, in one of his letters to Voſſius, propoſes ſuch a diviſion. From that epiſtle, and from another which the younger Meurſius ſent to G. I. Voſſius, who ſtrongly adviſed him to republiſh the whole of his father's writings, and from the collections of his poſthumous works which have appeared from Struvius, Groſchupſius, Moller, and ſome others, a catalogue of his works might be formed. Some aſſiſtance will alſo be derived from the indexes publiſhed in their reſpective works, by Hankins, Deſſelius, Wettenius, and Bartholinus. The plan which Meurſius recommends for publiſhing his works, is to inſert in the firſt volume all that he has written relative to Athens; in the ſecond, his hiſtorical pieces; in the third, his miſcellaneous diſſertations; and in the fourth, the various authors which he publiſhed, with his notes and corrections.

A ſcandalous and indecent work, which is entitled *Meurſii elegantiæ Latini ſermonis*, and has *Aloiſiæ Sigeæ Satyræ Sotadicæ* annexed to it, is very falſely attributed to Meurſius; nor indeed are the *Satires* with more reaſon aſſigned to Aloiſia Sigea, who was a Spaniſh lady eminent for her piety and virtue. The real author of theſe infamous productions was Weſtrenius, an advocate at Copenhagen, who probably aſſumed the name of Meurſius, in order to ſhield himſelf from the diſgrace which would naturally have attended the writer of ſuch a performance.

MEW, SEA-MEW, or *Sea-mall.* } See LARUS, ORNI-
Winter Mew, or *Coddy-moddy.* } THOLOGY *Index.*

MEWING, the falling off or change of hair, feathers, ſkin, horns, or other parts of animals, which happens in ſome annually, in others only at certain ſtages of their lives; but the generality of beaſts mew in the ſpring. An old hart caſts his horns ſooner than a young one, which is commonly in the months of February and March, after which they begin to button in March or April: and as the ſun grows ſtrong, and the ſeaſon of the year puts forth the fruits of the earth, ſo their heads grow, and are ſummed full by the middle of June. It is to be obſerved, that if a hart be gelt before he has a head, he will never have any; and if he be gelt after he has a head, he will never caſt his horns; again, if he be gelt when he has a velvet head, it will always be ſo, without fraying or burniſhing.

MEXICO, a province of the Spaniſh empire in America, once a celebrated kingdom, the moſt powerful and civilized in the new world; lying between the 14th and 21ſt degrees of north latitude, and between 91 and 103 degrees weſt longitude; being near 2000 miles in length, and in ſome places 600 miles in breadth.

1
Toltecans the firſt inhabitants.

The Toltecans are the moſt ancient Mexican nation of which we know any thing. They were expelled, as we are told, from their own country (ſuppoſed by Clavigero to have been *Tollan*, to the northward of Mexico) in the year 472; and for ſome time led a wandering life. In whatever place they determined to reſide for any conſiderable time, they erected houſes and cultivated the ground. Thus their migrations were extremely ſlow, and it was not till 104 years after they ſet out that they reached a place about 50 miles to the eaſtward of the city of Mexico, where they ſettled for 20 years, giving to their new place of reſidence the name of *Tollantzinco*. From thence they proceeded about 40 miles farther to the weſt, where they built a city called, from the name of their country, *Tollan*, or *Tula*.

2
Their hiſtory.

After the final ſettlement of the Toltecans, the government was changed into a monarchy. Their firſt king began his reign in 667, and their monarchy laſted 384 years, during which time they reckon juſt eight princes. We are not, however, to imagine that each of their kings lived long enough to make up this ſpace. It was a cuſtom among them that the name of the king ſhould be continued for 52 years, and no longer, from the time he aſcended the throne. If he died within that period, the government was carried on in his name by a regency; if he ſurvived, he was obliged to reſign his authority. During the four centuries that the Toltecan monarchy continued, they had increaſed very conſiderably in number, and had built many cities; but when in the height of proſperity, almoſt the whole nation was deſtroyed by a famine occaſioned by drought; and a peſtilence, probably the conſequence of the former. "According to Torquemada (ſays our author), at a certain feſtival-ball made by the *Toltecans*, the *ſad-looking* devil appeared to them of a gigantic ſize, with immenſe arms, and in the midſt of the entertainment he embraced and ſuffocated them; that then he appeared in the form of a child with a putrid head, and brought the plague; and, finally, at the perſuaſion of the ſame devil, they abandoned the country of Tula."

3 Succeeded by the Chichemecas.

They were ſucceeded by the Chichemecas, a much more barbarous people, who came from an unknown country called *Amaquemecan*, where they had for a long time reſided; but of which no traces of remembrance can be found among any of the American nations known to Europeans; ſo that Clavigero ſuppoſes it muſt have been very far to the northward.

The motive which the Chichemecas had for leaving their own country is not known. They were eighteen months on their journey, and took poſſeſſion of the deſolate country of the Toltecas about an hundred years after the former had left it. They were much more uncivilized than the Toltecans; but, however, had a regular form of monarchical government, and in other reſpects were leſs diſguſting in their manners than ſome of the neighbouring nations. The laſt king who reigned in Amaquemecan before the departure of the Chichemecas, had left his dominions between his two ſons Auchcauhtli and Xolotl, and the latter conducted the new colony. Having proceeded from the ruins of Tula towards Chempoalla and Tepepolio, Xolotl ſent his ſon to ſurvey the country. The prince croſſed the borders of the lakes and the mountains which ſurround the vale of Mexico; then aſcending to the top of a very high one, he viewed the whole country, and took poſſeſſion of it in the name of his father, by ſhooting four arrows to the four winds.

4 Xolotl their firſt king.

Xolotl being informed by his ſon of the nature of the country, choſe for the capital of his kingdom Tenayuca, about ſix miles to the northward of the city of Mexico, and diſtributed his people in the neighbouring territory; but as moſt of them went to the northward, that part obtained the name of the country of the Chichemecas, in diſtinction from the reſt. Here a review of the people was taken, and their number, according to Torquemada, was more than a million.

5 His people civilized by the Toltecans.

Xolotl finding himſelf peacefully ſettled in his new dominion, ſent one of his officers to explore the ſources of ſome of the rivers of the country. While performing this taſk he came to the habitations of ſome Toltecans, who it ſeems had ſtill kept together, and were likely once more to become a nation. As theſe people were not inclined to war, and greatly eſteemed for their knowledge and ſkill in the arts, the Chichemecas entered into a ſtrict alliance with them, and Prince Nopaltzin, who had firſt ſurveyed the country, married a Toltecan princeſs. The conſequence of this alliance was the introduction of the arts and knowledge of the Toltecans among the Chichemecas. Till now the latter had ſubſiſted entirely by hunting, and ſuch fruits and roots as the earth ſpontaneouſly produced. They were clad in the ſkins of wild beaſts, and, like theſe beaſts, they are ſaid to have ſucked the blood of the animals they caught; but after their connection with the Toltecans they began to ſow corn, to learn the art of digging and working metals, to cut ſtones, manufacture cotton, and, in every reſpect, to make great improvements.

6 New inhabitants arrive and obtain ſettlements.

When Xolotl had reigned about eight years in his new territories, an embaſſy of ſix perſons arrived from a diſtant country not far from *Amaquemecan*, expreſſing a deſire of coming with their people to reſide in the country of the Chichemecas. The king gave them a gracious reception, and aſſigned them a diſtrict; and, in a few years after, three other princes, with a great army of Acolhuans, who were likewiſe neighbours of Amaquemecan, made their appearance. The king was at that time at Tezcuco, to which place he had removed his court: and here he was accoſted by the princes, who, in a ſubmiſſive and flattering manner, requeſted him to allow them a place in his happy country, where the people enjoyed ſuch an excellent government. Xolotl not only gave them a favourable reception, but offered them his two daughters in marriage, expreſſing his concern that he had no more, that none might have been excluded from the royal alliance. On the third prince, however, he beſtowed a noble virgin of Chalco, in whom the Toltecan and Chichemecan blood were united. The nuptials were celebrated with extraordinary pomp; and the two nations, after the example of the ſovereigns, continued to intermarry. As the Acolhuans were the more civilized nation of the two, the name of Chichemecas began to be appropriated to the more rude and barbarous part, who preferred hunting to agriculture, or choſe a life of ſavage liberty in the mountains to the reſtraints of ſocial laws. Theſe barbarians aſſociated with the Otomies, another ſavage nation who lived to the northward, occupying a tract of more than three hundred miles in extent; and by their deſcendants the Spaniards were haraſſed for many years after the conqueſt of Mexico.

7 Diviſion of the dominions of Xolotl.

As ſoon as the nuptial rejoicings were over, Xolotl divided his territories into three parts, aſſigning one to each of the princes. Acolhuatzin, who had married his eldeſt daughter, had Azcopazalco, 18 miles to the weſtward of Tezcuco; Chiconquauhtli, who married the other, had a territory named Xaltocan; and Tzontecomatl, who married the lady of inferior rank, had one named Coatlichan. The country continued for ſome time to flouriſh, population increaſed greatly, and with it the civilization of the people; but as theſe advanced, the vices of luxury and ambition increaſed in proportion. Xolotl found himſelf obliged to treat his ſubjects with more ſeverity than formerly, and even to put ſome of them to death.—This produced a conſpiracy againſt him, which, however, he had the good fortune to eſcape; but while he meditated a ſevere revenge on the conſpirators, he was ſeized with the diſtemper of which he died, in the fortieth year of his reign, and in a very advanced age.

8 Nopaltzin the ſecond king.

Xolotl was ſucceeded by his ſon Nopaltzin, who at the time of his acceſſion is ſuppoſed to have been about ſixty years of age. In his time, the tranquillity of the kingdom, which had begun to ſuffer diſturbance under his father, underwent much more violent ſhocks, and civil wars took place. Acolhuatzin, the only one of the three princes who remained alive, thinking the territory he poſſeſſed too narrow, made war upon the lord of a neighbouring province named Tapotzotlan, and deprived him of his territory. Huetzin, ſon to the late Prince Tzontecomatl, lord of Coatlichan, fell in love with the grand-daughter of the queen, a celebrated beauty, but was rivalled by a neighbouring lord, who determined to ſupport his pretenſions by force of arms. Huetzin, however, got the better, defeated and killed his adverſary, and then poſſeſſed himſelf of the lady and his eſtate. This was followed by a rebellion of the whole province of Tollantzinco, ſo that the king himſelf was obliged to take the field. As the rebels were very numerous, the royal army was at firſt defeated; but having at laſt received a ſtrong reinforcement, the rebels were overcome, and their ringleaders ſeverely puniſhed. The king did not long ſurvive the reſtoration of tranquillity to his dominions. He died in the thirty-ſecond year of his reign, and ninety-ſecond of his age, leaving the throne to his eldeſt ſon Tlotzin, who was an excellent prince, and reigned thirty-ſix years.

9
Quinatzin a luxurious prince.

Quinatzin, the ſon and ſucceſſor of Tlotzin, proved a vain and luxurious prince. His acceſſion to the throne was celebrated with much greater pomp than any of his predeceſſors. Xolotl had removed his court from Tenayuca to Tezcuco; but being diſguſted with this laſt place, on account of the conſpiracy formed againſt him there, he had returned to Tenayuca.—There the court continued till the reign of Quinatzin, who removed it back to Tezcuco.

10
Diſturbances in various parts.

The reign of Quinatzin, though tranquil at firſt, was ſoon diſturbed by dangerous revolts and rebellions. Theſe firſt broke out in two ſtates, named Maztillen and Totopec, ſituated among the northern mountains. The king, having collected a great army, marched without delay againſt the rebels, and challenged their leaders to come down and fight him in the plain.—This challenge being accepted, a furious engagement enſued, in which, though great numbers fell on both ſides, no deciſive advantage was gained by either party. Frequent engagements took place for the ſpace of forty days, until at laſt the rebels, perceiving that their own numbers were daily diminiſhing, without any poſſibility of being recruited like the royal army, made a final ſurrender to the king, who puniſhed the ringleaders with great ſeverity. Tranquillity, however, was not yet reſtored: the rebellion ſpread to ſuch a degree, that the king was obliged not only to take the field in perſon, but to employ ſix other armies, under the command of faithful and experienced generals, to reduce the rebels. Thoſe proved ſo ſucceſsful in their enterpriſes, that in a ſhort time the rebellious cities were reduced to obedience, and the kingdom enjoyed the bleſſings of peace during the long reign of Quinatzin, who is ſaid to have ſat on the throne for no leſs than ſixty years. He was ſucceeded by his ſon Techotlatla; but as the affairs of the Acolhuans now began to be connected with thoſe of the Mexicans, it will be proper to give ſome account of that people.

11
Migrations of the Mexicans.

The Mexicans, called alſo the Aztecas, dwelt till the year 1160 in a country called *Aztlan*, ſituated to the north of the gulf of California, as appears by the route they purſued in their journey; but how far to the northward we are not certainly informed. Betancourt makes it no leſs than 2700 miles, and Boturini ſays it was a province of Aſia. The cauſe of their migration is ſaid to have been as follows:

Among the Aztecas was a perſon of great authority, named *Huiztilin*, to whoſe opinion every one paid the utmoſt deference. He had conceived a deſign to perſuade his countrymen to change their reſidence; and to effect this he fell upon the following ſtratagem. Having heard, while meditating on his ſcheme, a little bird ſinging on the branches of a tree, the notes of which reſembled the word *Tihui*, which in the Azteca language ſignified "let us go," he took that opportunity to work upon the ſuperſtition of the people. With this view, he took along with him a reſpectable perſon, and made him attend to the note of the bird. "What can it mean (ſays he), but that we muſt leave this country, and find ourſelves another? Without doubt it is the warning of ſome ſecret divinity who watches over our welfare: let us obey, therefore, his voice, and not draw his anger upon us by a refuſal." Tecpaltzin, for that was the name of his friend, readily agreed to the interpretation; and both of them being perſons of great influence, their united perſuaſions ſoon gained over to their project the bulk of the nation, and they accordingly ſet out.

12
Separation of the tribes.

The Aztecas, when they left their original habitations, were divided into ſix tribes; but at Culiacan the Mexicans were left with their god * by five of them, viz. the Xochimilcas, Tepanecas, Chalceſe, Tlahuicas, and Tlaſcalans. The cauſe of this ſeparation is not known, but it was probably occaſioned by ſome diſagreement among themſelves; for the remaining tribe was divided into two violent factions, which perſecuted one another: neither did they afterwards conſtruct any more edifices. However, they always travelled together, in order to enjoy the company of their imaginary god. At every place where they ſtopped an altar was erected to him; and at their departure they left behind them all their ſick, and probably alſo ſome others to take care of them, or ſuch as were not willing to endure the fatigue of farther journeys. They ſtopped in Tula nine years, and eleven more in the neighbouring parts. At laſt, in 1216, they arrived at Zumpanco, a conſiderable city in the vale of Mexico, where they were received in a very hoſpitable manner by the lord of that diſtrict. He not only aſſigned them proper habitations, but became very much attached to them; and even demanded from among them a wife for his ſon Ilhuicatl. This requeſt was complied with; and from this marriage all the Mexican kings deſcended.

13
The Mexicans perſecuted,

The Mexicans continued to migrate from one place to another along the lake of Tezcuco. Xolotl, who was then on the throne of the Acolhuans or Chichemecas, allowed them to ſettle in whatever places of his dominions they thought proper; but ſome of them finding themſelves haraſſed by a neighbouring lord, were obliged, in 1245, to retire to Chapoltepec, a mountain on the weſtern borders of the lake, ſcarcely two miles diſtant from the ſite of Mexico. This took place in the reign of Nopaltzin, when diſturbances began to take place in the Acolhuan dominions. The Mexicans, however, did not find themſelves any more ſecure in their new place of reſidence than formerly: they were perſecuted by the neighbouring lords, and obliged to take refuge in a number of ſmall iſlands, named *Acocolco*, at the ſouthern extremity of the lake of Mexico. Here for 52 years they lived in the moſt miſerable manner, ſubſiſting on fiſh, inſects, roots, &c. and clothing themſelves with the leaves of the amoxtli, which abounds in that lake.

14
and enſlaved.

In this miſerable plight the Mexicans continued till the year 1314, when they were reduced to a ſtate of the moſt abſolute ſlavery. This was done by the king of a petty ſtate named Colhuacan, who, it is ſaid, being unwilling to allow the Mexicans to maintain themſelves in his territories without paying tribute, made war upon them, ſubdued and enſlaved them. Others affirm that, pretending compaſſion for their miſerable ſituation, he offered them a more commodious place of reſidence. The Mexicans readily accepted the offer; but had ſcarcely ſet out to take poſſeſſion of their new place of reſidence when they were attacked by the Colhuans, made priſoners, and carried off for ſlaves.

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* *A wooden image.*

15
Regain their liberty by cruelty.

After ſome years a war broke out betwixt the Colhuans and Xochimilcas, in which the latter gained ſuch advantages, that they were obliged to employ their ſlaves to aſſiſt them. They accordingly ordered them to prepare for war, but without furniſhing them with arms neceſſary for a military enterpriſe; ſo that the Mexicans were obliged to content themſelves with long ſtaves, having their points hardened in the fire; they alſo made knives of the ſtone itztli, and ſhields of reeds woven together. They agreed not to waſte their time in making priſoners, but to content themſelves with cutting off one ear of their enemies, and then leaving them without farther injury. They adhered punctually to this reſolution; and ruſhing furiouſly upon the Xochimilcas, cut off an ear from as many as they could, killing thoſe who ſtruggled to ſuch a degree that they could not effect their purpoſe. In ſhort, ſo well did the Mexicans acquit themſelves in this engagement, that the Xochimilcas fled, and took refuge among the mountains. After the battle, the Colhuan ſoldiers preſented themſelves before their general with the priſoners they had taken, by the number of which alone they judged of their valour. The Mexicans had taken only four, and theſe they kept concealed for the abominable purpoſe of ſacrificing them. The Colhuans, therefore, ſeeing no trophies of their valour, began to reproach them with cowardice; but the Mexicans, producing their baſkets of ears, deſired them to judge from theſe how many priſoners they might have taken, had they not been unwilling to retard their victory by taking up time in binding them.

16
The firſt human ſacrifice in Mexico.

Notwithſtanding the valour diſplayed by the Mexicans in this engagement, it doth not appear that their haughty maſters were in the leaſt inclined to afford them eaſier terms than before. Having erected an altar to their god, they demanded of their lord ſomething precious to offer in ſacrifice to him; but he in diſdain ſent them a dirty cloth, encloſing the filthy carcaſs of a vile bird. This was carried by Colhuan prieſts; and without any ceremony laid upon the altar. The Mexicans, with apparent unconcern, removed this filthy offering, and put in its place a knife made of itztli, and an odoriferous herb. On the day of conſecration, the Colhuan prince attended with his nobility; not with a view to do honour to the feſtival, but to make a mockery of the Mexicans. Their deriſion, however, was ſoon changed into horror, when the Mexicans, after a ſolemn dance, brought forth the four Xochimilcan priſoners they had taken; and, after having made them dance a little, cut open their breaſts with the knife which lay on the altar, and plucking out their hearts, offered them, while yet palpitating with life, to their diabolical idol. This had ſuch an effect upon the ſpectators, that both king and ſubjects deſired the Mexicans immediately to quit their territories and go where they pleaſed. This order was inſtantly obeyed: the whole nation took their route towards the north, until they came to a place named *Acatzitzintlan*, ſituated betwixt two lakes, and afterwards named *Mexicaltzinco;* but for ſome reaſon or other, being diſcontented with this ſituation, as indeed they ſeem very often to have been, they proceeded to *Iztacalco*, ſtill nearer to the ſite of Mexico. Here they formed the image of a little mountain of paper, and danced round it a whole night, ſinging their victory over the Xochimilcas, and returning thanks to their god for having freed them from the yoke of the Colhuans. Clavigero is of opinion, that by this mountain they repreſented Colhuacan, as in their pictures it was always repreſented by a hunch-backed mountain; and this is the literal ſignification of the name.

17
The city of Mexico founded.

The city of Mexico was founded in the year 1325, in the moſt incommodious ſituation we can imagine, viz. on a ſmall iſland named Tenochtitlan, in the middle of a great lake, without ground to cultivate for their ſubſiſtence, or even room ſufficient to build their habitations. Their life was therefore as miſerable here for ſome time as it had been when they were on the iſlands at the end of the lake, and they were reduced to the ſame ſhifts to maintain themſelves. To enlarge the boundaries of their iſland, they drove paliſades into thoſe parts of the water which were moſt ſhallow, terracing them with ſtones and turf, and uniting to their principal iſland ſeveral other ſmaller ones which lay in the neighbourhood. To procure to themſelves afterwards ſtones, wood, &c. for conſtructing their habitations, as well as clothing and other neceſſaries, they inſtituted a commerce with the people who dwelt on the borders of the lake, ſupplying them with fiſh, waterfowl, and other more minute inhabitants of the lake and marſhes, which they contrived to render eatable; and in return for all this they received the neceſſaries above mentioned. The greateſt effort of their induſtry, however, was the conſtruction of floating gardens, by means of buſhes and the mud of the lake; and theſe they brought to ſuch perfection that they produced maize, pepper, chia, French beans, and gourds.

18
The two factions ſeparate.

For thirteen years that the Mexicans had to ſtruggle with extreme difficulty, they remained at peace; but no ſooner did they begin to proſper and live comfortably, than the inveterate enmity betwixt the two factions broke out in all its fury. This produced a ſeparation; and one of the parties took up their reſidence on a ſmall iſland at a little diſtance to the northward, which, from a heap of ſand found there, they at firſt named *Xaltilolco*, but afterwards *Tlatelolco*, from a terrace conſtructed by themſelves. This iſland was afterwards united to that of Tenochtitlan.

19
Monſtrous barbarity of their religion.

About this time the Mexicans divided their city into four parts, a diviſion which ſtill ſubſiſts; each quarter having now its tutelar ſaint, as it had formerly its tutelar god. In the midſt of their city was the ſanctuary of their great god *Mexitli*, whom they conſtantly preferred to all the reſt. To him they daily performed acts of adoration: but inſtead of making any progreſs in humanity, they ſeem to have daily improved in the moſt horrible barbarities, at leaſt in their religion. The dreadful ſacrifices made of their priſoners, could only be exceeded by that which we are now about to relate. Being now on a more reſpectable footing than formerly, they ſent an embaſſy to the petty king of Colhuacan, requeſting him to ſend them one of his daughters, that ſhe might be conſecrated the mother of their protecting god. The unſuſpecting prince readily complied with their deſire.—The unfortunate princeſs was conducted in great triumph to Mexico; but no ſooner was ſhe arrived, than ſhe was ſacrificed in a ſhocking manner; and, to add to the horror of the deed, the body was flayed, and one of the braveſt young men of the nation dreſſed in her ſkin. Her father, ignorant of this dreadful tranſaction, was invited by the Mexicans to be preſent at the apotheoſis of his daughter, and went to ſee the ſolemnity, and to worſhip the new divinity. He was led into the ſanctuary, where the young man ſtood clothed in the bloody ſkin of his daughter; but the darkneſs of the place prevented him from ſeeing what was before him. They gave him a cenſer in his hand, and ſome copal to begin his worſhip; but having diſcovered by the flame of the copal the horrible ſpectacle, he ran out in a diſtracted manner, calling upon his people to revenge the injury; but this they were not able to do at that time nor ever after.

20
Acamapitzin the firſt king of Mexico.

In the year 1352 the Mexican government was changed from an ariſtocracy to a monarchy. At firſt they were governed by 20 lords, of whom one had an authority ſuperior to the reſt. This naturally ſuggeſted the idea of monarchy; and to this change they were alſo induced by the contemptible ſtate in which their nation ſtill continued, thinking that the royal dignity would confer upon it a degree of ſplendour which otherwiſe it could not enjoy; and that by having one leader, they would be better able to oppoſe their enemies. Proceeding, therefore, to elect a king, the choice fell upon Acamapitzin, a man of great eſtimation among them, and deſcended from Opochtli, a noble Aztecan, and a princeſs of the royal family of Colhuacan. As he was yet a bachelor, they attempted to negociate a marriage, firſt with the daughter of the lord of Tacuba, and then of the king of Azcapozalco: but theſe propoſals being rejected with diſdain, they applied to Acolmiztli lord of Coatlichan, and a deſcendant of one of the three Acolhuan princes; who complied with their requeſt, and the nuptials were celebrated with great rejoicings.

21
The Tlatelolcos alſo chooſe a king.

In the mean time, the Tlatelolcos, the natural rivals of the Mexicans, reſolved not to be behind them in any thing which had the leaſt appearance of augmenting the glory of their ſtate. They likewiſe, therefore, choſe a king; but not thinking proper to chooſe him from among themſelves, they applied to the king of the Tepanecas, who readily ſent them his ſon; and he was crowned firſt king of Tlatelolco in 1353. In this the Tlatelolcos ſeem to have had a deſign of humbling their rivals, as well as rendering themſelves more reſpectable; and therefore it is probable, that they had repreſented the Mexicans as wanting in that reſpect due to the Tepanecan monarch, as having elected a king without his leave, though at the ſame time they were tributaries to him. The conſequence of this was, that he took a reſolution to double their tribute. Hitherto they had paid only a certain number of fiſh and water-fowl; but now they were ordered to bring alſo ſeveral thouſands of fir and willow plants to be ſet in the roads and gardens of Azcapozalco, and to tranſport to the court a great floating garden, which produced vegetables of every kind known in Anahuac. This being accompliſhed with great difficulty, the king commanded them next year to bring him another garden, with a duck and ſwan in it both ſitting upon eggs; but ſo, that on their arrival at Azcapozalco the brood might be ready to hatch. This was alſo done; and the prince had the ſatisfaction of ſeeing the young birds come out of the eggs. The third year they were ordered to bring a live ſtag along with a garden. This was more difficult than any of the former taſks; becauſe they were obliged, in order to hunt the ſtag, to go to the mountains of the continent, where they were in danger of falling into the hands of their enemies; however, this alſo was accompliſhed, and the deſire of the king gratified.

22
Mexicans oppreſſed.

In this manner the Mexicans were oppreſſed for no leſs than 50 years. They freed themſelves, however, from all their difficulties by vigorous exertions, abſurdly aſcribing to the protection of that malevolent being whom they worſhipped the glory of every deliverance. Acamapitzin governed this city, which at that time comprehended the whole of his dominions, for 37 years in peace. His queen being barren, he married another wife, but without abandoning the firſt; and theſe two, inſtead of being rivals to one another, lived together in the utmoſt harmony; the firſt wife taking upon herſelf the charge of educating *Huitzilihuitl*, the ſon of the ſecond. He had, beſides, ſeveral children by other women, and one named *Itzcoatl*, who afterwards proved one of the beſt and moſt renowned kings who ſat on the throne of Mexico. He is ſaid alſo to have conquered four conſiderable cities; but Clavigero thinks he muſt in this only have been an auxiliary, it being very improbable, that while he could ſcarce maintain his own territories, he ſhould think of foreign conqueſts.

23
Huitzilihuitl the ſecond king.

Acamapitzin died in 1389, greatly lamented by the Mexicans, and his death was followed by an interregnum of four months. As the deceaſed monarch had formally reſigned his authority into the hands of his nobles, it was neceſſary that a new election ſhould take place; and when this was done, the choice fell upon Huitzilihuitl, the ſon of Acamapitzin. As he was ſtill unmarried, it was reſolved, if poſſible, to procure him an honourable and advantageous match. With this view, a deputation of nobility was ſent to the king of Azcapozalco, requeſting, in very humble terms, an alliance with one of his daughters. The expreſſions made uſe of by theſe ambaſſadors are ſaid by our author to have been particularly elegant in the Mexican language: but it is difficult to underſtand how a ſpeech made among a people ignorant of the art of writing could be particularly recorded at the interval of ſome hundreds of years after. They are as follow: "We beſeech you, with the moſt profound reſpect, to take compaſſion on our maſter and your ſervant Huitzilihuitl, confined among the thick ruſhes of the lake.—He is without a wife, and we without a queen.—Vouchſafe, Sir, to part with one of your jewels or moſt precious feathers. Give us one of your daughters, who may come to reign over us in a country which belongs to you."

24
Marries a daughter of the king of the Tepanecans.

This piece of oratory had ſuch an effect upon the king, that he granted their requeſt, and a Tepanecan princeſs was conducted in great triumph to Mexico, where the marriage was ſolemnized with the utmoſt joy. Though this princeſs brought him a ſon the firſt year of their marriage, the king, in order to ſtrengthen himſelf by freſh alliances, married alſo the daughter of another prince, by whom he had Montezuma *Ilhuicamina*, the moſt celebrated of all the Mexican kings.

As the Mexicans advanced in wealth and power, ſo did their rivals the inhabitants of Tlatelolco.—Their firſt king died in 1399, leaving his ſubjects greatly improved in civilization, and the city much enlarged and beautified. The rivalſhip which ſubſiſted between the two cities had indeed greatly contributed to the aggrandizement of both. The Mexicans had formed ſo many alliances by marriage with the neighbouring nations, had ſo much improved their agriculture and floating gardens on the lake, and had built ſo many more veſſels to ſupply their extended commerce and fiſhing, that they were enabled to celebrate their ſecular year, anſwering to A. D. 1402, with greater magnificence than they had ever done ſince they left their original country of Atztlan.

25
Unfortunate reign of Techotlala's ſon.

All this time Techotlala, the ſon of Quinatzin, continued to reign in Acolhuacan, and for 30 years enjoyed uninterrupted tranquillity; but being now very far advanced in years, and finding his end approach, he called to him his ſon Ixtlilxochitl, and recommended to him to beware of the ambitious diſpoſition of the king of Azcapozalco, as he was apprehenſive that he might attempt ſomething againſt the peace of the empire. His ſuſpicions were verified; for on the death of Techotlala, which happened in 1406, the king of Azcapozalco, without making the uſual ſubmiſſions to the new king, to whom he was a feudatory, ſet out for his own territories, with a view to ſtir up the other feudatory princes to rebellion. Having called to him the kings of Mexico and Tlatelolco, he told them, that Techotlala, who had long tyrannized over that country, being dead, he deſigned to procure freedom to the princes, ſo that each might rule his own territory entirely independent of the king of Acolhuacan; but for this purpoſe he needed their aſſiſtance, and truſted to their well-known ſpirit to take part with him in the enterpriſe. He informed them likewiſe, that in order to enſure ſucceſs, he would find means to unite other princes in the confederacy.

The new king of Acolhuacan, in the mean time, was employed in ſettling the affairs of his kingdom, and endeavouring to gain the good will of his ſubjects. The combination againſt him was ſoon diſcovered: but though Ixtlilxochitl was deſirous of heading his army in perſon, he was diſſuaded from ſo doing by his courtiers; ſo that the conduct of the war was committed to his generals. To weaken the enemy, they ravaged the territories of ſix revolted ſtates: but, notwithſtanding this, and the ſuperior diſcipline of the royal army, the war was carried on by the rebels with great obſtinacy, their armies being conſtantly recruited by freſh troops in proportion to their loſſes. At laſt, after three years of a ruinous war, the king of Azcapozalco, finding that his reſources would at laſt fail him, ſued for peace; but with a deſign of accompliſhing by treachery what he had not yet been able to do by force. His adverſary, equally reduced with himſelf, conſented to a peace, though he knew very well that the Tepanecan prince intended to obſerve it no longer than ſuited his purpoſe.

26
Chimalpopoca third king of Mexico.

In the year 1409 died Huitzilihuitl king of Mexico, who likewiſe left the right of electing a ſucceſſor to the nobility. They made choice of his brother Chimalpopoca; and from thence it became an eſtabliſhed law to chooſe one of the brothers of the deceaſed king, or, if he had no brothers, to elect one of his grandſons. While the new prince was endeavouring to ſecure himſelf on the throne, the treacherous Tezozomoc uſed all means in his power to ſtrengthen the party he had formed againſt the king of Acolhuacan. In this he was attended with ſuch ſucceſs, that the unfortunate prince found himſelf reduced to the neceſſity of wandering among the neighbouring mountains, at the head of a ſmall army, accompanied by the lords of Huexotla and Coatlichan, who remained always faithful to him. The Tepanecans diſtreſſed him to ſuch a degree, by intercepting his proviſions, that he was forced to beg them of his enemies. One of his grandſons was ſent to Otompan, a rebel ſtate, to requeſt them to ſupply their king with the proviſions he ſtood in need of, and to exhort them to abandon the cauſe of the rebels, which they had eſpouſed. No taſk could be more dangerous; yet ſuch was the magnanimity of the young prince's diſpoſition, that he readily ſet out on the journey; nor was he deterred by the information he got that there were in the place certain Tepanecans who had come on purpoſe to publiſh a proclamation from Tezozomoc. He went boldly to the moſt public place of the town, and in preſence of thoſe who publiſhed the proclamation made known his requeſt. This heroiſm, however, did not meet with the ſucceſs it deſerved. His propoſitions were derided from the moment they were made; but the people did not offer any farther inſult, until one of the meaner ſort threw a ſtone at him, exciting others of the ſame ſtamp to put him to death. The Tepanecans, who had hitherto continued ſilent, perceiving their opportunity, joined in the general cry to kill the prince, and began alſo to throw ſtones. The prince attempted firſt to defend himſelf, and afterwards to eſcape by flight; but, both being equally impoſſible, he fell under a ſhower of ſtones. The Tepanecans exulted in this act of treachery, and ſoon after cut off Ixtlixochitl himſelf, after having treacherouſly perſuaded him to a conference with two of their captains. This perfidious act was committed in ſight of the royal army, who were too weak to revenge it; the royal corpſe was ſaved with difficulty; and *Nezahualcojotl*, heir apparent to the crown, was obliged to ſhelter himſelf among the buſhes from the fury of his enemies.

27
Diſtreſs and death of the king of Acolhuacan.

28
Acolhuacan conquered by Tezozomoc.

Tezozomoc having now in a great meaſure gained his point, proceeded to pour down his troops upon thoſe cities and diſtricts which had remained faithful to the late unfortunate monarch. The people made a moſt deſperate defence, and killed vaſt numbers of their enemies; but at laſt being themſelves reduced by the calamities of war, and in danger of total extermination, they were obliged to quit their habitations and fly to other countries. The tyrant, then, finding himſelf ſuperior to all his adverſaries, gave Tezcuco in fief to Chimalpopoca king of Mexico, Huexotla to Tlacacotl king of Tlatelolco; placing faithful governors in other places, and appointing Azcapozalco, the capital of his own territory, the royal reſidence and capital of Acolhuacan.

Prince Nezahualcojotl was preſent in diſguiſe at this diſpoſal of his dominions, along with ſeveral other perſons of diſtinction who were enemies of the tyrant; and ſo much was he tranſported with paſſion, that it was with difficulty he could be reſtrained from killing Tezozomoc on the ſpot, though this would certainly have been done at the expence of his own life. All the reſt of the Acolhuacan empire ſubmitted; and Nezahualcojotl ſaw himſelf for the preſent deprived of all hopes of obtaining the crown.

29
His tyranny and death.

Tezozomoc had now attained the ſummit of his ambition: but inſtead of conciliating the minds of his new ſubjects, oppreſſed them with new taxes; and being conſcious of the precarious ſituation in which he ſtood, and tormented with remorſe on account of his crimes, fell into melancholy, and was conſtantly haunted with frightful dreams. He was now become ſo old, that his body no longer retained its natural heat. He was therefore obliged to be covered up with cotton in a great cradle, not being able to ſit erect in a chair. In this miſerable condition, however, he never forgot his tyranny or cruelty. From his cradle he iſſued oppreſſive laws relating to the Acolhuacans; and almoſt with his laſt breath renewed his commands with regard to Nezahualcojotl. At laſt he expired in the year 1422, leaving the crown to his ſon Tajatzin.

30
The throne uſurped by Maxtlaton.

31
Tajatzin murdered.

Tezozomoc was no ſooner dead than Maxtlaton, without paying the leaſt regard to his father's will, began to exerciſe the functions of a ſovereign. Though it was the right of Tajatzin to invite to his father's funeral whom he pleaſed, Maxtlaton took that upon himſelf. Nezahualcajotl, though not invited, came among the reſt; but though Teuctzintli, brother to Maxtlaton, inſiſted upon his being put to death, the latter oppoſed it, as it could not then be done privately, and he hoped to find another opportunity. No ſooner were the funeral ceremonies over, however, than Maxtlaton behaved in ſuch a manner to his brother Tajatzin, that the prince thought proper to retire to Chimilpopoca king of Mexico, to whom he had been particularly recommended by his father, in order to have his advice. This monarch, agreeable to the character of that age and people, adviſed him to invite his brother to an entertainment, and then murder him. Unluckily for them both, this diſcourſe was overheard by a ſervant, who in expectation of a reward informed the tyrant of what he had heard: but inſtead of this, Maxtlaton, pretending to diſbelieve his ſtory, drove the informer from his preſence with ignominy. Notwithſtanding this pretence, the tyrant had not the leaſt doubt of the truth of what was told him; and therefore determined to rid himſelf of his brother without delay. This he ſoon accompliſhed in the very ſame way that had been projected againſt himſelf. Tajatzin, along with the kings of Mexico, Tlatelolco, and ſome other feudatory princes, were invited by Maxtlaton to an entertainment. The king of Mexico prudently excuſed himſelf, but the unſuſpecting Tajatzin fell into the ſnare. He came to the place of entertainment, and was inſtantly put to death. The company were greatly alarmed; but Maxtlaton, having explained to them his reaſons for ſo doing, they not only excuſed him, but proclaimed him king; to which it is not to be doubted that their fears greatly contributed.

32
Miſerable fate of the king of Mexico.

Though the king of Mexico eſcaped a ſudden death by his abſence at this time, it was only to periſh in a more ſlow and ignominious manner. The vengeance of Maxtlaton firſt appeared by ſending him a woman's dreſs in return to the preſent he ſent him as a feudatory; which being a reflection upon his courage, was the higheſt affront that could be offered him. This inſult, however, was quickly followed by one of a much higher nature. Having heard that one of the Mexican prince's wives was an extraordinary beauty, he enjoined ſome Tepanecan ladies, who were accuſtomed to viſit that princeſs, to invite her to ſpend ſome days with them at Azcapozalco. This being complied with, the tyrant eaſily got an opportunity of raviſhing her, and then ſent her back to her huſband. Chimilpopoca was ſo much affected by this misfortune, that he reſolved to offer himſelf up a ſacrifice to his god. Maxtlaton, however, was reſolved that he ſhould not have even this ſatisfaction. At the very time of the ceremony, therefore, he ſent a body of troops; who entering Mexico without reſiſtance, carried off the king alive, to the aſtoniſhment of the multitude; and who probably were ſo much confounded by this unexpected adventure, that they did not think of making any reſiſtance.

33
He is viſited in priſon by Nezahualcojotl.

Chimilpopoca being carried priſoner to Azcapozalco, was confined in a ſtrong wooden cage, the common priſon for criminals. Maxtlaton ſtill was not ſatiſfied: he wiſhed to get into his hands Nezahualcojotl; and with this view ſent a meſſage to him, pretending that he was willing to come to an agreement with him reſpecting the kingdom of Acolhuacan. Though the prince was well aſſured of the tyrant's treacherous intentions, he went boldly to his palace, preſented himſelf before him, and told him that he had heard of the impriſonment of the king of Mexico; he had heard alſo that he wiſhed to take away his own life; he deſired him to do ſo, and to gratify his malice. Maxtlaton was ſo ſtruck with this ſpeech, that he aſſured the prince he had not formed any deſign againſt his life, and that he neither had put to death the king of Mexico, nor would do ſo. He then gave orders for his being properly entertained, and even allowed him to pay a viſit to the king of Mexico in priſon. The unfortunate Chimilpopoca, after reciting his misfortunes, requeſted the prince not to return to court, where they would certainly fall upon ſome project for taking away his life; and having pathetically recommended to him the care of his ſubjects, made him a preſent of a gold pendant and ſome other jewels he wore; after which they took a laſt farewell.

34
Itzcoatl raiſed to the throne of Mexico, who aſſiſts Nezahualcojotl.

In the mean time, the Mexicans raiſed to the throne Itzcoatl, the ſon of Acamapitzin by a ſlave, and who was accounted the moſt prudent, juſt, and brave, of all the Mexican nation. His election was no leſs pleaſing to Nezahualcojotl and his party, than it was offenſive to Maxtlaton. An alliance was quickly concluded between the exiled prince and the king of Mexico; and this was ſoon followed by the commencement of hoſtilities on the part of the former. His firſt enterpriſe was againſt the city of Tezcuco, which he determined to take by aſſault, but was prevented by the ſubmiſſion of the inhabitants. He put to death, however, all the officers eſtabliſhed by the tyrant; and all the Tepanecans he found there. The very ſame day another large city named Acolman was furiouſly attacked by a detachment of his army; great numbers put to the ſword, and among the reſt the governor, who was brother to Maxtlaton; and the ſame day alſo Coatlichan was taken by the Chalceſe.

35 Dangerous embaſſy undertaken by Montezuma.

The Mexican monarch, hearing of the ſucceſſes of his ally, ſent an embaſſy to congratulate him upon them. His ambaſſador was a ſon of king Huitzilihuitl, named *Montezuma*, who for his invincible courage and great qualities was ſurnamed the *man of great heart and the archer of heaven*. The journey was extremely dangerous; but Montezuma undertook it without any fear, accompanied by another nobleman. They got in ſafety to the place where the prince was; but had the misfortune to be taken priſoners, and were carried to Chalco; the lord of which city, named Toteotzin, was an inveterate enemy to the Mexicans. By him he was immediately put in cloſe confinement, under the care of one Quateozin, who was inviolably attached to the Mexican intereſt. Orders were given to the latter to provide no ſuſtenance for the priſoners but what was preſcribed by his lord, until the mode of death which they were to ſuffer ſhould be determined. Toteotzin then ſent his priſoners to them, that they might be ſacrificed there if they thought proper. Theſe people, however, rejected the propoſal with diſdain; on which Toteotzin, thinking to regain the favour of Maxtlaton, informed him of the priſoners he had in his poſſeſſion. But Maxtlaton called him a double minded traitor, and commanded him inſtantly to ſet the priſoners at liberty. Before this anſwer arrived, however, Quateozin had inſtructed the priſoners how to make their eſcape, and directed them alſo not to return by land leſt they ſhould again be intercepted, but to embark at a certain place, and proceed by water to Mexico. They followed his advice exactly; and having got to the place to which they were directed, arrived ſafely at their city, to the great ſurpriſe and joy of the inhabitants.

36 Maxtlaton declares war againſt Mexico.

Toteotzin, enraged at the loſs of his priſoners, put Quateozin to a cruel death, deſtroying alſo all his family excepting one ſon and a daughter; of whom the latter fled to Mexico, where ſhe was highly honoured on her father's account. Maxtlaton, too, notwithſtanding his generoſity to the priſoners (which Clavigero derives from mere oppoſition to Toteotzin), prepared to wage a formidable war with the Mexicans, who had agreed to unite their troops with thoſe of the prince. The Mexican populace, terrified at engaging ſo powerful an enemy, demanded that their king ſhould ſubmit and beg for peace. So great was the tumult, that the king himſelf was obliged to conſent; and it required the utmoſt exertions of Montezuma's eloquence to perſuade the people to agree to a commencement of hoſtilities. This being done at laſt, the king next called together the chief nobility, and aſked which of them would have the courage to carry an embaſſy to the king of the Tepanecans? This adventure appeared ſo hazardous, that all of them kept a deep ſilence, until Montezuma declared himſelf willing to undertake the arduous enterpriſe. He was ordered to propoſe peace to Maxtlaton, but to accept of no diſhonourable conditions; to which he punctually adhered. Maxtlaton refuſed to give any immediate anſwer, but promiſed to give one next day, after he had conſulted his nobility. Montezuma, dreading ſome treachery if he ſtaid all night, promiſed to return next day; which he did, and was told that Maxtlaton had determined upon war. Montezuma then performed the ceremony of challenging him, by preſenting him with certain defenſive weapons, anointing his head, and fixing feathers upon it, as was cuſtomary to do with dead perſons. Laſtly, He proteſted, in the name of his maſter, that as Maxtlaton would not accept of the offered peace, he and all the Tepanecans would infallibly be ruined. Maxtlaton ſhowed not the leaſt ſign of diſpleaſure, but gave Montezuma arms in like manner to preſent to the king of Mexico; and directed him, for his perſonal ſecurity, to return in diſguiſe through a ſmall outlet from the palace. Montezuma followed his advice; but as ſoon as he found himſelf out of danger, began to inſult the Tepanecan guards; and though they ruſhed violently upon him, he not only eſcaped from their attacks, but killed one or two of them.

On his return to Mexico, the populace were again thrown into the utmoſt conſternation by the news that war was inevitable, as the chiefs of the two nations had challenged one another. They now requeſted the king to allow them to retire from their city, of which they ſuppoſed the ruin to be certain. The king encouraged them with the hopes of victory. "But if we are conquered (replied they), what will become of us?" "If that happens (anſwered the king), we are that moment bound to deliver ourſelves into your hands, to be made ſacrifices at your pleaſure." "Be it ſo (replied they), if we are conquered; but if we obtain the victory, we and our deſcendants are bound to be tributary to you; to cultivate your lands and thoſe of your nobles; to build your houſes; and to carry for you, when you go to war, your arms and baggage."

37 He is defeated and killed.

Matters being thus ſettled, intelligence was ſent to Prince Nezahualcojotl to repair with his army to Mexico, which he did without delay; and the day after his arrival a furious engagement took place. The Tepanecan army was commanded by a general named *Mazatl*; Maxtlaton himſelf not judging it proper to quit his capital. The ſoldiers on both ſides fought with the utmoſt bravery; but towards night the Mexicans, diſheartened by ſeeing the army of their enemies continually increaſing in number, began once more to loſe their courage and talk of ſurrendering. The king, greatly concerned, aſked Montezuma what ſhould be done to diſſipate the fears of the people? That brave prince replied, that they muſt fight till death; that if they died with their arms in their hands, it would be honourable; but to ſurvive their defeat, would be eternal ignominy. Nothing could be more ſalutary than this advice at ſo critical a juncture: for the Mexicans were already begun to implore the mercy of their enemies, and to promiſe to ſacrifice their chiefs, whoſe ambition had brought the whole nation

Mexico.

into ſuch a dilemma On hearing this, the whole body of nobility. with the king and Montezuma at their head, aſſaulted the enemy ſo furiouſly, that they repulsed them from a ditch of which they had taken poſſeſſion; after which, Montezuma, happening to encounter Mazatl the Tepanecan general, ſtruck him ſuch a blow on the head that he fell down lifeleſs. Thus the Mexicans were inſpired with freſh courage, and their enemies proportionally diſpirited: however, they retired for that night to the city, in ſome hopes of being able to retrieve their fortune next day. Maxtlaton encouraged them by every method in his power; but fortune proved ſtill more unfavourable than the day before. The Tepanecans were now entirely defeated, and the city of Azcapozalco taken. Maxtlaton, who ſeems not to have had the courage to fight, had not now the preſence of mind to fly. He attempted indeed to hide himſelf; but being quickly diſcovered, he was beaten to death with ſticks and ſtones. The city was plundered, the inhabitants butchered, and the houſes deſtroyed by the victors.

38
The Tepanecans entirely reduced.

This victory proved deciſive in favour of the confederates. Every other place of ſtrength in the country was quickly reduced, until the Tepanecans, finding themſelves on the verge of deſtruction, ſent an humble embaſſy to the king of Mexico, requeſting to be taken under his protection, and to become tributaries to him. Itzcoatl received them graciouſly; but threatened them with total extirpation if they violated the fidelity they had ſworn to him.

Itzcoatl, after this extraordinary ſucceſs, took care to have the above-mentioned contract ratified between the nobility and common people, by which the latter were bound to perpetual ſervices. Thoſe who had diſcouraged the ſoldiers in time of battle were baniſhed for ever from the ſtate of Mexico; while Montezuma and others who had diſtinguiſhed themſelves by their bravery, were rewarded with lands, as was uſual with other conquerors.

