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A.G.KÆSTNER.

THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum sane textus ideo melior, quia ex se fila gignunt. Nec noster vilior quia ex alienis libamus ut apes." Just. Lips. *Monit. Polit.* lib. i. cap. 1.

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PHILOSOPHICAL MAGAZINE.

OCTOBER 1798.

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THE maſs of iron found in Siberia by Pallas, and deſcribed in the third volume of his Travels*, is, in many reſpects, ſo like the maſſes deſcribed by Buchholz †, Rubin de Celis ‡, Dr. Lober §, Nauwerk ||, and others, that there is great reaſon to conclude, they have all had a ſimilar origin. This ſeems alſo to be in ſome meaſure confirmed by a circumſtance mentioned by Pallas, who ſays, that the Tartars conſidered the maſs to which he alludes, as a ſacred relick that had dropped from heaven.

The problematic maſs in queſtion was found between Kraſnojarſk and Abekanſk in the high ſlate mountains, quite open and uncovered. It weighed 1600 pounds; had a very

* Page 311.

† Naturforſcher, part iv. page 227.

‡ Philoſoph. Tranſactions, vol. lxxviii. part i. page 37.

§ Berl. Sammlungen, vol. vii. page 523.

|| Crell's Beytr. zu d. Chem. Annalen, vol. i. part ii. page 86.

irregular and somewhat compressed figure like a rough granite; was covered externally with a ferruginous kind of crust; and the inside consisted of malleable iron, brittle when heated, porous like a large sea sponge, and having its interstices filled with a brittle hard vitrified substance of an amber yellow colour. This texture and the vitrified substance appeared uniformly throughout the whole mass, and without any traces of slag or artificial fire.

Dr. Chladni shews with a great deal of ingenuity, that this mass neither originated by the wet method; nor could have been produced by art, the burning of a forest, by lightning, or by a volcanic eruption. It appears to him much more probable that it is of the same nature as the so called fire-balls (*bolides*) or flying dragons, and he quotes a variety of observations made on these phenomena; from which he endeavours to prove that they do not arise from an accumulation of the matter of the aurora borealis; a transition of electricity from one part of the atmosphere to another; an accumulation of porous inflammable substances in the higher regions, or the catching fire of a long train of inflammable air; but that their component parts must be considerably dense and heavy, as their course shews in so apparent a manner the effects of gravity; and because their mass, though it distends to a monstrous size, retains sufficient consistency and weight to continue an exceedingly rapid movement through a very large space, without being decomposed or dissolved, notwithstanding the resistance of the atmosphere. It seems to him probable, that this substance is by the effect of fire reduced to a tough fluid condition; because its form appears sometimes round and sometimes elongated, and as its extending till it bursts, as well as the bursting itself, allows us to suppose a previous capability of extension by elastic fluidity. At any rate, it appears to be certain, that such dense matter at so great a height is not collected from particles to be found in our atmosphere, or can be thrown together into large masses by any power with which we are acquainted;

acquainted; that no power with which we are acquainted is able to give to such bodies so rapid a projectile force in a direction almost parallel to the horizon; that the matter does not rise upwards from the earth, but exists previously in the celestial regions, and must have been conveyed thence to our earth. In the opinion of Dr. Chladni, the following is the only theory of this phenomenon that agrees with all the accounts hitherto given; which is not contrary to nature in any other respect; and which besides seems to be confirmed by various masses found on the spot where they fell.

As earthy, metallic and other particles form the principal component parts of our planets, among which iron is the prevailing part, other planetary bodies may therefore 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 their attractive force, they immediately fall down. By their exceedingly 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 burst. Mr. Chladni thinks also, that the greater part of the shooting-stars as they are called, are nothing else than fire-balls, which differ from the latter only in this, that their peculiarly great velocity carries them past the earth at a greater distance, so that they are not so strongly attracted by it as to fall down, and therefore in their paſſage through the high regions of the atmoſphere, occaſion only a tranſient electric flaſh, or actually take fire for a moment, and are again ſpeedily extinguiſhed, when they get to ſuch a diſtance from the earth that the air becomes too much rarefied for the exiſtence of fire.

The grounds on which Dr. Chladni founds the above theory, reſpecting the origin of the before-mentioned maſs of iron, and its ſimilarity to the productions of fire-balls, are farther explained by the author in the following manner:

1. As fire-balls conſiſt of denſe and heavy ſubſtances, which by their exceedingly quick movement, and the friction thence excited by the atmoſphere, become electric, are reduced to a ſtate of ignition, and melted by the heat, ſo that they extend to a great ſize, and burſt; it thence follows, that in places where fragments, produced by the burſting of a fire-ball, have been found, ſubſtances endowed with all theſe properties muſt alſo have been found. Iron, however, the principal component part of all the maſſes hitherto found, poſſeſſes all theſe properties in a very eminent degree. The weight and toughneſs of the principal component parts of fire-balls, which muſt be very conſiderable, ſince, with the greateſt poſſible diſtenſion, they retain conſiſtence enough to proceed with the utmoſt velocity through ſuch an immenſe ſpace without decompoſition of their maſs, and without their progreſs being obſtructed by the reſiſtance of the air, agree perfectly well with melted iron; their dazzling white light has by many obſervers been compared to that of melted iron; iron alſo exhibits the ſame appearances of flaming, ſmoking, and throwing out ſparks, and all theſe phenomena are moſt beautiful when they take place in vital air. Of the extenſion by elaſtic fluids expanded by the heat, and of the contraction which follows from cold, traces may be diſcovered in the internal ſpongy nature of the iron maſſes which have been found, and in the globular depreſſions of the exterior hard cruſt, the latter of which gives us reaſon to ſuppoſe, that in theſe places there have been air-bubbles, which,

which, on cooling, ſunk down. The mixture of ſulphur found in various maſſes, agrees alſo exceedingly well with the phenomena of fire-balls, and eſpecially with the great inflammability of ſulphur in very thin impure air; for it is well known that ſulphur in an air-pump will take fire in air in which few other bodies could do the ſame. In regard to thoſe maſſes in which no ſulphur was found, this may have ariſen from the ſulphur eſcaping in vapour, ſince ſome time after the appearance of fire-balls a ſtrong ſmell of ſulphur has been perceived. The brittleneſs of the Siberian iron maſs when heated, may ariſe from ſome ſmall remains of ſulphur, which may perhaps be the cauſe of the facility with which fragments of this maſs, as well as that found at Aix-la-Chapelle, could be roaſted.