39
Nezahualcojotl made king of Acolhuacan.

Itzcoatl, now finding himſelf firmly ſeated on the throne of Mexico, ſet about performing his engagements to the Acolhuacan prince, by ſeating him on the throne of his anceſtors. Having again joined their armies, they marched againſt Huaxotla, a city which refuſed to ſubmit even though terms of pardon were offered them. Inſtead of this, they raſhly ventured a battle, in which they were entirely defeated; and were then fain to ſend a deputation of their old men, pregnant women, &c. as was cuſtomary in caſes of diſtreſs. to move the enemy to compaſſion At laſt all obſtacles being removed, Nezahualcojotl was ſeated on the throne of Acolhuacan, the auxiliary troops were diſmiſſed, and Itzcoatl left at liberty to purſue his conqueſts, in which he was ſtill aſſiſted by the king of Acolhuacan. The firſt expedition was againſt Cojohuacan, and other two Tepanecan cities, who had not only refuſed ſubmiſſion themſelves, but excited others to ſhake off the yoke alſo. The war againſt them proved bloody. Three battles were fought, in which Itzcoatl gained no other advantage than making the enemy retreat a little; but in the fourth, while the two armies were hotly engaged, Montezuma, with a body of choſen troops, which he had placed in ambuſcade, attacked the rear-guard of the rebels with ſuch vigour, that they were ſoon diſordered, and obliged to fly to the city. The conquerors purſued them thither; and Montezuma perceiving that they intended to fortify themſelves in the greater temple, fruſtrated their deſign by getting poſſeſſion of it and burning the turret. By this diſaſter they were ſo much terrified, that they fled to the mountains ſouth of Cojohuacan; but even there the royal army overtook and purſued them more than 30 miles, till they came to another mountain, where, quite exhauſted with fatigue, and ſeeing no means of eſcape, they were obliged to ſurrender at diſcretion.

40
Conqueſts of the Mexicans.

Mexico.

Having thus happily accompliſhed the conqueſt of Cojohuacan and the other rebellious cities, the two kings returned to Mexico. Itzcoatl gave great part of the Tepanecan country, with the title of king of *Tacuba*, to *Totoquihuatzin*, a grandſon of Tezozomoc, but who does not appear to have been any way concerned in his projects againſt the Mexicans. An alliance was then formed among the three kings on the following terms: The king of Tacuba held his crown on condition of ſerving the king of Mexico with all his troops, at any time when required; for which he was to have a fifth part of the ſpoils taken from the enemy. The king of Acolhuacan was likewiſe to aſſiſt the king of Mexico in war; and for this he was to have a third part of the plunder, after deducting the ſhare of the king of Tacuba; and the remainder was to belong to the king of Mexico. The kings of Tacuba and Acolhuacan were both declared honorary electors of the kings of Mexico; the real electors being four nobles: and the king of Mexico was likewiſe bound to aſſiſt in the wars of his allies whenever it was demanded.

41
Alliance between the kings of Mexico, Acolhuacan, and Tepanecas.

After having thus ſettled matters among themſelves, and rewarded their ſoldiers, Itzcoatl ſet out with Nezahualcojotl for Tezcuco, where the Acolhuacan king was crowned with all poſſible ceremony. Here the new king took every method which prudence could ſuggeſt to eſtabliſh his authority on a permanent baſis; but while he was thus employed, the Xochimilcas, fearing leſt the Mexicans might conquer their country as they had done that of the Tepanecans, held a council on what was to be done to prevent ſuch a diſgrace. In this council it was determined to commence hoſtilities againſt that riſing ſtate, before it ſhould become more formidable by new conqueſts. Itzcoatl was no ſooner informed of this determination, than he ſent Montezuma with a great army againſt them. The Xochimilcas met him with one ſtill more numerous; but being worſe diſciplined, they were quickly defeated, and their city taken in a very ſhort time after. This conqueſt was followed by the reduction of Cuitlahuac, ſituated on a ſmall iſland in the lake of Chalco. Their inſular ſituation gave them confidence to attack the formidable power of the Mexicans. The king was ſo ſenſible of the difficulty of this enterpriſe, that he propoſed to attack them with the whole force of the alliance: Montezuma, however, with only a ſmall number of men of his own training, whom he furniſhed with proper veſſels, reduced them in ſeven days.

42
Other conqueſts.

43
Montezuma I king of Mexico.

Itzcoatl died in the year 1436, at a very advanced age, in the height of proſperity. and was ſucceeded by Montezuma I. the greateſt monarch that ever ſat on the Mexican throne. Before his coronation, in order to comply with the barbarous rites of his reli-

44 Chalco taken.

gion, he made war upon the Chalceſe, in order to procure the priſoners who were to be ſacrificed at his coronation; and ſcarce was this ceremony over, when a new war commenced, which terminated in the deſtruction of that city. This quarrel happened between the Chalceſe and the Tezcucans. Two of the royal princes of Tezcuco having gone a-hunting on the mountains which overlook the plains of Chalco, while employed in the chaſe, and ſeparated from their retinue, with only three Mexican lords, fell in with a troop of Chalceſe ſoldiers; who, to gratify the cruelty of their maſter, carried them all priſoners to Chalco. The cruel and inconſiderate tyrant who commanded there inſtantly put them all to death: after which he cauſed their bodies to be ſalted, dried, and placed in an hall of his palace, where they ſerved as ſupporters to the pine torches burned there for lights every evening. The king of Tezcuco, overwhelmed with grief, and to the laſt degree exaſperated at ſuch an inhuman act, called for the aſſiſtance of the allied kings. The city was attacked at once by land and water. The inhabitants, knowing that they had no mercy to expect, fought like men in deſpair. Even the old tyrant who commanded them, though unable to walk, cauſed himſelf to be carried in a litter among the combatants; notwithſtanding which they were totally defeated, and the moſt ſevere vengeance executed upon them.

45 Tlatelolco reduced, and Moquihuix made king.

Montezuma, on his return, found himſelf obliged to encounter an enemy more formidable on account of his vicinity, than more powerful ones at a diſtance. This was the king of Tlatelolco, who had formerly conſpired againſt the life of Itzcoatl; and finding himſelf diſappointed in this, had tried to reduce his power by entering into a confederacy with ſome of the neighbouring lords. At that time his deſigns proved abortive, but he reſumed them in the time of Montezuma; the conſequence of which was, that he was defeated and killed. One *Moquihuix* was choſen in his room; in whoſe election it is probable that Montezuma had a conſiderable ſhare. This was followed by conqueſts of a much more important nature. The province of *Cuihixcas*, lying to the ſouthward, was added to his dominions, comprehending a tract of country more than 150 miles in breadth; then, turning to the weſtward, he conquered another named *Tzompahuacan*. This ſucceſs, however, was for a ſhort time interrupted by a war with Atonaltzin, lord of a territory in the country of the Mixtacas. This prince, puffed up on account of the great wealth he poſſeſſed, took it into his head that he would allow no Mexican to travel through his country. Montezuma ſent ambaſſadors to know the reaſon of ſuch ſtrange conduct; but Atonaltzin gave them no other anſwer than ſhowing them ſome part of his wealth, making a preſent to the king, and deſiring him from thence to obſerve how much the ſubjects of Atonaltzin loved him; and that he willingly accepted of war, which was to determine whether he ſhould pay tribute to the Mexicans or the Mexicans to him. Montezuma having informed his allies of this inſolent anſwer, ſent a conſiderable army againſt Atonaltzin, but had the mortification to be informed of its defeat; in conſequence of which the pride of Atonaltzin was increaſed to a great degree. Montezuma, greatly chagrined at this firſt check, determined to head his next army in perſon; but before he could call together another, Atonaltzin had drawn into a confederacy with him the Huexotzincas and Tlaſcalans, who were glad of the opportunity, as they ſuppoſed, of reducing the power of the Mexicans. Their numbers, however, availed but little; Montezuma in the very firſt engagement totally defeated the confederate army. The allies of Atonaltzin were particularly unfortunate; for ſuch of them as were not killed in the field of battle, were deſtroyed by their own party out of revenge for the unfortunate event of the battle.

46 Atonaltzin defeated, and the Mexican dominions enlarged.

By this victory the Mexican monarch became maſter not only of the dominions of Atonaltzin, but of many other neighbouring princes, againſt whom he made war on account of their having put to death ſome Mexican merchants or couriers without any juſt cauſe. The conqueſt of *Cuetlachtlan* or *Cotaſta*, however, which he attempted in 1457, proved a much more difficult taſk. This province lies on the coaſt of the Mexican gulf, and had been formerly inhabited by the Olmecans, whom the Tlaſcalans had driven out. The inhabitants were very numerous; but dreading the power of Montezuma, called in thoſe of Tlaſcala, together with the Huexotzincas, to their aſſiſtance. Along with theſe the allies drew the Cholulans alſo into the confederacy; ſo that this ſeems to have been the moſt formidable combination that had yet been formed againſt the Mexican power. Montezuma collected an excellently equipped army; which, however, he did not on this occaſion command in perſon. It contained a great number of perſons of very high rank, among whom were three princes of royal blood, and *Moquihuix* king of Tlatelolco already mentioned. The combination of the three republics againſt Mexico was not known at court when the army ſet out; but Montezuma, being informed of it ſoon after, ſent an order to his generals to return. This accorded ſo ill with the romantic notions of valour entertained by the Mexicans, that a conſultation of the generals was held whether they ſhould obey it or not. At laſt it was determined that the king's order ſhould be obeyed; but no ſooner was this agreed to than Moquihuix accuſed them all of cowardice, and threatened, with his own troops, unaſſiſted, to go and conquer the enemy. His ſpeech had ſuch an effect upon them all, that they went to meet the confederates. The Cotaſteſe fought with great valour, but were unable to reſiſt the royal forces; and their allies were almoſt totally deſtroyed. Six thouſand two hundred of them were taken priſoners, and ſoon after ſacrificed to the Mexican god of war in the barbarous manner already deſcribed. The victory was ſaid to have been owing principally to the valour and good conduct of Moquihuix, inſomuch that to this day a ſong made in his praiſe on that occaſion is known in Mexico. Montezuma was ſo well pleaſed with the victory, that he not only forgave the diſobedience of his orders, but beſtowed upon Moquihuix a princeſs, one of his own couſins, to wife.

47 Inundation and famine at Mexico.

During the reign of this great monarch a violent inundation happened in Mexico. The lake, ſwelled by the exceſſive rains which fell in the year 1446, poured its waters into the city with ſo much violence that many houſes were deſtroyed, and the ſtreets inundated to ſuch a degree that boats were everywhere made uſe of. The inundation was ſoon followed by a famine. This was occaſioned by the ſtinting of the crop of maize in 1448; the ears while young and tender being deſtroyed by froſt. In 1450 the crop was totally loſt for want of water; and in 1451, beſides the unfavourable ſeaſons, there was a ſcarcity of ſeed. Hence, in 1452, the neceſſities of the people became ſo great, that they were obliged to ſell themſelves for ſlaves in order to procure ſubſiſtence. Montezuma permitted them to go to other countries for ſupport; but being informed that many ſold themſelves for a few days proviſion, he ordered, by proclamation, that no woman ſhould ſell herſelf for leſs than 400 ears of wheat, nor any man for leſs than 500. He opened alſo the public granaries for the relief of the lower claſſes; but nothing was able to ſtop the progreſs of the famine.

48
Axayacatl ſucceeds Montezuma.

Montezuma was ſucceeded by Axayacatl, who like his predeceſſor inſtantly commenced a war, for no other reaſon than that he might have priſoners to ſacrifice at his coronation. He purſued Montezuma's plan of conqueſt; in which, however, he was leſs ſucceſsful, many of the provinces reduced by that monarch having revolted after his death, ſo that it was neceſſary to reconquer them. On his returning ſucceſsful from one of theſe expeditions, he built a new temple, to which he gave the name of *Coatlon;* but the Tlatelolcos, whoſe ancient rivalſhip ſeems to have revived on the death of Montezuma, built another in oppoſition, which they called *Coaxolotl.* Thus the former hatred between the two nations was renewed, and a diſcord took place which ended in the ruin of the Tlatelolcos.

49
Death of the kings of Acolhuacan and Tacuba.

The Mexicans ſuſtained an irreparable loſs in 1469 and 1470 by the death of their allies the kings of Tacuba and Acolhuacan.

50
Tlatelolco reduced, and the king killed.

The king of Tacuba was ſucceeded by his ſon Chimalpopoca, and the Acolhuacan monarch by his ſon Nezahualpilli. A ſhort time after the acceſſion of the latter, the war broke out between the Tlatelolcos and Mexicans, which ended in the deſtruction of the former. King Moquihuix had been married by Montezuma to a ſiſter of Axayacatl, now on the throne of Mexico; but it appears that this princeſs never was greatly the object of his affection. On the contrary, he took all methods of expreſſing his diſlike, either out of enmity to herſelf, or envy of the ſuperior greatneſs of her brother. Not content with this, he entered into an alliance with a great number of the neighbouring ſtates, in order to reduce the Mexican greatneſs. His wife, however, being informed of this ſcheme, communicated the particulars to her brother; and ſoon after, being impatient of the ill uſage ſhe received, came to Mexico with her four ſons to claim the protection of her brother. This uncommon accident exaſperated the Mexicans and Tlatelolcos againſt each other to ſuch a degree, that wherever they met, they fought, abuſed, and murdered each other. The king of Tlatelolco prepared for war with many horrid ceremonies, of which the drinking of human blood was one. A day was appointed for attacking Mexico. Xiloman, lord of Colhuacan, was to begin the attack, afterwards to pretend flight, in order to induce the Mexicans to follow him; after which the Tlatelolcos were to fall upon their rear. For ſome reaſon, however, with which we are not acquainted, the Tlatelolcos began the attack without waiting for Xiloman; the conſequence of which was, that he retired in diſguſt, leaving them to finiſh their battle the beſt way they could. The engagement laſted till night, when the Tlatelolcos were obliged to retire. Axayacatl, during the night, diſpoſed of his troops in all the roads which led to Tlatelolco, appointing them to meet in the market-place. The Tlatelolcos, finding themſelves attacked on all ſides, retired gradually before the Mexicans, until at laſt they were forced into the market-place, where they found themſelves worſe than ever on account of its narrowneſs, which did not allow them room to act. The king ſtood on the top of the great temple, encouraging his men to exert themſelves againſt the enemy. His words, however, had now loſt their uſual influence. He not only was not obeyed, but was reproached with cowardice becauſe he did not come down and fight among the reſt. At laſt the Mexicans arrived at the temple, and aſcended to the balcony where the king was. He made a deſperate defence for a little; but by a violent puſh in the breaſt was thrown backwards upon the ſteps of the temple, and ſtunned or perhaps killed by the fall.

51
Axayacatl wounded and in great danger.

The Tlatelolcos being thus reduced, Axayacatl next ſet out on an expedition againſt the Matlazincas, a tribe in the vale of Toluca, who ſtill refuſed to ſubmit to the Mexican yoke. Having proved ſucceſsful in this expedition, he undertook to ſubdue alſo the northern part of the valley, now called *Valle d' Ixtlahuacan*, particularly *Xiquipilco*, a conſiderable city and ſtate of the Otomies, whoſe chief was much renowned for ſtrength and bravery. Axayacatl, who likewiſe valued himſelf on theſe qualities, encountered him in ſingle combat. In this, however, he was overmatched, and received a violent wound in the thigh; after which he would have been taken priſoner, had not ſome young Mexicans made a deſperate effort for his reſcue. Notwithſtanding this diſaſter, Axayacatl's army gained a complete victory, carrying off 11060 priſoners, among whom was the chief of the Otomies himſelf, and two of his officers who had attacked the king. Theſe chiefs were put to death at an entertainment of the allied kings, the ſight of their agonies not interrupting in the leaſt the mirth of the feaſt; ſo much were they familiarized to the ſhedding of human blood.

52
Is ſucceeded by Tizoc.

He was ſucceeded by his elder brother Tizoc. He intended to have built a larger temple than any that had yet been ſeen in Mexico, though that originally built had been greatly enlarged by ſome of his predeceſſors. For this purpoſe he collected a great quantity of materials; but before he could bring his projects to bear, he was taken off by a conſpiracy of his ſubjects. During the reign of Tizoc, the Acolhuacans made war upon the Huexotzincas, ruined their city, and conquered their territory. Nezahualpilli alſo, the Acolhuacan monarch, though he had already ſeveral wives, had not made any of them queen, having wiſhed to confer that honour upon one of the royal family of Mexico. Tizoc readily gave him one of his grand-daughters, who had a ſiſter of ſingular beauty named *Xocotzin.* The friendſhip betwixt theſe two ladies was ſuch, that the one could not think of being ſeparated from the other; for which reaſon the new queen ſought and obtained permiſſion to take her ſiſter along with her to Tezcuco. Xocotzin had not been long there before the king fell in love with her, and married her with the title of queen likewiſe. Soon after this ſecond marriage, the firſt queen brought forth a ſon named *Cacamatzin*, who ſucceeded him in the throne, and was afterwards taken priſoner by the Spaniards.

53
Ahuitzotl dedicates a temple with a multitude of human victims.

Ahuitzotl, the brother of Tizoc, ſucceeded him in the kingdom of Mexico. His firſt object was to finiſh the great temple begun by his predeceſſor; and ſuch was the number of workmen, that it was completed in four years. During the time that it was building, the king employed himſelf in making war with different nations, reſerving all the priſoners he took for victims at the dedication of the temple. The number of priſoners ſacrificed at this dedication is ſaid by Torquemada to have been 72,324; by other hiſtorians 64,060. The miſerable victims were ranged in two files, each a mile and an half in length, terminating at the temple. The ſame year another temple was built by a feudatory lord, in imitation of the great one built by the king; at the dedication of which a vaſt number of priſoners were alſo ſacrificed. Theſe temples were dedicated in 1486 In 1487 happened a violent earthquake; and Chimalpopoca king of Acolhuacan died, who was ſucceeded by Totoquihuatzin II.

Ahuitzotl died in 1502, of a diſorder produced by a contuſion in his head. At the time of his death, the Mexican empire was brought to its utmoſt extent. His ſucceſſor, Montezuma *Xocojotzin* or Montezuma *Junior*, was a perſon of great bravery, beſides which he was likewiſe a prieſt, and held in great eſtimation on account of his gravity and the dignity of his deportment. His election was unanimous; and the nobles congratulated themſelves on the happineſs the country was to enjoy under him, little thinking how ſhort the duration of their happineſs or of their empire was to be.

54
Montezuma.

The firſt care of the new monarch, as uſual, was to procure victims for the barbarous ſacrifices to be made at his coronation. The people of Atlixco, who had again ſhaken off the Mexican yoke, were the ſufferers on this occaſion, being once more reduced, though not without great loſs on the part of the Mexicans, ſome of whoſe braveſt officers periſhed in the war. The ceremony of coronation was performed with ſuch pomp as had never been ſeen before in Mexico; but no ſooner was this ceremony over than Montezuma began to diſcover a pride which nobody had ſuſpected before. All his predeceſſors had been accuſtomed to confer offices upon perſons of merit, and thoſe who appeared the moſt able to diſcharge them, without any partiality as to birth or wealth. Montezuma, however, diſapproved of the conduct of his predeceſſors, under pretence that the plebeians ſhould be employed according to their rank; for that in all their actions the baſeneſs of their birth and the meanneſs of their education appeared: and in conſequence of this maxim he deprived all the commoners of the offices they held about the court, declaring them incapable of holding any for the future. All the royal ſervants now were people of rank. Beſides thoſe who lived in the palace, 600 feudatory lords and nobles came to pay court to him. They paſſed the whole day in the antichamber, where none of their ſervants were permitted to enter; converſing in a low voice, and waiting the orders of their ſovereign.—The ſervants of theſe lords were ſo numerous that they occupied three ſmall courts of the palace, and many waited in the ſtreets.

55
Magnificence diſplayed in his palace.

In every reſpect Montezuma kept up, as far as was poſſible. an extravagant appearance of dignity. His kitchen utenſils were of the fineſt earthen ware, and his tablecloths and napkins of the fineſt cotton; but none of theſe ever ſerved the emperor more than once, being immediately made a preſent of to ſome nobleman. The veſſels in which his chocolate and other drinks from cocoa were prepared, were all of gold, or ſome beautiful ſea-ſhell, or naturally formed veſſels, curiouſly varniſhed. He had alſo gold plate, but it was uſed only on particular occaſions in the temple. The number and variety of his diſhes aſtoniſhed the Spaniards. He took great delight in the cleanlineſs of his own perſon, and of every thing about him. He bathed regularly every day, and had baths in all his palaces. Every day he wore four dreſſes, never uſing again thoſe which he had put off, but reſerving them as largeſſes for the nobility, or thoſe who had diſtinguiſhed themſelves in war. The expence of all this rendered him very diſagreeable to a great number of his ſubjects; though others were pleaſed with the readineſs he ſhowed to relieve the neceſſities of individuals, and his generoſity in rewarding his generals and miniſters who deſerved it. Among other actions worthy of imitation, he appointed the city of Colhuacan as an hoſpital for all invalids, who after having faithfully ſerved the crown either in the civil or military line, required a proviſion on account of their age and infirmities. In this place they were maintained and attended at the expence of the king.

56
His unſucceſsful war with Tlaſcala.

The reign of Montezuma, even before the arrival of the Spaniards, was far from being ſo glorious with regard to his ſucceſſes in war as thoſe of his predeceſſors had been. He reduced indeed one rebellious province, and conquered another which had never before been ſubjugated; but in his war with Tlaſcala he was by no means ſucceſsful. This was but a ſmall republic at no great diſtance from the capital, but the inhabitants were remarkable for their bravery and independent ſpirit. The neighbouring ſtates, however, who had been reduced by the Mexicans, envious of their liberty and proſperity, exaſperated the Mexicans againſt them, by repreſenting that the Tlaſcalans were deſirous of making themſelves maſters of the maritime provinces on the Mexican gulf, and that by their commerce with theſe provinces they were increaſing their wealth and power, and gaining the hearts of the people with whom they were to traffic. In conſequence of this repreſentation, ſtrong garriſons were placed on the frontiers of Tlaſcala, to obſtruct the commerce of the inhabitants, and thus to deprive them of the means of obtaining ſome of the neceſſaries of life. The Tlaſcalans complained; but received no other anſwer than that the king of Mexico was lord of all the world, and that the Tlaſcalans muſt ſubmit and pay tribute to him. The Tlaſcalans returned a ſpirited anſwer to this inſolent ſpeech, and began to fortify their frontier. They had already encloſed all the lands of the republic with intrenchments; and to theſe they now added a wall of ſix miles in length on the weſt ſide, where an invaſion was moſt to be apprehended; and ſo well did they defend themſelves, that though they were frequently attacked by the neighbouring ſtates in alliance with Mexico, or ſubject to it, not one of them was able to wreſt a foot of ground from them. Thus a continual ſeries of wars and engagements took place between the ſtates of Mexico and this republic, which continued till the arrival of the Spaniards.

57
Apprehenſions entertained by the Mexicans of the arrival of a new people.

During the remainder of Montezuma's reign the empire was diſturbed by various rebellions, of which the accounts are not ſufficiently intereſting to merit a particular detail; but in the year 1508, Montezuma began to entertain apprehenſions of that fatal event which at length overtook him. An expedition having been undertaken againſt a very diſtant region named Amatla, the army in marching over a lofty mountain were attacked by a furious north wind, accompanied with ſnow; which made great havock in the army, many of them periſhing with cold, and others being killed by the trees rooted up by the wind. The remains of the army continued their march to Amatla, where they were almoſt all killed in battle. By this and other calamities, together with the appearance of a comet, the Mexicans were thrown into the utmoſt conſternation. Montezuma was ſo terrified by theſe omens, that having in vain conſulted his aſtrologers, he applied to the king of Acolhuacan, who was reported to be very ſkilful in divination. Nezahualpilli having conferred with him upon the ſubject, told Montezuma that the comet preſaged ſome calamity which was about to befal their kingdoms by the arrival of a new people: but this being unſatisfactory to the emperor, the king of Acolhuacan challenged him to a game at foot-ball, ſtaking the truth of his prediction on the iſſue of the game. Montezuma loſt the game, but did not yet acquieſce in the truth of his prediction. He therefore applied to a celebrated aſtrologer, whom it ſeems he had not yet conſulted; but he confirmed the interpretation of Nezahualpilli: for which the emperor cauſed his houſe to be pulled down, and himſelf buried in the ruins.

58
Conqueſt of Mexico undertaken by Cortes.

Mexico itſelf was firſt diſcovered, though imperfectly, by a Spaniard named *Nunez de Balboa;* but in 1518 the conqueſt of it was undertaken by a celebrated adventurer named *Ferdinando Cortes*. On the 10th of February 1519, he ſet ſail from the Havannah in Cuba; and ſoon landed on the iſland of Cozumel, on the coaſt of Yucatan, diſcovered the preceding year. Here he joined one of his officers named *Pedro d'Alvaredo*, who had arrived ſome days before, and collected ſome booty and taken a few priſoners. But the general ſeverely cenſured his conduct; and the priſoners were diſmiſſed, after they had been informed by an Indian interpreter named *Melchior*, that ſuch injuries were entirely diſagreeable to the intentions and wiſhes of Cortes. Here he muſtered his army, and found that it amounted to 508 ſoldiers, 16 horſemen, and 109 mechanics, pilots, and mariners. Having encouraged his men by a proper ſpeech, and releaſed, by means of ſome Indian ambaſſadors, a Spaniard named *Jerom de Aguilar*, who had been detained a priſoner for eight years, he proceeded to the river Tabaſco, where he hoped to be received in a friendly manner, as one Grijalva had been a ſhort time before; but, from ſome unknown cauſe, he was violently attacked by them: however, the ſuperiority of the Spaniſh arms ſoon decided the victory, and the inhabitants were obliged to own the king of Caſtile as their ſovereign.

The Spaniards then continued their courſe weſtward, to the harbour of St Juan de Ulloa; where they were met by two Mexican canoes, which carried two ambaſſadors from the emperor of that country, and ſhowed the greateſt ſigns of peace and amity. Their language was unknown to Aguilar; but one of the female priſoners above mentioned underſtood it, and tranſlated it into the Yucatan tongue; after which Aguilar interpreted the meaning in Spaniſh. This ſlave was afterwards named *Donna Marina*, and proved very uſeful in their conferences with the natives.

59
State of the empire at that time.

At this time the Mexican empire, according to Dr Robertſon, was arrived at a pitch of grandeur to which no ſociety had ever attained in ſo ſhort a period. Though it had ſubſiſted only for 130 years, its dominion extended from the north to the ſouth ſea, over territories ſtretching about 500 leagues from eaſt to weſt, and more than 200 from north to ſouth; comprehending provinces not inferior in fertility, population, and opulence, to any in the torrid zone.—Though by nature Montezuma poſſeſſed a good deal of courage and reſolution; yet from the firſt moment that the Spaniards appeared on his coaſt, he diſcovered ſymptoms of timidity and embarraſſment, and all his ſubjects were embarraſſed as well as himſelf. The general diſmay which took place on this occaſion was partly owing to the ſtrange figure the Spaniards made, and the prodigious power of their arms; but partly alſo to the following circumſtance. An opinion prevailed almoſt univerſally among the Americans, that ſome dreadful calamity impended over their heads, from a race of formidable invaders who ſhould come from regions towards the riſing ſun, to overrun and deſolate their country.

By means of his two interpreters, Donna Marina and Aguilar, Cortes learned that the chiefs of the Mexican embaſſy were deputies from Pilpatoe and Teutile; the one governor of a province under the emperor, and the other the commander of all his forces in that province: the purport of their embaſſy was to inquire what his intentions were in viſiting their coaſts, and to offer him what aſſiſtance he might need in order to continue his voyage. Cortes, in his turn, alſo profeſſed the greateſt friendſhip; and informed the ambaſſadors, that he came to propoſe matters of the utmoſt conſequence to the welfare of the prince and his kingdom; which he would more fully unfold in perſon to the governor and the general. Next morning, without waiting for any anſwer, he landed his troops, his horſes, and his artillery; began to erect huts for his men, and to fortify his camp.

60
Cortes lands and fortifies his camp.

The next day the ambaſſadors had a formal audience; at which Cortes acquainted them, that he came from Don Carlos of Auſtria, king of Caſtile, the greateſt monarch of the eaſt, and was intruſted with propoſitions of ſuch moment, that he would impart them to none but the emperor himſelf, and therefore required to be conducted immediately to the capital. This demand produced the greateſt uneaſineſs;

61
The Indians endeavour to diſſuade him from going to the capital, but in vain.

and the ambaſſadors did all in their power to diſſuade Cortes from his deſign, endeavouring to conciliate his good will by the preſents ſent him by Montezuma. Theſe they introduced with great parade, and conſiſted of fine cotton cloth, of plumes of various colours, and of ornaments of gold and ſilver to a conſiderable value, the workmanſhip of which appeared to be as curious as the materials were rich. But theſe preſents ſerved only to excite the avidity of the Spaniards, and to increaſe their deſire for becoming maſters of a country which abounded with ſo many precious commodities. Cortes indeed could ſcarcely reſtrain himſelf ſo far as to hear the arguments made uſe of by the ambaſſadors to diſſuade him from going to the capital; and, in a haughty, determined tone, inſiſted on his former demand of being admitted to a perſonal interview with their ſovereign.

During this converſation, ſome painters in the retinue of the Mexican chiefs had been diligently employed in delineating, upon white cotton cloths, figures of the ſhips, horſes, artillery, ſoldiers, and whatever elſe attracted their eyes as ſingular.

62
Montezuma made acquainted with his deſign.

While exerting their utmoſt efforts in repreſenting all theſe wonderful things, meſſengers were immediately deſpatched to Montezuma with the pictures, and a full account of every thing that had paſſed ſince the arrival of the Spaniards, together with ſome European curioſities to Montezuma; which Cortes believed would be acceptable on account of their novelty. The Mexican monarchs had couriers poſted at proper ſtations along the principal roads; and as theſe were trained to agility by a regular education, they conveyed intelligence with ſurpriſing rapidity. Though the city in which Montezuma reſided was above 180 miles from St Juan de Ullua, Cortes's preſents were carried thither, and an anſwer returned to his demands, in a few days. As the anſwer was unfavourable, Montezuma had endeavoured to mollify the Spaniſh general by the richneſs of his preſents. Theſe conſiſted of the manufactures of the country; cotton ſtuffs ſo fine, and of ſuch delicate texture, as to reſemble ſilk; pictures of animals, trees, and other natural objects, formed with feathers of different colours, diſpoſed and mingled with ſuch ſkill and elegance as to rival the works of the pencil in truth and beauty of imitation. But what chiefly attracted their attention, were two large plates of a circular form; one of maſſive gold repreſenting the ſun, the other of ſilver repreſenting the moon. Theſe were accompanied with bracelets, collars, rings, and other trinkets of gold; and that nothing might be wanting which could give the Spaniards a complete idea of what the country afforded, ſome boxes filled with pearls, precious ſtones, and grains of gold unwrought, as they had been found in the mines or rivers, were ſent along with the reſt. Cortes received all with an appearance of the moſt profound reſpect for Montezuma; but when the Mexicans, preſuming upon this, informed him, that their maſter, though he deſired him to accept of what he had ſent as a token of his regard for the prince whom he repreſented, would not give his conſent that foreign troops ſhould approach nearer to his capital, or even allow them to continue longer in his dominions, Cortes declared, in a manner more reſolute and peremptory than formerly, that he muſt inſiſt on his firſt demand; as he could not, without diſhonour, return to his own ſovereign until he was admitted into the preſence of the prince whom he was appointed to viſit in his name.

63
Sends an unfavourable anſwer, but accompanied with rich preſents.

64
Cortes ſtill inſiſts on his demands.

The puſillanimity of the Indian monarch afforded time to the Spaniards to take meaſures which would have been out of their power had they been vigorouſly attacked on their firſt refuſal to obey his orders. Cortes uſed every method of ſecuring the affections of the ſoldiers; which indeed was very neceſſary, as many of them began to exclaim againſt the raſhneſs of his attempt in leading them againſt the whole force of the Mexican empire. In a ſhort time Teutile arrived with another preſent from Montezuma, and together with it delivered the ultimate orders of that monarch to depart inſtantly out of his dominions; and when Cortes, inſtead of complying with his demands, renewed his requeſt of audience, the Mexican immediately left the camp with ſtrong marks of ſurpriſe and reſentment. Next morning, none of the natives appeared; all friendly correſpondence ſeemed to be at an end, and hoſtilities were expected to commence every moment. A ſudden conſternation enſued among the Spaniards, and a party was formed againſt him by the adherents of Velaſques; who took advantage of the occaſion, and deputed one of their number, a principal officer, to remonſtrate, as if in name of the whole army, againſt his raſhneſs, and to urge the neceſſity of his returning to Cuba. Cortes received the meſſage without any appearance of emotion; and as he well knew the temper and wiſhes of his ſoldiery, with much complacency he pretended to comply with the requeſt now made him, and iſſued orders that the army ſhould be in readineſs next day to embark for Cuba. Upon hearing this, the troops, as Cortes had expected, were quite outrageous: they poſitively refuſed to comply with theſe orders, and threatened immediately to chooſe another general if Cortes continued to inſiſt on their departure.

65
Montezuma peremptorily commands him to leave his dominions.

Our adventurer was highly pleaſed with the diſpoſition which now appeared among his troops: nevertheleſs, diſſembling his ſentiments, he declared, that his orders for embarking had proceeded from a perſuaſion that it was agreeable to his fellow-ſoldiers, to whoſe opinion he had ſacrificed his own; but now he acknowledged his error, and was ready to reſume his original plan of operation. This ſpeech was highly applauded; and Cortes, without allowing his men time to cool, ſet about carrying his deſigns into execution. In order to give a beginning to a colony, he aſſembled the principal perſons in his army, and by their ſuffrages elected a council and magiſtrates, in whom the government was to be veſted. The perſons choſen were moſt firmly attached to Cortes; and the new ſettlement had the name of *Villa Rica de la Vera Cruz;* that is, the rich town of the true croſs.

66
Villa Rica founded.

67
The government of the new colony veſted in Cortes.

Before this court of his own making, Cortes did not heſitate at reſigning all his authority, and was immediately re-elected chief-juſtice of the colony, and captain-general of his army, with an ample commiſſion, in the king's name, to continue in force till the royal pleaſure ſhould be farther known. The ſoldiers eagerly ratified their choice by loud acclamations; and Cortes, now conſidering himſelf as no longer accountable to any ſubject, began to aſſume a much greater degree of dignity, and to exerciſe more extenſive powers than he had done before.

68
Character of Montezuma given by the cacique.

Cortes having thus ſtrengthened himſelf as well as he could, reſolved to advance into the country; and to this he was encouraged by the behaviour of the cacique, or petty prince of Zempoalla, a conſiderable town at no great diſtance. Here he was received in the moſt friendly manner imaginable, and had a reſpect paid towards him almoſt equivalent to adoration. The cacique informed him of many particulars relating to the character of Montezuma.—He told him that he was a tyrant, haughty, cruel, and ſuſpicious; who treated his own ſubjects with arrogance, ruined the conquered provinces by his extortions, and often tore their ſons and daughters from them by violence; the former to be offered as victims to his gods, the latter to be reſerved as concubines for himſelf and favonrites. Cortes, in reply, artfully inſinuated, that one great object of the Spaniards in viſiting a country ſo remote from their own was, to redreſs grievances, and to relieve the oppreſſed; and having encouraged him to hope for this interpoſition in due time, continued his march to Quiabiſlan, the territory of another cacique, and where, by the friendly aid of the Indians, a Spaniſh colony was ſoon formed.

During the reſidence of Cortes in theſe parts, he ſo far wrought on the minds of the caciques of Zempoalla and Quiabiſlan, that they ventured to inſult the Mexican power, at the very name of which they had been formerly accuſtomed to tremble. Some of Montezuma's officers having appeared to levy the uſual tribute, and to demand a certain number of human victims, as an expiation of their guilt in preſuming to hold intercourſe with thoſe ſtrangers whom the emperor had commanded to leave his dominions; inſtead of obeying his orders, they made them priſoners, treated them with great indignity, and, as their ſuperſtition was no leſs barbarous than Montezuma's, they threatened to ſacrifice them to their gods.

Though Cortes had now taken ſuch meaſures as in a manner enſured his ſucceſs; yet as he had thrown off all dependence on the governor of Cuba, who was his lawful ſuperior, and apprehended his intereſt at court, he thought proper, before he ſet out on his intended expedition, to take the moſt effectual meaſures againſt the impending danger. With this view, he perſuaded the magiſtrates of his colony to addreſs a letter to the king, containing a pompous account of their own ſervices, of the country they had diſcovered, &c. and of the motives which had induced them to throw off their allegiance to the governor of Cuba, and to ſettle a colony dependent on the crown alone, in which the ſupreme power, civil as well as military, had been veſted in Cortes; humbly requeſting their ſovereign to ratify what had been done by his royal authority.

Some ſoldiers and ſailors, ſecretly diſaffected to Cortes, formed a deſign of ſeizing one of the brigantines, and making their eſcape to Cuba, in order to give ſuch intelligence to the governor as might enable him to intercept the veſſel which was to carry the treaſure and deſpatches to Spain. This conſpiracy was conducted with profound ſecrecy; but at the moment when every thing was ready for execution, the ſecret was diſcovered by one of the aſſociates. The latent ſpirit of diſaffection which Cortes was now too well convinced had not been extinguiſhed amongſt his troops, gave him very great uneaſineſs. The only method which he could think of to prevent ſuch conſpiracies for the future was to deſtroy his fleet, and thus deprive his ſoldiers of every reſource except that of conqueſt: and with this propoſal he perſuaded his men to comply. With univerſal conſent therefore the ſhips were drawn aſhore, and, after being ſtripped of their ſails, rigging, iron work, and whatever elſe might be of uſe, they were broke in pieces.

69
Cortes burns his fleet.

Cortes having thus rendered it neceſſary for his troops to follow wherever he choſe to lead, began his march to Zempoalla with 500 infantry, 15 horſe, and ſix field pieces. The reſt of his troops being leſs fit for active ſervice, he left them as a garriſon in Villa Rica, under the command of Eſcalante, an officer of merit, and warmly attached to his intereſt. The cacique of Zempoalla ſupplied him with proviſions; and with 200 of thoſe Indians called *Tamancs*, whoſe office, in a country where tame animals were unknown, was to carry burdens, and perform all manner of ſervile labour. He offered likewiſe a conſiderable body of troops; but Cortes was ſatisfied with 400; taking care, however, to chooſe perſons of ſuch note, that they might ſerve as hoſtages for the fidelity of their maſter.

Nothing memorable happened till the Spaniards arrived on the confines of the republic of Tlaſcala. The inhabitants of that province were warlike, fierce, and revengeful, and had made conſiderable progreſs in agriculture and ſome other arts. They were implacable enemies to Montezuma; and therefore Cortes hoped that it would be an eaſy matter for him to procure their friendſhip. With this view, four Zempoallans of high rank were ſent ambaſſadors to Tlaſcala, dreſſed with all the badges of that office uſual among the Indians. The ſenate were divided in their opinions with regard to the propoſals of Cortes: but at laſt Magiſcatzin, one of the oldeſt ſenators, and a perſon of great authority, mentioned the tradition of their anceſtors, and the revelations of their prieſts; that a race of invincible men, of divine origin, who had power over the elements, ſhould come from the eaſt to ſubdue their country. He compared the reſemblance which the ſtrangers bore to the perſons figured in the traditions of Mexico, their dominion over the elements of fire, air, and water; he reminded the ſenate of their prodigies, omens, and ſignals, which had lately terrified the Mexicans, and indicated ſome very important event; and then declared his opinion, that it would be raſhneſs to oppoſe a force apparently aſſiſted by heaven, and men who had already proved, to the ſad experience of thoſe who oppoſed them, that they were invincible. This orator was oppoſed by Xicotencal, who endeavoured to prove that the Spaniards were at beſt but powerful magicians: that they had rendered themſelves obnoxious to the gods by pulling down their images and altars, (which indeed Cortes had very imprudently done at Zempoalla); and of conſequence, that they might eaſily be overcome, as the gods would not fail to reſent ſuch an outrage. He therefore voted for war, and adviſed the cruſhing of theſe invaders at one blow.

70
Sends ambaſſadors to the republic of Tlaſcala.

The advice of Xicotencal prevailed; and in conſequence of it, the ambaſſadors were detained; which giving Cortes the alarm, he drew nearer the city of Tlaſcala. They ſuffered him with his army drawn up in good order, to paſs a ſtrong wall between two mountains, which might have been very advantageouſly defended againſt him. He had not advanced far beyond this paſs, however, before a party of Tlaſcalans with plumes were diſcovered, which denoted that an army was in the field. Theſe he drove before him by a detachment of ſix horſe, obliged them to join another party, and then reinforcing the advanced detachment, charged the enemy with ſuch vigour that they began to retire. Five thouſand Tlaſcalans then ruſhed out of their hiding places, juſt as the infantry came up to aſſiſt their ſlender body of cavalry. The enemy attacked with the utmoſt fury: but were ſo much diſconcerted by the firſt diſcharge of the fire arms, that they retreated in confuſion, furniſhing the Spaniards with an opportunity of purſuing them with great ſlaughter. Cortes, however, ſuppoſing that this could not be their whole force, advanced with the utmoſt caution, in order of battle, to an eminence, from whence he had a view of the main body of the Tlaſcalan army commanded by Xicotencal, conſiſting of no fewer than 40,000 men. By theſe the ſmall army of Cortes was entirely ſurrounded: which Xicotencal no ſooner perceived, than he contracted the circle with incredible diligence, while the Spaniards were almoſt overwhelmed with ſhowers of arrows, darts, and ſtones. It is impoſſible but in this caſe many of the Spaniards muſt have periſhed, had it not been for the inſufficiency of the Indian weapons. This circumſtance gave the Spaniards a prodigious advantage over them; and therefore the Tlaſcalans, notwithſtanding their valour and ſuperiority in number, could accompliſh no more in the preſent inſtance, than to kill one horſe and ſlightly wound nine ſoldiers.

71 The Tlaſcalans reſolve on war.

The Tlaſcalans being taught by this, and ſome ſubſequent encounters, how much they were inferior to the Spaniards, began to conceive them to be really what Magiſcatzin had ſaid; a ſuperior order of beings, againſt whom human power could not prevail. In this extremity they had recourſe to their prieſts, requiring them to reveal the cauſes of ſuch extraordinary events, and to declare what means they ſhould take to repel ſuch formidable invaders. The prieſts, after many ſacrifices and incantations, delivered their reſponſe, That theſe ſtrangers were the offspring of the ſun, procreated by his animating energy in the regions of the eaſt: that, by day, while cheriſhed with the influence of his parental beams, they were invincible; but by night, when his reviving heat was withdrawn, their vigour declined and faded like herbs in the field, and they dwindled down into mortal men. In conſequence of this, the Tlaſcalans acted in contradiction to one of their moſt eſtabliſhed maxims in war, and ventured to attack the enemy in the night time, hoping to deſtroy them when enfeebled and ſurpriſed. But the Spaniſh centinels having obſerved ſome extraordinary movements among the Tlaſcalans, gave the alarm. Immediately the troops were under arms, and ſallying out, defeated their antagoniſts with great ſlaughter, without allowing them to approach the camp. By this diſaſter the Tlaſcalans were heartily diſpoſed to peace; but they were at a loſs to form an adequate idea of the enemies they had to deal with. They could not aſcertain the nature of theſe ſurpriſing beings, or whether they were really of a benevolent or malignant diſpoſition. There were circumſtances in their behaviour which ſeemed to favour each opinion. On the one hand, as the Spaniards conſtantly diſmiſſed the priſoners whom they took, not only without injury, but often with preſents of European toys, and renewed their offers of peace after every victory; this lenity amazed people accuſtomed to the exterminating ſyſtem of war known in America, and who ſacrificed and devoured without mercy all the captives taken in battle; and diſpoſed them to entertain ſentiments favourable to their humanity. But, on the other hand, as Cortes had ſeized 50 of their countrymen who brought proviſions to their camp, and cut off their heads; this bloody ſpectacle, added to the terror occaſioned by the fire-arms and horſes, filled them with dreadful ideas of their ferocity. Accordingly they addreſſed them in the following manner: "If (ſaid they) you are divinities of a cruel and ſavage nature, we preſent to you five ſlaves, that you may drink their blood and eat their fleſh. If you are mild deities, accept an offering of incenſe and variegated plumes. If you are men, here is meat, bread, and fruit, to nouriſh you." After this addreſs, the peace was ſoon concluded, to the great ſatisfaction of both parties. The Tlaſcalans yielded themſelves as vaſſals to the crown of Caſtile, and engaged to aſſiſt Cortes in all his operations; while he took the republic under his protection, and promiſed to defend their perſons and poſſeſſions from injury and violence.

72 But are defeated and ſue for peace.

73 Which is granted.

Cortes left no method untried to gain the favour and confidence of the Tlaſcalans; which, however, he had almoſt entirely loſt, by his untimely zeal in deſtroying their idols as he had done thoſe of Zempoalla. But he was deterred from this raſh action by his chaplain Father Bartholomew de Olmedo; and left the Tlaſcalans in the undiſturbed exerciſe of their ſuperſtition, requiring only that they ſhould deſiſt from their horrid practice of offering human victims. As ſoon as his troops were fit for ſervice, he reſolved to continue his march towards Mexico, notwithſtanding the remonſtrances of the Tlaſcalans, who looked upon his deſtruction as unavoidable if he put himſelf into the power of ſuch a faithleſs prince as Montezuma. But the emperor, probably intidimated with the fame of his exploits, had reſolved to admit his viſit; and informed Cortes that he had given orders for his friendly reception at Cholula, the next place of any conſequence on the road to Mexico. Cortes was received with much ſeeming cordiality; but 6000 Tlaſcalan troops who accompanied him were obliged to remain without the town, as the Cholulans refuſed to admit their ancient enemies within their precincts. Yet two of theſe, by diſguiſing themſelves, got into the city, and acquainted Cortes that they obſerved the women and children belonging to the principal citizens retiring every night in a great hurry, and that ſix children had been ſacrificed in the great temple; a ſign that ſome warlike enterpriſe was at hand. At the ſame time Donna Marina, the interpreter, received information from an Indian woman of diſtinction, whoſe confidence ſhe had gained, that the deſtruction of the Spaniards was concerted; that a body of Mexican troops lay concealed near the town; that ſome of the ſtreets were barricaded, in others deep pits or trenches were dug,

74 Cortes continues his march for Mexico.

75 Treachery of Montezuma and the Cholulans.

dug, and ſlightly covered over, as traps into which the horſe might fall; that ſtones and miſſive weapons were collected on the tops of the temples, with which to overwhelm the infantry; that the fatal hour was already at hand, and their ruin unavoidable.

76
Severe puniſhment of the Cholulans.

Cortes, alarmed at this news, ſecretly arreſted three of the chief prieſts, from whom he extorted a confeſſion that confirmed the intelligence he had already received. As not a moment was to be loſt, he inſtantly reſolved to prevent his enemies, and to inflict on them ſuch dreadful vengeance as might ſtrike Montezuma and his ſubjects with terror. On a ſignal given, the troops ruſhed out, and fell upon the multitude, deſtitute of leaders, and ſo much aſtoniſhed, that the weapons dropped from their hands, and they ſtood motionleſs, and incapable of defence. While the Spaniards attacked them in front, the Tlaſcalans did the ſame in the rear; the ſtreets were filled with ſlaughter; the temples, which afforded a retreat to the prieſts and ſome leading men, were ſet on fire, and they periſhed in the flames. At length the carnage ceaſed, after the ſlaughter of 6000 Cholulans, without the loſs of a ſingle Spaniard. Cortes then releaſed the magiſtrates; and reproaching them bitterly for their intended treachery, declared, that as juſtice was now appeaſed, he forgave the offence; but required them to recal the inhabitants who had fled, and re-eſtabliſh order in the town.

77
Diſaffection of Montezuma's ſubjects.

From Cholula, Cortes advanced directly towards Mexico; and throughout the whole of his journey was entertained with accounts of the oppreſſions and cruelty of Montezuma. This gave him the greateſt hope of accompliſhing his deſign; as he now perceived that the empire was entirely divided, and no ſort of unanimity prevailed among them. No enemy appeared to check his progreſs. Montezuma was quite irreſolute; and Cortes was almoſt at the gates of the capital before the emperor had determined whether to receive him as a friend or oppoſe him as an enemy. But as no ſign of open hoſtility appeared, the Spaniards, without regarding the fluctuations of Montezuma's ſentiments, continued their march to Mexico, with great circumſpection and the ſtricteſt diſcipline, though without ſeeming to ſuſpect the prince whom they were about to viſit.

78
Meeting of Cortes and Montezuma.

When they drew near the city, about 1000 perſons, who appeared to be of diſtinction, came forth to meet them, adorned with plumes, and clad in mantles of fine cotton. Each of theſe, in his order, paſſed by Cortes, and ſaluted him according to the mode deemed moſt reſpectful and ſubmiſſive in their country. They announced the approach of Montezuma himſelf, and ſoon after his harbingers came in ſight. There appeared firſt 200 perſons in an uniform dreſs, with large plumes of feathers, alike in faſhion, marching two and two, in deep ſilence, barefooted, with their eyes fixed on the ground. Theſe were followed by a company of higher rank, in their moſt ſhowy apparel: in the midſt of whom was Montezuma, in a chair or litter richly ornamented with gold and feathers of various colours. Four of his principal favourites carried him on their ſhoulders, others ſupported a canopy of curious workmanſhip over his head. Before him marched three officers with rods of gold in their hands, which they lifted up on high at certain intervals; and at that ſignal all the people bowed their heads, and hid their faces, as unworthy to look on ſo great a monarch. When he drew near, Cortes diſmounting, advanced towards him with officious haſte, and in a reſpectful poſture. At the ſame time Montezuma alighted from his chair, and leaning on the arms of two of his near relations, approached with a ſlow and ſtately pace, his attendants covering the ſtreet with cotton cloths, that he might not touch the ground. Cortes accoſted him with profound reverence, after the European faſhion. He returned the ſalutation, according to the mode of his country, by touching the earth with his hand, and then kiſſing it. This ceremony appeared ſuch amazing condeſcenſion in a proud monarch, who ſcarcely deigned to conſider the reſt of mankind as of the ſame ſpecies with himſelf, that all his ſubjects firmly believed thoſe perſons, before whom he humbled himſelf in this manner, to be ſomething more than human. Accordingly, as they marched through the crowd, the Spaniards frequently, and with much ſatisfaction, heard themſelves denominated *teules*, or *divinities*. Nothing material paſſed in this firſt interview. Montezuma conducted Cortes to the quarters which he had prepared for his reception; and immediately took leave of him with a politeneſs not unworthy of a court more refined: "You are now (ſays he), with your brothers, in your own houſe; refreſh yourſelves after your fatigue, and be happy until I return." The place allotted to the Spaniards for their lodging was a houſe built by the father of Montezuma. It was ſurrounded by a ſtone wall, with towers at proper diſtances, which ſerved for defence as well as for ornament; and its apartments and courts were ſo large as to accommodate both the Spaniards and their Indian allies. The firſt care of Cortes was to take precautions for his ſecurity, by planting the artillery ſo as to command the different avenues which led to it, by appointing a large diviſion of his troops to be always on guard, and by poſting centinels at proper ſtations, with injunctions to obſerve the ſame vigilant diſcipline as if they were within ſight of an enemy's camp.

In the evening Montezuma returned to viſit his gueſts with the ſame pomp as in their firſt interview; and brought preſents of ſuch value, not only to Cortes and to his officers, but even to the private men, as proved the liberality of the monarch to be ſuitable to the opulence of his kingdom. A long conference enſued, in which Cortes learned what was the opinion of Montezuma with reſpect to the Spaniards. It was an eſtabliſhed tradition, he told him, among the Mexicans, that their anceſtors came originally from a remote region, and conquered the provinces now ſubject to his dominion; that after they were ſettled there, the great captain who conducted this colony returned to his own country, promiſing, that at ſome future period his deſcendents ſhould viſit them, aſſume the government, and reform their conſtitutions and laws; that, from what he had heard and ſeen of Cortes and his followers, he was convinced that they were the very perſons whoſe appearance their prophecies taught them to expect; that accordingly he had received them, not as ſtrangers, but as relations of the ſame blood and parentage, and deſired that they might conſider themſelves as maſters in his dominions; for both himſelf and his ſubjects ſhould be ready to comply with their will, and even to prevent their wiſhes. Cortes made a reply in his uſual ſtyle with reſpect to the dignity and power of his ſovereign, and his intention in ſending him into that country; artfully endeavouring ſo to frame his diſcourſe, that it might coincide as much as poſſible with the idea which Montezuma had formed concerning the origin of the Spaniards. Next morning, Cortes and ſome of his principal attendants were admitted to a public audience of the emperor. The three ſubſequent days were employed in viewing the city; the appearance of which, ſo far ſuperior in the order of its buildings and the number of its inhabitants to any place the Spaniards had beheld in America, and yet ſo little reſembling the ſtructure of an European city, filled them with ſurpriſe and admiration.

79
Deſcription of the city of Mexico.

Mexico is ſituated in a large plain, environed by mountains of ſuch height, that though within the torrid zone, the temperature of its climate is mild and healthful. All the moiſture which deſcends from the high grounds is collected in ſeveral lakes, the two largeſt of which, of about 90 miles in circuit, communicate with each other. The waters of the one are freſh, thoſe of the other brackiſh. On the banks of the latter, and on ſome ſmall iſlands adjoining to them, the capital of Montezuma's empire was built. The acceſs to the city was by artificial cauſeways or ſtreets, formed of ſtones and earth, about 30 feet in breadth. As the waters of the lake, during the rainy ſeaſon, overflowed the flat country, theſe cauſeways were of conſiderable length. That of Tacuba on the weſt a mile and a half; that of Tezcuco on the north-weſt three miles; that of Cuoyacan towards the ſouth ſix miles. On the eaſt there was no cauſeway, and the city could be approached only by canoes. In each of theſe cauſeways were openings at proper intervals, through which the waters flowed; and over theſe beams of timber were laid, which being covered with earth, the cauſeway or ſtreet had everywhere an uniform appearance. As the approaches to the city were ſingular, its conſtruction was remarkable. Not only the temples of their gods, but the houſes belonging to the monarch, and to perſons of diſtinction, were of ſuch dimenſions, that in compariſon with any other buildings which had been diſcovered in America, they might be termed *magnificent*. The habitations of the common people were mean, reſembling the huts of other Indians. But they were all placed in a regular manner, on the banks of the canals which paſſed through the city, in ſome of its diſtricts, or on the ſides of the ſtreets which interſected it in other quarters. In ſeveral places were large openings or ſquares, one of which, allotted for the great market, is ſaid to have been ſo ſpacious that 40,000 or 50,000 perſons carried on traffic there. In this city, the pride of the New World, and the nobleſt monument of the induſtry and art of man, while unacquainted with the uſe of iron, the Spaniards, who are moſt moderate in their computations, reckon that there were at leaſt 60,000 inhabitants.

80
Uneaſineſs of the Spaniards.

But how much ſoever the novelty of thoſe objects might amuſe or aſtoniſh the Spaniards, they felt the utmoſt ſolicitude with reſpect to their own ſituation. From a concurrence of circumſtances, no leſs unexpected than favourable to their progreſs, they had been allowed to penetrate into the heart of a powerful kingdom, and were now lodged in its capital, without having once met with open oppoſition from its monarch. The Tlaſcalans, however, had earneſtly diſſuaded them from placing ſuch confidence in Montezuma as to enter a city of ſuch a peculiar ſituation as Mexico, where that prince would have them at mercy, ſhut up as it were in a ſnare, from which it was impoſſible to eſcape. They aſſured them that the Mexican prieſts had, in the name of the gods, counſelled their ſovereign to admit the ſtrangers into the capital, that he might cut them off there at one blow with perfect ſecurity. The Spaniards now perceived, too plainly, that the apprehenſions of their allies were not deſtitute of foundation; that, by breaking the bridges placed at certain intervals on the cauſeways, or by deſtroying part of the cauſeways themſelves, their retreat would be rendered impracticable, and they muſt remain cooped up in the centre of a hoſtile city, ſurrounded by multitudes ſufficient to overwhelm them, and without a poſſibility of receiving aid from their allies.

81
Some hoſtilities between the Spaniards and Mexicans.

Before he ſet out from Cholula, Cortes had received advice from Villa Rica, that Qualpopoca, one of the Mexican generals on the frontiers, having aſſembled an army in order to attack ſome of the people whom the Spaniards had encouraged to throw off the Mexican yoke, Eſcalante had marched out with part of the garriſon to ſupport his allies; that an engagement had enſued, in which, though the Spaniards were victorious, Eſcalante, with ſeven of his men, had been mortally wounded, his horſe killed, and one Spaniard had been ſurrounded by the enemy and taken alive; that the head of this unfortunate captive, after being carried in triumph to different cities, in order to convince the people that their invaders were not immortal, had been ſent to Mexico. Cortes, though alarmed with this intelligence, as an indication of Montezuma's hoſtile intentions, had continued his march. But as ſoon as he entered Mexico he became ſenſible, that, from an exceſs of confidence in the ſuperior valour and diſcipline of his troops, as well as from the diſadvantage of having nothing to guide him in an unknown country but the defective intelligence which he received from people with whom his mode of communication was very imperfect, he had puſhed forward into a ſituation, where it was difficult to continue, and from which it was dangerous to retire. Diſgrace, and perhaps ruin, was the certain conſequence of attempting the latter. The ſucceſs of his enterpriſe depended upon ſupporting the high opinion which the people of New Spain had formed with reſpect to the irreſiſtible power of his arms. Upon the firſt ſymptom of timidity on his part, their veneration would ceaſe, and Montezuma, whom fear alone reſtrained at preſent, would let looſe upon him the whole force of his empire. At the ſame time, he knew that the countenance of his own ſovereign was to be obtained only by a ſeries of victories; and that nothing but the merit of extraordinary ſucceſs could ſcreen his conduct from the cenſure of irregularity. From all theſe conſiderations, it was neceſſary to maintain his ſtation, and to extricate himſelf out of the difficulties in which one bold ſtep had involved him, by venturing upon another ſtill bolder. The ſituation was trying, but his mind was equal to it; and after revolving the matter with deep attention, he fixed upon a plan no leſs extraordinary than daring. He determined to ſeize Montezuma in his palace, and carry him a priſoner to the

82
Cortes reſolves to ſeize Montezuma in his palace.

the Spaniſh quarters. From the ſuperſtitious veneration of the Mexicans for the perſon of their monarch, as well as their implicit ſubmiſſion to his will, he hoped, by having Montezuma in his power, to acquire the ſupreme direction of their affairs; or at leaſt, with ſuch a ſacred pledge in his hands, he made no doubt of being ſecure from any effort of their violence.

This he immediately propoſed to his officers. The timid ſtartled at a meaſure ſo audacious, and raiſed objections. The more intelligent and reſolute, conſcious that it was the only reſource in which there appeared any proſpect of ſafety, warmly approved of it, and brought over their companions ſo cordially to the ſame opinion, that it was agreed inſtantly to make the attempt. At his uſual hour of viſiting Montezuma, Cortes went to the palace, accompanied by Alvarado, Sandoval, Lugo, Velaſquez de Leon, and Davila, five of his principal officers, and as many truſty ſoldiers. Thirty choſen men followed, not in regular order, but ſauntering at ſome diſtance, as if they had no object but curioſity; ſmall parties were poſted at proper intervals, in all the ſtreets leading from the Spaniſh quarters to the court; and the remainder of his troops, with the Tlaſcalan allies, were under arms, ready to ſally out on the firſt alarm. Cortes and his attendants were admitted without ſuſpicion; the Mexicans retiring, as uſual, out of reſpect. He addreſſed the monarch in a tone very different from that which he had employed in former conferences; reproaching him bitterly as the author of the violent aſſault made upon the Spaniards by one of his officers, and demanding public reparation for the loſs which he had ſuſtained by the death of ſome of his companions, as well as for the inſult offered to the great prince whoſe ſervants they were. Montezuma, confounded at this unexpected accuſation, and changing colour either from the conſciouſneſs of guilt, or from feeling the indignity with which he was treated, aſſerted his own innocence with great earneſtneſs; and, as proof of it, gave orders inſtantly to bring Qualpopoca and his accomplices priſoners to Mexico. Cortes replied, with ſeeming complaiſance, that a declaration ſo reſpectable left no doubt remaining in his own mind; but that ſomething more was requiſite to ſatisfy his followers, who would never be convinced that Montezuma did not harbour hoſtile intentions againſt them, unleſs, as an evidence of his confidence and attachment, he removed from his own palace and took up his reſidence in the Spaniſh quarters, where he ſhould be ſerved and honoured as became a great monarch. The firſt mention of ſo ſtrange a propoſal bereaved Montezuma of ſpeech, and almoſt of motion. At length he haughtily anſwered, "That perſons of his rank were not accuſtomed voluntarily to give up themſelves as priſoners; and were he mean enough to do ſo, his ſubjects would not permit ſuch an affront to be offered to their ſovereign." Cortes, unwilling to employ force, endeavoured alternately to ſoothe and intimidate him. The altercation became warm: and having continued above three hours, Velaſquez de Leon, an impetuous and gallant young man, exclaimed with impatience, "Why waſte more time in vain? Let us either ſeize him inſtantly, or ſtab him to the heart." The threatening voice and fierce geſtures with which theſe words were uttered, ſtruck Montezuma. The Spaniards, he was ſenſible, had now proceeded ſo far, as left him no hope that they would recede. His own danger was imminent, the neceſſity unavoidable. He ſaw both; and abandoning himſelf to his fate, complied with their requeſt.

83
The emperor carried to the Spaniſh quarters.

His officers were called. He communicated to them his reſolution. Though aſtoniſhed and afflicted, they preſumed not to queſtion the will of their maſter, but carried him in ſilent pomp, all bathed in tears, to the Spaniſh quarters.

84
Cortes rules the empire.

85
By a pretence, he obtains leave to build two brigantines on the lake.

They at firſt pretended to treat Montezuma with great reſpect; but ſoon took care to let him know that he was entirely in their power. Cortes wiſhed that the ſhedding the blood of a Spaniard ſhould appear the moſt heinous crime that could be committed; and therefore not only took a moſt exemplary vengeance on thoſe who had been concerned in the affair of Villa Rica, but even put the emperor himſelf in chains till the execution of the Mexican general was over. By theſe, and other inſults, he at laſt gained entirely the aſcendant over this unhappy monarch; and he took care to improve his opportunity to the utmoſt. He ſent his emiſſaries into different parts of the kingdom, accompanied with Mexicans of diſtinction, who might ſerve both to guide and to protect them. They viſited moſt of the provinces, viewed their ſoil and productions, ſurveyed with particular care the diſtricts which yielded gold or ſilver, pitched upon ſeveral places as proper for future colonies, and endeavoured to prepare the minds of the people for ſubmitting to the Spaniſh yoke: and while they were thus employed, Cortes, in the name and by the authority of Montezuma, degraded ſome of the principal officers in the empire, whoſe abilities or independent ſpirit excited his jealouſy; and ſubſtituted in their place perſons who he imagined would be more obſequious. One thing, however, was ſtill wanting to complete his ſecurity. He wiſhed to have ſuch a command of the lake as might enſure a retreat, if, either from levity or diſguſt, the Mexicans ſhould take arms againſt him, and break down the bridges or cauſeways, in order to encloſe him in the city. In order to obtain this without giving diſguſt to the emperor or his court, Cortes artfully inflamed the curioſity of the Indians with accounts of the Spaniſh ſhipping, and thoſe floating palaces that moved with ſuch velocity on the water, without the aſſiſtance of oars; and when he found that the monarch himſelf was extremely deſirous of ſeeing ſuch a novelty, he gave him to underſtand, that nothing was wanting to his gratification beſides a few neceſſaries from Vera Cruz, for that he had workmen in his army capable of building ſuch veſſels. The bait took with Montezuma; and he gave immediate orders that all his people ſhould aſſiſt Cortes in whatever he ſhould direct concerning the ſhipping. By this means, in a few days, two brigantines were got ready, full rigged and equipped; and Montezuma was invited on board, to make the firſt trial of their ſailing, of which he could form no idea. Accordingly he embarked for this purpoſe, and gave orders for a great hunting upon the water, in order that all his people might be diverted with the novelty preſented by the Spaniards. On the day appointed, the royal equipage was ready early in the morning; and the lake was covered with a multitude of boats and canoes loaded with people. The Mexicans had augmented the

the number of their rowers on board the royal barges, with an intention to diſgrace the Spaniſh veſſels, which they regarded as clumſy, unwieldy, and heavy. But they were ſoon undeceived; a freſh gale ſtarted up, the brigantines hoiſted ſail, to the utter aſtoniſhment of all the ſpectators, and ſoon left all the canoes behind; while the monarch exulted in the victory of the Spaniards, without once conſidering that now he had effectually rivetted his own chains.

86
Montezuma owns himſelf a vaſſal to the king of Spain.

Cortes having obtained this important point, reſolved to put the condeſcenſion of the emperor to a trial ſtill more ſevere. He urged Montezuma to acknowledge himſelf a vaſſal to the crown of Caſtile; to hold his crown of him as ſuperior, and to ſubject his dominions to the payment of an annual tribute. With this requiſition, humiliating as it was, Montezuma complied. He called together the chief men of his empire, and, in a ſolemn harangue, reminded them of the traditions and prophecies which led them to expect the arrival of a people ſprung from the ſame ſtock with themſelves, in order to take poſſeſſion of the ſupreme power; he declared his belief that the Spaniards were this promiſed race; and that therefore he recogniſed the right of their monarch to govern the Mexican empire, would lay his crown at his feet, and obey him as a tributary. While uttering theſe words, Montezuma diſcovered how deeply he was affected in making ſuch a ſacrifice. Tears and groans frequently interrupted his diſcourſe. The firſt mention of ſuch a reſolution ſtruck the aſſembly dumb with aſtoniſhment. This was followed by a ſullen murmur of ſorrow mingled with indignation; which indicated ſome violent eruption of rage to be near at hand. This Cortes foreſaw, and ſeaſonably interpoſed to prevent it, by declaring that his maſter had no intention to deprive Montezuma of the royal dignity, or to make any innovation upon the conſtitution and laws of the Mexican empire. This aſſurance, added to their dread of the Spaniſh arms, and the authority of their monarch's example, extorted the conſent of the aſſembly; and the act of ſubmiſſion and homage was executed with all the formalities which the Spaniards pleaſed to preſcribe.

87
The Spaniards divide their treaſure.

Montezuma, at the requeſt of Cortes, accompanied this profeſſion of fealty and homage with a magnificent preſent to his new ſovereign; and, after his example, his ſubjects brought in very liberal contributions. The Spaniards then collected all the treaſure which had been either voluntarily beſtowed upon them at different times by Montezuma, or had been extorted from his people under various pretences; and having melted the gold and ſilver, the value of theſe amounted to 600,000 peſos. The ſoldiers were impatient to have it divided; and Cortes complied with their deſire. A fifth of the whole was ſet apart as the tax due to the king. Another fifth was allowed to Cortes as commander. The ſums advanced by the governor of Cuba who had originally fitted out the expedition, were then deducted. The remainder was then divided among the army, including the garriſon of Vera Cruz, in proportion to their different ranks; and after ſo many deductions, the ſhare of a private man did not exceed 100 peſos. This ſum fell ſo far below their ſanguine expectations, that it required all the addreſs, and no ſmall exertions of the liberality of Cortes, to prevent an open mutiny. However, he at laſt reſtored tranquillity; but had no ſooner eſcaped this danger, than he involved himſelf, by his imprudent zeal for religion, in one much worſe. Montezuma, though often importuned, had obſtinately refuſed to change his religion, or aboliſh the ſuperſtitious rites which had been for ſuch a long time practiſed throughout his dominions. This at laſt tranſported the Spaniard with ſuch rage, that, in a ſally of zeal, he led out his ſoldiers in order to throw down the idols in the great temple by force. But the prieſts taking arms in defence of their altars, and the people crowding with great ardour to ſupport them, Cortes's prudence over ruled his zeal, and induced him to deſiſt from his raſh attempt, after diſlodging the idols from one of the ſhrines, and placing in their ſtead an image of the Virgin Mary.

88
Cortes attempts to deſtroy the Mexican idols.

89
Which produces a general diſaffection.

From this moment the Mexicans began to meditate the expulſion or the deſtruction of the Spaniards. The prieſts and leading men held frequent meetings with Montezuma for this purpoſe. But as any violent attempt might have proved fatal to the captive monarch, it was thought proper firſt to try more gentle means. Having called Cortes into his preſence, he obſerved, that now, as all the purpoſes of his embaſſy were fully accompliſhed, the gods had declared their will, and the people ſignified their deſire, that he and his followers ſhould inſtantly depart out of the empire. With this he required them to comply, or unavoidable deſtruction would fall ſuddenly on their heads. This unexpected requiſition, as well as the manner in which it was delivered, alarmed Cortes. However, he ſuppoſed that more might be gained by a feigned compliance than by open reſiſtance; and therefore replied with great compoſure, that he had already begun to prepare for his return; but as he had deſtroyed the veſſels in which he arrived, ſome time was requiſite for building other ſhips. This appeared reaſonable; and a number of Mexicans were ſent to Vera Cruz to cut down timber, and ſome Spaniſh carpenters were appointed to ſuperintend the work.

90
The Spaniards are commanded to depart.

91
An armament ſent from Cuba againſt Cortes.

Cortes flattered himſelf, that, during this interval, he might either find means to avert the threatened danger, or receive ſuch reinforcements as would enable him to defend himſelf. Nine months had now elapſed ſince Portocarrero and Montejo had ſailed with his deſpatches to Spain; and he daily expected a return, with a confirmation of his authority from the king, without which all that he had done ſerved only to mark him out as an object of puniſhment. While he remained in great anxiety on this account, news were brought that ſome ſhips had appeared on the coaſt. Theſe were imagined by Cortes to be a reinforcement ſent him from Spain: but his joy was of ſhort continuance, for a courier very ſoon arrived from Vera Cruz, with certain information that the armament was fitted out by Velaſquez, the governor of Cuba; and inſtead of bringing ſuccours, threatened them with immediate deſtruction.

Velaſquez had been excited to this hoſtile meaſure chiefly through the indiſcretion, or rather treachery, of the meſſengers of Cortes; who, contrary to his expreſs injunctions, had landed on the iſland of Cuba, and given intelligence of all that had paſſed: and Velaſquez, tranſported with rage at hearing of the proceedings of Cortes, had now ſent againſt him this armament; conſiſting of 18 ſhips, which carried 80 horſemen,

men, 800 infantry, of which 80 were muſketeers, and 120 croſs bowmen, commanded by a brave officer named *Pamphilo de Narvaez;* whoſe inſtructions were, to ſeize Cortes and his principal officers, to ſend them priſoners to him, and then to complete the diſcovery and conqueſt of the country in his name. This proved a moſt afflicting piece of news to Cortes.

92
Which is defeated by that general.

Having now no reſource but in war, he left 150 men under the command of Pedro de Alvarado, an officer of great bravery, and much reſpected by the Mexicans, to guard the capital and the captive emperor; while he himſelf marched with the remainder, to meet his formidable opponent, who had taken poſſeſſion of Zempoalla. Even after being reinforced by Sandoval his governor of Vera Cruz, the force of Cortes did not exceed 250 men. He hoped for ſucceſs chiefly from the rapidity of his motions and the poſſibility of ſurpriſing his enemies; and as he chiefly dreaded their cavalry, he armed his ſoldiers with long ſpears, accuſtoming them to that deep and compact arrangement which the uſe of this formidable weapon enabled them to aſſume. As he advanced, however, he repeated his propoſals of accommodation; but theſe being conſtantly rejected, and a price ſet upon his head, he at laſt attacked Narvaez in the night-time, entirely defeated and took him priſoner, obliging all his troops to own allegiance to himſelf.

93
Dangerous ſituation of the Spaniards left at Mexico.

Nothing could be more ſeaſonable than this victory, by which Cortes found his army very conſiderably increaſed; for moſt of the ſoldiers of Narvaez choſe rather to follow Cortes than to return to Cuba, whither the conqueror had offered to ſend them if they choſe. His affairs at Mexico, in the mean time, were in the utmoſt danger of being totally ruined; and had this deciſive victory been delayed but a few days longer, he muſt have come too late to ſave his companions. A ſhort time after the defeat of Narvaez, a courier arrived from Mexico with the diſagreeable intelligence that the Mexicans had taken arms; and having ſeized and deſtroyed the two brigantines which he had built in order to ſecure the command of the lake, had attacked the Spaniards in their quarters, killed ſome, and wounded many more, burnt their magazine of proviſions, and, in ſhort, carried on hoſtilities with ſuch fury, that though Alvarado and his men defended themſelves with undaunted reſolution, they muſt either be cut off by famine, or ſink under the multitude of their enemies. This revolt was excited by motives which rendered it ſtill more alarming. On the departure of Cortes for Zempoalla, the Mexicans flattered themſelves, that the long-expected opportunity of reſtoring their ſovereign to liberty, and driving out the Spaniards, was arrived; and conſultations were accordingly held for bringing about both theſe events. The Spaniards in Mexico, conſcious of their own weakneſs, ſuſpected and dreaded theſe machinations; but Alvarado, who had neither the prudence nor the addreſs of Cortes, took the worſt method imaginable to overcome them. Inſtead of attempting to ſoothe or cajole the Mexicans, he waited the return of one of their ſolemn feſtivals, when the principal perſons in the empire were dancing, according to cuſtom, in the court of the great temple; he ſeized all the avenues which led to it; and, allured partly by the rich ornaments which they wore in honour of their gods, and partly by the facility of cutting off at once the authors of that conſpiracy which he dreaded, he fell upon them, unarmed and unſuſpicious of danger, and maſſacred a great number; none eſcaping but ſuch as made their way over the battlements of the temple. An action ſo cruel and treacherous filled not only the city, but the whole empire, with indignation and rage; and the Mexicans immediately proceeded in the manner above mentioned.

94
Cortes allowed to return to Mexico;

Cortes advanced with the utmoſt celerity to the relief of his diſtreſſed companions: but as he paſſed along, had the mortification to find that the Spaniards were generally held in abhorrence. The principal inhabitants had deſerted the towns through which he paſſed; no perſon of note appeared to meet him with the uſual reſpect; nor were proviſions brought to his camp as uſual. Notwithſtanding theſe ſigns of averſion and horror, however, the Mexicans were ſo ignorant of the military art, that they again permitted him to enter the capital without oppoſition; though it was in their power to have eaſily prevented him, by breaking down the bridges and cauſeways which led to it.

95
but is furiouſly attacked by the natives.

Cortes was received by his companions with the utmoſt joy; and this extraordinary ſucceſs ſo far intoxicated the general himſelf, that he not only neglected to viſit Montezuma, but expreſſed himſelf very contemptuouſly concerning him. Theſe expreſſions being reported among the Mexicans, they all at once flew to arms, and made ſuch a violent and ſudden attack, that all the valour and ſkill of Cortes were ſcarce ſufficient to repel them. This produced great uneaſineſs among the ſoldiers of Narvaez, who had imagined there was nothing to do but to gather the ſpoils of a conquered country. Diſcontent and murmurings, however, were now of no avail; they were encloſed in a hoſtile city, and, without ſome extraordinary exertions, were inevitably undone. Cortes therefore, made a deſperate ſally; but, after exerting his utmoſt efforts for a whole day, was obliged to retire with the loſs of 12 killed, and upwards of 60 wounded. Another ſally was attempted with the like bad ſucceſs, and in it Cortes himſelf was wounded in the hand.

The Spaniſh general was now thoroughly convinced of his error; and therefore betook himſelf to the only reſource which was left; namely, to try what effect the interpoſition of Montezuma would have to ſoothe or overawe his ſubjects. When the Mexicans approached the next morning to renew the aſſault, that unfortunate prince, at the mercy of the Spaniards, and reduced to the ſad neceſſity of becoming the inſtrument of his own diſgrace, and of the ſlavery of his people advanced to the battlements in his royal robes, and with all the pomp in which he uſed to appear on ſolemn occaſions. At the ſight of their ſovereign, whom they had been long accuſtomed to reverence almoſt as a god, the Mexicans inſtantly forebore their hoſtilities, and many proſtrated themſelves on the ground: but when he addreſſed them in favour of the Spaniards, and made uſe of all the arguments he could think of to mitigate their rage, they teſtified their reſentment with loud murmurings; and at length broke forth

96
Montezuma killed.

forth with ſuch fury, that before the ſoldiers, appointed to guard Montezuma, had time to cover him with their ſhields, he was wounded with two arrows, and a blow on his temple with a ſtone ſtruck him to the ground. On ſeeing him fall, the Mexicans inſtantly fled with the utmoſt precipitation: but the unhappy monarch, now convinced that he was become an object of contempt even to his own ſubjects, obſtinately refuſed all nouriſhment; and thus in a ſhort time ended his days.

97
A terrible engagement between the Spaniards and Mexicans.

On the death of Montezuma, Cortes having loſt all hope of bringing the Mexicans to any terms of peace, prepared for retreat. But his antagoniſts, having taken poſſeſſion of a high tower in the great temple, which overlooked the Spaniſh quarters, and placing there a garriſon of their principal warriors, the Spaniards were ſo much expoſed to their miſſile weapons, that none could ſtir without danger of being killed or wounded. From this poſt, therefore, it was neceſſary to diſlodge them at any rate; and Juàn de Eſcobar, with a large detachment of choſen ſoldiers, was ordered to make the attack. But Eſcobar, though a valiant officer, and though he exerted his utmoſt efforts, was thrice repulſed. Cortes, however, ſenſible that not only his reputation, but the ſafety of his army, depended on the ſucceſs of this aſſault, cauſed a buckler to be tied to his arm, as he could not manage it with his wounded hand, and ruſhed with his drawn ſword among the thickeſt of the combatants. Encouraged by the preſence of their general, the Spaniards returned to the charge with ſuch vigour, that they gradually forced their way up the ſteps, and drove the Mexicans to the platform at the top of the tower. There a dreadful carnage began; when two young Mexicans of high rank, obſerving Cortes, as he animated his ſoldiers, reſolved to ſacrifice their own lives in order to cut off the author of ſo many calamities which deſolated their country. They approached him in a ſuppliant poſture, as if they intended to lay down their arms; and ſeizing him in a moment, hurried him towards the battlements, over which they threw themſelves headlong, in hopes of dragging him along with them. But Cortes, by his ſtrength and agility, diſengaged himſelf from their graſp; ſo that the two Mexicans periſhed alone.

As ſoon as the Spaniards became maſters of the tower, they ſet fire to it, and without further moleſtation continued the preparations for their retreat. This became the more neceſſary, as their enemies, aſtoniſhed at this laſt effort of their valour, had now entirely changed their ſyſtem of hoſtility; and, inſtead of inceſſant attacks, endeavoured, by barricading the ſtreets, and breaking down the cauſeways, to cut off the communication of the Spaniards with the continent, and thus to ſtarve an enemy whom they could not ſubdue. The firſt point to be determined, was whether they ſhould march out openly in the face of day, when they could diſcern every danger, or whether they ſhould endeavour to retire ſecretly in the night. The latter was preferred, partly from hopes that the ſuperſtition of the Mexicans would prevent them from attacking them in the night, and partly from their own ſuperſtition in giving credit to the predictions of a private ſoldier, who pretended to aſtrology, and aſſured them of ſucceſs if they retreated in this manner. Towards midnight, therefore, they began their march, in three diviſions. Sandoval led the van; Pedro Alvarado and Velaſquez de Lèon had the conduct of the rear; and Cortes commanded in the centre, where he placed the priſoners, among whom were a ſon and two daughters of Montezuma, together with ſeveral Mexicans of diſtinction, the artillery, baggage, and a portable bridge of timber intended to be laid over the breaches in the cauſeway. They marched in profound ſilence along the cauſeway which led to Tacuba, becauſe it was ſhorter than any of the reſt, and, lying moſt remote from the road towards Tlaſcala and the ſea coaſt, had been left moſt entire by the Mexicans.

98
Cortes retreats with great loſs.

They reached the firſt breach in the cauſeway without moleſtation, hoping that their retreat was undiſcovered. But the Mexicans had not only watched all their motions, but made preparations for a moſt formidable attack. While the Spaniards were intent upon placing their bridges in the breach, and occupied in conducting their horſes and artillery along it, they were ſuddenly alarmed with the ſound of warlike inſtruments, and found themſelves aſſaulted on all ſides by an innumerable multitude of enemies. Unfortunately the wooden bridge was wedged ſo faſt in the mud by the weight of the artillery, that it was impoſſible to remove it. Diſmayed at this accident, the Spaniards advanced with precipitation to the ſecond breach. The Mexicans hemmed them in on every ſide; and though they defended themſelves with their uſual courage, yet, crowded as they were in a narrow cauſeway, their diſcipline and military ſkill were of little avail; nor did the obſcurity of the night allow them to derive much advantage from their fire-arms or the ſuperiority of their other weapons. At laſt the Spaniards, overborne with the numbers of their enemies, began to give way, and in a moment the confuſion was univerſal. Cortes, with about 100 foot ſoldiers, and a few horſe, forced his way over the two remaining breaches in the cauſeway, the bodies of the dead ſerving to fill up the chaſms, and reached the main land. Having formed them as ſoon as they arrived, he returned with ſuch as were yet capable of ſervice, to aſſiſt his friends in their retreat. He met with part of his ſoldiers who had forced their way through the enemy, but found many more overwhelmed by the multitude of their aggreſſors, or periſhing in the lake; and heard the grievous lamentations of others whom the Mexicans were carrying off in triumph to be ſacrificed to the god of war.

In this fatal retreat more than one half of Cortes's army periſhed, together with many officers of diſtinction. All the artillery, ammunition, and baggage, were loſt; the greater part of the horſes and above 2000 Tlaſcalans were killed, and only a very ſmall part of their treaſure ſaved. The firſt care of the Spaniſh general was to find ſome ſhelter for his wearied troops; for, as the Mexicans infeſted them on every ſide, and the people of Tacuba began to take arms, he could not continue in his preſent ſtation. At laſt he diſcovered a temple ſeated on an eminence, in which he found not only the ſhelter he wanted, but ſome proviſions; and though the enemy did not intermit their attacks throughout the day, they were without much difficulty prevented from making any impreſſion. For ſix days after, they continued their march through a barren, ill cultivated, and thinly peopled country, where they were often obliged to feed on berries, roots, and the ſtalks of green maize; at the ſame time they were haraſſed without intermiſſion by large parties of Mexicans, who attacked them on all ſides. On the ſixth day they reached Otumba, not far from the road between Mexico and Tlaſcala. Early next morning they began to advance towards it, flying parties of the enemy ſtill hanging on their rear; and amidſt the inſults with which they accompanied their hoſtilities, Donna Marina remarked, that they often exclaimed with exultation, "Go on, robbers; go to the place where you ſhall quickly meet the vengeance due to your crimes." The meaning of this threat the Spaniards did not comprehend, until they reached the ſummit of an eminence before them. There a ſpacious valley opened to their view, covered with a vaſt army as far as the eye could reach. The Mexicans, while with one body of their troops they haraſſed the Spaniards in their retreat, had aſſembled their principal force on the other ſide of the lake; and marching along the road which led directly to Tlaſcala, poſted it in the plain of Otumba, through which they knew Cortes muſt paſs. 99 The battle of Otumba. At the ſight of this incredible multitude, which they could ſurvey at once from the riſing ground, the Spaniards were aſtoniſhed, and even the boldeſt began to deſpair. But Cortes, without allowing their fears time to operate, after warning them briefly that no alternative remained but to conquer or die, led them inſtantly to the charge. The Mexicans waited their approach with unuſual fortitude: yet ſuch was the ſuperiority of the Spaniſh diſcipline and arms, that the impreſſion of this ſmall body was irreſiſtible; and whichever way its force was directed, it penetrated and diſperſed the moſt numerous battalions. But while theſe gave way in one quarter, new combatants advanced from another; and the Spaniards, though ſucceſsful in every attack, were ready to ſink under theſe repeated efforts, without ſeeing any end to their toil, or any hope of victory. At that time Cortes obſerved the great ſtandard of the empire, which was carried before the Mexican general, advancing; and fortunately recollecting to have heard, that on the fate of it depended the event of every battle, he aſſembled a few of his braveſt officers, whoſe horſes were ſtill capable of ſervice, and, placing himſelf at their head, puſhed towards the ſtandard with ſuch impetuoſity that he bore down every thing before him. A choſen body of nobles, who guarded the ſtandard, made ſome reſiſtance, but were ſoon broken. Cortes, with a ſtroke of his lance, wounded the Mexican general, and threw him to the ground. One of his followers alighting, put an end to his life, and laid hold of the imperial ſtandard. The moment that their leader fell, and the ſtandard, towards which all directed their eyes, diſappeared, an univerſal panic ſtruck the Mexicans; and, as if the bond which held them together had been diſſolved, every enſign was lowered, each ſoldier threw away his weapons, and fled with precipitation to the mountains. 100 Mexicans defeated. The Spaniards, unable to purſue them far, returned to collect the ſpoils of the field; and theſe were ſo valuable as to be ſome compenſation for the wealth which they had loſt in Mexico; for in the enemy's army were moſt of their principal warriors dreſſed out in their richeſt ornaments, as if they had been marching to aſſured victory.

The day after this important action (being July 8. 1520), the Spaniards entered the Tlaſcalan territories, where they were received with the moſt cordial friendſhip. Cortes endeavoured to avail himſelf of this diſpoſition as much as poſſible; for which purpoſe he diſtributed among them the rich ſpoils taken at Otumba with ſuch a liberal hand, that he made himſelf ſure of obtaining from the republic whatever he ſhould deſire. He drew a ſmall ſupply of ammunition, and two or three field-pieces, from his ſtores at Vera Cruz. He deſpatched an officer of confidence with four ſhips of Narvaez's fleet to Hiſpaniola and Jamaica, to engage adventurers, and to purchaſe horſes, gunpowder, and other military ſtores. And as he knew that it would be in vain to attempt the reduction of Mexico, unleſs he could ſecure the command of the lake, he gave orders to prepare, in the mountains of Tlaſcala, materials for building 12 brigantines, ſo that they might be carried thither in pieces, ready to be put together, and launched when he ſtood in need of their ſervice. But, in the mean time, his ſoldiers, alarmed at the thoughts of being expoſed to ſuch calamities a ſecond time, preſented a remonſtrance to their general, in which they repreſented the imprudence of attacking a powerful empire with his ſhattered forces, and formally required him to return back to Cuba. All the eloquence of Cortes could now only prevail with them to delay their departure for ſome time, when he promiſed to diſmiſs ſuch as ſhould deſire it. However, this was only a pretence; for Cortes, in fact, had the conqueſt of Mexico as much at heart as ever. Without giving his ſoldiers an opportunity of caballing, therefore, he daily employed them againſt the people of the neighbouring provinces, who had cut off ſome detachments of Spaniards during his misfortunes at Mexico; and by which, as he was conſtantly attended with ſucceſs, his men ſoon reſumed their wonted ſenſe of ſuperiority.

101 Cortes receives an unexpected reinforcement.

But all the efforts of Cortes could have been of little avail, had he not unexpectedly obtained a reinforcement of Spaniſh ſoldiers. Theſe belonged to an armament fitted out by Franciſco de Garay, governor of Jamaica, who had long aimed at dividing with Cortes the glory and gain of annexing the empire of Mexico to the crown of Caſtile. They had, however, unadviſedly made their attempt on the northern provinces, where the country was poor and the inhabitants fierce and warlike; ſo that, after a ſucceſſion of diſaſters, they were now obliged to venture into Vera Cruz, and caſt themſelves upon the mercy of their countrymen; and here they alſo were ſoon perſuaded to throw off their allegiance to their maſter, and to enliſt with Cortes. About the ſame time a ſhip arrived from Spain, freighted by ſome private adventurers, with military ſtores; and the cargo was eagerly purchaſed by Cortes, while the crew, following the example of the reſt, joined him at Tlaſcala.

From theſe various quarters, the army of Cortes was augmented with 180 men and 20 horſes; by which means he was enabled to diſmiſs ſuch of the ſoldiers of Narvaez as were moſt troubleſome and diſcontented; after the departure of whom he ſtill muſtered 550 infantry, of whom 80 were armed with muſkets or croſs-bows, 40 horſemen, and nine pieces of artillery. 102 He ſets out again for Mexico. At the head of theſe, with 10,000 Tlaſcalans and other friendly Indians, he began his march towards Mexico, on the 28th of December, ſix months after his fatal retreat from that city.

As ſoon as Cortes entered the enemy's territories, he diſcovered various preparations to obſtruct his progreſs. But his troops forced their way with little difficulty; and took poſſeſſion of Tezcuco, the ſecond city of the empire, ſituated on the banks of the lake, about 20 miles from Mexico. Here he determined to eſtabliſh his head-quarters, as the moſt proper ſtation for launching his brigantines, as well as for making his approaches to the capital. In order to render his reſidence there more ſecure, he depoſed the cacique or chief, who was at the head of that community, under pretence of ſome defect in his title, and ſubſtituted in his place a perſon whom a faction of the nobles pointed out as the right heir of that dignity. Attached to him by this benefit, the new cacique and his adherents ſerved the Spaniards with inviolable fidelity.

As the conſtruction of the brigantines advanced ſlowly under the unſkilful hands of ſoldiers and Indians, whom Cortes was obliged to employ in aſſiſting three or four carpenters who happened fortunately to be in his ſervice, and as he had not yet received the reinforcement which he expected from Hiſpaniola, he was not in a condition to turn his arms directly againſt the capital. To have attacked a city ſo populous, ſo well prepared for defence, and in a ſituation of ſuch peculiar ſtrength, muſt have expoſed his troops to inevitable deſtruction. Three months elapſed before the materials for conſtructing the brigantines were finiſhed, and before he heard any thing with reſpect to the ſucceſs of his negotiation in Hiſpaniola. 103 Cortes makes great progreſs. This, however, was not a ſeaſon of inaction to Cortes. He attacked ſucceſſively ſeveral of the towns ſituated around the lake; and though all the Mexican power was exerted to obſtruct his operations, he either compelled them to ſubmit to the Spaniſh crown, or reduced them to ruins. Other towns he endeavoured to conciliate by more gentle means; and though he could not hold any intercourſe with the inhabitants but by the intervention of interpreters, yet, under all the diſadvantages of that tedious and imperfect mode of communication, he had acquired ſuch thorough knowledge of the ſtate of the country, as well as of the diſpoſitions of the people, that he conducted his negotiations and intrigues with aſtoniſhing dexterity and ſucceſs. Moſt of the cities adjacent to Mexico were originally the capitals of ſmall independent ſtates; and ſome of them having been but lately annexed to the Mexican empire, ſtill retained the remembrance of their ancient liberty, and bore with impatience the rigorous yoke of their new maſters. Cortes having early obſerved ſymptoms of their diſaffection, availed himſelf of this knowledge to gain their confidence and friendſhip. By offering with confidence to deliver them from the odious dominion of the Mexicans, and by liberal promiſes of more indulgent treatment if they would unite with him againſt their oppreſſors, he prevailed on the people of ſeveral conſiderable diſtricts, not only to acknowledge the king of Caſtile as their ſovereign, but to ſupply the Spaniſh camp with proviſions, and to ſtrengthen his army with auxiliary troops. Guatimozin, on the firſt appearance of defection among his ſubjects, exerted himſelf with vigour to prevent or to puniſh their revolt; but, in ſpite of his efforts, the ſpirit continued to ſpread. The Spaniards gradually acquired new allies; and with deep concern he beheld Cortes arming againſt his empire thoſe very hands which ought to have been active in his defence, and ready to advance againſt the capital at the head of a numerous body of his own ſubjects.

While, by theſe various methods, Cortes was gradually circumſcribing the Mexican power within ſuch narrow limits that his proſpect of overturning it ſeemed neither to be uncertain nor remote, all his ſchemes were well nigh defeated by a conſpiracy againſt his own perſon, and which was diſcovered only a ſhort time before it was to have been executed. Though many were concerned, Cortes did not think proper to puniſh any more than the principal ringleader, whom he cauſed immediately to be hanged; and then, without allowing them leiſure to ruminate on what had happened, and as the moſt effectual means of preventing the return of a mutinous ſpirit, he determined to call forth his troops immediately to action. Fortunately a proper occaſion for this occurred, without his ſeeming to court it. He received intelligence, that the materials for building the brigantines were at length completely finiſhed, and waited only for a body of Spaniards to conduct them to Tezcuco. The command of this convoy, conſiſting of 200 foot ſoldiers, 15 horſemen, and two field pieces, he gave to Sandoval, who by the vigilance, activity, and courage, which he manifeſted on every occaſion, was growing daily in his confidence, and in the eſtimation of his fellow-ſoldiers. The Tlaſcalans furniſhed 8000 *Tamenes*, an inferior order of men deſtined for ſervile taſks, to carry the materials on their ſhoulders, and appointed 15,000 warriors to accompany and defend them. Sandoval made the diſpoſition for their progreſs with great propriety, placing the Tamenes in the centre, one body of warriors in the front, another in the rear, with conſiderable parties to cover the flanks. To each of theſe he joined ſome Spaniards, not only to aſſiſt them in danger, but to accuſtom them to regularity and ſubordination. Parties of Mexicans frequently appeared hovering around them on the high grounds: but perceiving no proſpect of ſucceſs in attacking an enemy continually on his guard, and prepared to receive them, they did not venture to moleſt him; and Sandoval had the glory of conducting ſafely to Tezcuco a convoy on which all the future operations of his countrymen depended.

104 Mexico beſieged. Cortes determined to attack the city from three different quarters; from Tezcuco on the eaſt ſide of the lake, from Tacuba on the weſt, and from Cuayocan towards the ſouth. Thoſe towns were ſituated on the principal cauſeways which led to the capital, and intended for their defence. He appointed Sandoval to command in the firſt, Pedro de Alvarado in the ſecond, and Chriſtoval de Olid in the third; allotting to each a numerous body of Indian auxiliaries, together with an equal diviſion of Spaniards, who, by the junction of the troops from Hiſpaniola, amounted now to 86 horſemen, and 818 foot ſoldiers; of whom 118 were armed with muſkets or croſs bows. Their train of artillery conſiſted of three battering cannon, and 15 field-

pieces. He reſerved for himſelf, as the ſtation of greateſt importance and danger, the conduct of the brigantines, each armed with one of his ſmall cannon, and manned with 25 Spaniards.

As Alvarado and Olid proceeded towards the poſts aſſigned them, they broke down the aqueducts which the ingenuity of the Mexicans had erected for conveying water into the capital, and, by the diſtreſs to which this reduced the inhabitants, gave a beginning to the calamities which they were deſtined to ſuffer. Alvarado and Olid found the towns, of which they were ordered to take poſſeſſion, deſerted by their inhabitants, who had fled for ſafety to the capital, where Guatimozin had collected the chief force of his empire, as there alone he could hope to make a ſucceſsful ſtand againſt the formidable enemies who were approaching to aſſault him.