2. The whole texture of the maſſes betrayed evident ſigns of fuſion. This, however, cannot have been occaſioned by any common natural or artificial fire; and particularly for this reaſon, becauſe iron ſo malleable is not fuſible in ſuch fire, and, when it is fuſed with the addition of inflammable matters, loſes its malleability, and becomes like common raw iron. The vitrified ſubſtance in the Siberian maſs is equally incapable of being fuſed in a common fire. The fire then muſt have been much ſtronger than that produced by the common natural and artificial means, or the fuſion muſt have been effected by the force of exceedingly ſtrong electricity, or perhaps both cauſes may have been combined together.

3. Beſides the ſimilarity of the above-mentioned maſſes, the circumſtances reſpecting their falling are ſo like, that they cannot be conſidered as merely accidental, and therefore give more credibility to the accounts. This being premiſed, the principal queſtion then is, whether the phenomena of this kind obſerved were the effects of thunder, or aroſe from detached fragments of fire-balls? Several circumſtances quoted by Dr. Chladni ſeem to oppoſe the idea of their ariſing from thunder; but agree ſo perfectly with

every circumſtance remarked in regard to fire-balls, that, without aſſerting any thing abſurd, every relation of this kind may, he ſays, be admitted in their full and literal extent. In the atteſtations reſpecting that of Agram, it is mentioned that ſeveral people, in different parts of the kingdom, ſaw and obſerved the burſting of the fire-ball, and heard its exploſions and noiſe in the atmoſphere, and perceived alſo that ſomething fiery fell from the heavens, ſo that it was a circumſtance generally known in the neighbourhood, only that on account of the diſtance it was not exactly known in what place it had fallen. Hence it may be concluded, that it was no effects of lightning, but an actual fire-ball. Lightning, at a time of the year when ſtorms are not uncommon, would not have excited univerſal attention, much leſs would it have been obſerved at a great diſtance as a falling fiery maſs. From the ſimilarity of the maſſes, it is alſo highly improbable that, in all the places where they were found, fuſible parts only ſhould have been diſcovered, and ſhould have been changed in the ſame manner by lightning; eſpecially as in places ſtruck by lightning no maſſes of the like kind have been found, but always vitrified earthy particles, &c.

4. It is totally incomprehenſible how, on the high ſlate mountains, where the Siberian maſs was found, at a conſiderable diſtance from the iron mines; in the chalky ſoil of the extenſive plains of America, where for a hundred miles around there are no iron mines, and not even ſo much as a ſtone to be found; and at Aix-la-chapelle, where, as far as the author knows, there are no iron works, ſo many ferruginous particles could be collected in a ſmall ſpace, as would be neceſſary to form maſſes of 1600, 15000, and 17000, up to 33600 pounds. This circumſtance ſhews that theſe maſſes could as little have been fuſed by lightning, as by the burning of a foreſt, or of foſſile coal. Theſe maſſes were found quite expoſed and uncovered, and not at any depth in the earth, where we can much more readily admit

ſuch

ſuch an accumulation of ferruginous particles to have been melted by the effects of lightning.

Should it be aſked how ſuch maſſes originated, or by what means they were brought into ſuch an inſulated poſition; this queſtion would be the ſame as if it were aſked how the planets originated. Whatever hypotheſes we may form, we muſt either admit that the planets, if we except the many revolutions which they may have undergone, either on or near their ſurface, have always been ſince their firſt formation, and ever will be the ſame; or that nature, acting on created matter, poſſeſſes the power to produce worlds and whole ſyſtems, to deſtroy them, and from their materials to form new ones. For the latter opinion there are, indeed, more grounds than for the former, as alternations of deſtruction and creation are exhibited by all organiſed and unorganiſed bodies on our earth; which gives us reaſon to ſuſpect that nature, to which greatneſs and ſmallneſs, conſidered in general, are merely relative terms, can produce more effects of the ſame kind on a larger ſcale. But many variations have been obſerved on diſtant bodies, which, in ſome meaſure, render the laſt opinion probable. For example, the appearing and total diſappearing of certain ſtars, when they do not depend upon periodical changes. If we now admit that planetary bodies have ſtarted into exiſtence, we cannot ſuppoſe that ſuch an event can have otherwiſe taken place, than by conjecturing that either particles of matter, which were before diſperſed throughout infinite ſpace, in a more ſoft and chaotic condition, have united together in large maſſes, by the power of attraction; or that new planetary bodies have been formed from the fragments of much larger ones that have been broken to pieces, either perhaps by ſome external ſhock, or by an internal exploſion. Let whichever of theſe hypotheſes be the trueſt, it is not improbable, or at leaſt not contrary to nature, if we ſuppoſe that a large quantity of ſuch material particles, either on account of their too great diſtance, or becauſe prevented by a ſtronger movement in another direction, may not have united themſelves to the larger accumulating maſs of a new world; but have remained inſulated, and, impelled by ſome ſhock, have continued their courſe through infinite ſpace, until they approached ſo near to ſome planet as to be within the ſphere of its attraction, and then by falling down to occaſion the phenomena before mentioned.

It is worthy of remark, that iron is the principal component part of all the maſſes of this kindhither to diſcovered; that it is found almoſt every where on the ſurface of the earth, as a component part of many ſubſtances in the vegetable and animal kingdom; and that the effects of magnetiſm give us reaſon to conclude, that there is a large proviſion of it in the interior parts of the earth. We may therefore conjecture that iron, in general, is the principal matter employed in the formation of new planetary bodies; as is ſtill farther probable by this circumſtance, that it is excluſively connected with the magnetic power*; and alſo on account of their polarity, may be neceſſary to theſe bodies. It is alſo probable, if the above theory be juſt, that other ſubſtances contained in ſuch fallen maſſes, ſuch as ſulphur, ſiliceous earth, manganeſe, &c. may be peculiar not to our globe alone, but may belong to the common materials employed in the formation of all planetary worlds.

* The Profeſſor ſeems not to have been acquainted with a fact announced in our firſt volume (p. 426), that ſeveral other ſubſtances beſides iron poſſeſs magnetic properties. EDIT.

II. *Strictures*

II. *Strictures on Mr.* Joseph Collier's *"Observations on Iron and Steel*." By Mr.* David Mushet, *of the Clyde Iron Works. Communicated by the Author.*

IT is much to be wished, that men practically versed in the various manufactures of Britain would turn their attention to the best means of disseminating a knowledge of the principles and operations which have been determined by experience as the best to be followed in the large way, according to local and other circumstances. A candid and liberal communication of individual observation, by promoting the common interest, would tend ultimately to the benefit of each manufacturer, by the increased improvement and perfection of their various articles; for the real welfare of any particular branch depends less upon the superiority of one man's article over that of another, in the same line, than upon the general superiority of a national product over that of any other country—a pre-eminence that depends entirely on the aggregate mass of industry, ingenuity and intellect exerted in the one or the other.