105
The Spaniards defeat the Mexicans, and become maſters of the lake.

The firſt effort of the Mexicans was to deſtroy the fleet of brigantines, the fatal effects of whoſe operations they foreſaw and dreaded. Though the brigantines, after all the labour and merit of Cortes in forming them, were of inconſiderable bulk, rudely conſtructed, and manned chiefly with landmen, hardly poſſeſſed of ſkill enough to conduct them, they muſt have been objects of terror to a people unacquainted with any navigation but that of their lake, and poſſeſſed of no veſſel larger than a canoe. Neceſſity, however, urged Guatimozin to hazard the attack; and hoping to ſupply by numbers what he wanted in force, he aſſembled ſuch a multitude of canoes as covered the face of the lake. They rowed on boldly to the charge, while the brigantines, retarded by a dead calm, could ſcarcely advance to meet them. But as the enemy drew near, a breeze ſuddenly ſprung up; in a moment the ſails were ſpread, and the brigantines with irreſiſtible impetuoſity broke their feeble opponents, overſet many canoes, and diſſipated the whole armament with ſuch ſlaughter, as convinced the Mexicans, that the progreſs of the Europeans in knowledge and arts rendered their ſuperiority greater on this new element than they had hitherto found it by land.

From that time Cortes remained maſter of the lake; and the brigantines not only preſerved a communication between the Spaniards in their different ſtations, though at a conſiderable diſtance from each other; but were employed to cover the cauſeways on each ſide, and keep off the canoes, when they attempted to annoy the troops as they advanced towards the city. He formed the brigantines in three diviſions, allotting one to each ſtation, with orders to ſecond the operations of the officer who commanded there. From all the three ſtations he puſhed on the attack againſt the city with equal vigour; but in a manner ſo very different from that by which ſieges are conducted in regular war, as might appear no leſs improper than ſingular to perſons unacquainted with his ſituation. Each morning his troops aſſaulted the barricades which the enemy had erected on the cauſeways, forced their way over the trenches which they had dug, and through the canals where the bridges were broken down, and endeavoured to penetrate into the heart of the city, in hopes of obtaining ſome deciſive advantage, which might force the enemy to ſurrender, and terminate the war at once; but when the obſtinate valour of the Mexicans rendered the efforts of the day ineffectual, the Spaniards retired in the evening to their former quarters. Thus their toil and danger were, in ſome meaſure, continually renewed, the Mexicans repairing in the night what the Spaniards had deſtroyed through the day, and recovering the poſts from which they had driven them. But neceſſity preſcribed this ſlow and untoward mode of operation. The number of his troops was ſo ſmall, that Cortes durſt not, with a handful of men, attempt to make a lodgement in a city where he might be ſurrounded and annoyed by ſuch a multitude of enemies. The remembrance of what he had already ſuffered by the ill-judged confidence with which he had ventured into ſuch a dangerous ſituation, was ſtill freſh in his mind. The Spaniards, exhauſted with fatigue, were unable to guard the various poſts which they daily gained; and though their camp was filled with Indian auxiliaries, they durſt not devolve this charge upon them, becauſe they were ſo little accuſtomed to diſcipline, that no confidence could be placed in their vigilance. Beſides this, Cortes was extremely ſolicitous to preſerve the city as much as poſſible from being deſtroyed, both as he deſtined it to be the capital of his conqueſts, and wiſhed that it might remain as a monument of his glory. From all theſe conſiderations, he adhered obſtinately, for a month after the ſiege was opened, to the ſyſtem which he had adopted. The Mexicans, in their own defence, diſplayed valour which was hardly inferior to that with which the Spaniards attacked them. On land, on water, by night and by day, one furious conflict ſucceeded to another. Several Spaniards were killed, more wounded, and all were ready to ſink under the toils of unintermitting ſervice, which were rendered more intolerable by the injuries of the ſeaſon, the periodical rains being now ſet in with their uſual violence.

Aſtoniſhed and diſconcerted with the length and difficulties of the ſiege, Cortes determined to make one great effort to get poſſeſſion of the city before he relinquiſhed the plan which he had hitherto followed, and had recourſe to any other mode of attack. With this view he ſent inſtructions to Alvarado and Sandoval to advance with their diviſions to a general aſſault, and took the command in perſon of that poſted on the cauſeway of Cuyocan. Animated by his preſence, and the expectation of ſome deciſive event, the Spaniards puſhed forward with irreſiſtible impetuoſity. They broke through one barricade after another, forced their way over the ditches and canals, and having entered the city, gained ground inceſſantly, in ſpite of the multitude and ferocity of their opponents. Cortes, though delighted with the rapidity of his progreſs, did not forget that he might ſtill find it neceſſary to retreat; and in order to ſecure it, appointed Julian de Alderete, a captain of chief note in the troops which he had received from Hiſpaniola, to fill up the canals and gaps in the cauſeway as the main body advanced. That officer deeming it inglorious to be thus employed, while his companions were in the heat of action and the career of victory, neglected the important charge committed to him, and hurried on inconſiderately to mingle with the combatants. The Mexicans, whoſe military attention and ſkill were daily improving, no ſooner obſerved this, than they carried an account of it to their monarch.

Guatimozin inſtantly diſcerned the conſequences of the error which the Spaniards had committed, and, with admirable preſence of mind, prepared to take advantage of it. He commanded the troops poſted in the front to ſlacken their efforts, in order to allure the Spaniards to puſh forward, while he deſpatched a large body of choſen warriors through different ſtreets, ſome by land, and others by water, towards the great breach in the cauſeway, which had been left open. On a ſignal which he gave, the prieſts in the great temple ſtruck the great drum conſecrated to the god of war. No ſooner did the Mexicans hear its doleful ſolemn ſound, calculated to inſpire them with contempt of death and with enthuſiaſtic ardour, than they ruſhed upon the enemy with frantic rage. The Spaniards, unable to reſiſt men urged on no leſs by religious fury than hope of ſucceſs, began to retire, at firſt leiſurely, and with a good countenance; but as the enemy preſſed on, and their own impatience to eſcape increaſed, the terror and confuſion became ſo general, that when they arrived at the gap in the cauſeway, Spaniards and Tlaſcalans, horſemen and infantry, plunged in promiſcuouſly, while the Mexicans ruſhed upon them fiercely from every ſide, their light canoes carrying them through ſhoals which the brigantines could not approach. In vain did Cortes attempt to ſtop and rally his flying troops; fear rendered them regardleſs of his entreaties or commands. Finding all his endeavours to renew the combat fruitleſs, his next care was to ſave ſome of thoſe who had thrown themſelves into the water; but while thus employed, with more attention to their ſituation than to his own, ſix Mexican captains ſuddenly laid hold of him, and were hurrying him off in triumph; and though two of his officers reſcued him at the expence of their own lives, he received ſeveral dangerous wounds before he could break looſe. Above 60 Spaniards periſhed in the rout; and what rendered the diſaſter more afflicting, 40 of theſe fell alive into the hands of an enemy never known to ſhow mercy to a captive.

106
Cortes repulſed in an attack.

The approach of night, though it delivered the dejected Spaniards from the attacks of the enemy, uſhered in, what was hardly leſs grievous, the noiſe of their barbarous triumph, and of the horrid feſtival with which they celebrated their victory. Every quarter of the city was illuminated; the great temple ſhone with ſuch peculiar ſplendour, that the Spaniards could plainly ſee the people in motion, and the prieſts buſy in haſtening the preparations for the death of the priſoners. Through the gloom they fancied that they diſcerned their companions by the whiteneſs of their ſkins, as they were ſtripped naked and compelled to dance before the image of the god to whom they were to be offered. They heard the ſhrieks of thoſe who were ſacrificed, and thought they could diſtinguiſh each unhappy victim by the well-known ſound of his voice. Imagination added to what they really ſaw or heard, and augmented its horror. The moſt unfeeling melted into tears of compaſſion, and the ſtouteſt heart trembled at the dreadful ſpectacle which they beheld.

Cortes, who, beſides all that he felt in common with his ſoldiers, was oppreſſed with the additional load of anxious reflections natural to a general on ſuch an unexpected calamity, could not like them relieve his mind by giving vent to its anguiſh. He was obliged to aſſume an air of tranquillity in order to revive the ſpirits and hopes of his followers. The juncture, indeed, required an extraordinary exertion of fortitude. The Mexicans, elated with their victory, ſallied out next morning to attack him in his quarters. But they did not rely on the efforts of their own arms alone: they ſent the heads of the Spaniards whom they had ſacrificed to the leading men in the adjacent provinces, and aſſured them that the god of war, appeaſed by the blood of their invaders, which had been ſhed ſo plentifully on his altars, had declared with an audible voice, that in eight days time thoſe hated enemies ſhould be finally deſtroyed, and peace and proſperity re-eſtabliſhed in the empire.

107
The Mexicans renew the attack with great fury.

A prediction, uttered with ſuch confidence, and in terms ſo void of ambiguity, gained univerſal credit among a people prone to ſuperſtition. The zeal of the provinces which had already declared againſt the Spaniards augmented, and ſeveral which had hitherto remained inactive took arms with enthuſiaſtic ardour to execute the decrees of the gods. The Indian auxiliaries who had joined Cortes, accuſtomed to venerate the ſame deities with the Mexicans, and to receive the reſponſes of their prieſts with the ſame implicit faith, abandoned the Spaniards as a race of men devoted to certain deſtruction. Even the fidelity of the Tlaſcalans was ſhaken, and the Spaniſh troops were left almoſt alone in their ſtations. Cortes, finding that he attempted in vain to diſpel the ſuperſtitious fears of his confederates by argument, took advantage, from the imprudence of thoſe who had framed the prophecy in fixing its accompliſhment ſo near at hand, to give them a ſtriking demonſtration of its falſity. He ſuſpended all military operations during the period marked out by the oracle. Under cover of the brigantines, which kept the enemy at a diſtance, his troops lay in ſafety, and the fatal term expired without any diſaſter.

His allies, aſhamed of their own credulity, returned to their ſtation. Other tribes, judging that the gods, who had now deceived the Mexicans, had decreed finally to withdraw their protection from them, joined his ſtandard; and ſuch was the levity of a ſimple people, moved by every ſlight impreſſion, that, in a ſhort time after ſuch a general defection of his confederates, Cortes ſaw himſelf, if we may believe his own account, at the head of 150,000 Indians. Even with ſuch a numerous army, he found it neceſſary to adopt a new and more wary ſyſtem of operation. Inſtead of renewing his attempts to become maſter of the city at once, by ſuch bold but dangerous efforts of valour as he had already tried, he made his advances gradually, and with every poſſible precaution againſt expoſing his men to any calamity ſimilar to that which they ſtill bewailed. As the Spaniards puſhed forward, the Indians regularly repaired the cauſeways behind them. As ſoon as they got poſſeſſion of any part of the town, the houſes were inſtantly levelled with the ground. Day by day, the Mexicans, forced to retire as their enemies gained ground, were hemmed in within more narrow limits. Guatimozin, though unable to ſtop the career of the enemy, continued to defend his capital with obſtinate reſolution, and diſputed every inch of ground. But the Spaniards, having not only varied their mode of attack, but, by order of Cortes, having changed the weapons with

108
Cortes adopts a more cautious method of proceeding.

with which they fought, were again armed with the long Chinantlan ſpears, which they had employed with ſuch ſucceſs againſt Narvaez; and, by the firm array in which this enabled them to range themſelves, they repelled, with little danger, the looſe aſſault of the Mexicans; incredible numbers of whom fell in the conflicts, which they renewed every day. While war waſted without, famine began to conſume them within the city. The Spaniſh brigantines, having the entire command of the lake, rendered it impoſſible to receive any ſupply of proviſions by water. The vaſt number of his Indian auxiliaries enabled Cortes to ſhut up the avenues to the city by land. The ſtores which Guatimozin had laid up were exhauſted by the multitudes which crowded into the capital to defend their ſovereign and the temples of their gods. Not only the people, but perſons of the higheſt rank, felt the utmoſt diſtreſſes of want. What they ſuffered brought on infectious and mortal diſtempers, the laſt calamity that viſits beſieged cities, and which filled up the meaſure of their woes.

109 Guatimozin refuſes to ſubmit on any terms.

But, under the preſſure of ſo many and ſuch various evils, the ſpirit of Guatimozin remained firm and unſubdued. He rejected with ſcorn every overture of peace from Cortes; and, diſdaining the idea of ſubmitting to the oppreſſors of his country, determined not to ſurvive its ruin. The Spaniards continued their progreſs. At length all the three diviſions penetrated into the great ſquare in the centre of the city, and made a ſecure lodgment there. Three-fourths of the city were now reduced, and laid in ruins. The remaining quarter was ſo cloſely preſſed, that it could not long withſtand aſſailaints who attacked it from their new ſtation with ſuperior advantage, and more aſſured expectation of ſucceſs. The Mexican nobles, ſolicitous to ſave the life of a monarch whom they revered, prevailed on Guatimozin to retire from a place where reſiſtance was now vain, that he might rouſe the more diſtant provinces of the empire to arms, and maintain there a more ſucceſsful ſtruggle with the public enemy. In order to facilitate the execution of this meaſure, they endeavoured to amuſe Cortes with overtures of ſubmiſſion, that, while his attention was employed in adjuſting the articles of pacification, Guatimozin might eſcape unperceived. But they made this attempt upon a leader of greater ſagacity and diſcernment than to be deceived by their arts. Cortes ſuſpecting their intention, and aware of what moment it was to defeat it, appointed Sandoval, the officer on whoſe vigilance he could moſt perfectly rely, to take the command of the brigantines, with ſtrict injunctions to watch every motion of the enemy. Sandoval, attentive to the charge, obſerving ſome large canoes crowded with people rowing along the lake with extraordinary rapidity, inſtantly gave the ſignal to chaſe. Gracia Holguin, who commanded the fleeteſt brigantine, ſoon overtook them, and was preparing to fire on the foremoſt canoe, which ſeemed to carry ſome perſon whom all the reſt followed and obeyed. At once the rowers dropt their oars, and all on board, throwing down their arms, conjured him with cries and tears to forbear, as the emperor was there. Holguin eagerly ſeized his prize; and Guatimozin, with a dignified compoſure, gave himſelf up into his hands, requeſting only that no inſult might be offered to the empreſs or his children. When conducted to Cortes, he appeared neither with the ſullen fierceneſs of a barbarian, nor with the dejection of a ſupplicant. "I have done," ſaid he, addreſſing himſelf to the Spaniſh general, "what became a monarch. I have defended my people to the laſt extremity. Nothing now remains but to die. Take this dagger," laying his hand on one which Cortes wore, "plant it in my breaſt, and put an end to a life which can no longer be of uſe."

110 He is taken priſoner.

111 Mexico ſubmits.

As ſoon as the fate of their ſovereign was known, the reſiſtance of the Mexicans ceaſed; and Cortes took poſſeſſion of that ſmall part of the capital which yet remained undeſtroyed. Thus terminated the ſiege of Mexico, the moſt memorable event in the conqueſt of America. It continued 75 days, hardly one of which paſſed without ſome extraordinary effort of one party in the attack, or of the other in the defence of a city, on the fate of which both knew that the fortune of the empire depended. As the ſtruggle here was more obſtinate, it was likewiſe more equal, than any between the inhabitants of the Old and New Worlds. The great abilities of Guatimozin, the number of his troops, the peculiar ſituation of his capital, ſo far counterbalanced the ſuperiority of the Spaniards in arms and diſcipline, that they muſt have relinquiſhed the enterpriſe, if they had truſted for ſucceſs to themſelves alone. But Mexico was overturned by the jealouſy of neighbours who dreaded its power, and by the revolt of ſubjects impatient to ſhake off its yoke. By their effectual aid, Cortes was enabled to accompliſh what, without ſuch ſupport, he would hardly have ventured to attempt. How much ſoever this account of the reduction of Mexico may detract, on the one hand, from the marvellous relations of ſome Spaniſh writers, by aſcribing that to ſimple and obvious cauſes which they attribute to the romantic valour of their countrymen, it adds, on the other, to the merit and abilities of Cortes, who, under every diſadvantage, acquired ſuch an aſcendant over unknown nations, as to render them inſtruments towards carrying his ſcheme into execution.

The exultation of the Spaniards, on accompliſhing this arduous enterpriſe, was at firſt exceſſive. But this was quickly damped by the cruel diſappointment of thoſe ſanguine hopes which had animated them amidſt ſo many hardſhips and dangers. Inſtead of the inexhauſtible wealth which they expected from becoming maſters of Montezuma's treaſures, and the ornaments of ſo many temples, their rapaciouſneſs could collect only an inconſiderable booty amidſt ruins and deſolation (A). Guatimozin, aware of his impending fate, had ordered what remained of the riches amaſſed by his anceſtors to be thrown into the lake. The Indian auxiliaries, while the Spaniards were engaged in con-

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(A) The gold and ſilver according to Cortes, amounted only to 120,000 peſos, (Relat. 280, A.) a ſum far inferior to that which the Spaniards had formerly divided in Mexico.

flict with the enemy, had carried off the moſt valuable part of the ſpoil. The ſum to be divided among the conquerors was ſo ſmall, that many of them diſdained to accept of the pittance which fell to their ſhare, and all murmured and exclaimed; ſome againſt Cortes and his confidants, whom they ſuſpected of having ſecretly appropriated to their own uſe a large portion of the riches which ſhould have been brought into the common ſtock; others againſt Guatimozin, whom they accuſed of obſtinacy in refuſing to diſcover the place where he had hidden his treaſure.

112 Guatimozin tortured.

Arguments, entreaties, and promiſes, were employed in order to ſoothe them; but with ſo little effect, that Cortes, from ſolicitude to check this growing ſpirit of diſcontent, gave way to a deed which ſtained the glory of all his great actions. Without regarding the former dignity of Guatimozin, or feeling any reverence for thoſe virtues which he had diſplayed, he ſubjected the unhappy monarch, together with his chief favourite, to torture, in order to force from them a diſcovery of the royal treaſures, which it was ſuppoſed they had concealed. Guatimozin bore whatever the refined cruelty of his tormentors could inflict, with the invincible fortitude of an American warrior. His fellow-ſufferer, overcome by the violence of the anguiſh, turned a dejected eye towards his maſter, which ſeemed to implore his permiſſion to reveal all that he knew. But the high-ſpirited prince, darting on him a look of authority mingled with ſcorn, checked his weakneſs, by aſking, "Am I now repoſing on a bed of flowers?" Overawed by the reproach, he perſevered in his dutiful ſilence, and expired. Cortes, aſhamed of a ſcene ſo horrid, reſcued the royal victim from the hands of his torturers, and prolonged a life reſerved for new indignities and ſufferings.

113 The Spaniards become maſters of the whole Mexican empire.

The fate of the capital, as both parties had foreſeen, decided that of the empire. The provinces ſubmitted one after another to the conquerors. Small detachments of Spaniards marching through them without interruption, penetrated, in different quarters, to the great Southern ocean, which, according to the ideas of Columbus, they imagined would open a ſhort as well as eaſy paſſage to the Eaſt Indies, and ſecure to the crown of Caſtile all the envied wealth of thoſe fertile regions; and the active mind of Cortes began already to form ſchemes for attempting this important diſcovery. In his after-ſchemes, however, he was diſappointed; but Mexico hath ever ſince remained in the hands of the Spaniards.

114 Ancient diviſions of Mexico.

The *ancient* kingdom of Mexico, properly ſo called, was divided into ſeveral provinces, of which the vale of Mexico itſelf was the fineſt in every reſpect. It is ſurrounded by verdant mountains, meaſuring upwards of 120 miles in circumference at their baſe. A great part of this vale is occupied by two lakes, the upper one of freſh water, but the lower one brackiſh, communicating with the former by means of a canal. All the water running from the mountains is collected in this lower lake, on account of its being in the bottom of the valley; hence it was ready, when ſwelled by extraordinary rains, to overflow the city of Mexico, as has been already obſerved. This delightful region contained the three imperial cities of Mexico, Acolhuacan, and Tlacopan; beſides 40 others, with innumerable villages and hamlets; but the moſt conſiderable of theſe, according to Clavigero, now ſcarcely retain one-twentieth part of their former magnificence. The principal inland provinces to the northward were the Otomies; to the ſouth-weſt the Malatzincas and Cuitlatecas; to the ſouth the Tlahuicas and Cohuixcas; to the ſouth-eaſt, after the ſtates of Itzocan, Jauhtepac, Quauhquecollon, Atlixco, Tehuacan, and others, were the great provinces of the Mixtecas, the Zapotecas, and the Chiapanecas; towards the eaſt were the provinces of Tepayacac, the Popolocas, and Totonacas. The maritime provinces on the Mexican gulf were Coatzacualco and Cuetlachtlan, called by the Spaniards *Cotaſta*. On the Pacific ocean were thoſe of Coliman, Zacatollan, Tototepec, Tecuantepec, and Zoconochco.

The province of the Otomies began in the northern part of the vale of Mexico, extending through the mountains to the north to the diſtance of 90 miles from the city of Mexico; the principal cities being Tollan or Tula, and Xilotepec: the latter made the capital of the country by the Spaniards. Beyond the ſettlements of the Otomies, the country for more than a thouſand miles in extent was inhabited only by barbarous and wandering ſavages.

The Malatzinca province contained the valley of Tolocan, and all the country from *Taximaroa* to the frontier of the kingdom of Michuacan. The valley of Tolocan is upwards of 40 miles long from ſouth-eaſt to north-weſt, and 30 in breadth where broadeſt. Its principal city, named alſo *Tolocan*, is ſituated at the foot of a high mountain covered with ſnow, 30 miles diſtant from Mexico.

The country of the Cuitlatecas extended from north-eaſt to ſouth-weſt, upwards of 200 miles, extending as far as the Pacific ocean. Their capital was named Mexcaltepec, once a great and populous city, ſituated upon the ſea-coaſt; but of which the ruins are now ſcarcely viſible. That of the Tlahuicas was named Quauhnahuac, and ſituated about 40 miles to the ſouthward of Mexico. The province extended almoſt 60 miles ſouthward, commencing from the ſouthern mountains of the vale of Mexico.

The country of the Cohuixcas extended on the ſouthward as far as the Pacific ocean, through that part where at preſent the port and city of Acapulco lie. It was divided into the ſtates of Tzompanco, Chilapan, Tlapan, and Tiſtla; the latter a very hot and unwholeſome country. To this province belonged a place named *Tlachco*, celebrated for its ſilver mines.

The province of the Mixtecas extended from *Acatlan*, a place diſtant about 120 miles from Mexico, as far as the Pacific ocean towards the ſouth eaſt. The inhabitants carried on a conſiderable commerce, and had ſeveral well-inhabited cities and villages. To the eaſt of the Mixtecas were the Zapotecas, ſo called from their capital Teotzapotlan. In their diſtrict was the valley of Huaxyacac, now Oaxaca or Guaxaca.

The province of Mazatlan lay to the northward of the Mixtecas; and to the northward and eaſtward of the Zapotecas was *Chimantla*, having their capitals of the ſame name with their provinces. The Chiapanecas, Zoqui, and Queleni, were the laſt of the Mexican provinces towards the ſouth-eaſt. On the ſide of the mountain Popocatepec and around it lay ſeveral ſtates, of which the moſt conſiderable were Cholallan and Huexotzinco. Theſe two having, with the aſſiſtance of the Tlaſcalans, ſhaken off the Mexican yoke, re-eſtabliſhed their former ariſtocratical government. The Cholulans poſſeſſed a ſmall hamlet called Cuitlaxcoapan, in the place where the Spaniards afterwards founded the city of Angelopoli, which is the ſecond of New Spain.

To the eaſtward of Cholula lay a conſiderable ſtate named Tepeyacac; and beyond that the Popolocas, whoſe principal cities were Tecamachalco and Quecholac. To the ſouthward of the Popolocas was the ſtate of Tahuacan, bordering upon the country of the Mixtecas; to the eaſt, the maritime province of Cuetlachtlan; and to the north the Totonacas. The extent of this province was 150 miles, beginning from the frontier of Zacatlan, a ſtate diſtant about 80 miles from the court, and terminating in the gulf of Mexico. Beſides the capital, named *Mizquihuacan*, this country had the beautiful city of Chempoallan, ſituated on the coaſt of the gulf; remarkable for being that by which the Spaniards entered the Mexican empire.

Coliman was the moſt northerly of the provinces on the Pacific ocean; the capital, named alſo Coliman, being in lat. 19. long. 92. W. Towards the ſouth-eaſt was the province of Zacotlan, with its capital of the ſame name; then came the coaſt of the Cuitlatecas; after it that of the Cohuixcans, in which was the celebrated port of Acapulco. The *Jopi* bordered on the Cohuixca coaſt; and adjoining to that the Mixteca country, now called *Xicayan;* next to that was the large province of Tecuantepec; and laſtly, that of Xoconochco.

This province, the moſt ſoutherly of the Mexican empire, was bounded on the eaſt and ſouth-eaſt by the country of Xochitepec, which did not belong to Mexico; on the weſt by Tecuantepec; and on the ſouth by the ocean. The capital, called alſo *Xoconochco*, was ſituated between two rivers, in 14 degrees of latitude and 103. W. longitude. On the Mexican gulf there were, beſides the country of the Totonecas, the provinces of Cuetlachtlan and Coatzacualco; the latter bounded on the eaſt by the ſtates of Tabaſco and the peninſula of Yucatan. The province of Cuetlachtlan comprehended all the coaſt between the rivers Alvarado and Antigua, where the province of the Totonecas began.

115
Climate.

The climate of this vaſt country varies very much according to the ſituation of its different parts. The maritime places are hot, unhealthy, and moiſt. The lands which lie in the neighbourhood of high mountains, the tops of which are always covered with ſnow, muſt of neceſſity be cold; and Clavigero informs us, that he has been on a mountain not more than 25 miles diſtant from the city of Mexico, where there was white froſt and ice even in the dog-days. "All the other inland countries (ſays our author), where the greateſt population prevailed, enjoy a climate ſo mild and benign, that they neither feel the rigour of winter nor the heats of ſummer. It is true, in many of theſe countries, there is frequently white froſt in the three months of December, January, and February, and ſometimes even it ſnows; but the ſmall inconvenience which ſuch cold occaſions continues only till the riſing ſun: no other fire than his rays is neceſſary to give warmth in winter; no other relief is wanted in the ſeaſon of heat but the ſhade: the ſame clothing which covers men in the dog-days defends them in January, and the animals ſleep all the year under the open ſky.

116
Cauſes of mildneſs of the climate.

"This mildneſs and agreeableneſs of climate under the torrid zone is the effect of ſeveral natural cauſes entirely unknown to the ancients, who did not believe it to be inhabited; and not well underſtood by ſome moderns, by whom it is believed unfavourable to thoſe who live in it. The purity of the atmoſphere, the ſmaller obliquity of the ſolar rays, and the longer ſtay of this luminary above the horizon in winter, in compariſon of other regions farther removed from the equator, concur to leſſen the cold, and to prevent all that horror which disfigures the face of nature in other climes. During that ſeaſon a ſerene ſky and the natural delights of the country are enjoyed; whereas, under the frigid, and even for the moſt part under the temperate zones, the clouds rob man of the proſpect of heaven, and the ſnow buries the beautiful productions of the earth. No leſs cauſes combine to temper the heat of ſummer. The plentiful ſhowers which frequently water the earth after mid-day from April or May to September or October; the high mountains, continually loaded with ſnow, ſcattered here and there through the country of Anahuac; the cool winds which breathe from them in that ſeaſon; and the ſhorter ſtay of the ſun above the horizon, compared with the circumſtances of the temperate zone, transform the climes of thoſe happy countries into a cool and cheerful ſpring. But the agreeableneſs of the climate is counterbalanced by thunder ſtorms, which are frequent in ſummer, particularly in the neighbourhood of the mountain of Tlaſcala; and by earthquakes, which are at all times felt, though with leſs danger than terror. Storms of hail are neither more frequent nor more ſevere than in Europe."

117
Mexican volcanoes.

One undoubted inconvenience which Mexico has is that of volcanoes. One named by the Spaniards *Volcan d'Orizaba* is higher than the peak of Teneriffe, according to the Jeſuit Tallandier, who meaſured them both. It began to ſend forth ſmoke in the year 1545, and continued burning for 20 years, but has not diſcovered any ſymptoms of eruption ſince that time. It is of a conical figure; and may be ſeen at 50 leagues diſtance. The top is always covered with ſnow, but the lower part with woods of pine and other valuable timber. It is about 90 miles to the eaſtward of the capital.

Two other mountains, named *Popocatepec* and *Iztaccihuatl*, which lie near each other, at the diſtance of 33 miles to the ſouth-eaſt of Mexico, are likewiſe ſurpriſingly high. Clavigero ſuppoſes the former to be higher than the higheſt of the Alps, conſidering the elevated ground on which the baſe of it ſtands. It has a crater more than half a mile wide; from which, in the time of the Mexican kings, great quantities of ſmoke and flame iſſued. In the 17th century it frequently threw out great ſhowers of aſhes upon the adjacent places; but in the 18th century hardly any ſmoke has been obſerved. This mountain is named by the Spaniards *Volcan*, and the other *Sierra Nevada*. The latter has alſo ſometimes emitted flames.

Both of them have their tops always covered with ſnow in ſuch quantities, that the maſſes which fall down upon the neighbouring rocks ſupply the cities of Mexico, Gelopoli, Cholula, and all the adjacent country to the diſtance of 40 miles, with that commodity; of which the conſumpt is ſo great, that in 1746 the impoſt upon what was conſumed in the city of Mexico amounted to 15,222 Mexican crowns; ſome years after it amounted to 20,000; and is now in all probability a great deal more.

Beſides theſe volcanoes, there are others in Mexico of a very remarkable height. The great chain of mountains called the *Andes* is continued through the iſthmus of Panama and through all Mexico, until they are loſt in the unknown mountains of the north. The moſt conſiderable of that chain is known in Mexico by the name of *Sierra Madre*, particularly in Cinaloa and Tarahumara, provinces no leſs than 1200 miles diſtant from the capital.

118
Rivers and lakes.

Mexico is well watered by very conſiderable rivers, though none of them are comparable to thoſe of South America. Some of theſe run into the gulf of Mexico, and others into the Pacific ocean. The Alvarado has its principal ſource among the mountains of the Zapotecas, and diſcharges itſelf by three navigable mouths into the Mexican gulf, at the diſtance of 30 miles from Vera Cruz. The moſt celebrated of the rivers which run into the Pacific ocean is that called by the Spaniards *Guadalaxara* or *Great River*. It riſes in the mountains of Toloccan; and after running a courſe of more than 600 miles, diſcharges itſelf into the ocean in 22° latitude.

There are likewiſe in this country ſeveral lakes of very conſiderable magnitude; but thoſe of Nicaragua, Chapallan, and Pazquaro, which are of the greateſt extent, did not belong to the ancient Mexican empire. The moſt remarkable were thoſe in the vale of Mexico, upon which the capital of the empire was founded. Of theſe, the freſh water one, called the *lake of Chalco*, extended in length from eaſt to weſt 12 miles, as far as the city of Xochimilco; from thence, taking a northerly direction, it incorporated itſelf by means of a canal with the lake of Tezcuco; but its breadth did not exceed ſix miles. The other, named the *lake of Tezcuco*, extended 15, or rather 17 miles from eaſt to weſt, and ſomething more from ſouth to north; but its extent is now much leſs, by reaſon of the Spaniards having diverted the courſe of many of the ſtreams which run into it. This lake is ſalt, which Clavigero ſuppoſes to ariſe from the nature of the ſoil which forms its bed.

Beſides theſe, there are a number of ſmaller lakes, ſome of which are very delightful. There is a vaſt variety of mineral waters, of the nitrous, ſulphureous, and aluminous kinds, ſome of them ſo hot that meat may be boiled in them. At Tetuhuacan is a kind of petrifying water, as well as in ſeveral other parts of the empire. One of them forms a kind of ſmooth white ſtones, not diſpleaſing to the taſte; the ſcrapings of which taken in broth are celebrated as a diaphoretic, probably without any good reaſon. The doſe for a perſon not difficult to be ſweated is one dram of the ſcrapings. Many of the rivers of Mexico afford ſurpriſing and beautiful caſcades; particularly the great river Guadalaxara, at a place called *Tempizque*, 15 miles to the ſouthward of that city. Along a deep river called *Atoyaque* is a natural bridge, conſiſting of a vaſt mound of earth, along which carriages paſs conveniently. Clavigero ſuppoſes it to have been the fragment of a mountain thrown down by an earthquake, and then penetrated by the river.

119
Natural productions.

The mineral productions of Mexico are extremely valuable, ſuch as gold and ſilver in abundance, two ſpecies of copper, tin, lead, mercury, ſulphur, alum, vitriol, amber, and aſphaltum. It alſo produces diamonds, amethyſts, cats-eyes, cornelians, and ſome green ſtones reſembling emeralds, as alſo quarries of jaſper and marble of various colours. There are ſaid to be whole mountains of loadſtone, and a fine white talc which may be burnt into an excellent plaſter.

The ſoil is capable of producing all the neceſſaries, and even the luxuries of human life. Hiſtorians mention no fewer than 1200 plants which are all indigenous, or natives of the country; but as theſe are ſaid to be chiefly medicinal, we muſt conclude that provident nature has furniſhed them with many more which are intended for nouriſhment.

This country abounds with a great variety of flowers, numbers of which are peculiar to itſelf, while many exotics even rival them in luxuriance, ſuch in particular as are imported from Europe. Water-melons, apples, pears, peaches, apricots, figs, &c. are among the exotics, which thrive in a manner equal to any of the indigenous productions. All the maritime countries abound with cocoa-nut trees, of which Hernandez mentions four kinds, the ſmalleſt of which is moſtly uſed for chocolate and other drinks.

Prior to the introduction of corn from Europe, maize was the principal grain of Mexico, and of which there were ſeveral ſpecies. It was brought from America to Spain, and from thence to the other countries of Europe. The principal kind of pulſe uſed by the people was the French bean, the different ſpecies of which exceeded in number thoſe of the maize; and one of them in particular not only ſupported the poorer claſs, but even the Spaniſh nobility deemed it a luxury. Hiſtorians enumerate five ſpecies of eſculent roots, excluſive of many culinary vegetables imported from the Canaries, Spain, and other European countries. This country produces a variety of palm trees, from the fibres of the leaves of one ſpecies of which the Mexicans manufacture thread. The timber trees are numerous, and, in reſpect of quality, ſaid to be inferior to none in the world. There are whole woods of cedars and ebonies, and ſome trees mentioned by Clavigero are of a moſt ſtupendous magnitude. This author mentions one that meaſured 107 Paris feet in height; and Acoſta ſpeaks of one that was 16 fathoms in circumference. A remarkable fir tree hollowed by lightning, contained within it 100 young men, according to the teſtimony of the archbiſhop of Toledo, who went to view it in the year 1770.

120
Medicinal and aromatic gums.

This country abounds alſo with aromatic and medicinal trees, producing gums, reſins, &c. From one of theſe a balſam is produced not in the leaſt inferior to the celebrated balſam of Mecca. It is of a reddiſh black or yellowiſh white, of a ſharp bitter taſte, and of a ſtrong but moſt grateful odour. It is common in the provinces of Panuco and Chiapan, and other warm countries.

The tree producing liquid amber, the liquid ſtorax of the Mexicans, is of a large ſize, the leaves ſimilar to thoſe of the maple, indented, white in one part and dark in the other, diſpoſed of in threes; the fruit is thorny and round, but polygonous, with the ſurface and the angles yellow; the bark of the tree partly green and partly tawny. By inciſions in the trunk they extract that valuable ſubſtance named *liquid amber*, and the oil of the ſame name, which is ſtill more valuable. Liquid amber is likewiſe obtained from a decoction of the branches, but it is inferior to that obtained from the trunk.

The name *copalli* in Mexico is generic, and common to all the reſins; but eſpecially ſignifies thoſe made uſe of for incenſe. There are ten ſpecies of theſe trees yielding reſins of this kind; the principal of which is that from which the COPAL is got, ſo well known in medicine and varniſhes. A great quantity of this was made uſe of by the ancient Mexicans, and is ſtill uſed for ſimilar purpoſes by the Spaniards. The *tecopalli* or *tepecopalli* is a reſin ſimilar to the incenſe of Arabia; which diſtils from a tree of moderate ſize that grows in the mountains, having a fruit like an acorn, and containing the nut enveloped in a mucilage, within which there is a ſmall kernel uſeful in medicine.

The *mizquitl*, or mezquite, is a ſpecies of true acacia, and the gum diſtilling from it is ſaid to be the true gum arabic. It is a thorny ſhrub, with branches irregularly diſpoſed, the leaves ſmall, thin, and pinnated; the flowers being like thoſe of the birch-tree. Of the elaſtic gum, which is found in plenty in Mexico, the natives were in uſe to make foot-balls, which, though heavy, have a better ſpring than thoſe filled with air. With this they varniſh their hats, cloaks, boots, and great coats, in a manner ſimilar to what is done in Europe with wax; and by which means they are rendered all water proof.

121 Mexican animals. The quadrupeds found in Mexico at the arrival of the Spaniards, were lions, tygers, wild cats, bears, wolves, foxes, the common ſtags, white ſtags, bucks, wild goats, badgers, polecats, weaſels, martins, ſquirrels, polatucas, rabbits, hares, otters, and rats. All theſe animals are ſuppoſed to be common to both continents. The white ſtag, whether it be the ſame ſpecies of the other or not, is undoubtedly common to both, and was known to the Greeks and Romans. The Mexicans call it the *king of the ſtags*. M. Buffon imagines the white colour of this creature to be the effect of captivity; but Clavigero ſays, that it is found wild, and of the ſame white colour, on the mountains of New Spain. In many other points, he alſo controverts the opinions of this celebrated naturaliſt, who will not allow the lion, tyger, or rabbit, to be natives of America.

Clavigero enumerates the quadrupeds common to New Spain with the reſt of the continent of America. Among theſe he will not allow a place to the Peruvian ſheep, the *huanaco*, and ſloth; all of which are peculiar to South America. Hernandez indeed makes mention of the Peruvian ſheep, and gives a drawing of it; but this was only on account of a few individuals brought thence from Peru, which the Mexicans called by that name, in the ſame manner as he deſcribes ſeveral animals of the Philippine iſles; not that they had ever been bred in Mexico, or found in any country of North America, unleſs it was ſome individual carried there, as they are carried as a curioſity from Europe. The animals which he allows to be common to both countries are, the Mexican hog, the mouſete, the opoſſum, the armadillo, the *techichi*, a ſmall animal reſembling a dog; which being perfectly dumb, gave occaſion to a report that the Mexican dogs could not bark. The fleſh of this animal was eaten by them, and was eſteemed agreeable and nouriſhing food. After the conqueſt of Mexico, the Spaniards having neither large cattle nor ſheep, provided their markets with this quadruped; by which means, the ſpecies ſoon came to be extinct, though it had been very numerous. The land-ſquirrel is very numerous in the kingdom of Michuacan, has great elegance of form, and is extremely graceful in its movements; but it cannot be tamed, and bites moſt furiouſly every perſon who approaches it.

Beſides theſe, there are ſea lions, ratoons, and that voracious animal named the *tapir*. Oviedo informs us, that he has ſeen it at one bite tear off two or three hand-breadths of ſkin from a hound, and at another a whole leg and thigh. The fleſh is eatable, and its ſkin is valued on account of its being ſufficiently ſtrong to reſiſt muſket-balls. There are likewiſe great numbers of monkeys of many different kinds; ſome of which have heads reſembling thoſe of dogs. Some of them are ſtrong and fierce, equalling a man in ſtature when they ſtand upright.

Among the animals peculiar to Mexico, is one named *coyoto*, which appears to have been inaccurately deſcribed by natural hiſtorians; ſome making it one ſpecies and ſome another. It is about the ſize of a maſtiff, but more ſlender. The eyes are yellow and ſparkling, ears ſmall, pointed, and erect; the ſnout blackiſh, ſtrong limbs, and the feet armed with large crooked nails. The tail is thick and hairy, the ſkin a mixture of black, brown, and white; and the voice is compounded of the howl of the wolf and the bark of the dog. It purſues the deer, and will ſometimes even attack men. Its uſual pace is a trot, but ſo quick that a horſe at the gallop can ſcarcely overtake it. The *tlalcojotl* or *tlalcoyoto* is about the ſize of a middling dog, and the largeſt animal that lives under the earth. Its head has ſome reſemblance to that of a cat; but in colour and length of hair it reſembles the lion.—It has a long thick tail, and feeds upon poultry and ſmall animals, which it catches in the night-time. The *tepeizuintli*, or mountain-dog, though it is but of the ſize of a ſmall dog, is ſo bold that it attacks deer, and ſometimes kills them. Its hair and tail are long, the body black, but the head, neck, and breaſt, white. M. Buffon reckons this animal the ſame with the glutton, but Clavigero denies it. Another animal, larger than the two foregoing, is called the *xoloitzcuintli*. Some of theſe are no leſs than four feet in length. It has a face like the dog, but tuſks like the wolf, with erect ears, the neck groſs, and the tail long.—It is entirely deſtitute of hair, excepting only the ſnout, where there are ſome thick crooked briſtles. The whole body is covered with a ſmooth, ſoft, aſh-coloured ſkin, ſpotted partly with black and tawny. This ſpeices of animals, as well as the two former, are almoſt totally extinct. A Lyncean academician named *Giovanni Fabri*, has endeavoured to prove that the xoloitzcuintli is the ſame with the wolf of Mexico; but this is denied by Clavigero.

A curious animal of the mole kind is called *tozan* or *tuza*. It is about the ſize of an European mole, but very different otherwiſe. The body is about ſeven or eight inches long, and well made; the ſnout like that of a mouſe, the ears ſmall and round, with the tail ſhort. The mouth is armed with very ſtrong teeth, and its paws are furniſhed with ſtrong crooked nails, with which it digs its habitation in the earth. It is extremely deſtructive to the corn fields by the quantity of grain it ſteals, and to the highways by the number of holes it makes in them; for when, on account of the dimneſs of its ſight, it cannot find its firſt hole, it makes another, and ſo on. It digs the earth with its claws and two canine teeth which it has in the upper jaw.

122 Mexican birds.

The birds are ſo numerous, and of ſuch various appearances and qualities, that Mexico has been called the country of birds, as Africa is of quadrupeds. Hernandez deſcribes above 200 peculiar to the country. He allows to the eagles and hawks of Mexico a ſuperiority over thoſe of Europe; and the falcons of this country were formerly eſteemed ſo excellent, that, by the deſire of Philip II. a hundred of them were ſent every year over to Spain. The largeſt, the moſt beautiful, and the moſt valuable kind of eagles, is called by the Mexicans *itzquauhtli*, and will purſue not only the larger kinds of birds, but quadrupeds, and even men.

The ravens of Mexico do not, like thoſe of other countries, feed upon carrion, but ſubſiſt entirely by ſtealing corn. The carrion is devoured by the birds called in South America *gallinazzi*, in Mexico *zopilots* and *aure*. By Hernandez they are ſaid to be a ſpecies of ravens; but, according to Clavigero, they are very different, not only in their ſize, but in the ſhape of their head, their ſlight, and their voice.

The aquatic birds are very numerous, and of great variety.—There are at leaſt 20 ſpecies of ducks, a vaſt number of geeſe, with ſeveral kinds of herons, great numbers of ſwans, quails, water rails, divers, king's fiſhers, pelicans, &c. The multitude of ducks is ſometimes ſo great, that they cover the fields, and appear at a diſtance like flocks of ſheep. Some of the herons and egrets are perfectly white, ſome aſh-coloured; others have the plumage of the body white, while the neck, with the tops and upper part of the wings, and part of the tail, are enlivened with a bright ſcarlet, or beautiful blue.

Numbers of the other claſſes of birds are valuable for their fleſh, plumage, or ſong, while ſome are remarkable for their extraordinary inſtinct or other properties. Clavigero enumerates more than 70 ſpecies of thoſe which afford an agreeable and wholeſome food. Beſides the common fowls which were brought from the Canaries to the Antilles, and from theſe to Mexico, there were, and ſtill are, fowls peculiar to the country itſelf. Theſe partly reſemble the common fowl and partly the peacock, whence they had the name of *gallipavos* from the Spaniards. From Mexico they were imported into Europe, where they have multiplied very faſt, eſpecially in Italy, though the common fowls have multiplied much more in Mexico.

There are great numbers of birds valuable on account of their plumage, which was made uſe of by the Mexicans in their excellent moſaic works; an art which ſeems now to be totally loſt. Peacocks have been carried from the old continent to Mexico; but, not being attended to, have propagated very ſlowly. The birds remarkable for their ſong are likewiſe very numerous; among which that called the *centxonitl*, by Europeans the *mocking-bird*, is the moſt remarkable, on account of its counterfeiting naturally the notes of all others it hears. There are great numbers of beautiful parrots; and there is a bird which counterfeits the human voice, but in a kind of burleſque tone, and will follow travellers a great way. The *tzacua* is remarkable for its inſtinct. Birds of this kind live in ſociety, every tree being a village or city to them, having great numbers of neſts in the neighbourhood of each other, all hanging from the boughs. One of them, whoſe office it is to be the head or guard of the village, reſides in the middle of the tree; from which it flies about from one neſt to another, viſiting them all, and after ſinging a little, returns to its place, while the reſt continue perfectly ſilent. If any bird of a different ſpecies approaches the tree, he flies to it, and with his bill and wings endeavours to drive it off; but if a man or any large animal comes near, he flies ſcreaming to another tree; and if at that time any of his fellows happen to be returning to their neſts, he meets them, and, changing his note, obliges them to retire again: as ſoon as he perceives the danger over, he returns to his wonted round of viſiting the neſts.

123 Reptiles.

Mexico, like all other American countries, abounds with reptiles, many of them of an enormous ſize. The crocodiles are not leſs to be dreaded than thoſe of Africa or Aſia, and there are likewiſe ſome of thoſe monſtrous ſerpents met with in the Eaſt Indies and in South America: though happily the ſpecies of thoſe terrible creatures ſeems to be nearly extinct, as they are ſeldom to be found but in ſome ſolitary wood, or other remote place. There are great numbers of lizards, ſome of which the people ſuppoſe to be poiſonous; but Clavigero thinks this opinion ill founded. There are ſeveral kinds of poiſonous ſerpents, of which the rattleſnake is one.

124 Aquatic animals.

The aquatic animals are innumerable. Clavigero mentions a ſpecies of frogs ſo large that a ſingle one will weigh a pound, and which are excellent food.—Of fiſh proper for food, he ſays that he has counted upwards of 100 ſpecies, without taking in the turtle, crab, lobſter, or any other cruſtaceous animal. The ſharks are well known for their voracity. A whole ſheep's ſkin, and even a large butcher's knife, has been found in the belly of one of them. They are accuſtomed to follow veſſels, to devour any filth that is thrown overboard: and, according to Oviedo, they have been known to keep up with ſhips ſailing before a fair wind for no leſs than 500 miles. The bottetto is a fiſh about eight inches in length, but exceſſively thick. While this fiſh lies alive upon the beach, it ſwells whenever it is touched to an enormous ſize, and boys often take pleaſure in making it burſt with a kick. The liver is ſo poiſonous as to kill with ſtrong convulſions in half an hour after it is eaten.

125 Inſects.

Of flying and other minute inſects, the number is prodigiouſly great. There are a variety of beetles:

ſome of a green colour make a great noiſe in flying; on which account children are fond of them. There are great numbers of ſhining beetles, which make a delightful appearance at night, as well as the luminous flies which abound in the country. There are ſix kinds of bees and four kinds of waſps; of which laſt, one collects wax and honey of a very ſweet taſte; another is called the *wandering waſp* from its frequent change of abode; and in conſequence of theſe changes, it is conſtantly employed in collecting materials for its habitations. The lake of Mexico abounds with a kind of fly, the eggs of which are depoſited upon the flags and ruſhes in ſuch quantities as to form large maſſes. Theſe are collected by the fiſhermen, and carried to market for ſale. They are eaten by both Mexicans and Spaniards, and have much the ſame taſte as the caviare of fiſh. There are abundance of gnats in the moiſt places and lakes; but the capital, though ſituated upon a lake, is entirely free from them. The butterflies are in vaſt numbers, and their wings glow with colours far ſuperior to thoſe of Europe; the figures of ſome of them are given by Hernandez. But notwithſtanding its beauties and advantages, Mexico is ſubject to the dreadful devaſtations of locuſts, which ſometimes occaſion the moſt deſtructive famines.

There are ſome of the worms of Mexico made uſe of by the inhabitants as food; others are poiſonous. There are great numbers of ſcolopendræ and ſcorpions, ſome of the former growing to an immenſe ſize. Hernandez ſays, that he has ſeen ſome of them two feet long and two inches thick. The ſcorpions are very numerous; and in the hot parts of the country their poiſon is ſo ſtrong as to kill children, and give terrible pain to adults. Their ſting is moſt dangerous during thoſe hours of the day in which the ſun is hotteſt. There is a miſchievous kind of tick, which in the hot countries abounds among the graſs. From thence it eaſily gets upon the clothes, and from them upon the ſkin. There it fixes with ſuch force, from the particular figure of its feet, that it can ſcarcely be got off. At firſt it ſeems nothing but a ſmall black ſpeck, but in a ſhort time enlarges to ſuch a degree, from the blood which it ſucks, that it equals the ſize of a bean, and then aſſumes a leaden colour. If it is not ſpeedily removed, a wound is made ſimilar to that which the nigera or chegoe makes.

126
Silk and cochineal.

Mexico produces ſilk-worms: and the manufacture of ſilk might be carried on to great advantage, were it not prohibited for ſome political reaſons. Beſides the common ſilk, there is another found in the woods, very white, ſoft, and ſtrong. It grows on the trees in ſeveral maritime places, particularly in dry ſeaſons. Unleſs by poor people, however, this ſilk is not turned to any uſe, partly from inattention to their intereſts, but "chiefly (ſays our author) from the obſtructions which would be thrown in the way of any one who ſhould attempt a trade of that kind. We know from Cortes's letters to Charles V. that ſilk uſed to be ſold in the Mexican markets; and ſome pictures are ſtill preſerved, done by the ancient Mexicans upon a paper made of ſilk."

Cochineal is one of the moſt valuable products of Mexico, and great care is taken to rear the inſect in different parts; but the beſt is that which comes from the province of Mizteca. Some have reckoned that more than 2500 bags of cochineal are ſent every year from Mizteca to Spain; and the trade in that article carried on by the city of Oaxaca is computed at 200,000 crowns value.

127
General deſcription of the inhabitants.

Though Mexico was originally inhabited by a number of different nations, yet all of them reſembled each other pretty much, not only in character, but in external appearance. "They generally rather exceed (ſays Clavigero) than fall under the middle ſize, and are well proportioned in all their limbs. They have good complexions, narrow foreheads, black eyes, clean, firm, white, and regular teeth; thick, black, coarſe, gloſſy hair; thin beards, and generally no hair upon their legs, thighs, and arms, their ſkin being of an olive colour. There is ſcarcely a nation no earth in which there are fewer perſons deformed; and it would be more difficult to find a ſingle hump-backed, lame, or ſquint-eyed man among a thouſand Mexicans, than among a hundred of any other nation. The unpleaſantneſs of their colour, the ſmallneſs of their foreheads, the thinneſs of their beards, and the coarſeneſs of their hair, are ſo far compenſated by the regularity and fine proportion of their limbs, that they can neither be called very beautiful nor the contrary, but ſeem to hold a middle place between the extremes. Their appearance neither engages nor diſguſts; but among the young women of Mexico, there are many very beautiful and fair, whoſe beauty is at the ſame time rendered more winning by the natural ſweetneſs of their manner of ſpeaking, and by the pleaſantneſs and natural modeſty of their whole behaviour. They become gray-headed and bald earlier than the Spaniards; and although moſt of them die of acute diſeaſes, it is not very uncommon among them to attain the age of a hundred. They are now, and ever have been, moderate in eating, but their paſſion for ſtrong liquors is carried to the greateſt exceſs. Formerly they were kept within bounds by the ſeverity of the laws; but now that theſe liquors are become ſo common, and drunkenneſs is unpuniſhed, one half of the people ſeem to have loſt their ſenſes; and this, together with the poor manner in which they live, expoſed to all the baneful impreſſions of diſeaſe, and deſtitute of the means of correcting them, is undoubtedly the principal cauſe of the havock which is made among them by epidemical diſorders.

"Many perſons allow the Mexicans to poſſeſs a great talent of imitation, but deny them that of invention; a vulgar error, which is contradicted by the ancient hiſtory of that people. Their minds are affected by the ſame variety of paſſions with thoſe of other nations, but not to an equal degree. The Mexicans ſeldom exhibit thoſe tranſports of anger, or frenzies of love, which are ſo common in other countries. They are ſlow in their motions; and ſhow a wonderful tenacity and ſteadineſs in thoſe works which require time and long-continued attention. They are moſt patient of injury and hardſhip; and where they ſuſpect no evil intention, are moſt grateful for any kindneſs ſhown: but ſome Spaniards, who cannot diſtinguiſh patience from inſenſibility, nor diſtruſt from ingratitude, ſay proverbially, that the Indians are alike inſenſible to injuries or benefits. That habitual diſtruſt which they entertain of all who are not of their nation, prompts them often to lie and betray; ſo that good faith certainly has not been reſpected among them ſo much as it deſerves. They are by nature taciturn, ſerious, and auſtere; and ſhow more anxiety to puniſh crimes than to reward virtues.

"Generoſity and perfect diſintereſtedneſs are the principal features of their character. Gold with the Mexicans has not that value which it enjoys elſewhere. They ſeem to give without reluctance what has coſt them the utmoſt labour to acquire. The neglect of ſelfiſh intereſts, with the diſlike which they bear to their rulers, and conſequently their averſion to perform the taſks impoſed by them, ſeem to have been the only grounds of that much exaggerated indolence with which the Americans have been charged; and, after all, there is no ſet of people in that country who labour more, or whoſe labour is more neceſſary. The reſpect paid by the young people to the old, and by children to their parents, ſeem to be feelings that are born with them. Parents are very fond of their children; but the affection which huſbands bear to their wives is certainly leſs than that which wives bear to their huſbands; and it is very common for the men to love their neighbours wives better than their own.

"Courage and cowardice ſeem alternately ſo to affect their minds, that it is often difficult to determine whether the one or the other predominates. They meet dangers with intrepidity, when they proceed from natural cauſes, but are eaſily terrified by the ſtern look of a Spaniard. That ſtupid indifference about death and eternity, which many authors have thought inherent in the character of every American, is peculiar only to thoſe who are yet ſo rude and uninformed as to have no idea of a future ſtate."

128 Of the Toltecas and Chichemecas.

The Toltecas, who firſt inhabited Mexico, were accounted much more poliſhed than thoſe who came after them, inſomuch that in after ages it was cuſtomary to diſtinguiſh people of ingenuity and learning by the name of Toltecas. They always lived in ſociety, collected into cities, under the government of kings, and had regular laws. They were more addicted to the arts of peace than of war; and it was to them that the ſucceeding nations owned themſelves indebted for their knowledge of the culture of grain, cotton, pepper, &c. They underſtood the art of caſting gold and ſilver, and melting them in whatever forms they pleaſed, acquiring alſo great reputation from their ſkill in cutting gems of all kinds; and they were beſides well verſed in the ſciences of aſtronomy and chronology.

According to the ancient hiſtories of theſe people, they obſerved, about a hundred years before the Chriſtian era, how far the ſolar year exceeded the civil one; ſupplying the defect, as we do, by the addition of a day once in four years. In the year 660, while their monarchy continued in Tula, a celebrated aſtronomer, named Huematzin, aſſembled with the king's conſent all the wiſe men of the nation; and with their aſſiſtance painted a famous book named *Teoamoxtli*, or "divine book," in which were repreſented, in very plain figures, the origin of the Indians, their diſperſion after the confuſion of tongues at Babel, their journey in Aſia, their firſt ſettlements in America, the founding of the kingdom of Tula, and their progreſs till that time: but theſe, and other accounts of their great knowledge and accuracy, ſavour too much of exaggeration, or perhaps invention, from both which it is impoſſible to clear the Spaniards when ſpeaking of American affairs.

129 Their progreſs in agriculture.

The Chichemecas derived their knowledge of agriculture from the Toltecas, and of conſequence the Mexicans alſo. Being deſtitute of ploughs or animals of ſufficient ſtrength to aſſiſt them in their labour, they made uſe of an inſtrument of hard copper, which they called *coatl* or *coa*, but differing in ſhape either from a ſpade or mattock. They uſed copper axes to cut trees, the figure of which was the ſame with ours; only that they put the axe into the eye of the handle, inſtead of putting the handle into the eye of the axe as we do. They had ſeveral other inſtruments of agriculture, but the forms of them are not mentioned by hiſtorians. They watered their fields by means of the rivers and ſmall torrents which came from the mountains; raiſing dams to collect them, and forming canals to conduct them properly to the places which required moiſture. They uſed encloſures of ſtone, as well as hedges for the fields, uſing for their hedges the aloe plant, which is well calculated for the purpoſe; and what reparations were neceſſary they gave in December. They dibbled their maize: a method of ſowing more ſlow indeed than the ordinary one, but which certainly repays the trouble by a vaſtly larger crop, as well as by ſaving a very conſiderable quantity of ſeed. Cloſe to the newly ſown fields they commonly erected a ſmall tower of wood, where a man kept watch, in order to drive away the birds that came to feed upon the grain; a cuſtom ſtill preſerved among the Spaniards.

130 Magnificent gardens.

In the cultivation of their gardens, the Mexicans were extremely ſkilful and magnificent; planting in them not only kitchen herbs, but fruit trees, medicinal herbs, and flowers, with great taſte and regularity. Some of the royal gardens excited the admiration of the Spaniards ſo much, that Cortes, in a letter to Charles V. informed him that the garden at Huaxtepec was the moſt extenſive, the moſt beautiful, and moſt delightful, that had ever been beheld. It was ſix miles in circumference, and watered by a beautiful river which croſſed it; and there were pleaſure houſes erected at proper diſtances from one another. It was for many years preſerved by the Spaniards.——The plants moſt cultivated, next to maize, were cotton, cocoa, and aloe; which laſt ſerved a great many uſeful purpoſes. See ALOE.

131 Tame animals.

Though they had not the advantage of the larger quadrupeds, as horſes, oxen, or ſheep, they bred up an immenſe number of quadrupeds unknown in Europe. Private perſons brought up the ſmall quadrupeds already mentioned, reſembling little dogs; as well as turkeys, quails, geeſe, ducks, and other kinds of fowl. In the houſes of the great men were bred fiſh, deer, rabbits, and a variety of birds; and in the royal palaces, almoſt all the ſpecies of quadrupeds and winged animals to be found in theſe kingdoms were kept, as well as a great number of aquatic animals and reptiles. According to Clavigero, Montezuma II. ſurpaſſed all the kings in the world in this kind of magnificence;

and there never was a nation equal to the Mexicans in the care they took in taming animals.

132 Paintings. Painting was an art in great requeſt among the Mexicans, and one of very great uſe; as it was only by means of paintings that they recorded their hiſtories. This art they derived, like others, from the Toltecas. Some of theſe paintings were mere images of their gods, kings, heroes, or of terreſtrial objects. Others were hiſtorical, containing an account of particular events; others mythological, of which a volume is preſerved in the great library of the order of Bologna: others were codes of law, civil and religious; while ſome were chronological, aſtronomical, or aſtrological; in which were repreſented their calendar, the poſition of the ſtars, changes of the moon, eclipſes, and prognoſtications and variations of the weather. Great numbers of theſe were burned by the ſuperſtitious Spaniards, who imagined that they contained ſome emblems of heathen worſhip. They had likewiſe geographical paintings, which ſerved not only to ſhow the extent and boundaries of their poſſeſſions, but likewiſe the ſituation of places, the direction of the coaſts, and the courſe of the rivers. In his firſt letter to Charles V. Cortes ſays, that having made inquiries if there was any ſecure harbour for veſſels on the Mexican coaſt, Montezuma preſented him with a painting of the whole coaſt, from the port of Vera Cruz, at that time called *Chalchiuhuecan*, to the river Coatzacualco. Another author informs us alſo, that Cortes, in a long and difficult voyage which he made to the bay of Honduras, made uſe of a chart preſented to him by the lords of Coatzacualco, in which all the places and rivers were marked from the coaſt of Coatzacualco to Huejacallan.

The cloth on which paintings were done was made of the thread of the aloe or a kind of palm; or they painted on ſheep's ſkins or upon paper. This laſt was made of the leaves of a certain kind of aloe, ſteeped like hemp, and afterwards waſhed, ſtretched, and ſmoothed. They uſed alſo the bark of other trees, prepared with gum: but we are ignorant of the method they uſed in the manufacture. This paper is ſimilar in thickneſs to the European paſteboard, but ſofter, ſmoother, and more eaſy for writing. In general it was made up in very long ſheets, which they preſerved in rolls, or folded like bed ſkreens. The volume of Mexican paintings, preſerved in the library of Bologna, is a thick ſkin, ill dreſſed, compoſed of different pieces painted all over, and folded up in that manner. The beautiful colours which they employed both in their paintings and in their dyes, were obtained from wood, leaves, and the flowers of different plants, as well as from various animal ſubſtances. Their white was made from a kind of ſtone which burns into a fine plaſter; or from a mineral, which after being made into a paſte worked like clay, and formed into ſmall balls, turns white in the fire like Spaniſh white. Their *black* was got from another mineral, which has a diſagreeable ſmell, or from the ſoot of a kind of pine collected in ſmall earthen veſſels. They obtain *blue* and *azure* colours from indigo; but their mode of obtaining theſe was very different from that uſed by the moderns. They put the branches of the plant into hot, or rather lukewarm, water; and after having ſtirred them about for a ſufficient time with a ſtick or ladle, they paſſed the water, when impregnated with the dye, into certain pots or cups, in which they let it remain until the ſolid part of the dye was depoſited; after which they poured off the water. This ſediment was firſt dried in the ſun, and afterwards put between two plates before a fire until it grew hard. They had another plant which likewiſe afforded a blue colour, but inferior to the indigo. *Red* was obtained from the ſeeds of the achiot or rocou, and *purple* from cochineal. Their *yellows* were ochre, and a colour extracted from the beautiful flower of a plant reſembling artemiſia. With nitre theſe flowers afforded a fine orange colour; and by means of alum they extracted other colours.

The Mexican painters were by no means arrived at much perfection in the knowledge of light and ſhade, or of deſign; nevertheleſs, in ſome of the ancient paintings, particularly in the portraits of their kings, the proportions were exactly obſerved. 133 They did not uſe hieroglyphics or characters. Beſides paintings, however, the Mexicans are ſaid to have employed hieroglyphics and characters; but this is abſolutely denied by Clavigero; who tells us, that "they repreſented material things by their proper figures; but, in order to ſave labour, paper, and colours, they contented themſelves with repreſenting part of an object, which was ſufficient to make it underſtood. But as we cannot underſtand the writings of others till we have learned to read them; in like manner thoſe American authors, who ſay that the Mexicans made uſe of characters, required to have been firſt inſtructed in the Mexican manner of repreſenting objects, in order to have been able to underſtand the paintings which ſerved them in place of writing. When they would repreſent any perſon, they painted a man, or a human head, and over it a figure expreſſing the meaning of his name, as appears in the figures of the Mexican kings. To expreſs a city or village, they painted in like manner a figure which ſignified the ſame thing, with its name. To form their hiſtories or annals, they painted on the margin of the cloth or paper the figures of the years in ſo many ſquares, and at the ſide of each ſquare the event or events which happened that year: and if, on account of the number of years, the hiſtory of which they meant to relate, they could not all be contained in one canvas, they were continued on another. With reſpect to the order of repreſenting the years and events, it was at the liberty of the hiſtorian to begin at whichever angle of the piece he pleaſed; but at the ſame time conſtantly obſerving, that if the painting began at the upper angle of the right-hand, he proceeded towards the left; but if it began, as it moſt commonly did, at the upper angle of the left hand, he proceeded ſtraight downwards. If he painted the firſt year at the lower angle of the left, he continued towards the right; but if he began at the lower angle of the right, he painted ſtraight upwards: ſo that on the upper part of his canvas he never painted from left to right, nor ever on the lower part from right to left; never advanced upwards from the left, nor downwards from the right. When this method of the Mexicans is underſtood, it is eaſy to diſcover at firſt ſight which is the beginning and which the ending of any hiſtorical painting. Their paintings, however, ought not to be conſidered as a regular full hiſtory, but only as monuments and aids of tradition. We cannot expreſs too

134 Careful to preſerve their traditions.

ſtrongly the care which parents and maſters took to inſtruct their children and pupils in the hiſtory of the nation. They made them learn ſpeeches and diſcourſes which they could not expreſs by the pencil; they put the events of their anceſtors into verſe, and taught them to ſing them. This tradition diſpelled the doubts and undid the ambiguity which paintings alone might have occaſioned; and, by the aſſiſtance of thoſe monuments, perpetuated the memory of their heroes and of virtuous examples, their mythology, rites, laws, and cuſtoms.

135 Preſerved the memory of events by knotted threads.

“Nor did that people only make uſe of tradition, paintings, and ſongs, to preſerve the memory of events, but alſo of threads of different colours and differently knotted. This curious method of the repreſentation of things, however much uſed in Peru, does not appear to have been employed in the province of Anahuac, if not in the moſt early ages; for no traces of ſuch monuments are now to be found. Boturini ſays, that after the moſt diligent ſearch, he with difficulty found one in a place in Tlaſcala, the threads of which were already waſted and conſumed by time. If thoſe who peopled South America ever paſſed the country of Anahuac, they poſſibly might have left there this art, which was afterwards abandoned for that of painting, introduced by the Toltecans or ſome other nation ſtill more ancient.”

136 Their knowledge in ſculpture.

The Mexicans arrived at greater perfection in ſculpture, caſting of metals, and moſaic works, than in painting. Sculpture was likewiſe one of the arts exerciſed by the ancient Toltecans; but the Mexicans had ſculptors among them when they left their native country of Atztlan. Several of the Toltecan ſtatues, however, were preſerved till the time of the conqueſt, particularly that of the idol Tlaloc, placed upon the mountain of the ſame name, and ſome gigantic ſtatues in one of their temples. Stone and wood were the uſual materials of their ſtatues: the former was worked with a chiſſel made of flint; and, in ſpite of the unfitneſs of the inſtrument, ſuch was the phlegmatic nature of the people, that they ſurmounted every difficulty ariſing from the tediouſneſs of the work. In their ſtatues they learned to expreſs all the attitudes and poſtures of which the human body is capable. They obſerved the proportions exactly, and could when neceſſary execute the moſt delicate ſtrokes with the chiſſel. They not only made entire ſtatues, but cut out in wood and in ſtone figures in baſſo relievo; of which kind are thoſe of Montezuma II. and one of his ſons, recorded with praiſes by Acoſta. They alſo made ſtatues of clay and wood, employing for theſe a chiſſel of copper. The number of their ſtatues was in proportion to that of their idols; but ſo active were the Spaniſh prieſts in deſtroying theſe, that there is now ſcarce any veſtige of them remaining. The foundation of the firſt church in Mexico was laid with idols; on which occaſion many thouſand ſtatues of their gods were neceſſarily broke in pieces.

137 Excelled in the art of caſting metals.

In caſting of metals, however, the Mexicans greatly excelled their works either of painting or ſculpture. “The miracles they produced of this kind (ſays Clavigero), would not be credible, if, beſides the teſtimony of thoſe who ſaw them, a great number of curioſities of this kind had not been ſent from Mexico to Europe. The works of gold and ſilver ſent in preſents from the conqueror Cortes to Charles V. filled the goldſmiths of Europe with aſtoniſhment; who, as ſeveral authors of that period atteſt, declared that they were altogether inimitable. The Mexican founders made both of gold and ſilver the moſt perfect images of natural bodies. They made a fiſh in this manner, which had its ſcales alternately one of ſilver and the other of gold; a parrot with a moveable head, tongue, and wings; and an ape with a moveable head and feet, having a ſpindle in its hand in the attitude of ſpinning. They ſet gems in gold and ſilver, and made moſt curious jewellery of great value. In ſhort, theſe ſort of works were ſo admirably finiſhed, that even the Spaniſh ſoldiers, all ſtung with the ſame wretched thirſt for gold, valued the workmanſhip above the materials. This wonderful art, formerly practiſed by the Toltecas, the invention of which they aſcribed to one of their gods, has been entirely loſt by the debaſement of the Indians, and the indolent neglect of the Spaniards. We are doubtful if there are any remains of thoſe curious works; at leaſt we apprehend that it would be more eaſy to find them in ſome of the cabinets of Europe than in all New Spain. Covetouſneſs to profit by the materials muſt unqueſtionably have conquered all deſire to preſerve them as curioſities.” The works of the Mexicans in gold and ſilver, executed with the hammer, were much inferior to thoſe of the Europeans.

138 Beautiful moſaic.

But of all the works executed by the ancient Mexicans, thoſe of moſaic were the moſt curious, as well as moſt highly valued by themſelves. Theſe were made of the feathers of birds; and for procuring them they reared a great number of thoſe birds of fine plumage, with which the country abounded, not only in the royal palaces, but alſo in private houſes; and at certain ſeaſons they carried off the feathers for theſe purpoſes, or to ſell them at market. They valued particularly the feathers of the humming birds, on account of their ſmallneſs, fineneſs, and various colours; and in theſe, as well as other birds of fine plumage, nature ſupplied them not only with all the colours producible by art, but likewiſe with many which art cannot imitate. Their moſaic works, as well as indeed all others of the Mexicans, required infinite patience. At the undertaking of every work of this kind ſeveral artiſts aſſembled; and having agreed upon a deſign, and fixed their meaſures and proportions, each artiſt charged himſelf with the execution of a certain part of the image, and exerted himſelf ſo diligently in it, that he frequently ſpent a whole day in adjuſting a feather; firſt trying one and then another, viewing it ſometimes one way, then another, until he found one which gave his part that ideal perfection propoſed to be attained. When the part which each artiſt undertook was done, they aſſembled again to form the entire image from them. If any part happened to be in the leaſt deranged, it was wrought again until it was perfectly finiſhed. They laid hold of the feathers with ſmall pincers, that they might not do them the leaſt injury, and paſted them on the cloth with ſome glutinous matter; then they united all the parts upon a little table or a plate of copper, and flattened them ſoftly until they left the ſurface of the image ſo equal and ſmooth, that it appeared to be the work of a pencil. Theſe works were prodigiouſly admired by the Spaniards.

139 Their architecture.

The Mexicans were ſkilled in architecture even before

fore they left their native country; and many edifices ſtill remain which were conſtructed by them during their frequent journeys from one place to another. At their firſt arrival on the lake, they had no other materials to build their houſes with but reeds and mud, until the ſucceſs of their commerce allowed them to purchaſe better materials. When the city came to its perfection, the houſes of the principal people were conſtructed of ſtone and lime: they conſiſted of two floors, having halls, large court-yards, and chambers fitly diſpoſed: the roofs were flat and terraced; the walls ſo well whitened, poliſhed, and ſhining, that they appeared to the Spaniards when at a diſtance to have been conſtructed of ſilver. The floor was paved with plaſter, perfectly level, plain, and ſmooth. Many of their houſes were crowned with battlements and turrets; and their gardens had fiſh ponds, and the walks of them ſymmetrically laid out. The large houſes had in general two entrances, the principal one to the ſtreet, the other to the canal: they had no wooden doors to their houſes, but covered the entrance with ſmall reeds, from whence they ſuſpended a ſtring of cocoa ſhells, or ſome other materials which would make a noiſe, ſo as to awake the attention of the family when any perſon lifted up the reeds to enter the houſe. —The houſes of the poorer ſort were conſtructed of reeds, unburnt bricks, ſtone, or mud; and the roofs made of a kind of a long hay which grows plentifully in the fields, particularly in the warm parts of the country. For this purpoſe they uſed alſo the leaves of the aloe placed in the manner of tiles, to which they bear ſome reſemblance both in thickneſs and ſhape. One of the columns or ſupports of theſe houſes was generally a tree in the vigour of its growth; by which means, beſides the pleaſure derived from its foliage and ſhade, they ſaved themſelves ſome labour and expence. Theſe houſes had one or more apartments according to the circumſtances of the family.

The ancient Mexicans underſtood the method of conſtructing arches or vaults, as appears from ſome remains of their buildings as well as from their paintings. They had likewiſe cornices and other ornaments of architecture. They had alſo ſquare or cylindrical columns; but it is not known whether they had any capitals or not. They frequently adorned them with figures in *baſſo relievo;* but their great ambition was to have them all made out of one ſtone. The foundations of the large houſes in the capital were laid upon beams of cedar driven into the ground, on account of its want of ſolidity; and the ſame method is ſtill practiſed by the Spaniards. The roofs of theſe were made of cedar, fir, cypreſs, pine, &c. In the royal palaces the columns were of marble or even of alabaſter, which the Spaniards miſtook for jaſper. In the reign of Ahuizotl a new kind of ſtone, named *tetzontli*, was diſcovered in the Mexican lake, which was ever afterwards made uſe of for building. It is hard, light, and porous like a ſponge; by which means the lime adheres very firmly to it. It is valued likewiſe on account of its colour, which is a blood red. Some of the pavements were chequered with marble and other valuable ſtones.

140 Remarkable aqueducts.

The moſt remarkable pieces of Mexican architecture were their aqueducts. There were two which conveyed the water to the capital from the diſtance of two miles. Theſe were conſtructed of ſtone and cement five feet high, and two paces broad, upon a road for that purpoſe upon the lake; by which the water was brought to the entrance of the city, from whence it was ſent forth in ſmaller channels to ſupply the different fountains. The famous aqueduct of Chempoallan, which was done in the 16th century, is worthy of being ranked among the greateſt in Europe. The conductor of this work was a Franciſcan miſſionary named *Tembleque;* and it was executed with great ſkill by the Chempoalleſe. The water was brought from a great diſtance, and the country through which it muſt paſs was mountainous and rocky; but every difficulty was overcome by the induſtry of the Mexicans. The aqueduct, including all the turnings and windings, exceeded 30 miles in length. The principal difficulty conſiſted in croſſing three great precipices, over which they were obliged to conſtruct three bridges, the firſt of 47, the ſecond of 13, and the third of 67 arches. The largeſt arch was 100 feet high, and 61 broad; ſo that a large veſſel could have paſſed under it. It muſt, however, be obſerved, that, in executing this undertaking, the Mexicans were undoubtedly aſſiſted by European tools, and the directions of European workmen; ſo that we cannot with ſtrict propriety call it one of their works.

141 Excellent jewellers.

They were expert jewellers, and underſtood the art of cutting and poliſhing the ſtones, as well as of ſetting them. The gems moſt common in their country were the emeralds, amethyſts, carnelians, turquoiſes, and ſome others. Emeralds were ſo common, that no lord or noble wanted them; and none of them died without having one fixed to his lip, that it might ſerve him, as they imagined, in the other world, inſtead of a heart. When Cortes returned the firſt time to Spain, he brought with him five emeralds, valued, by the jewellers there, at 100,000 ducats. The firſt was in the form of a roſe; the ſecond of an horn; the third of a little fiſh with eyes of gold; the fourth in the form of a bell, with a fine pearl for a clapper. The fifth was a ſmall cup with a foot of gold, and four little golden chains which united in a pearl in the form of a button. For this alone the Genoeſe merchants offered 40,000 ducats, in order to ſell it again to the grand ſignior. Beſides theſe, he had two emerald vaſes valued at 300,000 ducats; but theſe laſt were laſt by ſhipwreck in the unfortunate expedition of Charles V. againſt Algiers. There are no ſuch gems wrought at preſent, nor is it even known where the emerald mines are ſituated; though it is ſaid there are ſtill ſome large pieces of this precious ſtone, in ſome of the churches; but the prieſts take care to ſecure them with iron chains, leſt they ſhould be carried off.

142 Manufactures of different kinds.

In other more common manufactures the Mexicans were by no means deficient. The earthen ware of Cholula was much praiſed by the Spaniards; and they had the art of ornamenting this kind of ware with various colours, though they did not underſtand the making of glaſs. Their carpenters wrought with inſtruments of copper; and there are ſtill remains of their labours which diſplay a tolerable ſkill. Almoſt every one was acquainted with the method of making cloth. Being deſtitute of wool, common ſilk, lint, or hemp, they were obliged to ſupply the deficiency by other materials. For wool they ſubſtituted cotton, for ſilk they uſed feathers, the wool of the hare or rabbit; and inſtead of lint and hemp, they uſed the fibrous part of the leaves of the aloe. From theſe laſt they obtained a thread as fine as from lint; and from ſome ſpecies they had a coarſer ſort reſembling hemp. To obtain this thread they ſoaked the leaves in water, cleaned them, expoſed them to the ſun, and then beat them till they were fit to be ſpun. Sometimes they interwove with their cotton the fineſt down on the belly of the rabbits or hares, after having ſpun it into thread; and of theſe they made moſt beautiful cloths, which were particularly uſed for winter waiſtcoats for the lords. Their cotton manufactures were equal to any produced in Europe; they wove them with different figures and colours, repreſenting different animals and flowers. Of feathers interwoven with cotton they made mantles and bed-curtains, carpets, gowns, &c. Theſe were exceedingly beautiful; but this kind of manufacture is now loſt, though there are ſtill ſome of theſe garments in the poſſeſſion of the principal lords, who wear them upon ſolemn occaſions.

143 Their horrible religion.

All theſe advances towards civilization, however, in the ancient Mexicans, were much more than counterbalanced by the horrible barbarities they committed in their religious ceremonies, and in which they exceeded every nation on earth. Human ſacrifices were indeed in uſe among all the ancient heathens; but ſuch prodigious maſſacres at the dedication of their temples are unheard of in hiſtory. Whether they uſed theſe barbarous ſacrifices in their own country, or whether the practice began with that of the four Xochimilca priſoners, is not known; but as they only uſed their priſoners or ſlaves whom they bought in this way, it is impoſſible that, during the infancy of their ſtate, the number of human victims could have been very great. Moſt of thoſe unhappy creatures periſhed by having their breaſts opened, and their hearts pulled out; ſome were drowned, others ſtarved to death with hunger; and ſometimes they were burnt. Priſoners of high rank were allowed to die by what Clavigero calls the *gladiatorian* ſacrifice, which was performed in the following manner: Near to the greater temple of large cities, in an open ſpace of ground ſufficient to contain an immenſe number of people, was a round terrace eight feet high, upon which was placed a large round ſtone reſembling a millſtone in ſhape, but much larger, almoſt three feet high, well poliſhed, and having figures cut upon it. On this ſtone, which was called *temalcatl*, the priſoner was placed, armed with a ſhield and ſhort ſword, and tied by one foot. Here he was encountered by a Mexican officer or ſoldier better armed than himſelf. If the priſoner was vanquiſhed, he was carried, dead or alive, to the temple, where his heart was taken out and offered in the uſual manner; but if he conquered ſix combatants, he gained his life and liberty. An inſtance, however, is given in which this cuſtom was infringed; for the Huetzotzincas having taken the principal lord of Cholula, a man of ſingular bravery, he overcame ſeven combatants; notwithſtanding which he was put to death; but on this account the Huetzotzincas were rendered for ever infamous among theſe nations.

144 Gladiatorian ſacrifice.

145 Number of human victims annually ſacrificed.

Hiſtorians differ concerning the number of victims who periſhed annually in theſe ſacrifices: Clavigero inclines to think it was 20,000, but others make it much more. Zumarraga, the firſt biſhop of Mexico, ſays in a letter of the 12th of June 1531, addreſſed to the general chapter of his order, that in that capital alone there were above 20,000 victims annually ſacrificed. Some authors, quoted by Gomara, ſay that 50,000 were annually ſacrificed in the various parts of the empire. Acoſta ſays, that there was a certain day of the year on which they ſacrificed 5000 victims, and another on which 20,000 were ſacrificed. According to others they ſacrificed, on the mountain Tepeyacac only, 20,000 annually to one of their female deities. On the other hand, Bartholomew de las Caſas reduces the number of human victims to 50 or at moſt to 100. "We are ſtrongly of opinion (ſays Clavigero), that all theſe authors have erred in the number; Las Caſas by diminution, and the reſt by exaggerating the truth."

146 Their monſtrous auſterities.

Beſides the cruelties which they practiſed upon others, the Mexicans were accuſtomed to treat themſelves with the moſt inhuman auſterities, thinking that the diabolical rage of their deities would be appeaſed by human blood. "It makes one ſhudder (ſays Clavigero), to read the auſterities which they practiſed upon themſelves, either in atonement for their tranſgreſſions, or in preparation for their feſtivals. They mangled their fleſh as if it had been inſenſible, and let their blood run in ſuch profuſion as if it had been a ſuperfluous fluid in the body. The effuſion of blood was frequent and daily with ſome of their prieſts. They pierced themſelves with the ſharpeſt ſpines of the aloe, and bored ſeveral parts of their bodies, particularly their ears, lips, tongue, and the fat of their arms and legs. Through the holes which they made with theſe ſpines they introduced pieces of cane, the firſt of which were ſmall; but every time this penitential ſuffering was renewed, a thicker piece was made uſe of. The blood which flowed from them was carefully collected in the leaves of the plant *aczojatl*. They fixed the bloody ſpines in little balls of hay, which they expoſed upon the battlements of the walls of the temple, to teſtify the penance which they did for the people. Thoſe who exerciſed ſuch ſeverities upon themſelves within the encloſure of the greater temple of Mexico, bathed in a pond that was formed there, and which, from being always tinged with blood, was called *ezapan*."

147 Their dreſs.

The dreſs of the Mexicans was very ſimple; that of the men conſiſted only of a large belt or girdle, the two ends of which hung down before and behind; the women wore a ſquare mantle, about four feet long; the two ends were tied upon the breaſt or upon one ſhoulder. The Mexican gown was alſo a piece of ſquare cloth, in which the women wrapped themſelves from the waiſt down to the middle of the leg. They wore alſo a ſmall under veſt or waiſtcoat without ſleeves, named *huepilli*.

The dreſs of the poorer ſort was made of the thread of the mountain palm, or of coarſe cotton; but thoſe of better ſtation wore the fineſt cotton embelliſhed with various colours, and figures of animals or flowers; or woven with feathers, or the fine hair of the rabbit, &c. The men wore two or three mantles, and the women three or four veſts, and as many gowns, putting the longeſt undermoſt, ſo that a part of each of them might be ſeen. Their ſhoes were only ſoles of leather, or coarſe cloth of the mountain palm tied with ſtrings; but thoſe of the great people were adorned with ribbands of gold and jewels. They all wore long hair, and thought themſelves diſhonoured by being ſhaved, or having their hair clipped, except the conſecrated virgins in the temple. The women wore it looſe; but the men tied it up in different forms, and adorned their heads with fine feathers, both when they danced and went to war. With this ſimplicity, however, they mixed no ſmall quantity of extravagance. Beſides feathers and jewels, with which they uſed to adorn their heads, they wore ear-rings, pendants at their upper lip, as well as many at their noſes, necklaces, bracelets for the hands and arms, as well as certain rings like collars which they wore about their legs. The ear-rings of the poor were ſhells, pieces of cryſtal, amber, &c.; but the rich wore pearls, emeralds, amethyſts, or other gems ſet in gold.

Inſtead of ſoap the Mexicans uſed a kind of fruit called *copalxocotl;* the pulp of which is white, viſcous, and very bitter, makes water white, raiſes a froth, and will clean linen like ſoap. They uſed alſo a kind of root named *amolli,* which is not unlike the *ſaponaria* of the old continent. It is now more uſed for waſhing the body, eſpecially the head, than for clothes. Clavigero ſays, that there is a kind of this root which dyes the hair of a golden colour, and that he has been witneſs to this effect on the hair of an old man.

148 Modern inhabitants, &c. The principal inhabitants of Mexico, in modern times, are Spaniards ſent thither by the court, to fill the poſts of government. They are obliged, like thoſe in the mother country who aſpire to any eccleſiaſtical, civil, or military employments, to prove that there have been neither heretics, Jews, Mohammedans, nor any perſon in their family who has been called before the inquiſition for four generations. Merchants who are deſirous of going to Mexico, as well as to other parts of America, without becoming coloniſts, are compelled to obſerve the ſame forms. They are alſo obliged to ſwear that they have 300 palms of merchandiſe, their own property, in the fleet in which they embark, and that they will not carry their wives with them. On theſe abſurd conditions they become the principal agents of the European commerce with the Indies. Though their charter is only to continue three years, and a little longer for countries more remote, it is of great importance. To them alone belongs the right of ſelling, as commiſſioners, the major part of the cargo. If theſe laws were obſerved, the merchants ſtationed in the new world would be confined to diſpoſe of what they have received on their own account.

The predilection which adminiſtration has for Spaniards born in Europe, has reduced the Spaniſh Creoles to acquieſce in ſubordinate ſtations. The deſcendants of the companions of Cortes, and of thoſe who came after them, being conſtantly excluded from all places of honour or of truſt that were any way conſiderable, have ſeen the gradual decay of the power that ſupported their fathers. The habit of being obliged to bear that unjuſt contempt with which they have been treated, has at laſt made them become really contemptible. They have totally loſt, in the vices which originate from indolence, from the heat of the climate, and from a ſuperfluous enjoyment of all things, that firmneſs and that ſort of pride which have ever characterized their nation. A barbarous luxury, ſhameful pleaſures, and romantic intrigues, have enervated all the vigour of their minds; and ſuperſtition hath completed the ruin of their virtues. Blindly devoted to prieſts too ignorant to enlighten them by their inſtructions, too depraved to edify them by their example, and too mercenary to attend to both theſe duties of their function, they have no attachment to any part of their religion but that which enfeebles the mind; and have neglected what might have contributed to rectify their morals.

The Meſtees, who conſtitute the third order of citizens, are held in ſtill greater contempt. It is well known that the court of Madrid, in order to repleniſh a part of that dreadful vacancy which the avarice and cruelty of the conquerors had occaſioned, and to regain the confidence of thoſe who had eſcaped their fury, encouraged as much as poſſible the marriage of Spaniards with Indian women. Theſe alliances, which became pretty common throughout all America, were particularly frequent in Mexico, where the women had more underſtanding and were more agreeable than in other places. The Creoles transferred to this mixed progeny the contemptuous ſlight they received from the Europeans. Their condition, equivocal at firſt, in proceſs of time was fixed between the whites and the blacks.

Theſe blacks are not very numerous in Mexico. As the natives are more intelligent, more robuſt, and more induſtrious, than thoſe of the other colonies, they have hardly introduced any Africans except ſuch as were required either to indulge the caprice, or perform the domeſtic ſervice, of rich people. Theſe ſlaves, who are much beloved by their maſters, on whom they abſolutely depend, who purchaſed them at an extravagant price, and who make them the miniſters of their pleaſures, take advantage of the high favour they enjoy, to oppreſs the Mexicans. They aſſume over theſe men, who are called *free,* an aſcendant which keeps up an implacable hatred between the two nations. The law has ſtudied to encourage this averſion, by taking effectual meaſures to prevent all connexion between them. Negroes are prohibited from having any amorous correſpondence with the Indians; the men, on pain of being mutilated; the women, of being ſeverely puniſhed. On all theſe accounts, the Africans, who in other ſettlements are enemies to the Europeans, are in the Spaniſh Indies their warm friends.

Authority has no need of this ſupport, at leaſt in Mexico, where population is no longer what it was formerly. The firſt hiſtorians, and thoſe who copied them, have recorded, that the Spaniards found there 10,000,000 of ſouls. This is ſuppoſed to have been the exaggerated account of conquerors, to exalt the magnificence of their triumph; and it was adopted, without examination, with ſo much the more readineſs, as it rendered them the more odious. We need only trace with attention the progreſs of thoſe ruffians who at firſt deſolated theſe fine countries, in order to be convinced that they had not ſucceeded in multiplying men at Mexico and the adjacent parts, but by depopulating the centre of the empire; and that the provinces which are remote from the capital, differed in nothing from the other deſerts of South and North

America. It is making a great conceſſion, to allow that the population of Mexico has only been exaggerated one-half: for it does not now much exceed 2,000,000.

149
Mexicans cruelly treated by the Spaniards.

It is generally believed, that the firſt conquerors maſſacred the Indians out of wantonneſs, and that even the prieſts incited them to theſe acts of ferocity. Undoubtedly theſe inhuman ſoldiers frequently ſhed blood without even an apparent motive; and certainly their fanatic miſſionaries did not oppoſe theſe barbarities as they ought to have done. This was not, however, the real cauſe, the principal ſource of the depopulation of Mexico; it was the work of a ſlow tyranny, and of that avarice which exacted from its wretched inhabitants more rigorous toil than was compatible with their conſtitution and the climate.

This oppreſſion was coeval with the conqueſt of the the country. All the lands were divided between the crown, the companions of Cortes, and the grandees or miniſters who were moſt in favour at the court of Spain. The Mexicans, appointed to the royal domains, were deſtined to public labours, which originally were conſiderable. The lot of thoſe who were employed on the eſtates of individuals was ſtill more wretched. All groaned under a dreadful yoke; they were ill fed; they had no wages given them; and ſervices were required of them, under which the moſt robuſt men would have ſunk. Their misfortunes excited the compaſſion of Bartholomew de las Caſas.

150
Bartholomew de las Caſas takes their part.

This man, ſo famous in the annals of the new world, had accompanied his father in the firſt voyage made by Columbus. The mildneſs and ſimplicity of the Indians affected him ſo ſtrongly, that he made himſelf an eccleſiaſtic, in order to devote his labours to their converſion. But this ſoon became the leaſt of his attention. As he was more a *man* than a *prieſt*, he felt more for the cruelties exerciſed againſt them than for their ſuperſtitions. He was continually hurrying from one hemiſphere to the other, in order to comfort the people for whom he had conceived an attachment, or to ſoften their tyrants. This conduct, which made him be idolized by the one and dreaded by the other, had not the ſucceſs he expected. The hope of ſtriking awe, by a character revered among the Spaniards, determined him to accept the biſhoprick of Chiapa in Mexico. When he was convinced that this dignity was an inſufficient barrier againſt that avarice and cruelty which he endeavoured to check, he abdicated it. It was then that this courageous, firm, diſintereſted man, accuſed his country before the tribunal of the whole univerſe. In his account of the tyranny of the Spaniards in America, he accuſes them of having deſtroyed 15,000,000 of Indians. They ventured to find fault with the acrimony of his ſtyle; but no one convicted him of exaggeration. His writings, which indicate the amiable turn of his diſpoſition, and the ſublimity of his ſentiments, have ſtamped a diſgrace upon his barbarous countrymen, which time hath not, and never will, efface.

151
Their condition rendered ſomewhat eaſier.

The court of Madrid, awakened by the repreſentations of the virtuous Las Caſas, and by the indignation of the whole world, became ſenſible at laſt, that the tyranny it permitted was repugnant to religion, to humanity, and to policy; and reſolved to break the chains of the Mexicans. Their liberty was now only conſtrained by the ſole condition, that they ſhould not quit the territory where they were ſettled. This precaution owed its origin to the fear that was entertained of their going to join the wandering ſavages to the north and ſouth of the empire.

With their liberty their lands ought alſo to have been reſtored to them; but this was not done. This injuſtice compelled them to work ſolely for their oppreſſors. It was only decreed, that the Spaniards, in whoſe ſervice they laboured, ſhould ſtipulate to keep them well, and pay them to the amount of 5l. 5s. a-year.

From theſe profits the tribute impoſed by government was ſubtracted, together with 4s. 4½d. for an inſtitution which it is aſtoniſhing the conquerors ſhould have thought of eſtabliſhing. This was a fund ſet apart in each community, and appropriated to the relief of ſuch Indians as were decayed or indiſpoſed, and to their ſupport under private or public calamities.

The diſtribution of this fund was committed to their caciques. Theſe were not the deſcendants of thoſe whom they found in the country at the time of the conqueſt. The Spaniards choſe them from among thoſe Indians who appeared the moſt attached to their intereſts; and were under no apprehenſions at making theſe dignities hereditary. Their authority was limited to the ſupporting the police in their diſtrict, which in general extended eight or ten leagues; to the collecting the tribute of thoſe Indians who laboured on their own account, that of the others being ſtopt by the maſters whom they ſerved; and to the preventing their flight by keeping them always under their inſpection, and the not ſuffering them to contract any engagement without their conſent. As a reward of their ſervices, theſe magiſtrates obtained from government a property. They were permitted to take out of the common ſtock 2½d. annually for every Indian under their juriſdiction. At laſt they were empowered to get their fields cultivated by ſuch young men as were not yet ſubject to the poll tax; and to employ girls, till the time of their marriage, in ſuch occupations as were adapted to their ſex, without allowing them any ſalary except their maintenance.

Theſe inſtitutions, which totally changed the condition of the Indians of Mexico, irritated the Spaniards to a degree not to be conceived. Their pride would not ſuffer them to conſider the Americans as free men; nor would their avarice permit them to pay for labour which hitherto had coſt them nothing. They employed themſelves ſucceſſively, or in combination, craft, remonſtrances, and violence, to effect the ſubverſion of an arrangement which ſo ſtrongly contradicted their warmeſt paſſions; but their efforts were ineffectual. Las Caſas had raiſed up for his beloved Indians protectors who ſeconded his deſign with zeal and warmth. The Mexicans themſelves, finding a ſupport, impeached their oppreſſors before the tribunals; and even the tribunals that were either weak or in the intereſt of the court. They carried their reſolution ſo far, as even unanimouſly to refuſe to work for thoſe who had treated any of their countrymen with injuſtice. This mutual agreement, more than any other circumſtance, gave ſolidity to the regulations which had been decreed. The other, preſcribed by the laws, was gradually eſtabliſhed. There was no longer any regular ſyſtem of oppreſſion; but merely ſeveral of thoſe particular vexations which a vanquiſhed people, who have loſt their government, can hardly avoid from thoſe who have ſubdued it.

Theſe clandeſtine acts of injuſtice did not prevent the Mexicans from recovering from time to time, certain detached portions of that immenſe territory of which their fathers had been deſpoiled. They purchaſed them of the royal domain, or of the great proprietors. It was not their labour which enabled them to make theſe acquiſitions: for this they were indebted to the happineſs of having diſcovered, ſome of them mines, others treaſures which had been concealed at the time of the conqueſt. The greateſt number derived their reſources from the prieſts and monks, to whom they owed their exiſtence.

Even thoſe who experienced a fortune leſs propitious, procured for themſelves, by the ſole profits of their pay, more conveniences than they had enjoyed before they underwent a foreign yoke. We ſhould be very much deceived, were we to judge of the ancient proſperity of the inhabitants of Mexico by what has been ſaid of its emperor, its court, its capital, and the governors of its provinces. Deſpotiſm had there produced thoſe fatal effects which it produces everywhere. The whole ſtate was ſacrificed to the caprices, pleaſures, and magnificence, of a ſmall number of perſons.

The government drew conſiderable advantages from the mines which it cauſed to be worked, and ſtill greater from thoſe which were in the hands of individuals. The ſalt works greatly added to its revenue. Thoſe who followed agriculture, at the time of harveſt paid in a kind of a third of all the produce of the lands, whether they belonged to them as their own property, or whether they were only the farmers of them. Men who lived by the chaſe, fiſhermen, potters, and all mechanics, paid the ſame proportion of their induſtry every month. Even the poor were taxed at certain fixed contributions, which their labour or their alms might put them in a condition to pay.