What I recommend is the more necessary, as inaccurate and fallacious principles are often brought forward by men of science, even the best intentioned, from a want of that practical knowledge, which can only be acquired by a long and personal acquaintance with the processes carried on in the large way of manufacture. The mischiefs hence occasioned are incredible: it tends to separate the man of science and the manufacturer; it shackles the latter with increasing prejudice; makes him view the former with a suspicious eye; is the principal reason why science has been so long excluded from our manufactories; and why the accurate results of the laboratory have so long been despised by the practical artist, and been deemed undeserving of experi-

* See Phil. Mag. vol. i. p. 46.

ment on an extended ſcale. The artiſt and the man of ſcience ſhould mutually inform each other: principles will then, and not till then, acquire conſiſtence and correctneſs, and their value will be eſtabliſhed on the ſureſt foundation.

The precept I inculcate I ſhall myſelf follow, to the beſt of my ability, by communicating, through the medium of the Philoſophical Magazine, a ſeries of papers intended as an introduction to a knowledge of the manufacturing of iron in this country, with details of the various proceſſes in uſe: to be followed by a ſeries of experiments relative to the principles of iron and ſteel, which have occupied my leiſure time for ſome years paſt, and which preſent ſome facts not generally known. But as it may tend to clear the path, and enable me afterwards to proceed with leſs interruption, I ſhall in this paper confine myſelf chiefly to the correcting of ſome miſtakes into which Mr. Collier, in his Obſervations on Iron and Steel, has been betrayed by a want of knowledge in the mechanical proceſſes now in uſe, and the minute practical details of the various modifications of iron. Theſe can only be deduced, with certainty, from a keen, perſonal, and long continued inveſtigation of the confirmed modes of practice on a large ſcale. To ſpread information on theſe intereſting ſubjects, and to correct erroneous opinions, formed from the peruſal of writers eminent in the ſcientific walks of life, are the reaſons ſtated by Mr. Collier for preſenting the public with his Obſervations. To paſs over his obſervations in ſilence, would be doing him as well as the public injuſtice, ſince it would be to aid the diſſemination of that error, which he ſo laudably wiſhes to root out; in his endeavours to the performance of which, he ſurely ought to meet with the aſſiſtance and approbation of every one intereſted for the welfare and proſperity of his country.

One rock on which Mr. Collier ſplits, is in cenſuring and quoting the French chemiſts, and others, without recollecting whether the fuel uſed is the ſame in France as in Britain;

Britain; and alfo that chemical writers in general, from neceffity as often as choice, confine their experiments fimply to the laboratory: thefe, however accurate, will always be found materially varied when followed out on a large fcale.

When M. Fourcroy ftates the length of time neceffary for cementing fteel, moft evidently he alludes, not to fteel manufactured in the large way, but to that effected in chemical experiments; elfe, he never could have mentioned an *earthen box*. It is well known that bars of iron $\frac{1}{8}$th of an inch in thicknefs, the length is no way material, will pafs into the ftate of good fteel during 12 hours cementation with a white heat. Had M. Fourcroy meant any other than *bar fteel*, he would not have mentioned iron as the fubftance to be operated upon.

In regard to the time neceffary for cementing fteel on a large fcale, Mr. C. has ftruck the extreme from the chemical gentlemen whom he quotes, and who only give the refults from their laboratories. In the lengthened procefs of 16 days, ftated by Mr. C. as being the requifite time for cementing malleable iron into fteel, he includes the time which the furnace is allowed to cool, before the workmen can penetrate to the contents; and this period may be lengthened or fhortened from local circumftances. The procefs, I prefume, is reckoned complete when the iron is deemed fufficiently faturated with carbon: this is judged of by the trial bars: if thefe are found perfect, then the whole converfion will be in a fimilar ftate: fhould the furnace after this remain a month unemptied, this adds nothing to the real length of time neceffary for cementation: I have feen feveral inftances, where the workmen have emptied the furnace of high converted fteel, for drawing into German fteel, upon the 11th day.

It would be a very difficult matter for Mr. Collier to point out any greater advantage which fteel poffeffes, than that noticed by Mr. Nicholfon; namely, its property of becom-

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ing hard when plunged into cold water. This alone gives it an almost entire mastery over all other metals and substances; it constitutes its solidity, durability, and polish; in short, all its utility, when manufactured into the many various instruments of use, is derived from this unrivalled peculiarity of the metal.

It is impossible to discover what could have led Mr. C. in attempting an explanation of the use of "plunging into water," to say, that it is done to prevent the steel "returning to the state of malleable iron:" the fallacy of this assertion must be obvious to the least intelligent workman. Plunging and heating alternately are the speediest methods for bringing steel back to malleability: the seldomer it is plunged or heated, the longer it will preserve the carbonic principle, and consequently remain good. Has Mr. C. been told that at steel manufactories, where bar steel is drawn into shapes, and bars of various dimensions, that all these are immersed in water, lest they should, if left without this precaution to cool in the open air, become malleable iron? Were this the case, steel could never be subjected to the file—nor could files be struck—because steel could not then exist unless in a hardened state. Let me ask Mr. Collier, whether, at those manufactories of steel which he has frequented, the trial bars taken from the aperture of the furnace were found, when cold, in the state of malleable iron, or otherwise?

The note at the bottom of page 47 is extremely vague. Can there be an expression more indefinite, than that "a partial abstraction of oxygen takes place by plunging hot metal into cold water?" From what is the oxygen abstracted? Is it from the hot metal, or is it the oxygen of the decomposed water? If from the former, pray what state of the metal does Mr. C. allude to? Pure steel contains no oxygen; malleable iron, properly manufactured, is also void of the base of vital air: crude iron alone contains oxygen, an additional quantity of which it absorbs, when *dropt fluid*

into

into cold water. I ſhall therefore ſuppoſe he meant to ſay, that the oxygen of the decompoſed water partially united with the hot metal: this, without further explanation, would be ſtill very unſatisfactory; ſince it does not ſpecify the modification of the metal operated upon. Plunge very hot malleable iron into cold water, and part of the water will be decompoſed; its oxygen will unite with a portion of the iron; this portion, however, will be found to have ſeparated from the bar or maſs, to have loſt its metallic brilliancy and weight, and to have paſſed into the ſtate of a black oxyde. Similar phenomena take place in treating ſteel after the ſame manner. Crude iron is leſs ſuſceptible of changing its metallic fracture by ſuch treatment; though it is rendered very infuſible by the expulſion of its carbon.

Mr. C. ſays that "blaſt furnaces are like two four-ſided pyramids joined baſe to baſe;" Mr. Chaptal ſays the ſame thing, and ſuch I queſtion not may be their ſhape in France. In Britain however they are entirely conical, excepting 6 or 7 feet at the under end, which forms a ſquare funnel: a more juſt idea of the figure would be conveyed by comparing them to two inverted cones, the baſe of the larger reſting upon that of the ſmaller.

In *charging* the furnace Mr. Collier has forgot to mention the principal material, and its proportions, viz. the *ore*, and erroneouſly ſtates, that "equal portions of coal cinder and lime-ſtone" are introduced, without even mentioning whether theſe proportions are by meaſure or weight. The proportions of ore, coal, and lime-ſtone, are very various at different works; the whole depending upon an intimate union and knowledge of the quantity and quality of the various principles and ſubſtances contained in each: the proportion of materials beſides is varied at pleaſure, to produce the quality of crude iron wanted.

At ſome works the quantity of lime uſed is 1 to 3 of cinders by weight, but this is an exceſſive proportion, and is only neceſſary to correct the impurities of ſome iron-

ſtones;

ſtones; in common 1 to 4 or 5 is uſed, and where Cumberland or Lancaſhire ore is ſmelted in contact with wood-charcoal, $\frac{1}{20}$th will abundantly ſuffice.

From Mr. Collier's deſcription, a perſon unverſed in the mode of conducting blaſt furnaces would be apt to conceive that the furnace was firſt charged, and then kindled to effect reduction: this of courſe conveys an idea that frequent filling and kindling are neceſſary. The furnace is firſt ſufficiently heated with coal cinder alone; the charging then commences, and continues hourly for a great length of time—two, three, and four years: inſtances have been of a furnace continuing to ſmelt, without much interruption, for nine years.

The mention of bellows is a proof how deficient Mr. Collier's information has been reſpecting the preſent general ſtate of machinery attached to iron works. Excepting a very few charcoal furnaces, all the blaſt furnaces in Britain are ſupplied with air from caſt-iron cylinders of various dimenſions, conſtructed on various plans. The compreſſion of air from theſe is greater than could poſſibly be obtained by means of bellows, more fit for combuſtion, and capable of ſupporting a column of mercury of ſix inches, which is equal to 6,784 feet of water. By ſuch a heavy compreſſion of air, 1500 to 1800 cubical feet will paſs through the diſcharging pipe into the furnace in one minute, when its diameter does not exceed $2\frac{3}{4}$ or 3 inches at moſt.

Mr. Collier writes with more information on the manufacturing of bar iron. Still however he does not diſtinguiſh, with ſufficient accuracy, between the various proceſſes. The ſecond method he deſcribes is only followed out where bar iron is manufactured with charred wood: the effects produced by the uſe of wood-charcoal are ſo material, that they undoubtedly merited to be mentioned, and particularly diſtinguiſhed from thoſe of charred or raw pit-coal.

One of the principal operations, well known by the name of the Puddling Proceſs, is very ſlightly noticed, and in a

manner

manner not easily to be understood. Dr. Beddoes has lately given a more accurate detail of the various phenomena exhibited during that operation*.

The substitution of large rollers, in place of the stamping-hammer, is well calculated to overcome a large quantity of iron, and for imposing on the bar a beautiful finish, especially if afterwards passed under a small tilt-hammer; but the quality of the iron must still be inferior to that manufactured with heavy hammers. The compression of the bar, on all sides, when passing through the grooved rollers, must tend to enfold, rather than expel, a portion of the slug; whereas the heavy blows of a hammer, which with the helve weighs from 3 to 4000lb. cannot fail more entirely to dissipate all the substances fused in contact with the iron, and to give a degree of fibre and tenacity not to be acquired by a regular and continued pressure.

Numerous and diversified are the opinions respecting the existing causes, which constitute the very great difference, in quality, between the bar iron manufactured in Great Britain, and that made in Sweden, Siberia, Spain, &c. I have reason to imagine that this difference arises neither from the rust, acquired by the iron being laid in damp places, nor yet from the superior richness of the foreign ores. In Siberia and Sweden the iron is pushed off to market at stated periods, and becomes comparatively old kept, merely from the great distance it has to travel before it can reach a market. Mr. Collier seems inclined to impute this superiority to a greater quantity of iron contained in the ore; and to its being more destitute of mixtures: hence he states the average of the Swedish ores to be 70 pounds pure iron—crude iron he must mean—in the hundred, and English ores 30 to 40. I have seen many of the northern ores, some of them very rich in iron, equal to 65 and 70 per cent.; but many more of them not yielding beyond 40, and some of them as low as 20. Norwegian ore from the mine of Horke-

* Dr. Beddoes's paper shall be given in a future Number.

Dhal-

Dhal-Grube is powerfully obedient to the magnet, yet yields only 21 pounds in 100 of the ore.

Admitting, however, that rich ores make a ſuperior quality of iron, why then are not ſuch qualities produced from the ores found in Cumberland or Lancaſhire, ſince the hæmatites and kidney of the former are as rich in iron as the fineſt Swediſh ores? Mr. Collier ſhould have diſtinguiſhed, too, between the argillaceous ores, commonly called ironſtones, found in ſtrata more or leſs inclined to the horizon, ſo univerſally diffuſed and ſmelted; and thoſe of Cumberland and Lancaſhire, formed into knobs, or in vertical ſtrata, which are only partially uſed. The former are the only ores uſed in quantity to produce grey crude iron, and contain of iron from 18 to 42 pounds in 100: the latter are uſed in great part for fabricating the inferior qualities of crude iron, ſuch as ſhip ballaſt, forge pigs, &c. &c. The Cumberland ore exhibits a variety of qualities and proportions of iron:

The fine Hæmatites ore yields of iron 68 to 70lbs. per 100.
Kidney - - - 60 to 63.
Common - - 53 to 60.

Lancaſhire ore will be found to yield, upon an average, 57 pounds iron in 100.

I ſhould be apt to aſcribe the general ſuperiority of foreign iron over Britiſh, ſolely to the uſe of wood charcoal in all the ſtages of the operation; and the ſuperiority of the individual fabrics over each other, to the native excellence of the iron contained in the ore. It is well known that the Swediſh marks of bar iron, (L) and o——o, are manufactured from a peculiar ore, found in the mine of Danamora; and that no other Swediſh ores yield ſuch a quality of iron, even when manufactured in the ſame manner and with the ſame fuel. It is the ſame in Siberia, where the old and new ſable fabrics have gained, by the native ſuperiority of the iron contained in the ore, an excellence little inferior to the principal Swediſh marks. From numerous experiments I am convinced, that the iron contained in our iron-ſtones, or argillaceous ores of iron, is in many of a superior quality, and capable of producing bar iron equal to foreign, if treated in the same manner: this, however, is out of the question in Britain, and can never be a subject of general contemplation; though by those who have opportunity the experiment might be made.