The Mexicans are now leſs unhappy. Our fruits, our corn, and our cattle, have rendered their food more wholeſome, agreeable, and abundant. Their houſes are better built, better diſpoſed, and better furniſhed. Shoes, drawers, ſhirts, a garment of wool or cotton, a ruff, and a hat, conſtitute their dreſs. The dignity which it has been agreed to annex to theſe enjoyments has made them better economiſts, and more laborious. This caſe, however, is far from being univerſal; it is even very uncommon in the vicinity of the mines, towns, and great roads, where tyranny ſeldom ſleeps; but we often find it with ſatisfaction in remote parts, where the Spaniards are not numerous, and where they have in ſome meaſure become Mexicans.

The employments of this people are very various. The moſt intelligent, and thoſe who are in eaſy circumſtances, devote themſelves to the moſt neceſſary and moſt uſeful manufactures, which are diſperſed through the whole empire. The moſt beautiful manufactures are eſtabliſhed among the people of Tlaſcala. Their old capital, and the new one, which is called *Angelos*, are the centre of this induſtry. Here they manufacture cloth that is pretty fine, callicoes that have an agreeable appearance, certain ſlight ſilks, good hats, gold lace, embroidery, lace, glaſſes, and a great deal of hardware.

152
Manufactures and produce of the country.

The care of flocks affords a maintenance to ſome Mexicans, whom fortune or nature have not called to more diſtinguiſhed employments. America, at the time it was diſcovered, had neither hogs, ſheep, oxen, horſes, nor even any domeſtic animal. Columbus carried ſome of theſe uſeful animals to St Domingo, from whence they were generally diſperſed; and in Mexico, more than in any other place, theſe have multiplied prodigiouſly. They count their horned cattle by thouſands, whoſe ſkins are become an object of conſiderable exportation. The horſes are degenerated, but the quality is compenſated by the number. Hogs lard is here ſubſtituted for butter. Sheep's wool is dry, coarſe, and bad, as it is everywhere between the tropics.

The vine and olive tree have experienced the ſame degeneracy. The cultivation of them was at firſt prohibited, with a view of leaving a free market for the commodities of the mother country. In 1706, permiſſion was given to the Jeſuits, and a little afterwards to the marquis Del Valle, a deſcendant from Cortes, to cultivate them. The attempts have not proved ſucceſsful. The trials, indeed, that have been made, have not been abandoned; but no perſon has ſolicited the liberty of following an example which did not promiſe any great emoluments. Other cultures have been more ſucceſsful. Cotton, ſugar, ſilk, cocoa, tobacco, and European corn, have all thriven in ſome degree. The Spaniards are encouraged to proſecute the labours which theſe cultures require, from the happy circumſtance of their having diſcovered iron mines, which were entirely unknown to the Mexicans, as well as ſome mines of a kind of copper that is hard enough to ſerve for implements of huſbandry. All theſe articles, however, for want of men and induſtry, are merely conſumed within the country.—There is only the vanilla, indigo, and cochineal, which make part of the trade of Mexico with other nations.

New Mexico, ſo called becauſe of its being diſcovered later than Old Mexico, a country of America, is bounded on the north by high mountains, beyond which is a country altogether unknown; by Louiſiana on the eaſt; by New Spain on the ſouth; and on the weſt by the gulf of California, and the Rio Colorado; extending, it is ſaid, above 1000 miles from eaſt to weſt, and about 900 from ſouth to north; but the twentieth part of the country within theſe limits is neither cultivated nor inhabited either by Spaniards or Indians. As it lies in the midſt of the temperate zone, the climate, in general, is very pleaſant; the ſummers, though very warm, are neither ſultry nor unwholeſome; and the winters, though pretty ſharp, are far from being inſupportable, and, for the moſt part clear and healthy.

The greateſt encomiums are laviſhed on the fertility of the ſoil, the richneſs of the mines, and the variety of valuable commodities produced in this country. It is ſaid to be beautifully diverſified with fields, meadows, riſing grounds, and rivers; abounding with fruit and timber trees, turquoiſes, emeralds, and other precious ſtones, mines of gold and ſilver, a great variety of wild and tame cattle, fiſh and fowls. Upon the whole, we may ſafely affirm, that New Mexico is among the pleaſanteſt, richeſt, and moſt plentiful countries in America, or any other part of the world. There are few great or navigable rivers in it: the moſt conſiderable are, the Rio Solado and Rio del Norte, which, with ſeveral ſmaller ſtreams, fall into the gulf of Mexico. On the coaſt of the gulf are divers bays, ports, and creeks, which might be eaſily converted into excellent harbours, if the Spaniards were poſſeſſed of any portion of that commercial ſpirit which animates the other maritime nations of Europe.

The Spaniſh writers tell us, that New Mexico is inhabited by a great variety of Indian nations or tribes, totally unconnected with each other; but the principal are the Apaches, a brave, warlike, reſolute people; fond of liberty, and the inveterate enemies of tyranny and oppreſſion. About the cloſe of the 17th century, thinking themſelves aggrieved by the Spaniſh government, they made a general inſurrection, and did a great deal of miſchief; but were at laſt obliged to ſubmit, and have ſince been curbed by ſtronger garriſons. Moſt of the natives are now Chriſtians. When the Spaniards firſt entered this country, they found the natives well clothed, their lands cultivated, their villages neat, and their houſes built with ſtone. Their flocks alſo were numerous, and they lived more comfortably than moſt of the other ſavages of America. As to religion, they were idolaters, and worſhipped the ſun and moon; but whether they offered human ſacrifices, we are not ſufficiently informed.

The number of provinces in this country is not well aſcertained: ſome writers making them only five, others 10, 15, 20, and 25; but adding no deſcription, either of them or the towns contained in them, excepting the capital, Santa Fé, which we are told ſtands near the ſource of the Rio del Norte, in 36° of north latitude, and about 130 leagues from the gulf: that it is a well built, handſome, rich town; and the ſeat of the biſhop, ſuffragan of Mexico, as well as the governor of the province, who is ſubordinate to the viceroy of Mexico or New Spain.

MEZERAY, Francis Eudes de, an eminent French hiſtorian, the ſon of Iſaac Eudes a ſurgeon, was born at Rye, in Lower Normandy, in 1610; and took the ſurname of *Mezeray*, from a hamlet near Rye. Having performed his ſtudies at Caen, he diſcovered a ſtrong inclination to poetry; but going to Paris, he, by the advice of one of his friends, applied himſelf to the ſtudy of politics and hiſtory, and procured the place of commiſſary at war, which he held for two campaigns. He then ſhut himſelf up in the college of St Barbe, in the midſt of books and manuſcripts; and, in 1643, publiſhed the firſt volume of the Hiſtory of France, in folio; and ſome years after, the other two volumes. Mezeray in that work ſurpaſſed all who had written the hiſtory of France before him, and was rewarded by the king with a penſion of 4000 livres. In 1668, he publiſhed an Abridgement of his Hiſtory of France, in three volumes 4to, which was well received by the public; but as he inſerted in that work the origin of moſt of the taxes, with very free reflections, M. Colbert complained of it, when Mezeray promiſed to correct what he had done in a ſecond edition; but thoſe corrections being only palliations, the miniſter cauſed half of his penſion to be ſuppreſſed. Mezeray complained of this in very ſevere terms; when he obtained no other anſwer than the ſuppreſſion of the other half. Vexed at this treatment, he reſolved to write on ſubjects that could not expoſe him to ſuch diſappointments; and compoſed his treatiſe on the origin of the French, which did him much honour. He was elected perpetual ſecretary to the French academy; and died in 1683. He is ſaid to have been a man extremely negligent in his perſon, and ſo careleſs in his dreſs, that he might have paſſed for a beggar rather than for what he was. He was actually ſeized one morning by the *archers des pauvres*, or pariſh officers; which miſtake was ſo far from provoking him, that he was highly diverted with it, and told them, that he was not able to walk on foot, but that as ſoon as a new wheel was put to his chariot, he would attend them wherever they thought proper." He uſed to ſtudy and write by candle light, even at noon-day in ſummer; and, as if there had been no ſun in the world, always waited upon his company to the door with a candle in his hand. With regard to religion, he affected Pyrrhoniſm; which however was not, it ſeems, ſo much in his heart as in his mouth. This appeared from his laſt ſickneſs; for having ſent for thoſe friends who had been the moſt uſual witneſſes of his licentious talk about religion, he made a ſort of recantation, which he concluded with deſiring them "to forget what he might formerly have ſaid upon the ſubject of religion, and to remember, that Mezeray dying was a better believer than Mezeray in health." Beſides his hiſtory, he alſo wrote, 1. A continuation of the hiſtory of the Turks. 2. A French tranſlation of John de Saliſbury's Latin treatiſe on the vanities of the court. 3. There are attributed to him ſeveral ſatires againſt the government; and in particular, thoſe that bear the name of *Sandricourt*.

MEZIERS, a ſtrong town of France in the department of Ardennes, with a citadel. It was beſieged with a powerful army by Charles V. who was obliged to raiſe the ſiege in 1521. It is ſeated on the river Maeſe, partly upon a hill, and partly in a valley, in E. Long. 4. 48. N. Lat. 49. 46.

MEZIRIAC, Claude Gaspar Backet Sieur de, one of the moſt ingenious men of the 17th century, was born at Breſſe, of an ancient and noble family. He was a good poet in French, Italian, and Latin; an excellent grammarian, a great Greek ſcholar, and an admirable critic. He was well verſed in the controverſies, both in philoſophy and religion; and was deeply ſkilled in algebra and geometry, of the former of which he gave proof by publiſhing the ſix books of Diophantus, enriched with a very able commentary and notes. In his youth he ſpent a conſiderable time at Paris and at Rome; at which laſt place he wrote a ſmall collection of Italian poems, in competition with Vaugelas, who was there at the ſame time; among which there are imitations of the moſt beautiful ſimiles contained in the firſt eight books of the Æneid. He alſo tranſlated Ovid's Epiſtles; a great part of which he illuſtrated with very curious commentaries of his own. Whilſt

Mezuzoth. Mezzotinto.

he was at Paris, they talked of making him preceptor of Louis XIII. upon which he left the court in great haſte, and afterwards declared that he had never felt ſo much pain upon any occaſion of his life; for he ſeemed to have already upon his ſhoulders the important weight of the whole kingdom. He undertook the tranſlation of all Plutarch's works, with notes; which he had brought nearly to a concluſion, when he died at Bourg, in Breſſe, anno 1638, at 45 years of age. He left behind him ſeveral finiſhed works, that were not printed.

MEZUZOTH, in the Jewiſh cuſtoms, certain pieces of parchment which the Jews fix to the door-poſts of their houſes, taking that literally which Moſes commands them, ſaying, "Thou ſhalt never forget the laws of thy God, but thou ſhalt write them upon the poſts of thy houſe, and on thy gates." This expreſſion means nothing elſe, but that thou ſhalt always remember them, whether thou comeſt into thy houſe or goeſt out. But the Hebrew doctors imagined, that the lawgiver meant ſomething more than this. They pretended that, to avoid making themſelves ridiculous, by writing the commandments of God without their doors, or rather to avoid expoſing themſelves to the profanation of the wicked, they ought at leaſt to write them on a parchment, and to encloſe it in ſomething. Therefore they wrote theſe words upon a ſquare piece of parchment prepared on purpoſe, with a particular ink, and a ſquare kind of character. Deut. vi. 4, 5, 6, 7, 8, 9. "Hear, O Iſrael, the Lord our God is one Lord," &c.—Then they left a little ſpace, and afterwards went on, Deut. xi. 13. "And it ſhall come to paſs, if thou ſhalt hearken diligently to my commandments," &c. as far as, "Thou ſhalt write them upon the door-poſts of thy houſe," &c. After this they rolled up the parchment, and put it into a caſe of reeds or other matter; they wrote on the end of the caſe the word *Shaddai*, which is one of the names of God; and they put it at the doors of their houſes, chambers, and all places moſt frequented; they fixed it to the knockers of the door, on the right ſide; and as often as they entered in or went out they touched it in this place, with the end of their finger, which they afterwards kiſſed out of devotion. The Hebrew word *mezuza* properly ſignifies the door-poſts of a houſe; but it is alſo given to this roll of parchment now mentioned.

MEZZOTINTO, a particular manner of repreſenting figures on copper, ſo as to form prints in imitation of painting in Indian ink. See ENGRAVING.

The invention of this art has been uſually attributed to Prince Rupert. But Baron Heinikin, a very judicious and accurate writer upon the ſubject of engraving, aſſerts, with great appearance of truth, that it was a lieutenant-colonel de Siegan, an officer in the ſervice of the landgrave of Heſſe, who firſt engraved in this manner; and that the print which he produced was a portrait of the princeſs Amelia Elizabeth of Heſſe, engraved in the year 1643. Prince Rupert learned the ſecret from this gentleman, and brought it into England when he came over the ſecond time with Charles II. Prince Rupert's print of An Executioner holding a Sword in one Hand and a Head in the other, a half length, from Spagnoletto, is dated 1658. This art has never been cultivated with ſucceſs in any country but England.

Mezzotinto.

The prince laid his grounds on the plate with a channelled roller: but one Sherwin, about the ſame time, laid his grounds with a half round file, which was preſſed down with a heavy piece of lead. Both theſe grounding tools have been laid aſide for many years; and a hand tool, reſembling a ſhoemaker's cutting board-knife, with a fine crenelling on the edge, was introduced by one Edial, a ſmith by trade, who afterwards became a mezzotinto painter.

It is very different from the common way of engraving. To perform it, they rake, hatch, or punch, the ſurface of the plate all over with a knife, or inſtrument made for the purpoſe, firſt one way, then the other, acroſs, &c. till the ſurface of the plate be thus entirely furrowed with lines or furrows, cloſe and as it were contiguous to each other; ſo that, if an impreſſion was then taken from it, it would be one uniform blot or ſmut. This done, the deſign is drawn or marked on the ſame face; after which, they proceed with burniſhers, ſcrapers, &c. to expunge and take out the dents or furrows, in all the parts where the lights of the piece are to be; and that more or leſs as the lights are to be ſtronger or fainter; leaving thoſe parts black which are to repreſent the ſhadows or deepenings of the draught.

As it is much eaſier to ſcrape or burniſh away parts of a dark ground correſponding with the outline of any deſign ſketched upon it, than to form ſhades upon a light ground by an infinite number of hatches, ſtrokes, and points, which muſt all terminate with exactneſs on the outline, as well as differ in their force and manner; the method of ſcraping, as it is called, in mezzotinto, conſequently becomes much more eaſy and expeditious than any other method of engraving. The inſtruments uſed in this kind of engraving are cradles, ſcrapers, and burniſhers.

In this engraving, the plate muſt be prepared and poliſhed in the ſame manner as for other engraving; and afterwards divided equally by lines parallel to each other, and traced out with very ſoft chalk.—The diſtance of theſe lines ſhould be about one-third of the length of the face of the cradle which is to be uſed, and theſe lines ſhould be marked with capital letters, or ſtrokes of the chalk. The cradle is then to be placed exactly betwixt the two firſt lines, and paſſed forwards in the ſame direction; being kept as ſteady as poſſible, and preſſed upon with a moderate force. The ſame operation muſt be repeated with reſpect to all the other lines; till the inſtrument has thus paſſed over the whole ſurface of the plate.—Other lines muſt be then drawn from the extremities of the other two ſides, in the ſame manner; which, interſecting the firſt at right angles, will with them form ſquares; and the ſame operation muſt be repeated with the cradle as in the caſe of the firſt. New lines muſt then be drawn diagonally, and the cradle paſſed betwixt them as before; and when the firſt diagonal operation is performed, the lines muſt be croſſed at right angles as the former, and the cradles paſſed betwixt them in the ſame manner.—The plate having undergone the action of the cradle, according to the diſpoſition of the firſt order of lines, a ſecond ſet muſt be formed, having the ſame diſtances from each other as the firſt. But they muſt be ſo placed as to divide thoſe already made into ſpaces one-third leſs than their whole extent; i. e. every one after the firſt on each ſide will take in one-third of that before it, e. g. beginning at A, of which the firſt third muſt be left out; a third of B will conſequently be taken in, and ſo of the reſt. Theſe lines of the ſecond order muſt be marked with ſmall letters, or leſſer ſtrokes, to diſtinguiſh them from the firſt: and the ſame treatment of the plate muſt be purſued with reſpect to them as was practiſed for the others. When this ſecond operation is finiſhed, a third order of lines muſt be made; the firſt of which, e. g. in A, muſt omit two-thirds of it, and conſequently take in two-thirds of B, &c. By theſe means, the original ſpaces will be exactly divided into equal thirds; and the cradle muſt be again employed betwixt theſe lines as before.—When the whole of this operation is finiſhed, it is called *one turn;* but in order to produce a very dark and uniform ground, the plate muſt undergo the repetition of all theſe ſeveral operations for above twenty times; beginning to paſs the cradle again betwixt the firſt lines, and proceeding in the ſame manner through all the reſt. When the plate is prepared with a proper ground, the ſketch muſt be chalked on it, by rubbing the paper on the backſide with chalk. It is alſo proper to overtrace it afterwards with black lead or Indian ink. The ſcraping is then performed, by paring or cutting away the grain of the ground in various degrees; ſo that none of it is left in the original ſtate except in the touches of the ſtrongeſt ſhade. The general manner of proceeding is the ſame as drawing with white upon black paper. The maſſes of light are firſt begun with; and thoſe parts which go off into light in their upper part, but are brown below: the reflections are then entered upon; after which the plate is blackened with a printer's blacking-ball made of felt, in order to diſcover the effect: and then the work is proceeded with; obſerving always to begin every part in the places where the ſtrongeſt lights are to be.

The art of ſcraping mezzotintos has been applied to the printing with a variety of colours, in order to produce the reſemblance of paintings. The inventor of the method of doing this was J. C. Le Blon, a native of Frankfort, and pupil of Carlo Marata, between the years 1720 and 1730. It was eſtabliſhed by the inventor on this principle, that there are three primitive colours, of which all the reſt may be compoſed by mixing them in various proportions; that any two of theſe colours being mixed together, preſerve their original power, and only produce a third colour ſuch as their compound muſt neceſſarily give; but if tranſparent colours be mixed, and three primitive kinds compounded together, they deſtroy each other, and produce black, or a tendency to it, in proportion to the equality or inequality of the mixture; and that if, therefore, theſe three colours be laid, either ſeparately or upon each other, by three plates, engraved correſpondently on theſe principles to the colouring of the deſign, the whole variety of teints neceſſary may be produced. The requiſites, therefore, to the execution of any deſign in this method of printing are as follows: 1. To ſettle a plan of the colouring to be imitated; ſhowing where the preſence of each of the three ſimple colours is neceſſary, either in its pure ſtate or combined with ſome other, to produce the effect required; and to reduce this plan to a painted ſketch of each, in which not only the proper outlines, but the degree of ſtrength ſhould be expreſſed. 2. To engrave three plates according to this plan, which may print each of the colours exactly in the places where, and proportion in which, they are wanted. 3. To find three tranſparent ſubſtances proper for printing with theſe three primitive colours. The manner in which M. Le Blon prepared the plates was as follows: The three plates of copper were firſt well fitted with reſpect to ſize and figure to each other, and grounded in the ſame manner as thoſe deſigned for mezzotinto prints: and the exact place and boundary of each of the three primitive colours, conformably to the deſign, were ſketched out on three papers, anſwering in dimenſions to the plate. Theſe ſketches were then chalked on the plates; and all the parts of each plate that were not to convey the colour to which it was appropriated to the print, were entirely ſcraped away, as in forming the light of mezzotinto prints. The parts that were to convey the colours were then worked upon; and where the moſt light or diluted teints of the colour were to be, the grain in the ground was proportionably taken off; but where the full colour was required, it was left entire. In this regard was had, not only to the effects of the colour in its ſimple ſtate, but to its combined operation, either in producing orange-colour, green, or purple, by its admixture with one alone; and likewiſe to its forming brown, gray, and ſhades of different degrees, by its co-operation with both the others. But though the greateſt part of the engraving was performed in the mezzotinto manner, yet the graver was employed occaſionally for ſtrengthening the ſhades, and for correcting the outline where it required great accuracy and ſteadineſs. It was found neceſſary ſometimes to have two ſeparate plates for printing the ſame colour, in order to produce a ſtronger effect: but the ſecond plate, which was uſed to print upon the firſt, was intended only to glaze and ſoften the colours in particular parts that might require it. With reſpect to the black and brown teints, which could not be ſo conveniently produced in a due degree by the mixture of the colours, umber and black were likewiſe uſed.

With reſpect to the order in which the plates are to be applied, it may be proper to obſerve, that the colour which is leaſt apparent in the picture ſhould be laid on firſt; that which is betwixt the moſt and leaſt apparent next; and that which predominates laſt; except where there may be occaſion for two plates for the ſame colour, as was before mentioned; or where there is any required for adding browns and ſhades.

M. Le Blon applied this art to portraits, and ſhowed, by the ſpecimens he produced, the poſſibility of its being brought, by farther improvements, to afford imitations of painting which might have ſome value. It is nevertheleſs much better adapted to the ſimpler ſubjects, where there are fewer intermixtures of colours; and where the accuracy of the reflections, and demi-teints, are not ſo eſſentially neceſſary to the truth of the deſign, from the greater latitude of form, and diſpoſition of the colour, as in plants, anatomical figures, and ſome ſubjects of architecture. But perhaps plates engraved or rather finiſhed with the tool, particularly with reſpect to the outline, would be better accommodated in ſome of theſe caſes than thoſe prepared only by ſcraping.

M. Cochin remarks, at the end of an account he has given of M. le Blon's manner, that though this ingenious artiſt confined his method principally to the uſe of three colours; yet, ſhould this invention be again taken up and cultivated, there would be more probability of ſucceſs in uſing a greater variety; and that ſeveral different kinds might be printed by one plate, provided they were laid on in their reſpectively proper places by printing-balls, which ſhould be uſed for that colour only. His hint might however be very greatly improved, by the further aſſiſtance of pencils, accommodated to the plates, for laying on the colours in the proper parts.—For the method of taking off mezzotinto prints on glaſs, ſee *Back-painting*.

MIASMA, among phyſicians, a particular kind of effluvia, by which certain fevers, particularly intermittents, are produced.

MICA, *Muſcovy glaſs*, or *Glimmer*, a ſpecies of mineral ſubſtance. See Mineralogy *Index*.

MICAH, or *The Book of Micah*, a canonical book of the Old Teſtament, written by the prophet Micah, who is the ſixth of the twelve leſſer prophets. He is cited by Jeremiah, and propheſied in the days of Jotham, Ahaz, and Hezekiah. He cenſures the reigning vices of Jeruſalem and Samaria, and denounces the judgements of God againſt both kingdoms. He likewiſe foretels the confuſion of the enemies of the Jews, the coming of the Meſſiah, and the glorious ſucceſs of his church.

MICHAEL, or Michel, (i. e. *who is like to God?*) The ſcripture account of Michael is, that he was an archangel, who preſided over the Jewiſh nation, as other angels did over the Gentile world, as is evident of the kingdoms of Perſia and Greece, (Dan. x. 13.); that he had an army of angels under his command (Rev. xii. 7.); that he fought with the Dragon, or Satan and his angels; and that, contending with the Devil, he diſputed about the body of Moſes, (Jude 9.). As to the combat between Michael and the Dragon, ſome authors underſtand it literally, and think it means the expulſion of certain rebellious angels, with their head or leader, from the preſence of God. Others take it in a figurative ſenſe; and refer it either to the conteſt that happened at Rome between St Peter and Simon Magus, in which the apoſtle prevailed over the magician, or to thoſe violent perſecutions under which the church laboured for three hundred years, and which happily ceaſed when the powers of the world became Chriſtian. Among the commentators who maintain the former opinion is Grotius; and among thoſe who take it in a figurative ſenſe are Hammond and Mede.

The conteſt about the body of Moſes is likewiſe taken both literally and figuratively. Thoſe who underſtand it literally are of opinion, that Michael by the order of God hid the body of Moſes after his death; and that the Devil endeavoured to diſcover it, as a fit means to entice the people to idolatry, by a ſuperſtitious worſhip of his relics. But this diſpute is figuratively underſtood to be a controverſy about rebuilding the temple, and reſtoring the ſervice of God among the Jews at Jeruſalem; the Jewiſh church being fitly enough ſtyled the body of Moſes. It is thought by ſome, that this ſtory of the conteſt between Michael and the Devil was taken by St Jude out of an apocryphal book called *The Aſſumption of Moſes*.

The Romiſh church celebrates three appearances of Michael, of which no mention is made in ſcripture, and which have happened, they ſay, a long time after the age of the apoſtles. The firſt appearance of this archangel was at Coloſſæ in Phrygia, but at what time is uncertain. The ſecond is that of Mount Garganus, in the kingdom of Naples, about the end of the fifth century. The third is his appearance to Aubert biſhop of Avranches, upon a rock called the *Tomb*, where at this day is the abbey of St Michael. This was about the year 706. The firſt of theſe feſtivals is obſerved on the 6th of September, the ſecond on the 8th of May, and the laſt on the 16th of October. It has been ſuppoſed, that it was Michael the archangel who conducted the Iſraelites in their journey through the wilderneſs, (ſee Exod. xxxii. 20, 23, and xxxiii. 2.); that it was he who appeared to Moſes in the burning buſh; who appeared to Joſhua in the fields of Jericho, and to Gideon and Manoah the father of Samſon; and, in a word, to him have been imputed the greateſt part of the moſt remarkable appearances either in the Old or New Teſtament.

Michael Angelo. See Angelo.

Mount Michael, formerly one of the moſt celebrated ſtate priſons of France, lies about 20 miles from Granville. It is a rock ſituated in the middle of the bay of Avranches; and is only acceſſible at low water. Nature has completely fortified one ſide, by its craggy and almoſt perpendicular deſcent, which renders it impracticable to mount it by any addreſs or courage, however conſummate. The other parts are ſurrounded by walls fenced with ſemilunar towers after the Gothic manner; but ſufficiently ſtrong, together with the advantage of its ſituation, to render it impregnable to any attack. At the foot of the mountain begins a ſtreet or town, which winds round its baſe to a conſiderable height. Above are chambers where ſtate priſoners are kept, and where there are other buildings intended for reſidence. On the ſummit is erected the abbey itſelf, occupying a prodigious ſpace of ground, and of a ſtrength and ſolidity equal to its enormous ſize; ſince it has for many centuries withſtood all the injuries of the weather, to which it is ſo much expoſed. In an apartment, called the *Sale de Chavalerie*, the knights of St Michael uſed to meet in ſolemn convocation on important occaſions. They were the defenders and guardians of this mountain and abbey, as thoſe of the Temple, and of St John of Jeruſalem, were of the holy ſepulchre. The hall in which they met is very ſpacious, but rude and barbarous. At one end is a painting of the archangel, the patron of their order; and in this hall Louis XI. firſt inſtituted and inveſted with the inſignia of knighthood the chevaliers of the croſs of St Michael. There is a miſerable dark apartment, or rather dungeon, in which many eminent perſons were formerly confined. In the middle of it is a cage, compoſed of prodigious bars of wood; and the wicket which gives entrance into it is 10 or 12 inches in thickneſs. The inſide of it compriſes about 12 or 14 feet ſquare, and it is nearly 20 in height. Towards

wards the latter end of the 17th century, a newſwriter in Holland, who had preſumed to print ſome very ſevere and ſarcaſtic reflections on Madame de Maintenon, was confined in this place. Some months after his publication, he was induced, by a perſon ſent expreſsly for that purpoſe, to make a tour into French Flanders. The moment he had quitted the Dutch territories, he was put under arreſt; and immediately, by his majeſty's expreſs command, conducted to Mount Michael, where he was ſhut up in this cage. Here he lived upwards of 23 years; and here he at length expired. During the long nights of winter, no candle or fire was allowed him. He was not permitted to have any book. He ſaw no human face, except the gaoler, who came once every day to preſent him, through a hole in the wicket, with his little portion of bread and wine. No inſtrument was given him with which he could deſtroy himſelf: but he found means at length to draw out a nail from the wood, with which he engraved, or cut on the bars of his cage, certain fleurs de lis and armorial bearings, which formed his only employment and recreation. They are very curiouſly performed conſidering the rudeneſs of his inſtrument.

The ſubterraneous chambers in this mountain are ſaid to be ſo numerous, that the gaolers themſelves do not know them. There are certain dungeons called *oubliettes*, into which they were accuſtomed anciently to let down malefactors guilty of very heinous crimes: they provided them with a loaf of bread and a bottle of wine, and then they were totally forgotten, and left to periſh by hunger in the dark vaults of the rock. This puniſhment, however, has not been inflicted by any king in the laſt or preſent century.

Here alſo is a remarkable chamber, in one corner of which is a kind of window: between this and the wall of the building is a very deep ſpace, of near 100 feet perpendicular, at the bottom of which is another window opening to the ſea. It is called the *Hole of Montgomeri;* and the hiſtory of it is as follows: In the year 1559, Henry II. king of France was unfortunately killed at a tournament by the count de Montgomeri*. He was a Huguenot; and having eſcaped the maſſacre of Paris, made head againſt the royal forces in Normandy, ſupported by Queen Elizabeth with arms and money. Being driven from his fortreſſes in theſe parts, he retired to a rock called the *Tombelaine.* This is another ſimilar to Mount Michael; only three quarters of a league from it, and of nearly equal dimenſions. At that time there was a caſtle upon it, which has ſince been demoliſhed, and of which ſcarce any veſtiges now remain. From this fortreſs, acceſſible only at low-water, he continually made excurſions, and annoyed the enemy, who never dared to attack him. He coined money, laid all the adjacent country under contribution, and rendered himſelf univerſally dreaded. Deſirous, however, to ſurpriſe Mount Michael, he found means to engage one of the monks reſident in the abbey; who promiſed to give him the ſignal for his enterpriſe by diſplaying a handkerchief. The monk having made the ſignal, betrayed him, and armed all his aſſociates, who waited Montgomeri's arrival. The chieftain came, attended by 50 choſen ſoldiers, all deſperate, and capable of any attempt. They croſſed the ſand; and having placed their ſcaling-ladders, mounted one by one. As they came to the top, they were deſpatched, each in turn, without noiſe. Montgomeri, who followed laſt, diſcovered the perfidy, and eſcaped with only two of his men, with whom he regained the Tombelaine. They preſerve with great care the ladders and grappling irons uſed on this occaſion. The count was at laſt beſieged and taken priſoner, by the mareſchal de Matignon, in 1574, at Domfront, in Normandy; and Catharine de Medicis, who hated him for having been, though innocently, the cauſe of her huſband's death, cauſed him to be immediately executed.

The church of Mount Michael is a great curioſity. It ſtands on nine pillars of moſt enormous dimenſions, built on the ſolid rock. Each of them appears to be about 25 feet in circumference: beſides theſe, there are two others much inferior in ſize, on which the centre of the church reſts, and over which is the tower. The following is the legendary account of the origin of this church: In the reign of Childibert II. there was a biſhop of Avranches named *St Aubert.* To this holy man the archangel Michael was pleaſed to appear one night, and ordered him to go to this rock to build a church. St Aubert treated this as a dream; upon which the angel appeared a ſecond time; and being ſtill diſobeyed, he returned a third time, when, by way of imprinting his command upon the ſaint's memory, he made a hole in his ſkull, by touching it with his thumb. The ſkull is ſtill preſerved in the treaſury of the church. It is encloſed in a little ſhrine of gold, and a cryſtal, which opens over the orifice, admits the gratification of curioſity by the minuteſt examination of it. The hole is of a ſize and ſhape proportionable to the thumb ſaid to have produced it; but it is impoſſible to determine whether it has been really made by a knife or any other way. It is not to be ſuppoſed that the ſaint would forget ſuch a ſenſible mark of the angel's diſpleaſure; he therefore immediately repaired to the rock, and conſtructed a ſmall church, as he had been commanded. Here, however, true hiſtory ſupplies the place of fable; and informs us, that it was in 966 when Richard the ſecond duke of Normandy began to build the abbey. It was completed about the year 1070, under William the Conqueror, though many other additions were made by ſucceeding abbots.

In the treaſury of the church are innumerable other relics: among which ſome few have a real and intrinſic value. There is a fine head of Charles VI. of France, cut in a cryſtal, and the repreſentation of a cockleſhell in gold, weighing many pounds, given by Richard II. duke of Normandy, when he founded the abbey. There is an arm ſaid to belong to *St Richard* king of England; but who this ſaint was it muſt be very difficult to determine. Such is the hiſtory of the priſon, abbey, and church of Mount Michael previous to the revolution; they have probably undergone ſome changes ſince that period.

ST MICHAEL'S, a borough town of Cornwall, between St Columb and Truro, 247 miles from London. Though one of the oldeſt boroughs in the county by preſcription, and of great note in the Saxon times, it is a mean hamlet in the pariſhes of Newland and St Enidore; yet it is governed by a portreeve, choſen yearly by a jury of the chief inhabitants, out of the ſix chief tenants, called deputy lords of the manor, becauſe they hold lands in the borough. Here is no market, but two fairs. A court leet is held here twice a year. This place was formerly called Modilhole, and afterwards Michael. Its liſt of members begins in the 6th of Edward VI.

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* See *France*, No. 140.

St Michael's Mount, in the county of Cornwall, in the corner of Mount's Bay, is a very high rock, only divided by the tide from the main land, ſo that it is land and iſland twice a day. The town here was burnt by the French in the reign of King Henry VIII. At the bottom of this mount, in digging for tin, there have been found ſpear heads, battle axes, and ſwords, of braſs, all wrapt up in linen. The county is contracted here into a ſort of iſthmus, ſo that it is ſcarcely four miles between the Channel and the Severn ſea.—Large trees have been driven in by the ſea between this mount and Penzance.

MICHAELIS, John David, a celebrated biblical critic, and author of many eſteemed works, was the eldeſt ſon of Dr Chriſtian Benedict Michaelis, profeſſor in the univerſity of Halle in Lower Saxony, and was born at that place, Feb. 27. 1717. His father devoted him at an early age to an academical life; and with that view he received the firſt part of his education in a celebrated Pruſſian ſeminary, called the *Orphan houſe*, at Glanche, in the neighbourhood of his native place. He commenced his academical career at Halle in 1733, and took his maſter's degree in the faculty of philoſophy in 1739. In 1741 he made an excurſion to this country, where his ſuperior knowledge of the oriental languages, which was conſiderably increaſed by his indefatigable reſearches in the Bodleian library at Oxford, introduced him to the acquaintance, and gained him the eſteem, of our firſt literary characters; with ſeveral of whom, and particularly Biſhop Lowth, he was in correſpondence for many years. On his return to Halle, after an abſence of fifteen months, he began to read lectures on the hiſtorical books of the Old Teſtament, which he continued after his removal to Gottingen in 1745. In 1746 he was appointed profeſſor extraordinary, and ſoon after profeſſor of philoſophy, in that univerſity. The next year he obtained a place of ſecretary to the Royal Society there, of which he was director in 176·, and was ſoon afterwards made aulic counſellor by the court of Hanover. In 1764 his diſtinguiſhed talents, but chiefly a publication relative to a journey to Arabia, which was undertaken by ſeveral literary men, at the expence of the king of Denmark, in conſequence of his application by means of Count Bernſdorff, procured him the honour of being choſen a correſpondent, and afterwards foreign member, of the Academy of Inſcriptions at Paris, of whom the inſtitution admitted only eight; and in the ſame year he became a member of the ſociety of Haerlem. In 1775, Count Hopkin, who eighteen years before had prohibited the uſe of his writings at Upſal, when he was chancellor of that univerſity, prevailed upon the king of Sweden to confer on him the order of the Polar Star, as a national compenſation. In 1786 he was raiſed to the diſtinguiſhed rank of privy counſellor of juſtice by the court of Hanover; and in 1788 received his laſt literary honour, by being unanimouſly elected a fellow of the Royal Society of London.—His great critical knowledge of the Hebrew language, which he diſplayed in a new tranſlation of the Bible, and in other works, raiſed him to a degree of eminence almoſt unknown before in Germany; and his indefatigable labours were only equalled by his deſire of communicating the knowledge he acquired to the numerous ſtudents of all countries who frequented his admirable lectures, which he continued to deliver on various parts of the ſacred writings in half-yearly courſes, and on the Hebrew, Arabic, and Syriac languages, to the laſt year of his life. He was profeſſor in the univerſity of Gottingen 45 years, and, during that long period, he filled the chair with dignity, credit, and uſefulneſs. He died October 22. 1791, aged 74. He is ſaid to have left behind him ſeveral valuable MSS. Of the works that were publiſhed during his life-time, and which are very numerous, a catalogue, in the order of their publication, is given in the *Gentleman's Magazine* for March 1792.

MICHAELMAS, or *Feaſt of St Michael and all Angels*, a feſtival of the Chriſtian church, obſerved on the 29th of September. See Michael.

MICKLE, William Julius, the celebrated tranſlator of the Luſiad, was the ſon of the reverend Alexander Mickle a Scottiſh clergyman, who had formerly been a diſſenting miniſter in London, an aſſiſtant to the reverend Dr Watts, and one of the tranſlators of Bayle's Dictionary. This gentleman having reſided a few years in London, was preſented to the church of Langholm in Scotland, where he married; and our author was one of the younger ſons. He was born about the year 1735, and was educated by his father. In his early years his paſſion for poetry frequently diſcovered itſelf; though till the age of 13 he did not ſhow any particular attachment to books. At that time having accidentally met with Spencer's Faery Queen, he became enamoured of his manner of writing, and inſtantly began to imitate him. After the death of his father, he came to Edinburgh to reſide with an uncle who was a brewer there, and who admitted him into a ſhare of his buſineſs; not being qualified to ſucceed in this line, he went to London about the time of the concluſion of the war which began in 1755, with a view to procure a commiſſion in the marine ſervice. Here he was diſappointed; but introduced himſelf to the firſt Lord Lyttelton, to whom he ſent one of his poems. From his Lordſhip, however, he received no other favour than being admitted to ſeveral interviews, and encouraged to perſevere in his poetical plans.

So cloſely did our author cultivate the ſtudy of the muſes, that before he was 18 years of age he had written two tragedies and half an epic poem; but all theſe were committed to the flames. The firſt of his poems which appeared in print was publiſhed in one of the Edinburgh magazines, and entitled, "On paſſing through the Parliament Cloſe of Edinburgh at Midnight." This was afterwards inſerted in A Collection of Original Poems by a Scotch gentleman, vol. ii. p. 137.

From the time of Mr Mickle's arrival in London till the year 1765, it is not known how he employed his time, though it is probable that he was employed in ſome branch of the printing buſineſs; and in 1765 he engaged himſelf as corrector to the Clarendon preſs. This year he publiſhed the poem which firſt brought him into notice, entitled, "Pollio, an Elegiac Ode, written in the Wood near R—— (Roſlin) Caſtle," 4to. This was an elegy written on the death of his brother; which, previous to its publication, had been ſhown to Lord Lyttelton, and received ſome corrections from him. The latter, in an epiſtle to the author, ſpoke of it as equal to any thing of the kind in our language. In 1767 he publiſhed a poem called "The Concubine, in two cantos, after the manner of Spencer," 4to; and in 1769 he publiſhed, "A Letter to Mr Harwood, wherein ſome of his evaſive gloſſes, falſe tranſlations, and blundering criticiſms, in ſupport of the Arian Hereſy, contained in his literal tranſlation of the New Teſtament, are pointed out and confuted," 8vo: and next year he publiſhed "Mary Queen of Scots, an Elegy;" "Hengiſt and Mary, a Ballad;" and "Knowledge, an Ode;" in Pearch's Collection of Poems. In 1770 he publiſhed "Voltaire in the Shades, or Dialogues on the Deiſtical Controverſy," 8vo. The Elegy on Mary had been ſubmitted to the judgement of Lord Lyttleton, who declined to criticiſe it, not for its deficiency in poetical merit, but from thinking differently from the author concerning that unfortunate princeſs.

About this time Mr Mickle was a frequent writer in the Whitehall Evening Poſt; but a more important work now engaged his attention. When no more than 17 years of age he had read Caſtara's tranſlation of the Luſiad of Camoens into French, and then projected the deſign of giving an Engliſh tranſlation of it. From this, however, he was prevented by various avocations till the year 1771, when he publiſhed the firſt book as a ſpecimen: and having prepared himſelf by acquiring ſome knowledge of the Portugueſe language, he determined to apply himſelf entirely to this work. With this view he quitted his reſidence at Oxford, and went to a farm houſe at Foreſt-hill, where he purſued his deſign with unremitting aſſiduity till the year 1775, when the work was entirely finiſhed.

During the time that Mr Mickle was engaged in this work, he ſubſiſted entirely by his employment as corrector of the preſs; and on his quitting that employment he had only the ſubſcriptions he received for his tranſlation to ſupport him. Notwithſtanding theſe difficulties, he adhered ſteadily to the plan he had laid down, and completed it in about five years.

When his work was finiſhed, Mr Mickle applied to a perſon of great rank, with whom his family had been connected, for permiſſion to dedicate it to him. Permiſſion was granted, and his patron honoured him with a very polite letter; but after receiving a copy, for which an extraordinary price was paid for the binding, he did not think proper to take any notice of the author. At laſt a gentleman of high rank in the political world, a firm friend to the author, and who afterwards took him under his protection, waited on the patron, and heard him declare that he had not read the work, but that it had been repreſented not to have the merit it was at firſt ſaid to poſſeſs. The applauſe with which the work was received, however, ſoon baniſhed from the author's mind thoſe diſagreeable ſenſations which had been occaſioned by the contemptuous neglect of his patron, as well as ſome ſevere criticiſms which had been circulated concerning it. A ſecond edition was prepared in 1778, with a plate prefixed to it, executed by the celebrated artiſt Mortimer; on whom Mr Mickle wrote an epitaph in 1779. This year alſo he publiſhed a pamphlet, entitled, "A Candid Examination of the Reaſons for depriving the Eaſt India Company of its Charter, contained in The Hiſtory and Management of the Eaſt India Company from its Commencement to the Preſent Time; together with ſome Strictures on the Self-Contradictions and Hiſtorical Errors of Dr Adam Smith, in his Reaſons for the Abolition of the ſaid Company," 4to. About this time ſome of his friends thought of recommending him to the king as deſerving of a penſion; but this ſcheme was never put in execution. Dr Lowth biſhop of London, would have put him into orders, and provided for him in the church; but this was not agreeable to our author's diſpoſition. While he was meditating a publication of all his poems, in which he would moſt probably have found his account, he was appointed ſecretary to Commodore Johnſtone, who had lately obtained the command of the Romney man of war. In November 1779 he arrived at Liſbon, and was named by his patron joint agent for the prizes which were taken. In this capital and its neighbourhood he reſided more than ſix months, being every where received with every mark of politeneſs and attention; and during this period he compoſed his poem called "Almada Hill," which in 1781 was publiſhed in quarto. He collected alſo many particulars concerning the manners of the Portugueſe, which he intended alſo to have publiſhed. During his ſtay at Liſbon the Royal Academy was opened; and Mr Mickle, who was preſent at the ceremony of its commencement, had the honour to be admitted a member under the preſidency of Don John of Braganza, duke of Lafoens. His preſence being thought neceſſary in England to attend to the proceedings of the courts of law reſpecting the condemnation of ſome of the prizes, he did not accompany the Commodore in his laſt expedition, nor did he go any more to ſea. In 1782 he publiſhed "The Prophecy of Queen Emma, an ancient Ballad lately diſcovered, written by Johannes Turgottus, prior of Durham, in the reign of William Rufus; to which is added by the Editor, an Account of the Diſcovery, and Hints towards a Vindication of the Authenticity, of the Poems of Oſſian and Rowley," 8vo.

In June this year Mr Mickle married Miſs Tomkins, daughter of the perſon with whom he reſided at Foreſt-hill, while engaged in tranſlating the Luſiad. Having received ſome fortune with this lady, as well as made ſome money himſelf when in the ſervice of Commodore Johnſtone, he now enjoyed a comfortable independence. He afterwards fixed his reſidence at Wheatley in Oxfordſhire, and devoted his time to the reviſion of his poetical works, which he propoſed to publiſh by ſubſcription. During the laſt ſeven years of his life he was employed in writing for the European Magazine. The Fragments of Leo, and ſome of the moſt approved reviews of books, in that periodical work, were of his production. He died after a ſhort illneſs, on the 25th of October 1788, at Wheatley, leaving one ſon behind him. His poetry poſſeſſes much beauty, variety, harmony of numbers, and vigour of imagination:

his life was without reproach; his foibles were few and inoffenſive; his virtues many; and his genius very conſiderable.

MICROCOSM, a Greek term ſignifying the *little world;* uſed by ſome for *man*, as being ſuppoſed an epitome of the univerſe or great world.

MICROGRAPHY, the deſcription of objects viewed with the aſſiſtance of a microſcope. See *Microscopic objects*.

MICROMETER, an aſtronomical inſtrument, by which ſmall angles, or the apparent magnitudes of objects viewed through teleſcopes or microſcopes are meaſured with great exactneſs.

Micrometer firſt invented by Gaſcoigne.

1. The firſt TELESCOPIC micrometers were only mechanical contrivances for meaſuring the image of an object in the focus of the object-glaſs. Before theſe contrivances were thought of, aſtronomers were accuſtomed to meaſure the field of view in each of their teleſcopes, by obſerving how much of the moon they could ſee through it, the ſemidiameter being reckoned at 15 or 16 minutes; and other diſtances were eſtimated by the eye, comparing them with the field of view. Mr Gaſcoigne, an Engliſh gentleman, however, fell upon a much more accurate method before the year 1641, and had a Treatiſe on Optics prepared for the preſs; but he was killed during the civil wars in the ſervice of Charles I. and his manuſcript was never found. His inſtrument, however, fell into the hands of Mr R. Townly *, who ſays, that by the help of it he could mark above 40,000 diviſions in a foot.

2. Mr Gaſcoigne's inſtrument being ſhown to Dr Hooke, he gave a drawing and deſcription of it, and propoſed ſeveral improvements †. Mr Gaſcoigne divided the image of an object in the focus of the object-glaſs, by the approach of two pieces of metal ground to a very fine edge, in the place of which Dr Hooke would ſubſtitute two fine hairs ſtretched parallel to one another.

Huygens's micrometer.

3. Mr Huygens meaſured the apparent diameters of the planets, by firſt determining the quantity of the field of view in his teleſcope; which, he ſays, is beſt done by obſerving the time that a ſtar takes up in paſſing over it, and then preparing two or three long and ſlender braſs plates, of various breadths, the ſides of which are very ſtraight, and converging to a ſmall angle. In uſing theſe pieces of braſs, he made them ſlide in two ſlits, made in the ſides of the tube, oppoſite to the place of the image, and obſerved in what place it juſt covered the diameter of any planet, or any ſmall diſtance that he wanted to meaſure ‡. It was obſerved, however, by Sir Iſaac Newton, that the diameters of planets, meaſured in this manner, will be larger than they ſhould be, as all lucid objects appear to be when they are viewed upon dark ones.

Marquis of Malvaſia's micrometer.

4. In the Ephemerides of the Marquis of Malvaſia, publiſhed in 1662, it appears that he had a method of meaſuring ſmall diſtances between fixed ſtars and the diameters of the planets, and alſo of taking accurate draughts of the ſpots of the moon by a net of ſilver wire, fixed in the focus of the eye-glaſs. He likewiſe contrived to make one of two ſtars paſs along the threads of this net, by turning it, or the teleſcope, as much as was neceſſary for that purpoſe; and he counted, by a pendulum-clock, beating ſeconds, the time that elapſed in its paſſage from one wire to another, which gave him the number of minutes and ſeconds of a degree contained between the intervals of the wires of his net, with reſpect to the focal length of his teleſcope.

Auzout's micrometer.