Most of the bog ores of Sweden and Russia contain less iron than some of our iron-stones, and give out a much less portion of volatile matter in torrefying; so that such iron-stones, by severe torrefaction, might be reduced to contain as much iron in 60 or 63 parts as in 100 when in a raw state. Several of the fine iron-stones found in Lanarkshire are composed as follows:

Iron - - -	40	
Carbonic acid, sulphur, &c.	38,	which flies off in torrefying.
Clay, lime and silex -	22	
	100 parts:	

so that in 100 pounds of iron-stone thus roasted, there would be contained of iron $64\frac{1}{2}$ pounds. Ores in such a state, and containing such a quantity of iron, would most likely smelt to great advantage in contact with wood-charcoal. In distinguishing the qualities of crude iron, Mr. Collier has copied the French writers, without adverting to the difference between the fracture of crude iron manufactured with pit-coal, and that produced with the charcoal of wood; this last is that described by the French metallurgists. Crude iron manufactured with pit-coal is either white, mottled, or grey: of the latter colour there are many shades; the darker the grey, and the larger the grain, the softer and more fusible is the quality of the iron. These properties are expressly derived from, and dependent upon, the proportion of fuel used in reduction; the greater the quantity of fuel, the larger and more brilliant will be the grains of the fracture of the metal. The carbon contained in crude iron—for *all* crude iron contains carbon—will be in exact proportion to the relative quantity of fuel made uſe of. Mr. Collier aſſerts, that the ſecond ſtate of the metal only contains it; and although he admits of a third ſtate of crude iron, manufactured with a ſtill larger proportion of fuel, he takes no notice of the invariable conſequence, viz. an extra combination of carbon. Query, Can it be ſaid with propriety, that crude iron holds carbon in ſolution, when it can be ſeparated from it by ſimple mechanical diviſion?

It is to be wiſhed that Mr. Collier had furniſhed an analyſis of thoſe ores, found in the neighbourhood of Sheffield, which he ſays contain phoſphat of iron, and from which they derive their cold ſhort quality: if the property of forming cold ſhort irons is a proof of the exiſtence of phoſphat of iron in the ore, then I know of no ores that do not contain it; as I have never ſeen crude iron that could not be converted into cold ſhort iron, at pleaſure, by the management of the proceſs of malleability. I would not wiſh to deny the exiſtence of ſiderite—I cannot—for it is already an eſtabliſhed truth; but I cannot ſubſcribe to its being the exiſting, alterative principle in the ore, which contaminates the iron, and renders it brittle when cold; unleſs I am convinced, by its having been *precipitated from the ore*, before it came in contact with combuſtion. The great Lavoiſier himſelf appears to have been uncertain, whether the ſubſtance called ſiderite was a binary combination or not: hence he claſſes it among the phoſphurets, and expreſſes his doubts of the oxygenation of the phoſphorus. Mr. Chaptal, however, in experiments, which I ſuppoſe have been made poſterior to Mr. Lavoiſier's publication, has proved it to be a real ſolution of iron in the phoſphoric acid. What I contend for is this, that the ſiderite of iron may be an unknown combination, formed during the proceſs of making the iron malleable. At ſome future period I ſhall enter more at large into what *I conceive* to be the exiſting cauſes of cold and ſhort hot irons, and adduce experiments for their ſupport.

The

The account of caſe-hardening is very unſatisfactory; and although the analogy betwixt it and the cementing of ſteel be great, yet it would puzzle any one to make bar ſteel from iron by following the proceſs deſcribed; and ſtill more to produce bar ſteel from caſt-iron, by cementing it in the manner mentioned by Mr. Collier.

I hope Mr. Collier will not feel offended by the freedom with which I have examined his obſervations. Great are the improvements wiſhed for, and expected, in the manufacturing of iron; and it is only by numerous experiments, and liberal diſcuſſions on the ſubject, that theſe great deſiderata are to be obtained.

III. *Obſervations on Platina, and its Utility in the Arts, together with ſome Remarks on the Advantages which reflecting have over achromatic Teleſcopes. By* ALEXIS ROCHON, *Director of the Marine Obſervatory at Breſt. From the* Journal de Phyſique, 1798.

PLATINA is a metal exceedingly refractory, unchangeable, very compact, and capable of receiving a fine poliſh. This ſingular metal has never yet been found but in the gold mines of Choco. The Spaniards gave it the name of *juan blanca,* that is to ſay white gold, and *platino del Pinto,* which ſignifies little ſilver of Pinto. It is brought to us from Choco, under the form of triangular grains the angles of which are rounded. Theſe grains are irregular, ductile, and ſuſceptible of being attracted by the loadſtone. It is never pure, and always contains a black ſhining ſand, over which an artificial magnet has great power. This ſand is interſperſed with gold grains and fragments of ſmall coloured cryſtals. The ſpecific gravity of platina is to that of gold as 22 to $19\frac{1}{2}$ *. Like that precious metal, it reſiſts the action of ſimple acids,

* We have ſeen ſome platina where the difference was ſtill greater. EDIT.

and its colour inclines a little more to that of ſilver than to that of iron.

During the time I reſided at Corunna in 1770, the intendant general of Galicia, Pietra Buena, who came originally from Saint-Malo, made me a preſent of a ſmall ingot of platina, which was combined with a great deal of zinc and red copper. This ingot, which weighed about eight ounces, was in Spain conſidered as a very rare and curious ſpecimen. Buffon afterwards gave me two diſhes of a mixture altogether ſimilar, which had been manufactured at Lima. If platina be thus manufactured in Peru, it needs excite no wonder that travellers have not thought it worth while to bring to Europe works made by a mixture which deprives this metal of the advantages it has in its natural ſtate over all other metallic ſubſtances.

It is believed that platina was not known in Europe before the appearance of Don Antonio de Ulloa's Voyage, printed in 1748: but it appears that it was known to Julius Scaliger; for he mentions a ſimilar metal in one of his works printed at Franckfort in 1601. "Know alſo," ſays he, "that in Honduras, a diſtrict between Mexico and Darien, there are mines which contain a metal never yet brought to a ſtate of fuſion by fire, or by any of the arts employed by the Spaniards*." Scaliger then knew that there had been diſcovered, between Mexico and the iſthmus of Darien, a metal ſo refractory that the Spaniards had never been able to melt it. He made uſe of this as an argument againſt Jerome Cardan, whom he attacked on account of the definition he had given of metals. This paſſage, which is curious and deciſive, was pointed out to me by Izquierdo, director of his Spaniſh majeſty's cabinet, who is not only an able naturaliſt, but well acquainted with the arts, to which he is a friend and a patron.

* Præterea ſcito, in Funduribus, qui tractus eſt inter Mexicam et Darien, fodinas eſſe aurichalci, quod nullo igne, nullis Hiſpanicis artibus, hactenus liqueſcere potuit.

In

In the Memoirs of the Swedish Academy for 1751, there is an account of several experiments on platina, by Theodore Scheffer; but the most interesting of these is one which proves that this metal may be reduced to complete fusion when united with a very small quantity of arsenic. William Lewis, who made a valuable series of experiments on the same subject, would not repeat the experiment of Scheffer, because it appeared to him absurd to reduce a refractory metal to a state of fusion, by means of a substance which a moderate heat sublimes and volatilises. The illustrious Turgot, whose talents and virtues, superior to the age in which he lived, will be handed down to the remotest posterity, sent to Peru during his administration the celebrated botanist Dombei. This voyage, the object of which comprehended great and enlarged views, was of equal importance to the arts and the sciences; and Dombei, according to the instructions given him, was to spare no pains to procure for men of science such a quantity of platina as might be useful to them in their researches. Turgot, whose knowledge in natural philosophy was profound and extensive, had foreseen that a metal indestructible by its nature would be of inestimable value in the construction of telescopes, and of those instruments which navigators employ at sea to determine the longitude by the distance of the sun and stars from the moon. All opaque bodies are not equally proper for reflecting the light in a regular manner, and indeed those which possess this useful property are very few in number. Tempered steel, pyrites known under the name of the Inca's stone, and glass covered at the back with tin, cannot be employed in forming specula for telescopes, though they reflect the light regularly. The violent friction necessary to polish tempered steel; the nature and imperfections of pyrites; the difficulty of avoiding double refraction in quicksilvered glass, are the causes which prevent these substances from being used. Opticians, therefore, have hitherto been obliged to employ for this purpose a metal composed of arsenic, red copper, and tin, the proportions of which they vary to a certain degree. This metal, which is attacked by all acids, soon tarnishes when exposed to the air. To preserve the polish necessary to these specula, requires a care and attention which few people can bestow; and the great superiority of reflecting over refracting telescopes has not induced astronomers to give them the preference, as it is exceedingly difficult to guard them from rust, especially when they are frequently used in the night-time.

Herschel, however, did not entertain the same apprehensions; and by means of a large reflecting telescope, that celebrated astronomer was enabled to discover the planet which bears his name. With this instrument also he made other interesting discoveries. Herschel, we are assured, employs magnifying powers which astonish all astronomers; but when they shall employ the like means to examine the stars, their astonishment may perhaps be lessened. We are indeed taught by experience, that the image of an object is never very distinct, unless it occupy on the retina the space of half a minute; and we may assure ourselves of this, by looking at Jupiter through a good reflecting or refracting telescope, which magnifies the diameters of objects more than a hundred times. The disk of Jupiter, which will be well defined on being magnified to this degree, ceases to be so when the magnifying power of the telescope is reduced to four or five times. This fact is confirmed by a series of experiments made at Calais by my colleague Fourcroy. It is then evident, that extraordinary magnifying powers are more favourable than hurtful in observations made on objects the diameters of which are infinitely small.

If the discoveries of Herschel were not sufficient to shew the great superiority of reflecting over refracting telescopes, it would not be difficult to call in theory to the aid of experience; and it might be proved, that the aberration of refrangibility, which cannot take place in reflectors, is never entirely removed in the best achromatic telescopes. The

laws

laws of reflection are invariable, but thofe of refraction and difperfion are fufceptible of variations. The fubftance of glafs is never perfectly homogeneous. Reflection, optical illufions, and the lofs of light, are unavoidable in achromatic telefcopes, on account of the multiplicity of glaffes employed in their conftruction; but the fpecula of telefcopes, whatever be the nature of the fubftance of which they are compofed, are not liable to the fame faults.

In fpeaking of achromatic telefcopes, it is impoffible not to recollect, that the immortal Euler was led to the difcovery of them by a reafoning purely metaphyfical. By reflecting on the ftructure of the eye, this great geometrician concluded, that the Supreme Being had compofed that organ of different humours, only for the purpofe of deftroying the aberration of refrangibility. If the metaphyfical ideas of Euler on the ftructure of the eye do not accord with the numerous experiments which my colleague Tenon enabled me to make on the humours which compofe that organ; the inference he drew from them was not lefs happy, fince it fuggefted to him the plan of making achromatic telefcopes by employing two different refracting fubftances. The Englifh exclaimed at firft againft this idea of Euler; but John Dollond, who at firft oppofed that eminent mathematician's theory, found in the great difperfion of flint glafs the means of realifing it. The nature of the refearches of that ingenious optician, and the advantages he derived from them, have well entitled him to fhare with Euler in the glory of this noble and important difcovery.

The glafs of lead is not the only kind that caufes a ftrong difperfion; for feveral other kinds of metallic glafs poffefs the fame ufeful property. Some philofophers have imagined that there is a conftant relation between the fpecific gravity of glafs and its difperfion; but it is to be remarked, that the difperfion which takes place in ether and fpirit of wine is ftronger than that produced in water, which is a much heavier liquor. Though opticians hitherto have employed only flint and common glaſs in the conſtruction of achromatic teleſcopes, it is certain that the ſame object might be attained with other tranſparent ſubſtances, both ſolid and fluid*; but, as the queſtion propoſed by the Academy has in view only the improvement of flint glaſs, I ſhall here offer ſome obſervations, which may be of uſe to thoſe who wiſh to become candidates for the prize †.

Flint glaſs is brought to us from England in very thin plates. It is blown into globes, which are cut up and ſtretched out when they have attained to the proper ſize and thickneſs. Blown glaſs will conſiſt of parallel layers, if the workman is not able to take up at once the neceſſary quantity of matter; and theſe layers, the junction of which is

* This idea has been realiſed by Dr. Blair of Edinburgh. Flint glaſs reflects the green light conſiderably leſs than crown glaſs, in proportion to the whole refraction of red and violet light; ſo that when the divergency of the red and violet light cauſed by the refraction of the two mediums is equal, the divergency of the red and green light is always greater in the crown than in the flint glaſs, and the divergency of the violet and green light is always leſs in the crown than in the flint glaſs. After a variety of experiments, Dr. Blair diſcovered that the muriatic and nitric acids, which are diſperſive fluids of conſiderable ſtrength, inſtead of refracting the green light leſs than crown glaſs, in proportion to the whole refraction of the red and violet light, refracted the green light more than crown glaſs in proportion to the whole refraction of red and violet light: he therefore mixed theſe two kinds of diſperſive mediums, and thus obtained a medium which diſperſes the rays much more than crown glaſs, and yet cauſes them all to diverge accurately in the ſame proportion in which they are made to diverge by the refraction of crown glaſs; which entirely removes the aberration from the unequal refrangibility of light. For this diſcovery Dr. Blair has obtained a patent. EDIT.