5. In 1666, Meſſrs Auzout and Picard publiſhed a deſcription of a micrometer, which was nearly the ſame with that of the Marquis of Malvaſia, excepting the method of dividing it, which they performed with more exactneſs by a ſcrew. In ſome caſes they uſed threads of ſilk, as being finer than ſilver wires. Dechales alſo recommends a micrometer conſiſting of fine wires, or ſilken threads, the diſtances of which were exactly known, diſpoſed in the form of a net, as peculiarly convenient for taking a map of the moon.

De la Hire's micrometer.

6. M. de la Hire ſays, that there is no method more ſimple or commodious for obſerving the digits of an eclipſe than a net in the focus of the teleſcope. Theſe, he ſays, were generally made of ſilken threads; and that for this particular purpoſe ſix concentric circles had alſo been made uſe of, drawn upon oiled paper; but he adviſes to draw the circles on very thin pieces of glaſs with the point of a diamond. He alſo gives ſeveral particular directions to aſſiſt perſons in the uſe of them.

Common micrometer.
Plate CCCXXXV. Fig. 1.

7. *Conſtruction of Different Micrometers.* The firſt we ſhall deſcribe is the common micrometer. Let ABCD be a ſection of the teleſcope at the principal focus of the object-glaſs, or where the wires are ſituated, which are placed in a ſhort tube containing the eye-glaſs, and may be turned into any poſition by turning that tube; mn is a fine wire extended over its centre; vw, xy, are two parallel wires well defined, and perpendicular to mn; vw is fixed, and xy moves parallel to it by means of a ſcrew, which carries two indexes over a graduated plate, to ſhow the number of revolutions and parts of a revolution which it makes. Now to meaſure any angle, we muſt firſt aſcertain the number of revolutions and parts of a revolution correſponding to ſome known angle, which may be thus done: 1ſt, Bring the inner edges of the wires exactly to coincide, and ſet each index to 0; turn the ſcrew, and ſeparate the wires to any diſtance; and obſerve the time a ſtar m is in paſſing along the wire mn from one vertical wire to the other: for that time, turned into minutes and ſeconds of a degree, will be the angle anſwering to the number of revolutions, or the angle correſponding to the diſtance. Thus, if d = coſ. of the ſtar's declination, we have $15' dm$, the angle correſponding to this diſtance; and hence, by proportion, we find the angle anſwering to any other. 2dly, Set up an object of a known diameter, or two objects at a given diſtance, and turn the ſcrew till the vertical wires become tangents to the object, or till their opening juſt takes in the diſtance of the two objects upon the wire mn; then from the diameter, or diſtance of the two objects from each other, and their diſtance from the glaſs, calculate the angle, and obſerve the number of revolutions and parts correſponding. 3dly, Take the diameter of the ſun on any day, by making the wires tangents to the oppoſite limbs, and find, from the nautical almanac, his diameter on that day. Here it will be beſt to take the upper and lower limbs of the ſun when on the meridian, as he has then no motion perpendicular to the horizon. If the edges do not coincide when the indexes ſtand at 0, we muſt allow for the error. Inſtead of making a proportion, it is better to have a table calculated to ſhow the angle correſpond-

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* Phil. Tranſ. N° 25.

† See Phil. Tranſ. Abr. vol. i. p. 217. Hooke's Poſthumous Works, p. 497, 498; and Phil. Tranſ. xlvii. p. 190.

‡ Syſtema Saturnium, p. 82.

ing to every revolution and parts of a revolution. But the obſerver muſt remember, that when the micrometer is fixed to teleſcopes of different focal lengths, a new table muſt be made. The whole ſyſtem of wires is turned about in its own plane, by turning the eye-tube round with the hand, and by that means the wire *mn* can be thrown into any poſition, and conſequently angles in any poſition may be meaſured. Dr Bradley added a ſmall motion by a rack and pinion to ſet the wires more accurately in any poſition.

Fig. 2.

8. But the micrometer, as now contrived, is of uſe, not only to find the angular diſtance of bodies in the field of view at the ſame time, but alſo of thoſe which, when the teleſcope is fixed, paſs through the field of view ſucceſſively; by which means we can find the difference of their right aſcenſions and declinations. Let A *a*, B *b*, C *c*, be three parallel and equidiſtant wires, the middle one biſecting the field of view; HOR a fixed wire perpendicular to them paſſing through the centre of the field; and F *f*, G *g*, two wires parallel to it, each moveable by a micrometer ſcrew, as before, ſo that they can be brought up to HOR, or a little beyond. Then to find the angular diſtance of two objects, bring them very near to B *b*, and in a line parallel to it, by turning about the wires, and bring one upon HOR, and by the micrometer ſcrew make F *f* or G *g* paſs through the other; then turn the ſcrew till that wire coincides with HOR, and the arc which the index has paſſed over ſhows their angular diſtance. If the objects be further remote than you can carry the diſtance of one of the wires F *f*, G *g* from HOR, then bring one object to F *f* and the other to G *g*; and turn each micrometer ſcrew till they meet, and the ſum of the arcs paſſed over by each index gives their angular diſtance. If the objects be two ſtars, and one of them be made to run along HOR, or either of the moveable wires as occaſion may require, the motion of the other will be parallel to theſe wires, and their difference of declinations may be obſerved with great exactneſs; but in taking any other diſtances, the motion of the ſtars being oblique to them, it is not quite ſo eaſy to get them parallel to B *b*; becauſe if one ſtar be brought near, and the eye be applied to the other to adjuſt the wires to it, the former ſtar will have gotten a little away from the wire. Dr Bradley, in his account of the uſe of this micrometer, publiſhed by Dr Maſkelyne in the Philoſophical Tranſactions for 1772, thinks the beſt way is to move the eye backwards and forwards as quick as poſſible; but it ſeems to be beſt to fix the eye at ſome point between, by which means it takes in both at once ſufficiently well defined to compare them with B *b*. In finding the difference of declinations, if both bodies do not come into the field of view at the ſame time, make one run along the wire HOR, as before, and fix the teleſcope and wait till the other comes in, and then adjuſt one of the moveable wires to it, and bring it up to HOR, and the index gives the difference of their declinations. The difference of time between the paſſage of the ſtar at either of the croſs moveable wires, and the tranſit of the other ſtar over the croſs fixed wire (which repreſents a meridian), turned into degrees and minutes, will give the difference of right aſcenſion. The ſtar has been here ſuppoſed to be biſected by the wire; but if the wire be a tangent to it, allowance muſt be made for the breadth of the wire, provided the adjuſtment be made for the coincidence of the wires. In obſerving the diameters of the ſun, moon, or planets, it may perhaps be moſt convenient to make uſe of the outer edges of the wires, becauſe they appear moſt diſtinct when quite within the limb: but if there ſhould be any ſenſible inflection of the rays of light in paſſing by the wires, it will be beſt avoided by uſing the inner edge of one wire and the outward edge of the other; for by that means the inflection at both limbs will be the ſame way, and therefore there will be no alteration of the relative poſition of the rays paſſing by each wire. And it will be convenient in the micrometer to note at what diviſion the index ſtands when the moveable wire coincides with HOR; for then you need not bring the wire when a ſtar is upon it up to HOR, only reckon from the diviſion at which the index then ſtands to the above diviſion.

The divided object-glaſs micrometer hinted at by Mr Savery.

9. With a micrometer thus adapted to a teleſcope, Mr S. Savery of Exeter propoſed a new way of meaſuring the difference between the greateſt and leaſt apparent diameters of the ſun, although the whole of the ſun was not viſible in the field of view at once. The method we ſhall briefly deſcribe. Place two object-glaſſes inſtead of one, ſo as to form two images whoſe limbs ſhall be at a ſmall diſtance from each other; or inſtead of two perfect lenſes, he propoſed to cut a ſingle lens into four parts of equal breadths by parallel lines, and to place the two ſegments with their ſtraight ſides againſt each other, or the two middle fruſtums with their oppoſite edges together; in either caſe, the two parts which before had a common centre and axis, have now their centres and axes ſeparated, and conſequently two images will be formed as before by two perfect lenſes. Another method in reflectors was to cut the large concave reflector through the centre, and by a contrivance to turn up the outer edges whilſt the ſtraight ones remained fixed; by which means the axis of the two parts became inclined, and formed two images. Two images being formed in this manner, he propoſed to meaſure the diſtance between the limbs when the diameters of the ſun were the greateſt and leaſt, the difference of which would be the difference of the diameters required. Thus far we are indebted to Mr Savery for the idea of forming two images; and the admirable uſes to which it was afterwards applied, we ſhall next proceed to deſcribe.

Improved by Mr John Dollond.

10. The divided object-glaſs micrometer, as now made, was contrived by the late Mr John Dollond, and by him adapted to the object-end of a reflecting teleſcope, and has been ſince by the preſent Mr P. Dollond his ſon applied with equal advantage to the end of an achromatic teleſcope. The principle is this: The object-glaſs is divided into two ſegments in a line drawn through the centre; each ſegment is fixed in a ſeparate frame of braſs, which is moveable, ſo that the centres of the two ſegments may be brought together by a handle for that purpoſe, and thereby form one image of an object; but when ſeparated they will form two images, lying in a line paſſing through the centre of each ſegment; and conſequently the motion of each image will be parallel to that line, which can be thrown into any poſition by the contrivance of another handle to

Fig. 3.

turn the glaſs about in its own plane. The braſs-work carries a vernier to meaſure the diſtance of the centres of the two ſegments. Now let E and H be the centres of the two ſegments, F their principal focus, and PQ two diſtant objects in FE, FH, produced, or the oppoſite limbs of the ſame object PBQD; then the images of P and Q, formed by each ſegment, or the images of the oppoſite limbs of the object PBQD, coincide at F: hence two images *m z* F, *n x* F of that object are formed, whoſe limbs are in contact; therefore the angular diſtance of the points P and Q is the ſame as the angle which the diſtance EH ſubtends at F, which, as the angles ſuppoſed to be meaſured are very ſmall, will vary as EH extremely nearly; and conſequently if the angle correſponding to one interval of the centres of the ſegments be known, the angle correſponding to any other will be found by proportion. Now to find the interval for ſome one angle, take the horizontal diameter of the ſun on any day, by ſeparating the images till the contrary limbs coincide, and read off by the vernier the interval of their centres, and look into the nautical almanac for the diameter of the ſun on that day, and you have the correſponding angle. Or if greater exactneſs be required than from taking the angle in proportion to the diſtances of their centres, we may proceed thus:—Draw FG perpendicular to EH, which therefore biſects it; then one half EH, or EG, is the tangent of half the angle EFH; hence, half the diſtance of their centres is to the tangent of half the angle correſponding to that diſtance as half any other diſtance of the centres is to the tangent of half the correſponding angle (A).

11. From this the method of meaſuring ſmall angles is manifeſt; for we conſider P, Q either as two objects whoſe images are brought together by ſeparating the two ſegments, or as the oppoſite limbs of one object PBQA, whoſe images, formed by the two ſegments E, H, touch at F; in the former caſe, EH gives the angular diſtance of the two objects; and in the latter, it gives the angle under which the diameter of the object appears. In order to find the angular diſtance of two objects, therefore, ſeparate the ſegments till the two images which approach each other coincide; and to find the diameter of an object, ſeparate the ſegments till the contrary limbs of the images touch each other, and read off the diſtance of the centres of the ſegment from the vernier (B), and find the angle as directed in the laſt article. Hence appears one great ſuperiority in this above the wire micrometer; as, with the one any diameter of an object may be meaſured with the ſame eaſe and accuracy; whereas with the other we cannot with accuracy meaſure any diameter, except that which is at right angles to the direction of motion.

12. But, beſides theſe two uſes to which the inſtrument ſeems ſo well adapted, Dr Maſkelyne * has ſhown, how it may be applied to find the difference of right aſcenſions and declinations. For this purpoſe, two wires at right angles to each other, biſecting the field of view, muſt be placed in the principal focus of the eye-glaſs, and moveable about in their own plane.—Let HCR *c* be the field of view, HR and C *c* the two wires; turn the wires till the weſternmoſt ſtar (which is the beſt, having further to move) run along ROH; then ſeparate the two ſegments, and turn about the micrometer till the two images of the ſame ſtar lie in the wire C *c*; and then, partly by ſeparating the ſegments, and partly by raiſing or depreſſing the teleſcope, bring the two innermoſt images of the two ſtars to appear and run along ROH, as *a*, *b*, and the vernier will give the difference of their declinations; becauſe, as the two images of one of the ſtars coincided with C *c*, the image of each ſtar was brought perpendicularly upon HR, or to HR in their proper meridian. And, for the ſame reaſon, the difference of their times of paſſing the wire CO *c* will give their difference of right aſcenſions. Theſe operations will be facilitated, if the teleſcope be mounted on a polar axis. If two other wires KL, MN, parallel to C *c*, be placed near H and R, the obſervation may be made on two ſtars whoſe difference of meridians is nearly equal to HR the diameter of the field of view, by bringing the two images of one of the ſtars to coincide with one of theſe wires. If two ſtars be obſerved whoſe difference of declinations is well ſettled, the ſcale of the micrometer will be known.

* Phil. Tranſ. 1771.

Fig. 4.

13. It has hitherto been ſuppoſed, that the images of the two ſtars can be both brought into the field of view at once upon the wire HOR: but if they cannot, ſet the micrometer to the difference of their declinations as nearly as you can, and make the image which comes firſt run along the wire HOR, by elevating or depreſſing the teleſcope; and when the other ſtar comes in, if it do not alſo run along HOR, alter

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(A) If the object is not diſtant let *f* be the principal focus; then F*f* : FG :: FG : FK (FG being produced to meet a line joining the apparent places of the two objects P, Q,), ∴ dividendo, *f*G : FG :: GK : FK, and alternando, *f*G : GK :: FG : FK :: (by ſimilar triangles) EH : PQ, hence $\frac{EH}{fG} = \frac{PQ}{GK}$, therefore the angle ſubtended by EH at *f* = the angle ſubtended by PQ at G; and conſequently, as *f*G is conſtant, the angle meaſured at G is, in this caſe, alſo proportional to EH. The inſtrument is not adapted to meaſure the angular diſtance of bodies, one of which is near and the other at a diſtance, becauſe their images would not be formed together.

(B) To determine if there be any error in the adjuſtment of the micrometer ſcale, meaſure the diameter of any ſmall well-defined object, as Jupiter's equatoreal diameter, or the longeſt axis of Saturn's ring, both ways, that is, with 0 on the vernier to the right and left of 0 on the ſcale, and half the difference is the error required. This error muſt be added to or ſubtracted from all obſervations, according as the diameter meaſured with 0 on the vernier, when advanced on the ſcale, is leſs or greater than the diameter meaſured the other way. And it is alſo evident, that half the ſum of the diameters thus meaſured gives the true diameter of the object.

the micrometer till it does, and half the ſum of the numbers ſhown by the micrometer at the two ſeparate obſervations of the two ſtars on the wire HOR will be the difference of their declinations. That this ſhould be true, it is manifeſtly neceſſary that the two ſegments ſhould recede equally in oppoſite directions; and this is effected by Mr Dollond in his new improvement of the object glaſs micrometer.

Fig. 5.

14. The difference of right aſcenſions and declinations of Venus or Mercury in the ſun's diſk and the ſun's limb may be thus found. Turn the wires ſo that the north limb *n* of the ſun's image AB, or the north limb of the image V of the planet, may run along the wire RH, which therefore will then be parallel to the equator, and conſequently C*c* a ſecondary to it; then ſeparate the ſegments, and turn about the micrometer till the two images V*v* of the planet paſs C*c* at the ſame time, and then by ſeparating the ſegments, bring the north limb of the northernmoſt image V of the planet to touch HR, at the time the northernmoſt limb *n* of the ſouthernmoſt image AB of the ſun touches it, and the micrometer ſhows the difference of declinations of the northernmoſt limbs of the planet and ſun, for the reaſon formerly given (Art. 11.) we having brought the northernmoſt limbs of the two innermoſt images V and AB to HR, theſe two being manifeſtly interior to *v* and the northernmoſt limb N of the image PQ. In the ſame manner we take the difference of declinations of their ſouthernmoſt limbs; and half the difference of the two meaſures (taking immediately one after another) is equal to the difference of the declinations of their centres, without any regard to the ſun's or planet's diameters, or error of adjuſtment of the micrometer; for as it affects both equally, the difference is the ſame as if there were no error: and the difference of the times of the tranſits of the eaſtern or weſtern limbs of the ſun and planet over C*c* gives the difference of their right aſcenſions.

Fig. 6.

15. Inſtead of the difference of right aſcenſions, the diſtance of the planet from the ſun's limb, in lines parallel to the equator, may be more accurately obſerved thus: Separate the ſegments, and turn about the wires and micrometer, ſo as to make both images V, *v*, run along HR, or ſo that the two interſections I, T of the ſun's image may paſs C*c* at the ſame time. Then bring the planet's and ſun's limbs into contact, as at V, and do the ſame for the other limb of the ſun, and half the difference gives the diſtance of the centre of the planet from the middle of the chord on the ſun's diſk parallel to the equator, or the difference of the right aſcenſions of their centres, allowing for the motion of the planet in the interval of the obſervations, without any regard to the error of adjuſtment, for the ſame reaſon as before. For if you take any point in the chord of a circle, half the difference of the two ſegments is manifeſtly the diſtance of the point from the middle of the chord; and as the planet runs along HR, the chord is parallel to the equator.

Fig. 7.

In like manner, the diſtances of their limbs may be meaſured in lines perpendicular to the equator, by bringing the micrometer into the poſition already deſcribed, (Art. 13.), and inſtead of bringing V to HR, ſeparate the ſegments till the northernmoſt limbs coincide as at V; and in the ſame manner make their ſouthernmoſt images to coincide, and half the difference of the two meaſures, allowing for the planet's motion, gives the difference of the declinations of their centres.

Hence the true place of a planet in the ſun's diſc may at any time of its tranſit be found; and conſequently the neareſt approach to the centre and the time of ecliptic conjunction may be deduced, although the middle ſhould not be obſerved.

Diſadvantage of the object-glaſs micrometer.

16. But however valuable the object-glaſs micrometer undoubtedly is, difficulties ſometimes have been found in its uſe, owing to the alteration of the focus of the eye, which will cauſe it to give different meaſures of the ſame angle at diffetent times. For inſtance, in meaſuring the ſun's diameter, the axis of the pencil coming through the two ſegments from the contrary limbs of the ſun, as PF, QF, fig. 3. croſſing one another in the focus F under an angle equal to the ſun's ſemidiameter, the union of the limbs cannot appear perfect, unleſs the eye be diſpoſed to ſee objects diſtinctly at the place where the images are formed; for if the eye be diſpoſed to ſee objects nearer to or further off than that place, in the latter caſe the limbs will appear ſeparated, and in the former they will appear to lap over (c). This imperfection led Dr Maſkelyne to inquire, whether ſome method might not be found of producing two diſtinct images of the ſun, or any other object, by bringing the axis of each pencil to coincide, or very nearly ſo, before the formation of the images, by which means the limbs when brought together would not be liable to appear ſeparated from any alteration of the eye; and this he found would be effected by the refraction of two priſms, placed either without or within the teleſcope; and on this principle, placing the priſms within, he conſtructed a new micrometer, and had one executed by Mr Dollond, which upon trial anſwered as he expected. The conſtruction is as follows.

Dr Maſkelyne's priſmatic micrometer.

Fig. 8, 9.

17. Let AB be the object-glaſs; *a b* the image, ſuppoſe of the ſun, which would have been formed in the principal focus Q; but let the priſms PR, SR be placed to intercept the rays, and let EF, WG, be two rays proceeding from the eaſtern and weſtern limbs of the ſun, converging, after refraction at the lens, to *a* and *b*; and ſuppoſe the refraction of the priſms to be ſuch, that in fig. 8. the ray EFR, after refraction at

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(c) For if the eye can ſee diſtinctly an image at F, the pencils of rays, of which PF, QF are the two axes, diverging from F, are each brought to a focus on the retina at the ſame point; and therefore the two limbs appear to coincide: but if we increaſe the refractive power of the eye, then each pencil is brought to a focus, and they croſs each other before the rays come to the retina, conſequently the two limbs on the retina will lap over; and if we diminiſh the refractive power of the eye, then each pencil being brought to a focus beyond the retina, and not croſſing till after they have paſſed it, the two limbs on the retina muſt be ſeparated.

R by the priſm PR, may proceed in the direction RQ; and as all the rays which were proceeding to *a* ſuffer the ſame refraction at the priſm, they will all be refracted to Q; and therefore, inſtead of an image *a b*, which would have been formed by the lens alone, an image Q *c* is formed by thoſe rays which fall on the priſm PR; and for the ſame reaſon, the rays falling on the priſm SR will form an image Q *d*: and in fig. 9. the image of the point *b* is brought to Q, by the priſm PR, and conſequently an image Q *d* is formed by thoſe rays which fall on PR: and for the ſame reaſon, an image Q *c* is formed by the rays falling on SR. Now in both caſes, as the rays EFR, WGR, coming from the two oppoſite limbs of the ſun, and forming the point of contact of the two limbs, proceed in the ſame direction RQ, they muſt thus accompany each other through the eye-glaſs and alſo through the eye, whatever refractive power it has, and therefore to every eye the images muſt appear to touch. Now the angle *a* R *b* is twice the refraction of the priſm, and the angle *a* C *b* is the diameter of the ſun; and as theſe angles are very ſmall, and have the ſame ſubtenſe *a b*, we have the angle *a* R *b* : angle *a* C *b* :: CQ : RQ.—Now as CQ is conſtant, and alſo the angle *a* R *b* being twice the refraction of the priſm, the angle *a* C *a* varies as RQ. Hence the extent of the ſcale for meaſuring angles becomes the focal length of the object-glaſs, and the angle meaſured is in proportion to the diſtance of the priſms from the principal focus of the object-glaſs; and the micrometer can meaſure all angles (very ſmall ones excepted, for the reaſon given in Art. 19.) which do not exceed the ſum of the refractions of the priſms; for the angle *a* C *b*, the diameter of the object to be meaſured, is always *leſs* than the angle *a* R *b*, the ſum of the refractions of the priſms, except when the priſms touch the object glaſs, and then they become *equal*. The ſcale can never be out of adjuſtment, as the point 0, where the meaſurement begins, anſwers to the focus of the object-glaſs, which is a fixed point for all diſtant objects, and we have only to find the value of the ſcale anſwering to ſome known angle: for inſtance, bring the two limbs of the ſun's images into contact, and meaſure the diſtance of the priſms from the focus, and look in the nautical almanac for the ſun's diameter, and you get the value of the ſcale.

Fig. 8.

18. In fig. 8. the limb Q of the image Q *c*, is illuminated by the rays falling on the object glaſs between A and F, and of the image Q *d* by thoſe falling between B and G; but in fig. 9. the ſame limbs are illuminated by the rays falling between B and F, A and G reſpectively, and therefore will be more illuminated than in the other caſe; but the difference is not conſiderable in achromatic teleſcopes, on account of the great aperture of the object glaſs compared with the diſtance FG.

'It might be convenient to have two ſets of priſms, one for meaſuring angles not exceeding 36′, and therefore fit for meaſuring the diameters of the ſun and moon, and the lucid parts and diſtances of the cuſps in their eclipſes; and another for meaſuring angles not much greater than 1′, for the conveniency of meaſuring the diameters of the planets. For as QC : QR :: ſum of the refractions of the priſms : angle *a* C *b*, the apparent diameter of the object, it is evident that if you diminiſh the third term, you muſt increaſe the ſecond in the ſame ratio, in order to meaſure the ſame angle; and thus by diminiſhing the refractive angle of the priſms, you throw them further from Q, and conſequently avoid the inconvenience of bringing them near to Q, for the reaſon in the next paragraph; and at the ſame time you will increaſe the illumination in a ſmall degree. The priſms muſt be achromatic, each compoſed of two priſms of flint and crown glaſs, placed with their refracting angles in contrary directions, otherwiſe the images will be coloured.

19. In the conſtruction here deſcribed, the angle meaſured becomes evaneſcent when the priſms come to the principal focus of the object-glaſs, and therefore 0 on the ſcale then begins: but if the priſms be placed in the principal focus they can have no effect, becauſe the pencil of rays at the junction of the priſms would then vaniſh, and therefore it is not practicable to bring the two images together to get 0 on the ſcale. Dr Maſkelyne, therefore, thought of placing another pair of priſms within, to refract the rays *before* they came to the other priſms, by which means the two images would be formed into one before they came to the principal focus, and therefore 0 on the ſcale could be determined. But to avoid the error ariſing from the multiplication of mediums, he, inſtead of adding another pair of priſms, divided the object-glaſs through its centre, and ſliding the ſegments a little it ſeparated the images, and then by the priſms he could form one image very diſtinctly, and conſequently could determine 0 on the ſcale; for by ſeparating the two ſegments you form two images, and you will ſeparate the two pencils ſo that you may move up the two priſms, and the two pencils will fall on each reſpectively, and the two images may be formed into one. In the inſtrument which Dr Maſkelyne had made, 0 on the ſcale was choſen to be about $\frac{2}{3}$ of the focal length of the object-glaſs, and each priſm refracted 27′. By this means all angles are meaſured down to 0.

20. In the Philoſophical Tranſactions for 1779, Mr Ramſden has deſcribed two new micrometers, which he contrived with a view of remedying the defects of the object-glaſs micrometer.

Ramſden's reflecting micrometer.

21. 1. One of theſe is a *catoptric* micrometer, which, beſide the advantage it derives from the principle of reflection, of not being diſturbed by the heterogeneity of light, avoids every defect of other micrometers, and can have no aberration, nor any defect ariſing from the imperfection of materials or of execution; as the extreme ſimplicity of its conſtruction requires no additional mirrors or glaſſes to thoſe required for the teleſcope; and the ſeparation of the images being effected by the inclination of the two ſpecula, and not depending on the focus of any lens or mirror, any alteration in the eye of an obſerver cannot affect the angle meaſured. It has peculiar to itſelf the advantages of an adjuſtment, to make the images coincide in a direction perpendicular to that of their motion; and alſo of meaſuring the diameter of a planet on both ſides of the zero, which will appear no inconſiderable advantage to obſervers who know how much eaſier it is to aſcertain the contact of the external edges of two images than their perfect coincidence.

Fig. 10.

22. A repreſents the ſmall ſpeculum divided into two equal parts; one of which is fixed on the end of the arm B; the other end of the arm is fixed on a ſteel

Micrometer.

axis X, which croſſes the end of the teleſcope C. The other half of the mirror A is fixed on the arm D, which arm at the other end terminates in a ſocket y, that turns on the axis X; both arms are prevented from bending by the braces $a\ a$. G repreſents a double ſcrew, having one part e cut into double the number of threads in an inch to that of the part g: the part e having 100 threads in one inch, and the part g 50 only. The ſcrew e works in a nut F in the ſide of the teleſcope, while the part g turns in a nut H, which is attached to the arm B; the ends of the arms B and D, to which the mirrors are fixed, are ſeparated from each other by the point of the double ſcrew preſſing againſt the ſtud h, fixed to the arm D, and turning in the nut H on the arm B. The two arms B and D are preſſed againſt the direction of the double ſcrew $e\,g$ by a ſpiral ſpring within the part n, by which means all ſhake or play in the nut H, on which the meaſure depends, is entirely prevented.

From the difference of the threads on the ſcrew at e and g, it is evident, that the progreſſive motion of the ſcrew through the nut will be half the diſtance of the ſeparation of the two halves of the mirror; and conſequently the half mirrors will be moved equally in contrary directions from the axis of the teleſcope C.

23. The wheel V fixed on the end of the double ſcrew has its circumference divided into 100 equal parts, and numbered at every fifth diviſion with 5, 10, &c. to 100, and the index I ſhows the motion of the ſcrew with the wheel round its axis, while the number of revolutions of the ſcrew is ſhown by the diviſions on the ſame index. The ſteel ſcrew at R may be turned by the key S, and ſerves to incline the ſmall mirror at right angles to the direction of its motion. By turning the finger head T, the eye-tube P is brought nearer or farther from the ſmall mirror, to adjuſt the teleſcope to diſtinct viſion; and the teleſcope itſelf hath a motion round its axis for the conveniency of meaſuring the diameter of a planet in any direction. The inclination of the diameter meaſured with the horizon is ſhown in degrees and minutes by a level and vernier on a graduated circle, at the breech of the teleſcope.

Fig. 11.

A correction to be applied to the angle.

24. Beſides the table for reducing the revolutions and parts of the ſcrew to minutes, ſeconds, &c. it will require a table for correcting a ſmall error which ariſes from the excentric motion of the half-mirrors. By this motion their centres of curvature will approach a little towards the large mirror: the equation for this purpoſe in ſmall angles is inſenſible; but when angles to be meaſured exceed ten minutes, it ſhould not be neglected. Or, the angle meaſured may be corrected by diminiſhing it in the proportion the verſed ſine of the angle meaſured, ſuppoſing the eccentricity radius, bears to the focal length of the ſmall mirror."

25. Mr Ramſden preferred Caſſegrain's conſtruction of the reflecting teleſcope to either the Gregorian or Newtonian; becauſe in the former, the errors of one ſpeculum are corrected by thoſe of the other. From a property of the reflecting teleſcope, not generally known, that the apertures of the two ſpecula are to each other very nearly in the proportion of their focal lengths, it follows, that their aberrations will be in the ſame proportion; and theſe aberrations will be in the ſame direction, if the two ſpecula are concave; or in contrary directions, if one ſpeculum is concave and the other convex. In the Gregorian teleſcope, both ſpecula being concave, the aberration at the ſecond image will be the ſum of the aberrations of the two mirrors; but in the Caſſegrainian teleſcope one mirror being concave and the other convex, the aberration at the ſecond image will be the difference between the two aberrations. By aſſuming ſuch proportions for the *foci* of the ſpecula as are generally uſed in the reflecting teleſcope, which is about as 1 to 4, the aberration in the Caſſegrainian conſtruction will be to that in the Gregorian as 3 to 5.

Mr Ramſden's eye-glaſs micrometer.

26. The other is a *dioptric* micrometer, or one ſuited to the principle of refraction. This micrometer is applied to the erect eye-tube of a refracting teleſcope, and is placed in the conjugate focus of the firſt eye-glaſs: in which poſition, the image being conſiderably magnified before it comes to the micrometer, any imperfection in its glaſs will be magnified only by the remaining eye-glaſſes, which in any teleſcope ſeldom exceeds five or ſix times. By this poſition alſo the ſize of the micrometer glaſs will not be the $\frac{1}{100}$ part of the area which would be required if it was placed in the object-glaſs; and, notwithſtanding this great diſproportion of ſize, which is of great moment to the practical optician, the ſame extent of ſcale is preſerved, and the images are uniformly bright in every part of the field of the teleſcope.

Plate CCCXXXVI.

27. Fig. 12. repreſents the glaſſes of a refracting teleſcope; $x\,y$, the principal pencil of rays from the object-glaſs O; $t\,t$ and $u\,u$, the axis of two oblique pencils; a, the firſt eye-glaſs; m, its conjugate focus, or the place of the micrometer; b the ſecond eye-glaſs; c the third; and d the fourth, or that which is neareſt the eye. Let p be the diameter of the object-glaſs, e the diameter of a pencil at m, and f the diameter of the pencil at the eye; it is evident, that the axes of the pencils from every part of the image will croſs each other at the point m; and e, the width of the micrometer-glaſs, is to p the diameter of the object-glaſs, as $m\,a$ is to $g\,o$, which is the proportion of the magnifying power at the point m; and the error cauſed by an imperfection in the micrometer glaſs placed at m will be to the error, had the micrometer been at O, as m is to p.

Fig. 13.

28. Fig. 13. repreſents the micrometer; A, a convex or concave lens biſected by a plane acroſs its centre; one of theſe ſemi lenſes is fixed in a frame B, and the other in the frame E; which two frames ſlide on a plate H, and are preſſed againſt it by thin plates $a\ a$: the frames B and E are moved in contrary directions by turning the button D: L is a ſcale of equal parts on the frame B; it is numbered from each end towards the middle with 10, 20, &c. There are two verniers on the frame E, one at M and the other at N, for the convenience of meaſuring the diameter of a planet, &c. on both ſides the zero. The firſt diviſion on both theſe verniers coincides at the ſame time with the two zeros on the ſcale, L; and, if the frame is moved towards the right, the relative motion of the two frames is ſhown on the ſcale L by the vernier M; but if the frame B be moved towards the left, the relative motion is ſhown by the vernier N.—This micrometer has a motion round the axis of viſion, for the convenience of meaſuring the diameter of a planet, &c. in any direction, by turn-

ing an endleſs ſcrew F; and the inclination of the diameter meaſured with the horizon is ſhown on the circle *g* by a vernier on the plate V. The teleſcope may be adjuſted to diſtinct viſion by a ſcrew, which moves the whole eye-tube with the micrometer nearer to or farther from the object-glaſs, as teleſcopes are generally made; or the ſame effect may be produced without moving the micrometer, by ſliding the part of the eye tube *m* on the part *n*, by help of a ſcrew or pinion.

Diſadvantages of the common micrometer.

29. Notwithſtanding theſe improvements on micrometers, they are ſtill liable to many ſources of error. The imperfections of the wire micrometer, (which was ſtill the moſt correct inſtrument for meaſuring ſmall angles) when employed to determine the diſtance of cloſe double ſtars, have been ably pointed out by Dr Herſchel.

30. When two ſtars are taken between the parallel wires the diameters muſt be included. Dr Herſchel * has in vain attempted to find lines ſufficiently thin to extend them acroſs the centres of the ſtars ſo that their thickneſs might be neglected. The threads of the ſilk-worm, with ſuch lenſes as he uſes, are ſo much magnified that their diameter is more than that of many of the ſtars. Beſides, if they were much ſmaller, the deflection of light would make the attempt to meaſure the diſtance of the centres this way fruitleſs; for he has always found the light of the ſtars to play upon thoſe lines and ſeparate their apparent diameters into two parts. Now ſince the ſpurious diameters of the ſtars thus included, are continually changing with the ſtate of the air, and the length of time we look at them, we are, in ſome reſpect, left at an uncertainty; and our meaſures taken at different times, and with different degrees of attention, will vary on that account. Nor can we come at the true diſtance of the centres of any two ſtars, unleſs we know the ſemidiameters of the ſtars themſelves; for different ſtars have different apparent diameters, which, with a power of 227, may differ from each other as far as two ſeconds (D).

31. The next imperfection ariſes from a deflection of light upon the wires when they approach very near to each other; for if this be owing to a power of repulſion lodged at the ſurface, it is eaſy to ſee that ſuch powers muſt interfere with each other, and give the meaſures larger in proportion than they would have been if the repulſive power of one wire had not been oppoſed by a contrary power of the other wire.

32. Another diſadvantage of theſe micrometers is an uncertainty of the real zero. The leaſt alteration in the ſituation and quantity of light will affect the zero; and a change in the poſition of the wires will ſometimes produce a difference. To remove this difficulty Dr Herſchel always found his zero while the apparatus preſerved the ſituation which it had when his obſervations were made; but this introduces an additional obſervation.

33. The next imperfection, is that every micrometer hitherto uſed requires either a ſcrew, or a divided bar and pinion, to meaſure the diſtance of the wires or the two images. Thoſe acquainted with works of this kind are ſenſible how difficult it is to have ſcrews perfectly equal in every thread or revolution of each thread; or pinions and bars that ſhall be ſo evenly divided as to be depended upon in every leaf and tooth to the two or three thouſandth part of an inch: and yet, on account of the ſmall ſcale of thoſe micrometers, theſe quantities are of the greateſt conſequence; an error of a ſingle thouſandth part inducing in moſt inſtruments a miſtake of ſeveral ſeconds.

34. The greateſt imperfection of all is, that the wires require to be illuminated; and when Dr Herſchel had double ſtars to meaſure, one of which was very obſcure, he was obliged to be content with leſs light than is neceſſary to make the wires diſtinct; and ſeveral ſtars on this account could not be meaſured at all, though not too cloſe for the micrometer.

Dr Herſchel, therefore, was led to direct his attention to the improvement of theſe inſtruments; and the reſult of his endeavours has been a very ingenious *lamp-micrometer*, which is not only free from the imperfections above ſpecified, but alſo poſſeſſes the advantages of a large ſcale.

Dr Herſchel's lamp micrometer.

Fig. 14.

35. It is repreſented in fig. 14. where ABGCFE is a ſtand nine feet high, upon which a ſemicircular board *qhogp* is moveable upwards or downwards, and is held in its ſituation by a peg *p* put into any one of the holes of the upright piece AB. This board is a ſegment of a circle of fourteen inches radius, and is about three inches broader than a ſemicircle, to give room for the handles *r* D, *e* P, to work. The uſe of this board is to carry an arm L, thirty inches long, which is made to move upon a pivot at the centre of the circle, by means of a ſtring, which paſſes in a groove upon the edge of the ſemicircle *pgohq*; the ſtring is faſtened to a hook at *o* (not expreſſed in the figure, being at the back of the arm L), and paſſing along the groove from *oh* to *q* is turned over a pulley at *q*, and goes down to a ſmall barrel *e*, within the plane of the circular board, where a double-jointed handle *e*P commands its motion. By this contrivance, we ſee, the arm L may be lifted up to any altitude from the horizontal poſition to the perpendicular, or be ſuffered to deſcend by its own weight below the horizontal to the reverſe perpendicular ſituation. The weight of the handle P is ſufficient to keep the arm in any given poſition; but if the motion ſhould be too eaſy, a friction ſpring applied to the barrel will moderate it at pleaſure.

36. In front of the arm L a ſmall ſlider, about three inches long, is moveable in a rabbet from the end L towards the centre backwards and forwards. A ſtring is faſtened to the left ſide of the little ſlider, and goes towards L, where it paſſes round a pulley at *m*, and returns under the arm from *m*, *n*, towards the centre, where it is led in a groove on the edge of the arm, which is of a circular form, upwards to a barrel (raiſed above the plane of the circular board) at *r*, to which the handle *r* D is faſtened. A ſecond ſtring is faſtened to the ſlider, at the right ſide, and goes towards the centre, where it paſſes over a pulley *n*; and the weight *w*, which is ſuſpended by the end of this ſtring, returns the ſlider towards the centre, when a contrary turn of the handle permits it to act.

37. By *a* and *b* are repreſented two ſmall lamps, two inches high, $1\frac{1}{2}$ in breadth by $1\frac{1}{4}$ in depth. The ſides, back, and top, are made ſo as to permit no light to be ſeen, and the front conſiſts of a thin braſs ſliding door. The flame in the lamp *a* is placed three-tenths of an inch from

* Phil. Tranſ. 1782.

(D) Theſe imperfections are remedied in the inſtrument deſcribed in p. 801.

Micrometer.

from the left ſide, three-tenths from the front, and half an inch from the bottom. In the lamp *b* it is placed at the ſame height and diſtance, meaſuring from the right ſide. The wick of the flame conſiſts only of a ſingle very thin lamp cotton-thread; for the ſmalleſt flame being ſufficient, it is eaſier to keep it burning in ſo confined a place. In the top of each lamp muſt be a little ſlit lengthways, and a ſmall opening in one ſide near the upper part, to permit the air to circulate to feed the flame. To prevent every reflection of light, the ſide opening of the lamp *a* ſhould be to the right, and that of the lamp *b* to the left. In the ſliding door of each lamp is made a ſmall hole with the point of a very fine needle juſt oppoſite the place where the wicks are burning, ſo that when the ſliders are ſhut down, and every thing dark, nothing ſhall be ſeen but two fine lucid points of the ſize of two ſtars of the third or fourth magnitude. The lamp *a* is placed ſo that its lucid point may be in the centre of the circular board where it is fixed. The lamp *b* is hung to the little ſlider which moves in the rabbet of the arm, ſo that its lucid point, in an horizontal poſition of the arm, may be on a level with the lucid point in the centre. The moveable lamp is ſuſpended upon a piece of braſs faſtened to the ſlider by a pin exactly behind the flame, upon which it moves as a pivot. The lamp is balanced at the bottom by a leaden weight, ſo as to remain upright, when the arm is either lifted above or depreſſed below the horizontal poſition. The double-jointed handles *r*D, *e*P, conſiſt of deal rods, 10 feet long, and the loweſt of them may have diviſions, marked upon it near the end P, expreſſing exactly the diſtance from the central lucid point in feet, inches, and tenths.

38. Hence we ſee, that a perſon at a diſtance of 10 feet may govern the two lucid points, ſo as to bring them into any required poſition ſouth or north preceding or following from 0 to 90° by uſing the handle P, and alſo to any diſtance from ſix-tenths of an inch to five or ſix and twenty inches by means of the handle D. If any reflection or appearance of light ſhould be left from the top or ſides of the lamps, a temporary ſcreen, conſiſting of a long piece of paſteboard, or a wire frame covered with black cloth, of the length of the whole arm, and of any required breadth, with a ſlit of a half an inch broad in the middle, may be affixed to the arm by four bent wires projecting an inch or two before the lamps, ſituated ſo that the moveable lucid point may paſs along the opening left for that purpoſe.

Fig. 15.

Fig. 15. repreſents part of the arm L, half the real ſize; S the ſlider; *m* the pulley, over which the cord *xtyz* is returned towards the centre; *v* the other cord going to the pulley *n* of fig. 14. R the braſs piece moveable upon the pin *c*, to keep the lamp upright. At R is a wire rivetted to the braſs piece, upon which is held the lamp by a nut and ſcrew. Fig. 16. 17. repreſent the lamps *a*, *l*, with the ſliding doors open, to ſhow the ſituation of the wicks. W is the leaden weight with a hole *d* in it, through which the wire R of fig. 15. is to be paſſed when the lamp is to be faſtened to the ſlider S. Fig. 18 repreſents the lamp *a* with the ſliding door ſhut; *l* the lucid point; and *ik* the openings at the top, and *s* at the ſides, for the admiſſion of air.

Fig. 16, 17.

Fig. 18.

39. The motions of this micrometer are capable of great improvement by the application of wheels and pinions, and other mechanical reſources; but as the principal object is only to be able to adjuſt the two lucid points to the required poſition and diſtance, and to keep them there for a few minutes, while the obſerver meaſures their diſtance, it will be unneceſſary to ſay more upon the ſubject.

Micrometer.

Method of applying the lamp micrometer.

40. It is well known that we can with one eye look into a teleſcope, and ſee an object much magnified, while the other eye may ſee a ſcale upon which the magnified picture is thrown. In this manner Dr Herſchel generally determined the power of his teleſcopes; and any one who has been accuſtomed to make ſuch obſervations will ſeldom miſtake ſo much as one in fifty in determining the power of an inſtrument, and that degree of exactneſs is fully ſufficient for the purpoſe.

41. When Dr Herſchel uſes this inſtrument he puts it at ten feet diſtance from the left eye, in a line perpendicular to the tube of his Newtonian teleſcope, and raiſes the moveable board to ſuch a height that the lucid point of the central lamp may be upon a level with the eye. The handles, lifted up, are paſſed through two loops faſtened to the tube, juſt by the obſerver, ſo as to be ready for his uſe. The end of the tube is cut away, ſo as to leave the left eye entirely free to ſee the whole micrometer.

42. The teleſcope being directed to a double ſtar, it is viewed with the right eye, and at the ſame time with the left it is ſeen projected upon the micrometer: then, by the handle P, the arm is raiſed or depreſſed ſo as to bring the two lucid points to a ſimilar ſituation with the two ſtars; and, by the handle D, the moveable lucid point is brought to the ſame diſtance of the two ſtars, ſo that the two lucid points may be exactly covered by the ſtars.

43. With a rule, divided into inches and fortieth parts, the diſtance of the lucid points is thus determined with the greateſt accuracy; and the meaſure thus obtained is the tangent of the magnified angle under which the ſtars are ſeen to a radius of ten feet; therefore, the angle being found and divided by the power of the teleſcope, the real angular diſtance of the centres of a double ſtar is aſcertained. On September 25. 1781, Dr Herſchel meaſured α Herculis with this inſtrument. Having cauſed the two lucid points to coincide with the ſtars, he found the radius or diſtance of the central lamp from the eye 10 feet 4.15 inches; the tangent or diſtance of the two lucid points 50.6 fortieth parts of an inch; this gives the magnified angle $35'$, and dividing by the power 460, we obtain $4'' \, 34'''$ for the diſtance of the centres of the two ſtars. The ſcale of the micrometer at this convenient diſtance, with the power of 460, is above a quarter of an inch to a ſecond; and by putting on a power of 932, we obtain a ſcale of more than half an inch to a ſecond, without increaſing the diſtance of the micrometer; whereas the moſt perfect micrometers, with the ſame inſtrument, had a ſcale of leſs than the two thouſandth part of an inch to a ſecond.

Mr Brewſter's micrometer.

44. Mr Brewſter has lately directed his attention to the improvement of micrometers, and has invented one in particular which appears to be highly deſerving of notice in this place. In this inſtrument a pair of *fixed* wires is made to ſubtend different angles by varying the magnifying power of the teleſcope, by ſliding one tube within another; whereas in all other micrometers with

wires this effect is produced by mechanical contrivances. Mr Brewſter's method of ſhutting and opening the wires optically is therefore free from all thoſe ſources of error to which other micrometers are ſubject, and renders it particularly uſeful to the practical aſtronomer; while the mode of changing the magnifying power by the motion of a ſecond object glaſs affords a length of ſcale equal to the local diſtance of the principal object-glaſs. The ſame principle is peculiarly applicable to the Gregorian teleſcope; for the magnifying power of this inſtrument can be changed by merely increaſing or diminiſhing the diſtance of the eye-piece from the large ſpeculum.

45. In the common micrometer, which can manifeſtly, as well as Mr Cavallo's and Mr Brewſter's, be uſed in the menſuration of diſtances, the focal length of the teleſcope to which it is attached remains always the ſame; ſo that a correction computed from an optical theorem muſt be applied to every angle that is meaſured: but in Mr Brewſter's teleſcope and micrometer, the focal length varies in the ſame proportion as the diſtance of the object; and conſequently no correction of the angles can be neceſſary. To obviate the neceſſity of having a ſtand for the inſtrument, which would prevent its uſefulneſs at ſea, Mr Brewſter divides the ſecond or moveable object-glaſs into two, as in the divided object-glaſs micrometer. By this contrivance two images are formed, and theſe images are ſeparated or made to form different angles at the eye, by bringing the moveable object-glaſs nearer to the fixed one. In determining the angle, therefore, we have only to bring the two images of the object into contact; and ſuch contact the eye is capable of aſcertaining even during the agitation of a carriage, as the two images retain the ſame relative poſition whatever be their abſolute motion.

This ingenious inſtrument, being formed with ſliding tubes, is very portable and convenient; and will be found extremely uſeful to military gentlemen, and others who may wiſh to aſcertain diſtances without a more cumberſome apparatus. *Haüy's Nat. Phil. by Gregory*, v. ii. p. 427.

46. Mr Brewſter, we underſtand, ſtill continues to direct his attention to the ſubject of micrometers, keeping in view the improvement of theſe inſtruments, not only in greater accuracy of conſtruction, but alſo in their more extenſive application to various practical purpoſes. An account of thoſe uſes and improvements is to form the ſubject of an appropriate publication; and, if we are rightly informed, the author deems them of ſufficient importance to ſecure to himſelf, by patent, the excluſive right to the advantages which he thinks will ariſe from uſing them.

Cavallo's mother-of-pearl micrometer.

47. A very ſimple micrometer for meaſuring ſmall angles with the teleſcope has been invented by Mr Cavallo *. It conſiſts of a thin and narrow ſlip of mother-of-pearl finely divided, and ſituated in the focus of the eye-glaſs of a teleſcope, juſt where the image of the object is formed. It is immaterial whether the teleſcope be a refractor or a reflector, provided the eye glaſs be a convex lens.

The ſimpleſt way of fixing it is to ſtick it upon the diaphragm, which generally ſtands within the tube, in the focus of the eye-glaſs. When thus fixed, the diviſions of the micrometrical ſcale will appear very diſtinct, unleſs the diaphragm is not exactly in the focus; in which caſe, the ſcale muſt be placed accurately in the focus of the eye-glaſs, either by moving the diaphragm, or by interpoſing any thin ſubſtance, ſuch as paper or card between it and the ſcale. This conſtruction is fully ſufficient, when the teleſcope is always to be uſed by the ſame perſon; but when different perſons are to uſe it, then the diaphragm which ſupports the micrometer muſt be conſtructed ſo as to be eaſily moved backwards or forwards, though that motion need not be greater than about $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Fig. 19.

The ſcale of the micrometer is repreſented in fig. 19. which is about four times greater than one which Mr Cavallo has adapted to a three-feet achromatic teleſcope that magnifies about 84 times. It is ſomething leſs than the 24th part of an inch broad; its thickneſs is equal to that of common writing paper; and the length of it is determined by the breadth of the field of view. The diviſions are 200ths of an inch, and the lines which form them reach from one edge of the ſcale to about the middle of it, excepting every fifth and tenth diviſion, which are longer. Two diviſions of the ſcale in the teleſcope already mentioned are very nearly equal to one minute; and as a quarter of one of thoſe diviſions may be eaſily diſtinguiſhed by the eye, an angle of one-eighth part of a minute, or of $7''\frac{1}{2}$, may be meaſured with it.

Fig 20.

In looking through a teleſcope furniſhed with ſuch a micrometer, the field of view appears divided by the micrometer ſcale, the breadth of which occupies about $\frac{1}{7}$th of the aperture; and as the ſcale is ſemitranſparent, that part of the object which is behind it may be diſcerned ſufficiently well to aſcertain the diviſion, with which its borders coincide. Fig. 20. ſhows the appearance of the field of the teleſcope with the micrometer, when directed to the title page of the Philoſophical Tranſactions, in which it appears that the thickneſs of the letter C is equal to three-fourths of a diviſion, the diameter of the O is equal to three diviſions, and ſo on.

48. After having adapted this micrometer to the teleſcope, we muſt then aſcertain the value of the diviſions. It is hardly neceſſary to mention in this place, that though thoſe diviſions meaſure the chords of the angles, and not the angles or arches themſelves, and the chords are not as the arches, yet in ſmall angles the chords, arches, ſines, and tangents, follow the ſame proportion ſo very nearly, that the difference may be ſafely neglected: ſo that if one diviſion of this micrometer is equal to one minute, we may conclude, that two diviſions are equal to two minutes, three diviſions to three minutes, and ſo on. In order to aſcertain the value of the diviſions of this micrometer, the following ſimple and accurate method may be adopted.

Mark upon a wall the length of ſix inches, by making two dots or lines ſix inches aſunder, or by fixing a ſix-inch ruler upon a ſtand; then place the teleſcope before it ſo that the ruler or ſix-inch length may be at right angles with the direction of the teleſcope, and juſt 57 feet $3\frac{1}{2}$ inches diſtant from the object-glaſs of the teleſcope: this done, look through the teleſcope at the ruler or other extenſion of ſix inches, and obſerve how many diviſions of the micrometer are equal to it, and that ſame number of diviſions is equal to half a degree, or 30′ as may be ſhewn by plane trigonometry.

49. When this value has been once aſcertained, any other angle meaſured by any other number of diviſions is determined by ſimple proportion. Thus, if the diameter of the ſun ſeen through the ſame teleſcope, be equal to

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* *Ph. Tranſ.* 1771. p. 283.

12 diviſions, ſay as 11$\frac{1}{2}$ diviſions are to 30 minutes, ſo are 12 diviſions to $\left(\frac{12'\times 30'}{11.5}\right)$ 31′.3, which is the required diameter of the ſun.

Notwithſtanding the facility of this calculation, a ſcale may be made anſwering to the diviſions of a micrometer, which will ſhow the angle correſponding to any number of diviſions by mere inſpection. Thus, for the above-mentioned ſmall teleſcope, the ſcale is repreſented in fig. 21. AB is a line drawn at pleaſure; it is then divided into 23 equal parts, and thoſe diviſions which repreſent the diviſions of the micrometer that are equal to one degree, are marked on one ſide of it. The line then is divided again into 60 equal parts, which are marked on the other ſide of it; and theſe diviſions repreſent the minutes which correſpond to the diviſions of the micrometer: thus the figure ſhows, that ſix diviſions of the micrometer are equal to 15$\frac{1}{2}$ minutes, 11$\frac{1}{2}$ diviſions are nearly equal to 29 minutes, &c. What has been ſaid of minutes may be ſaid of ſeconds alſo, when the ſcale is to be applied to a large teleſcope.

Fig. 21.

50. We ſhall therefore add ſome practical rules to render this micrometer uſeful to perſons unacquainted with trigonometry and the uſe of logarithms.

Problem I. The angle, not exceeding one degree, which is ſubtended by an extenſion of one foot perpendicular to the axis of the teleſcope being given, to find its diſtance from the object-glaſs of the teleſcope.

Rule 1. If the angle be expreſſed in minutes, ſay, as the given angle is to 60, ſo is 687.55 to a fourth proportional, which gives the anſwer in inches.—2. If the angle be expreſſed in ſeconds, ſay, as the given angle is to 3600, ſo is 687.55 to a fourth proportional, which expreſſes the anſwer in inches.

Example. At what diſtance is a globe of one foot diameter when it ſubtends an angle of two ſeconds?

$$2'' : 3600'' :: 687.55 : \frac{3600\times 687.55}{2} = 1237590$$

inches, or 103132$\frac{1}{2}$ feet, which is the anſwer required.

Problem II. The angle, not exceeding one degree, which is ſubtended by any known extenſion, being given, to find its diſtance from the object-glaſs of the teleſcope.

Rule. Proceed as if the extenſion were of one foot by Problem I. and call the anſwer B; then, if the extenſion in queſtion be expreſſed in inches, ſay, as 12 inches are to that extenſion, ſo is B to a fourth proportional, which is the anſwer in inches; but if the extenſion in queſtion be expreſſed in feet, then you need only multiply it by B, and the product is the anſwer in inches.

Example. At what diſtance is a man ſix feet high, when he appears to ſubtend an angle of 30″.

By Problem I. if the man were one foot high, the diſtance would be 82506 inches; but as he is ſix feet high, therefore multiply 82506 by 6, and the product gives the required diſtance, which is 495036 inches, or 41253 feet.

For greater conveniency, eſpecially in travelling, or in ſuch circumſtances in which one has not the opportunity of making even the eaſy calculations required in thoſe problems, the following two tables have been computed; the firſt of which ſhows the diſtance anſwering to any angle from one minute to one degree, which is ſubtended by a man, the height of which has been called an extenſion of ſix feet; becauſe, at a mean, ſuch is the height of a man when dreſſed with hat and ſhoes on.

Thus, if it is required to meaſure the extenſion of a ſtreet, let a foot ruler be placed at the end of the ſtreet; meaſure the angle it ſubtends, which ſuppoſe to be 36′, and in the table you will have the required diſtance oppoſite 36′, which is 95$\frac{1}{2}$ feet. Thus alſo a man who appears to be 49′ high, is at the diſtance of 421 feet.

Angles ſubtended by an Extenſion of one Foot at different Diſtances.

Angles.	Diſtances in Feet.	Angles.	Diſtances in Feet.
Min. 1	3437,7	Min. 31	110,9
2	1718.9	32	107,4
3	1145,9	33	104,2
4	859,4	34	101.1
5	687.5	35	98,2
6	572,9	36	95.5
7	491,1	37	92,9
8	429.7	38	90,4
9	382,0	39	88,1
10	343.7	40	85,9
11	312,5	41	83,8
12	286,5	42	81,8
13	264.4	43	79,9
14	245.5	44	78,1
15	229,2	45	76,4
16	214,8	46	74,7
17	202,2	47	73,1
18	191,0	48	71,6
19	180,9	49	70,1
20	171,8	50	68,7
21	162,7	51	67.4
22	156,2	52	66,1
23	149,4	53	64,8
24	143,2	54	63,6
25	137,5	55	62,5
26	132,2	56	61,4
27	127,3	57	60,3
28	122,7	58	59,2
29	118,5	59	58,2
30	114,6	60	58,3

Angles ſubtended by an Extenſion of ſix Feet at different Diſtances.

Angles.	Diſtances in Feet.	Angles.	Diſtances in Feet.
Min. 1	20626,8	14	1473,3
2	10313.	15	1375.
3	6875,4	16	1298,1
4	5156,5	17	1213,3
5	4125,2	18	1145,9
6	3437.7	19	1085,6
7	2946 6	20	1031,4
8	2578,2	21	982,2
9	2291,8	22	937,6
10	2062,6	23	896,8
11	1875,2	24	859.4
12	1718,8	25	825.
13	1586,7	26	793,3

Angles.

Angles.	Diſtances in Feet.	Angles.	Diſtance in Feet.
Min. 27	763,9	Min. 44	4683
28	736,6	45	4581
29	711,3	46	448,4
30	687,5	47	438 9
31	665,4	48	429,7
32	644,5	49	421.
33	625.	50	412,5
34	606,6	51	404,4
35	589,3	52	396,7
36	572,9	53	389,2
37	557,5	54	381,9
38	542,8	55	375,
39	528,9	56	368,3
40	515,6	57	361,9
41	503,1	58	355,6
42	491,1	59	349,6
43	479,7	60	343,7

Mr Brewſter's circular mother-of-pearl micrometer.

51. The following is the account of a micrometer invented by Mr Brewſter, of the circumſtances which led to the invention, and of its advantages. We ſhall give it in his own words *.

"In the winter of 1805 (he obſerves), when I was employed in delineating the ſurface of the moon, I wiſhed to meaſure the diameter of the lunar ſpots by applying Mr Cavallo's micrometer to a thirty-inch achromatic teleſcope made by Berge. But as the eye-piece was moved by a rack and pinion, and conſequently could not turn round its axis, the micrometer muſt have remained ſtationary, and could only meaſure angles in one direction. This difficulty, indeed, might have been ſurmounted by a mechanical contrivance for turning the diaphragm about its centre, or more ſimply by giving a motion of rotation to the tube which contains the third and fourth eye-glaſſes. Such a change in the eye-piece, however, was both inconvenient and difficult to be made. Mr Cavallo's micrometer, therefore, has this great diſadvantage, that it cannot be uſed in reflecting teleſcopes, or in any achromatic teleſcope where the adjuſtment of the eye-piece is effected by rackwork, unleſs the ſtructure of theſe inſtruments is altered for the purpoſe. Another diſadvantage of this micrometer ariſes from the ſlip of mother-of-pearl paſſing through the centre of the field. The picture in the focus of the eye glaſs is broken into two parts, and the view is rendered ſtill more unpleaſant by the inequality of the ſegments into which the field is divided. In addition to theſe diſadvantages, the different diviſions of the micrometer are at unequal diſtances from the eye-glaſs which views them, and therefore can neither appear equally diſtinct nor ſubtend equal angles at the eye.

"Finding that Mr Cavallo's inſtrument laboured under theſe imperfections, I thought of a circular mother-of-pearl micrometer which is free from them all, and has likewiſe the advantage of a kind of diagonal ſcale, increaſing in accuracy with the angle to be meaſured. This micrometer, which I got executed by Miller and Adie, optical inſtrument-makers in Edinburgh, and which I have often uſed, both in determining ſmall angles in the heavens and ſuch as are ſubtended by terreſtrial objects, is repreſented in fig. 27. which exhibits its appearances in the focus of the fourth eye-glaſs. The black ring, which forms part of the figure, is the diaphragm, and the remaining part is a ring of mother-of-pearl, having its interior circumference divided into 360 equal parts. The mother-of-pearl ring, which appears connected with the diaphragm, is completely ſeparate from it, and is fixed at the end of a braſs tube which is made to move between the third eye-glaſs and the diaphragm, ſo that the divided circumference may be placed exactly in the focus of the glaſs next the eye. When the micrometer is thus fitted into the teleſcope, the angle ſubtended by the whole field of view, or by the diameter of the innermoſt circle of the micrometer, muſt be determined either by meaſuring a baſe or by the paſſage of an equatoreal ſtar, and the angles ſubtended by any number of diviſions or degrees will be found by a table conſtructed in the following manner.

Plate CCCXXXVI. Fig. 27.

Fig. 28.

52. "Let A mpn B, fig. 28. be the interior circumference of the micrometer ſcale, and let mn be the object to be meaſured. Biſect the arch mn in p, and draw C m, C p, C n. The line C p will be at right angles to mn, and therefore mn will be twice the ſine of half the arch mn. Conſequently, AB : mn = rad. ſine of $\frac{1}{2}mpn$; therefore $mn \times R = \text{ſin.}\ \frac{1}{2}mpn \times AB$, and $mpn = \frac{\text{ſin.}\ \frac{1}{2}mpn \times AB}{R} = \frac{\text{ſin.}\ \frac{1}{2}mpn}{R} \times AB$; a formula by which the angle ſubtended by the chord of any number of degrees may be eaſily found. The firſt part of the formula, viz. $\frac{\text{ſin.}\ \frac{1}{2}mpn}{R}$ is conſtant, while AB varies with the ſize of the micrometer and with the magnifying power which is applied. We have therefore computed the following table, containing the value of the conſtant part of the formula for every degree or diviſion of the ſcale.

Deg.	Conſtant Part of the Formula	Deg.	Conſtant Part.	Deg.	Conſtant Part.	Deg.	Conſtant Part.
1	.0087	21	.1822	41	.3502	61	.5075
2	.0174	22	.1908	42	.3584	62	.5150
3	.0262	23	.1994	43	.3665	63	.5225
4	.0349	24	.2079	44	.3746	64	.5299
5	.0436	25	.2164	45	.3827	65	.5373
6	.0523	26	.2250	46	.3907	66	.5446
7	.0610	27	.2334	47	.3987	67	.5519
8	.0698	28	.2419	48	.4067	68	.5592
9	.0785	29	.2504	49	.4147	69	.5664
10	.0872	30	.2588	50	.4226	70	.5735
11	.0958	31	.2672	51	.4305	71	.5807
12	.1045	32	.2756	52	.4384	72	.5878
13	.1132	33	.2840	53	.4462	73	.5948
14	.1219	34	.2923	54	.4540	74	.6018
15	.1305	35	.3007	55	.4617	75	.6088
16	.1392	36	.3090	56	.4695	76	.6157
17	.1478	37	.3173	57	.4771	77	.6225
18	.1564	38	.3256	58	.4848	78	.6293
19	.1650	39	.3338	59	.4924	79	.6361
20	.1736	40	.3420	60	.5000	80	.6428

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* Phil. Mag. vol. xxix. p. 48.

Mr Brewſter's circular micrometer.

Deg.	Conſtant Part of the Formula	Deg.	Conſtant Part.	Deg.	Conſtant Part.	Deg.	Conſtant Part
81	.6494	106	.7986	131	.9100	156	.9781
82	.6561	107	.8039	132	.9135	157	.9799
83	.6626	108	.8090	133	.9171	158	.9816
84	.6691	109	.8141	134	.9205	159	.9833
85	.6756	110	.8192	135	.9239	160	.9848
86	.6820	111	.8241	136	.9272	161	.9863
87	.6884	112	.8290	137	.9304	162	.9877
88	.6947	113	.8339	138	.9336	163	.9890
89	.7009	114	.8387	139	.9367	164	.9903
90	.7071	115	.8434	140	.9397	165	.9914
91	.7133	116	.8480	141	.9426	166	.9925
92	.7193	117	.8526	142	.9455	167	.9936
93	.7254	118	.8572	143	.9483	168	.9945
94	.7314	119	.8616	144	.9511	169	.9954
95	.7373	120	.8660	145	.9537	170	.9962
96	.7431	121	.8704	146	.9563	171	.9969
97	.7490	122	.8746	147	.9588	172	.9976
98	.7547	123	.8788	148	.9613	173	.9981
99	.7604	124	.8829	149	.9636	174	.9986
100	.7660	125	.8870	150	.9659	175	.9990
101	.7716	126	.8910	151	.9681	176	.9994
102	.7771	127	.8949	152	.9703	177	.9996
103	.7826	128	.8988	153	.9724	178	.9998
104	.7880	129	.9026	154	.9744	179	1.0000
105	.7934	130	.9063	155	.9763	180	1.0000

53. "In order to find the angle ſubtended by any number of degrees, we have only to multiply the conſtant part of the formula correſponding to that number in the table by AB, or the angle ſubtended by the whole field. Thus if AB is 30 minutes, as it happens to be in the micrometer which I have conſtructed, the angle ſubtended by 1 degree of the ſcale will be $30' \times .009 = 16\frac{1}{5}$ ſeconds, and the angle ſubtended by 40 degrees will be $30' \times .342 = 10'\ 15.6''$; and by making the calculation it will be found that as the angle to be meaſured increaſes, the accuracy of the ſcale alſo increaſes; for when the arch is only 1 or 2 degrees, a variation of 1 degree produces a variation of about 16 ſeconds in the angle; whereas when the arch is between 170 and 180, the variation of a degree does not produce a change much more than one ſecond in the angle. This is a moſt important advantage in the circular ſcale, as in Cavallo's micrometer a limit is neceſſarily put to the ſize of the diviſions.

"It is obvious, from an inſpection of fig. 27. that there is no occaſion for turning the circular micrometer round its axis, becauſe the divided circumference lies in every poſſible direction. In fig. 2. for example, if the object has the direction *a b* it will be meaſured by the arch *a o b*, and if it lies in the line *c d* it will be meaſured by the arch *c r d*.

"In the circular micrometer which I have been in the habit of uſing, AB, or the diameter of the field of view, is exactly half an inch, the diameter of the braſs tube in which it is fixed is one inch, the length of the tube half an inch, and the degrees of the divided circumference $\frac{1}{230}$th of an inch."

54. II. The micrometer has not only been applied to teleſcopes, and employed for aſtronomical purpoſes; but there have alſo been various contrivances for adapting it to MICROSCOPICAL obſervations. Mr Leeuwenhoeck's method of eſtimating the ſize of ſmall objects was by comparing them with grains of ſand, of which 100 in a line took up an inch. Theſe grains he laid upon the ſame plate with his objects, and viewed them at the ſame time. Dr Jurin's method was ſimilar to this; for he found the diameter of a piece of fine ſilver wire, by wrapping it as cloſe as he could about a pin, and obſerving how many rings made an inch; and he uſed this wire in the ſame manner as Leeuwenhoeck employed his ſand. Dr Hooke looked upon the magnified object with one eye, while at the ſame time he viewed other objects placed at the ſame diſtance with the other eye. In this manner he was able, by the help of a ruler, divided into inches and ſmall parts, and laid on the pedeſtal of the microſcope, to caſt as it were the magnified appearance of the object upon the ruler, and thus exactly to meaſure the diameter which it appeared to have through the glaſs; which being compared with the diameter as it appeared to the naked eye, ſhowed the degree in which it was magnified.

Application of the micrometer to microſcopes.

55. Mr Martin * recommended ſuch a micrometer for a microſcope as had been applied to teleſcopes: for he adviſes to draw a number of parallel lines on a piece of glaſs, with the fine point of a diamond, at the diſtance of one fortieth of an inch from one another, and to place it in the focus of the eye-glaſs. By this method, Dr Smith contrived to take the exact draught of objects viewed by a double microſcope; for he adviſes to get a lattice, made with ſmall ſilver wires or ſquares, drawn upon a plain glaſs by the ſtrokes of a diamond, and to put it into the place of the image, formed by the object-glaſs: then by transferring the parts of the object, ſeen in the ſquares of the glaſs or lattice upon ſimilar correſponding ſquares drawn on paper, the picture may be exactly taken. Mr Martin alſo introduced into compound microſcopes another micrometer, conſiſting of a ſcrew.

* *Martin's Optics*, p. 277.

65. The mode of actual admeaſurement (Mr Adams obſerves †) is without doubt the moſt ſimple that can be uſed; as by it we comprehend, in a manner, at one glance, the different effects of combined glaſſes; and as it ſaves the trouble, and avoids the obſcurity, of the uſual modes of calculation: but many perſons find it exceedingly difficult to adopt this method, becauſe they have not been accuſtomed to obſerve with both eyes at once. To obviate this inconvenience, the late Mr Adams contrived an inſtrument called the *Needle-Micrometer*, which was firſt deſcribed in his *Micrographia Illuſtrata*; and of which, as now conſtructed, we have the following deſcription by his ſon Mr George Adams in the ingenious Eſſays above quoted.

† *Microſcopical Eſſays*, p. 59.

This micrometer conſiſts of a ſcrew, which has 50 threads to an inch; this ſcrew carries an index, which points to the diviſions on a circular plate, which is fixed at right angles to the axis of the ſcrew. The revolutions of the ſcrew are counted on a ſcale, which is an inch divided into 50 parts; the index to theſe diviſions is a flower-de-luce marked upon the ſlider, which carries the needle point acroſs the field of the microſcope. Every revolution of the micrometer ſcrew meaſures $\frac{1}{50}$th part of an inch, which is again ſubdivided by means of the diviſions on the circular plate, as this is divided into 20 equal parts, over which the index paſſes at every revolution of the ſcrew; by which means we obtain with eaſe the meaſure of 1000th part of an inch: for 50, the number of threads on the ſcrew in one inch, being multiplied by 20, the diviſions on the circular plate are equal to 1000; ſo that each diviſion on the circular plate ſhows that the needle has either advanced or receded 1000th part of an inch.

Fig. 25.

57. To place this micrometer on the body of the microſcope, open the circular part FKH, fig. 25. by taking out the ſcrew G, throw back the ſemicircle FK, which moves upon a joint at K; then turn the ſliding tube of the body of the microſcope, ſo that the ſmall holes which are in both tubes may exactly coincide, and let the needle *g* of the micrometer have a free paſſage through them; after this, ſcrew it faſt upon the body by the ſcrew G. The needle will now traverſe the field of the microſcope, and meaſure the length and breadth of the image of any object that is applied to it. But further aſſiſtance muſt be had, in order to meaſure the object itſelf, which is a ſubject of real importance; for though we have aſcertained the power of the microſcope, and know that it is ſo many thouſand times, yet this will be of little aſſiſtance towards aſcertaining an accurate idea of its real ſize; for our ideas of bulk being formed by the compariſon of one object with another, we can only judge of that of any particular body, by comparing it with another whoſe ſize is known: the ſame thing is neceſſary, in order to form an eſtimate by the microſcope; therefore, to aſcertain the real meaſure of the object, we muſt make the point of the needle paſs over the image of a known part of an inch placed on the ſtage, and write down the revolutions made by the ſcrew, while the needle paſſed over the image of this known meaſure; by which means we aſcertain the number of revolutions on the ſcrew, which are adequate to a real and known meaſure on the ſtage. As it requires an attentive eye to watch the motion of the needle point as it paſſes over the image of a known part of an inch on the ſtage, we ought not to truſt to one ſingle meaſurement of the image, but ought to repeat it at leaſt ſix times; then add the ſix meaſures thus obtained together, and divide their ſum by ſix, or the number of trials; the quotient will be the mean of all the trials. This reſult is to be placed in a column of a table next to that which contains the number of the magnifiers.

Fig. 22, 23, 24.

58. By the aſſiſtance of the ſectoral ſcale, we obtain with eaſe a ſmall part of an inch. This ſcale is ſhown at fig. 22, 23, 24, in which the two lines *ca*, *cb*, with the ſide *ab*, form an iſoſceles triangle; each of the ſides is two inches long, and the baſe ſtill only of one-tenth of an inch. The longer ſides may be of any given length, and the baſe ſtill only of one tenth of an inch. The longer lines may be conſidered as the line of lines upon a ſector opened to one-tenth of an inch. Hence whatever number of equal parts *ca*, *cb* are divided into, their tranſverſe meaſure will be ſuch a part of one-tenth as is expreſſed by their diviſions. Thus if it be divided into ten equal parts, this will divide the inch into 100 equal parts; the firſt diviſion next *c* will be equal to 100th part of an inch, becauſe it is the tenth part of one-tenth of an inch. If theſe lines are divided into twenty equal parts, the inch will be by that means divided into 200 equal parts. Laſtly, if *ab*, *ca*, are made three inches long, and divided into 100 equal parts, we obtain with eaſe the 1000th part. The ſcale is repreſented as ſolid at fig. 23. but as perforated at fig. 22. and 24. ſo that the light paſſes through the aperture, when the ſectoral part is placed on the ſtage.

59. To uſe this ſcale, firſt fix the micrometer, fig. 25. to the body of the microſcope; then fit the ſectoral ſcale, fig. 24. in the ſtage, and adjuſt the microſcope to its proper focus or diſtance from the ſcale, which is to be moved till the baſe appears in the middle of the field of view; then bring the needle point *g*, fig. 25. (by turning the ſcrew L) to touch one of the lines *ca*, exactly at the point anſwering to 20 on the ſectoral ſcale. The index *a* of the micrometer is to be ſet to the firſt diviſion, and that on the dial plate to 20, which is both the beginning and end of its diviſions; we are then prepared to find the magnifying power of every magnifier in the compound microſcope which we are uſing.

60. *Example.* Every thing being prepared agreeable to the foregoing directions, ſuppoſe you are deſirous of aſcertaining the magnifying power of the lens marked N° 4. turn the micrometer ſcrew until the point of the needle has paſſed over the magnified image of the tenth part of one inch; then the diviſion, where the two indices remain, will ſhow how many revolutions, and parts of a revolution, the ſcrew has made, while the needle point traverſed the magnified image of the one tenth of an inch; ſuppoſe the reſult to be 26 revolutions of the ſcrew, and 14 parts of another revolution, this is equal to 26 multiplied by 20, added to 14; that is, 534,000 parts of an inch.—The 26 diviſions found on the ſtraight ſcale of the micrometer, while the point of the needle paſſed over the magnified image of one-tenth part of an inch, were multiplied by 20, becauſe the circular plate CD, fig. 25. is divided into 20 equal parts; this produced 520; then adding the 14 parts of the next revolution, we obtain the 534,000 parts of an inch, or five tenths and 3400 parts of another tenth, which is the meaſure of the magnified image of one-tenth of an inch, at the aperture of the eye-glaſſes or at their foci. Now if we ſuppoſe the focus of the two eye-glaſſes to be one inch, the double thereof is two inches; or if we reckon in the 1000th part of an inch, we have 2000 parts for the diſtance of the eye from the needle point of the micrometer. Again, if we take the diſtance of the image from the object at the ſtage at 6 inches, or 6000, and add thereto 2000, double the diſtance of the focus of the eye-glaſs, we ſhall have 8000 parts of an inch for the diſtance of the eye from the object; and as the glaſſes double the image, we muſt double the number 534 found upon the micrometer, which then makes 1068: then, by the following analogy, we ſhall obtain the number of times the microſcope magnifies the diameter of the object; ſay, as 240, the diſtance of the eye from the image of the object, is to 800, the diſtance of the eye from the object; ſo is 1068, double the meaſure found on the micrometer, to 3563, or the number of times the microſcope magnifies the diameter of the object. By working in this manner, the magnifying power of each lens uſed with the compound microſcope may be eaſily found, though the reſult will

Fig. 25.

be different in different compound microſcopes, varying according to the combination of the lenſes, their diſtance from the object and one another, &c.

61. Having diſcovered the magnifying power of the microſcope, with the different object-lenſes that are uſed therewith, our next ſubject is to find out the real ſize of the objects themſelves, and their different parts: this is eaſily effected, by finding how many revolutions of the micrometer ſcrew anſwer to a known meaſure on the ſectoral ſcale or other object placed on the ſtage; from the number thus found, a table ſhould be conſtructed, expreſſing the value of the different revolutions of the micrometer with that object lens, by which the primary number was obtained. Similar tables muſt be conſtructed for each object lens. By a ſet of tables of this kind, the obſerver may readily find the meaſure of any object he is examining; for he has only to make the needle point traverſe over this object, and obſerve the number of revolutions the ſcrew has made in its paſſage, and then look into his table for the real meaſure which correſponds to this number of revolutions, which is the meaſure required.

Deſcription of Mr Coventry's micrometers for microſcopes.

62. Mr Coventry of Southwark has favoured us with the deſcription of a micrometer of his own invention; the ſcale of which, for minuteneſs, ſurpaſſes every inſtrument of the kind of which we have any knowledge, and of which, indeed, we could ſcarcely have formed a conception, had he not indulged us with ſeveral of theſe inſtruments, graduated as underneath.

The micrometer is compoſed of glaſs, ivory, ſilver, &c. on which are drawn parallel lines from the 10th to the 10,000th part of an inch. But an inſtrument thus divided, he obſerves, is more for curioſity than uſe: but one of thoſe which Mr Coventry has ſent us is divided into ſquares, ſo ſmall that ſixteen millions of them are contained on the ſurface of one ſquare inch, each ſquare appearing under the microſcope true and diſtinct; and though ſo ſmall, it is a fact, that animalcula are found which may be contained in one of theſe ſquares.

The uſe of micrometers, when applied to microſcopes, is to meaſure the natural ſize of the object, and how much that object is magnified. To aſcertain the real ſize of an object in the ſingle microſcope, nothing more is required than to lay it on the micrometer, and adjuſt it to the focus of the magnifier, noticing how many diviſions of the micrometer it covers. Suppoſe the parallel lines of the micrometer to be the 1000th of an inch, and the object covers two diviſions; its real ſize is 500ths of an inch; if five, 200ths, and ſo on.

But to find how much the object is magnified, is not mathematically determined ſo eaſily by the ſingle as by the compound microſcope: but the following ſimple method (ſays Mr Coventry) I have generally adopted, and think it tolerably accurate. Adjuſt a micrometer under the microſcope *o*, ſay the 100th of an inch of diviſions, with a ſmall object on it; if ſquare, the better: notice how many diviſions one ſide of the object covers, ſuppoſe 10: then cut a piece of white paper ſomething larger than the magnified appearance of the object: then fix one eye on the object through the microſcope, and the other at the ſame time on the paper, lowering it down till the object and the paper appear level and diſtinct: then cut the paper till it appear exactly the ſize of the magnified object; the paper being then meaſured, ſuppoſe an inch ſquare: Now, as the object under the magnifier, which appeared to be one inch ſquare, was in reality only ten hundredths, or the tenth of an inch, the experiment proves that it is magnified ten times in length, one hundred times in ſuperfices, and one thouſand times in cube, which is the magnifying power of the glaſs; and, in the ſame manner, a table may be made of the power of all the other glaſſes.

In uſing the compound microſcope, the real ſize of the object is found by the ſame method as in the ſingle: but to demonſtrate the magnifying power of each glaſs to greater certainty, adopt the following method.— Lay a two-feet rule on the ſtage, and a micrometer level with its ſurface (an inch ſuppoſe, divided into 100 parts): with one eye ſee how many of thoſe parts are contained in the field of the microſcope, (ſuppoſe 50); and with the other, at the ſame time, look for the circle of light in the field of the microſcope, which with a little practice will ſoon appear diſtinct; mark how much of the rule is interſected by the circle of light, which will be half the diameter of the field. Suppoſe eight inches; conſequently the whole diameter will be ſixteen. Now, as the real ſize of the field, by the micrometers, appeared to be only 50 hundredths, or half an inch, and as half an inch is only one 32d part of 16 inches, it ſhows the magnifying power of the glaſs to be 32 times in length, 1024 ſuperfices, and 32,768 cube (E).

63. Another way of finding the magnifying power of compound microſcopes, is by uſing two micrometers of the ſame diviſions; one adjuſted under the magnifier, the other fixed in the body of the microſcope in the focus of the eye-glaſs. Notice how many diviſions of the micrometer in the body are ſeen in one diviſion of the micrometer under the magnifier, which again muſt be multiplied by the power of the eye-glaſs. Example: Ten diviſions of the micrometer in the body are contained in one diviſion under the magnifier; ſo far the power is increaſed ten times: now, if the eye-glaſs be one inch focus, ſuch glaſs will of itſelf magnify about ſeven times in length, which, with the ten times magnified before, will be ſeven times ten, or 70 times in length, 4900 ſuperficies, and 343,000 cube.

“If (ſays Mr Coventry) theſe micrometers are employed in the ſolar microſcope, they divide the object into ſquares on the ſcreen in ſuch a manner as to render it extremely eaſy to make a drawing of it. And (ſays he) I apprehend they may be employed to great advantage with ſuch a microſcope as Mr Adams's lucernal; becauſe this inſtrument may be uſed either by day or night, or in any place, and gives the actual magnifying power without calculation.”

(E) It will be neceſſary, for great accuracy, as well as for comparative obſervations, that the two-feet rule ſhould always be placed at a certain diſtance from the eye: eight inches would, in general, be a proper diſtance.

MICROMETER.

Plate CCCXXXV

Fig. 1.

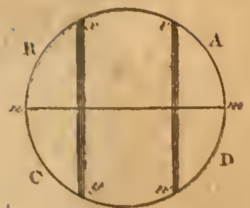
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Fig. 3.

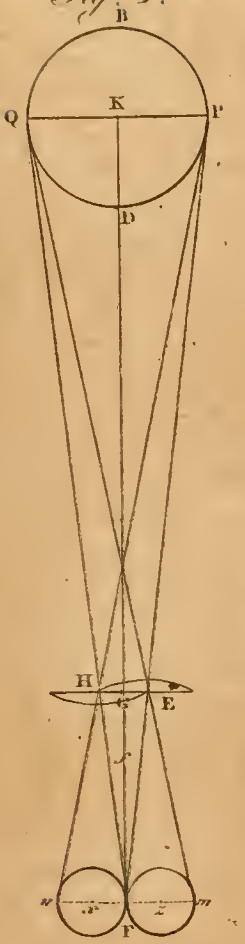
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Fig. 8.

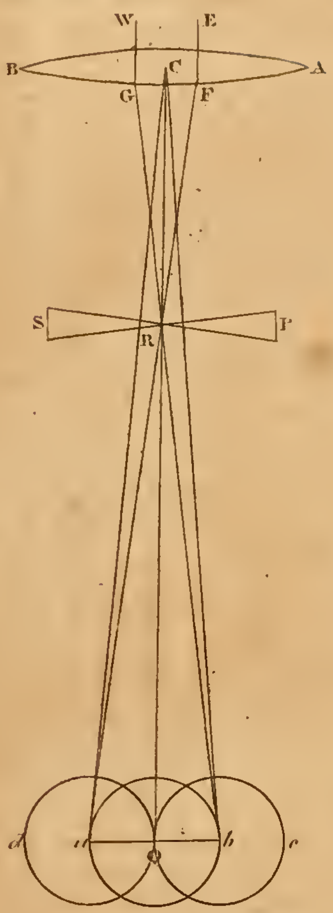
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Fig. 9.

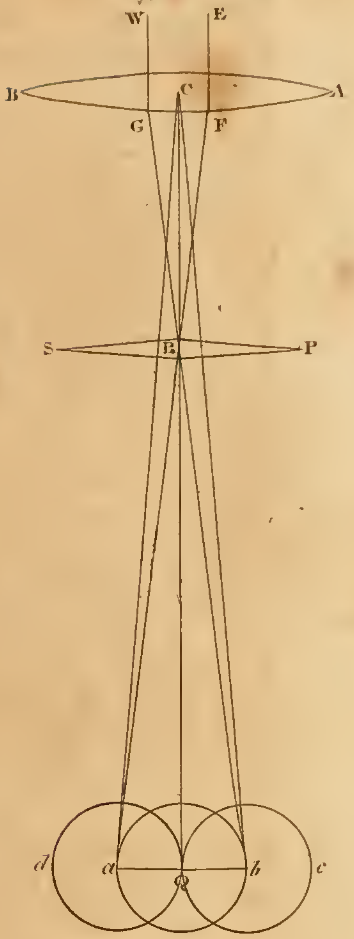
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Fig. 4.

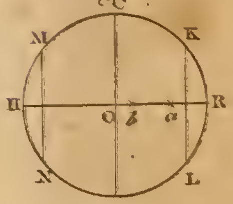

Fig. 5.

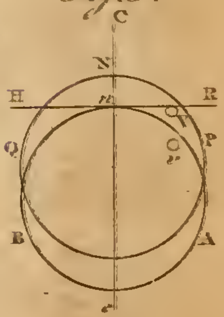
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Fig. 6.

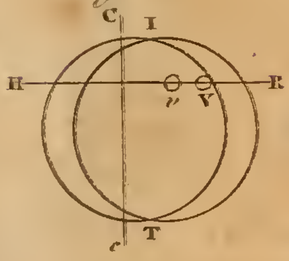

Fig. 7.

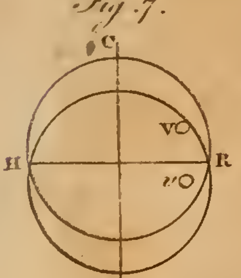

Fig. 10.

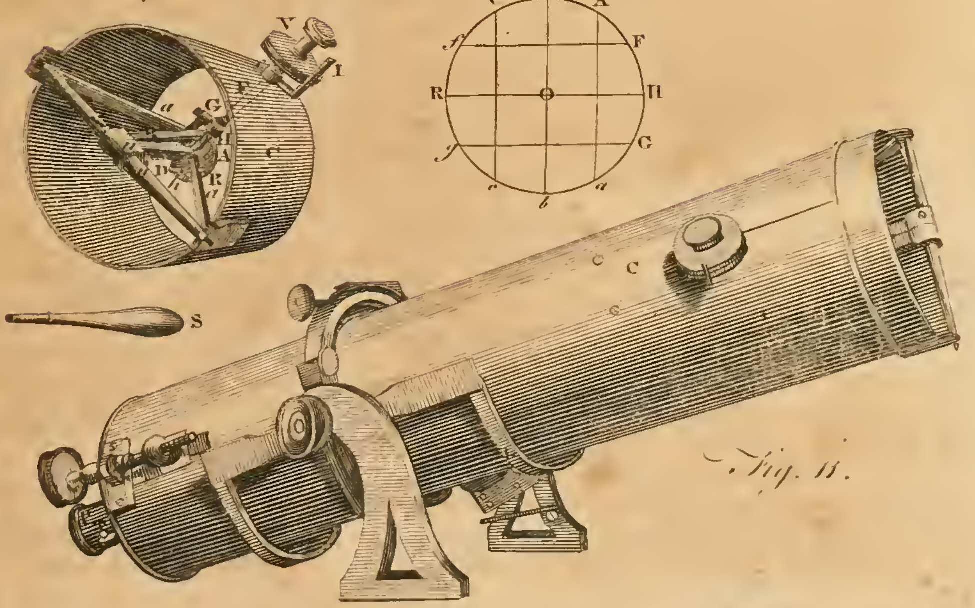
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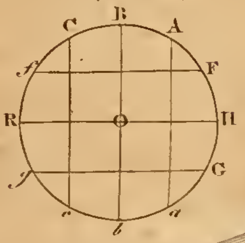
Fig. 2.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C

Fig. 11.

A. Bell Prin. Wal. Sculptor fecit.

MICROMETER

Plate CCCXXXVI

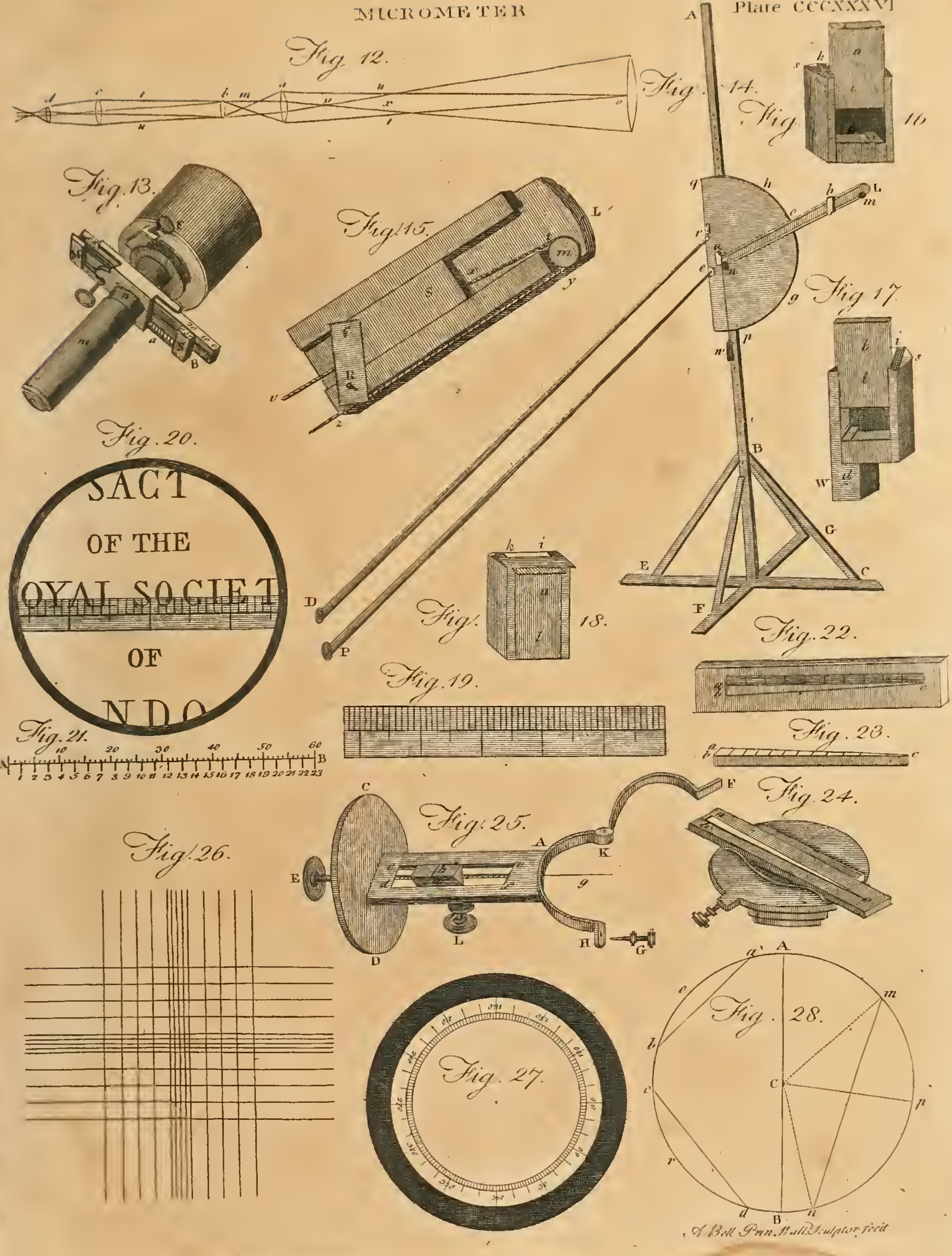

Fig. 12.
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Fig. 13.
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Fig. 14.
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Fig. 15.
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Fig. 16
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Fig. 17
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Fig. 18.
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Fig. 19.
Fig. 20.
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Fig. 21.
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Fig. 22.
Fig. 23.
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Fig. 24.
Fig. 25.
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K
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g
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Fig. 26.
Fig. 27.
Fig. 28.
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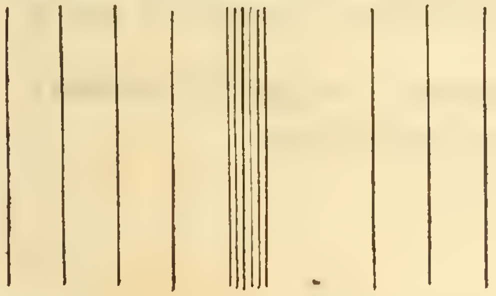
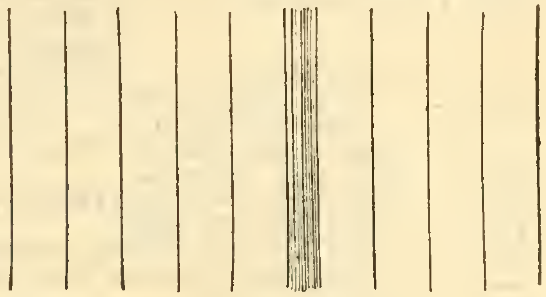
A Bell Prin. Wall Sculptor fecit

The caſe with which we have been favoured by Mr Coventry contains ſix micrometers, two on ivory and four on glaſs. One of thoſe on ivory is an inch divided into one hundred parts, every fifth line longer than the intermediate ones, and every tenth longer ſtill, for the greater eaſe in counting the diviſions under the microſcope, and is generally uſed in meaſuring the magnifying power of microſcopes. The other ivory one is divided into ſquares of the 50th and 100th of an inch, and is commonly employed in meaſuring opaque objects.

Thoſe made of glaſs are for tranſparent objects, which, when laid on them, ſhow their natural ſize.—That marked on the braſs 100, are ſquares divided to the 100th of an inch: that marked 5000 are parallel lines forming nine diviſions, each diviſion the 1000th of an inch; the middle diviſion is again divided into 5, making diviſions to the 5000th of an inch. That marked 10,000 is divided in the ſame manner, with the middle diviſion divided into 10, making the 10,000th of an inch. Example:





The glaſs micrometer without any mark is alſo divided, the outſide lines into 100th, the next into 1000th, and the inſide lines into the 4000th of an inch: theſe are again croſſed with an equal number of lines in the ſame manner, making ſquares of the 100th, 1000th, and 4000th of an inch, thus demonſtrating each other's ſize. The middle ſquare of the 1000th of an inch (ſee fig. 26.) is divided into ſixteen ſquares; now as 1000 ſquares in the length of an inch, multiplied by 1000, gives one million in an inch ſurface; by the ſame rule, one of thoſe ſquares divided into 16 muſt be the ſixteen millionth part of an inch ſurface. See fig. 26. which is a diminiſhed view of the apparent ſurface exhibited under the magnifier N° 1. of Wilſon's microſcope. In viewing the ſmalleſt lines, Mr Coventry uſes N° 2. or 3.; and they are all better ſeen, he ſays, by candle than by day-light.

MICROPUS, BASTARD CUDWEED: A genus of plants belonging to the ſyngeneſia claſs, and in the natural method ranking under the 49th order, *Compoſitæ*. See BOTANY *Index*.

END OF THE THIRTEENTH VOLUME.

ERRATA.

Page.	Col.	Line.
511	1	25 from bottom, *read*, It is numbered each way; from 0 to 90° towards the eye end for angles of altitude, and from 0 to 50° towards the object end for angles of depreſſion.
—	—	10 from bottom, *for* into 10°, *read*, to every 10°.
513	—	In the margin, oppoſite *Ex*. 7. ſupply a reference to fig. 10. and oppoſite to *Ex*. 8. ſupply a reference to fig. 11.
515	2	13 and 14 from bottom, *for* diſtance between, *read* diſtance between them.
517	2	12 *for* .7844, *read* .7854.
518	2	22 from bottom, *read* $\frac{1}{3}D \times (F+L+4E+2R)$.
519	2	5 *read* $F+L(=HI+MD)$.
520	1	6 from bottom, *for* each lines, *read* ſuch lines.
—	2	11 from bottom, *for* cylinder, *read* pyramid.
521	1	15 *for* AE, *read* RE.
523	2	18 *for* Prob. 3. read Prob. 6.
525	1	31 *for* .5230, *read* .5236, and col. 2. line 7. *for* CA, *read* CA^2.
526	2	26 *for* .1077, *read* 1077; and in line 34. *for* .009, &c. *read* .000928371.
527	2	10 from bottom, *for* as EB at A, *read* as EB at B.
528	2	5 *for* $39^2 \times 32^2$, *read* 39×32^2, and line 6. *for* — *read* =

In the article METHODISTS, *paſſim*, *for* Hanſon, *read* Hampſon.

DIRECTIONS FOR PLACING THE PLATES OF VOL. XIII.

PART I.

Plate CCCXVI—CCCXXX. to face	page 136
CCCXXXI. CCCXXXII.	184

PART II.

CCCXXXIII. CCCXXXIV.	528
CCCXXXV. CCCXXXVI.	806

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