† This memoir, the author tells us in a note, was read on his public admiſſion into the Academy of Sciences at Paris, in the year 1766. It was printed in the ſecond part of his *Voyage to Madagaſcar*; but that part, owing to an accident which could neither be foreſeen nor prevented, was never given to the public. It contained nautical details, obſervations on the charts of India, and a diſſertation on the inſtruments which may be uſeful or neceſſary for the navigator.

rarely

rarely perfect, will form laminæ, that may be easily observed on looking at the edge of the glass. Undulating threads are almost always found also at the joinings of the layers. Opticians distinguish two kinds of these threads, the first of which they call ropes, because they are full and of different densities: they are always prejudicial to the goodness of optical instruments. The second are less troublesome, but more common. They are capillary tubes, which produce two pencils of light in a direction perpendicular to their axes.

I have already given, in a work entitled *Memoires sur la Mecanique et la Physique*, a method of obtaining large object glasses from thin plates of flint glass, and of freeing them from threads when their disposition in the substance of the glass does not render it impossible. This process, which I have still brought to greater perfection, consists in exposing the glass to a fire sufficiently strong to melt it. When the glass is soft, it must be rolled up with a pair of iron pincers, and formed into a cylinder three inches in thickness. Those folds which would infallibly result from too rapid bending ought to be carefully avoided. The edges of the glass must be kept in by a ring of clay. The cylinder must then be left in the furnace a sufficient length of time to be annealed; and when this operation is terminated, it must be polished, in order to discover its faults. It is then to be sawn through at the places most filled with threads, and to be put into the furnace a second time to give it the proper form.

The detail into which I have entered on the nature of glass proper for optical purposes, ought not to make us lose sight of the great advantages which reflectors have over achromatic telescopes. Since the discoveries of Herschel, the utility of the former cannot be doubted; but it is of great importance to employ, in the construction of these instruments, a metal the polish of which may be bright and unchangeable. Twenty pounds of this precious metal, which

were

were presented to me by the minister of the marine, on hearing an account given of the utility of my researches, have greatly contributed to their success. Opticians who study the nature of those substances used in the composition of specula, know that no metal or semi-metal can supply the place of tin. It is tin which renders red copper brittle, *elastic*, and susceptible of a fine polish. This metal produces also the same effects on all other metallic substances. Platina is subjected to the same law. But I shall not here relate the numerous trials I was obliged to make before I could obtain a satisfactory result. I shall confine myself to an account of that process, which was attended with the greatest success.

The platina in grains must be purified in a strong fire by means of nitre and the salt of glass*. To the platina, when purified, add the eighth part of that metal employed in the composition of common specula; for tin without red copper would not produce a good effect. This mixture is then to be exposed to the most violent heat, which must be still excited by the oxygen gas that disengages itself from nitre when thrown into the fire. One melting would be insufficient: five or six are requisite to bring the mixture to perfection. It is necessary that the metal should be in a state of complete fusion at the moment when it is poured into the mould. By this process I have been enabled to construct a telescope with platina, which magnifies the diameters of objects five hundred times, with a degree of clearness and distinctness requisite for the nicest observations. The large speculum of platina weighs fourteen pounds: it is eight inches in diameter, and its focus is six feet. This speculum, which is unchangeable, was cast and polished by Carrochez.

The utility of platina in the arts is not confined to the construction of telescopes and nautical instruments. Robin, a celebrated watch-maker, wished to employ it in making

* The flux used in the English glass-houses, and called by the workmen *sandifer*. EDIT.

for

for me escapements and compensation balances. He is of opinion, that this metal is extremely proper for the holes in which the pivots move, because it preserves oil without the least alteration. Platina has no occasion, like gold, to be combined with any other metal, to render it fit for being used in the arts. This new metal afforded me excentric watch dial-plates superior to those brought from England. Cotteau, an ingenious enameller, who himself made various experiments with platina, told me, that for his art he preferred it to all other metals. Platina is also a metal of inestimable value for constructing different instruments of chemistry. I have formed it into crucibles*.

The experiments which I lately made at Saint Gobin with Deslandes, director of the plate-glass manufactory, do not permit me to doubt of the utility of crucibles made of platina in bringing flint-glass to perfection; and Deslandes, who has been able to give to the glass of Saint Gobin a superiority which foreigners cannot dispute, is of my opinion in regard to crucibles of this metal. Crucibles indeed of earth, whatever be its nature, become in part vitrified. The glass which thence results is imperfect; and it may be seen by the naked eye, that the vitreous substance contained in the crucible does not form one homogeneous mass. It may be readily perceived, that crucibles of platina cannot be attended with the same inconvenience.

[To be concluded in the next Number.]

* Since this memoir was read, I caused to be cast a crucible of platina capable of containing thirty pounds of flint-glass; and to give it more strength, it is covered on the outside with a case of cast iron an inch in thickness. In the latter operation I was assisted by my colleague Perrier.

IV. *Cit.*

IV. *Cit. CHAPTAL's Process for whitening Prints, printed Books, and other Articles of Paper.*

SIMPLE immersion in oxygenated muriatic acid, letting the article remain in it a longer or shorter space of time, according to the strength of the liquid, will be sufficient to whiten an engraving. If it be required to whiten the paper of a bound book, as it is necessary that all the leaves should be moistened by the acid, care must be taken to open the book well, and to make the boards rest on the edge of the vessel, in such a manner that the paper alone be dipped in the liquid: the leaves must be separated from each other, in order that they be equally moistened on both sides.

The liquor assumes a yellow tint, and the paper becomes white in the same proportion. At the end of two or three hours the book may be taken from the acid liquor and plunged into pure water, with the same care and precaution as recommended in regard to the acid liquor, that the water may exactly touch the two surfaces of each leaf. The water must be renewed every hour to extract the acid remaining in the paper, and to dissipate the disagreeable smell.

By following this process, there is some danger that the pages will not be all equally whitened, either because the leaves have not been sufficiently separated, or because the liquid has had more action on the front margins than on those near the binding. On this account the practice followed by book-binders, when they wish to whiten printed paper, is to be preferred. They destroy the binding entirely, that they may give to each leaf an equal and perfect immersion; and this is the second process recommended by M. Chaptal.

"They begin," says he, "by unsewing the book and separating it into leaves, which they place in cases formed in a leaden tub, with very thin slips of wood or glass, so that the leaves when laid flat are separated from each other by intervals

tervals ſcarcely ſenſible. The acid is then poured in, making it fall on the ſides of the tub, in order that the leaves may not be deranged by its motion. When the workman judges, by the whiteneſs of the paper, that it has been ſufficiently acted upon by the acid, it is drawn off by a cock at the bottom of the tub, and its place is ſupplied by clear, freſh water, which weakens and carries off the remains of the acid, as well as its ſtrong ſmell. The leaves are then to be dried, and, after being preſſed, may be again bound up.

"The leaves may be placed alſo vertically in the tub; and this poſition ſeems to poſſeſs ſome advantage, as they will then be leſs liable to be torn. With this view I conſtructed a wooden frame, which I adjuſted to the proper height, according to the ſize of the leaves which I wiſhed to whiten. This frame ſupported very thin ſlips of wood, leaving only the ſpace of half a line between them. I placed two leaves in each of theſe intervals, and kept them fixed in their place by two ſmall wooden wedges, which I puſhed in between the ſlips. When the paper was whitened I lifted up the frame with the leaves, and plunged them into cold water to remove the remains of the acid, as well as the ſmell. This proceſs I prefer to the other.

"By this operation books are not only cleaned, but the paper acquires a degree of whiteneſs ſuperior to what it poſſeſſed when firſt made. The uſe of this acid is attended alſo with the valuable advantage of deſtroying ink ſpots. This liquor has no action upon ſpots of oil, or animal greaſe; but it has been long known that a weak ſolution of potaſh will effectually remove ſtains of that kind.

"When I had to repair prints ſo torn that they exhibited only ſcraps paſted upon other paper, I was afraid of loſing theſe fragments in the liquid, becauſe the paſte became diſſolved. In ſuch caſes I encloſed the prints in a cylindric glaſs veſſel, which I inverted on the water in which I had put the mixture proper for extricating the oxygenated muri-

atic

atic acid gas. This vapour, by filling the whole infide of the jar, acted upon the print; extracted the greafe as well as ink fpots; and the fragments remained pafted to the paper."

Method of preparing the Oxygenated Muriatic Acid.

To oxygenate the muriatic acid, nothing is neceffary but to dilute it, and mix it in a very ftrong glafs veffel with manganefe, in fuch a manner that the mixture may not occupy the whole content of the glafs. Air bubbles are formed on the furface of the liquor; the empty fpace becomes filled with a greenifh vapour; and, at the end of fome hours, the acid may be farther diluted with water and then ufed. It has an acid tafte, becaufe the whole is not faturated with oxygen; but it poffeffes all the virtues of the oxygenated muriatic acid. This procefs may be followed when there is not time to fet up an apparatus for diftilling, in order to procure the oxygenated acid.

V. *Procefs for removing Spots of Greafe from Books and Prints. By M.* Deschamps, *Jun. Member of the Philofophical Society at Lyons. From* Bibliotheque Econoniique, *Vol. I.*

A TASTE for elegant editions, books in good prefervation, and proof impreffions of prints, can be confidered as a mania only by thofe who are unacquainted with literature. In a well printed, carefully preferved, and neat book, the fenfe feems to pafs through the organs of fight, in order to meet the underftanding; while, in a bad, confufed edition, or a dirty, ftained and difgufting copy, the confufion of the characters deranges, as it were, the connection of the author's thoughts; their obfcurity divefts ideas of their brilliancy;

brilliancy; and the dirtineſs of the paper, which offends the eye, makes the ſubject loſe much of its charms and attraction. It is a great misfortune, therefore, to thoſe who purchaſe books for the ſake of reading them, when the objects of their enjoyment are injured by the too cloſe application of a candle or lamp. For this reaſon M. Deſchamps, at the requeſt of a man of letters, to whom an accident of this kind had happened, deviſed the following proceſs, which was attended with complete ſucceſs:

After having gently warmed the paper ſtained with greaſe, wax, oil, or any fat body whatever, take out as much as poſſible of it, by means of blotting-paper. Then dip a ſmall bruſh in the eſſential oil of well rectified ſpirit of turpentine, heated almoſt to ebullition (for when cold it acts only very weakly), and draw it gently over both ſides of the paper, which muſt be carefully kept warm. This operation muſt be repeated as many times as the quantity of the fat body imbibed by the paper, or the thickneſs of the paper, may render neceſſary. When the greaſy ſubſtance is entirely removed, recourſe may be had to the following method to reſtore the paper to its former whiteneſs, which is not completely reſtored by the firſt proceſs. Dip another bruſh in highly rectified ſpirit of wine, and draw it, in like manner, over the place which was ſtained, and particularly round the edges, to remove the border, that would ſtill preſent a ſtain. By employing theſe means, with proper caution, the ſpot will totally diſappear; the paper will reſume its original whiteneſs; and if the proceſs has been employed on a part written on with common ink, or printed with printers ink, it will experience no alteration.

VI. *Obſer-*

VI. *Observations on the Mole, and the Means of extirpating that destructive Animal. From* Economische Hefte, *Vol. VII. Part 5. and Vol. IX. Part 4.*

THE great damage which moles occasion in cultivated land, and particularly in gardens, is well known; and the best means of remedying this evil is by destroying all those that make their appearance, as far as possible. The secrets which quacks sell for extirpating these destructive animals are of very little avail; and even poison produces no effect, as the mole does not drink, and lives only on roots and worms. In regard to gins and traps, the moles must be enticed to them by some kind of bait, which does not always produce the intended effect. Buffon advises a trench to be dug around the hills under which they conceal themselves, and thus to cut them off from all communication with the neighbouring ground. This method requires three or four people to dig trenches; and though it may prove effectual, it is attended with too much trouble. The other methods proposed by different naturalists are neither easier nor more certain *.

It is well known that this animal lives under the earth; and if at any time it comes forth from its holes, it is only when compelled to do so, in consequence of large quantities of water accumulated after the heavy rains which fall in summer, or when the earth is so much parched and dried by the continued drought, that it can no longer continue its labour; but it again creeps back into the earth when it finds a spot convenient for its purpose.

This animal, as already remarked, feeds upon roots and worms, and for this reason is generally found in rich fertile soil; but never in that which is marshy or stony. In the

* Valmont de Bomare recommends suffocating them in their holes by means of sulphur. EDIT.

winter

winter time it retires to elevated places, becauſe it is there beſt ſecured from inundations. In ſummer, however, it deſcends to the low hillocks and flat land, and above all makes choice of meadows for the place of its reſidence; becauſe it finds the earth there freſher and ſofter for it to dig through. If the weather continues long dry, it repairs to the borders of ditches, the banks of rivers and ſtreams, and to places contiguous to hedges.

The mole breeds generally at the beginning of winter, and the months when they are found big with young are January and February. In the month of April a great many of their young may be ſeen. Among 122 caught in the month of May by my method, there were only four big with young. This animal cannot live without digging; it is obliged to find its nouriſhment in the bowels of the earth; and on that account is under the neceſſity of making thoſe long ſubterranean paſſages which are found between one mole-hill and another. In general it begins to dig five or ſix inches under the ſurface; it ſcrapes the earth before it on one ſide till the quantity becomes too great for it to labour with eaſe; it then works towards the ſurface; and by puſhing with its head, and the aſſiſtance of its nervous paws, gradually raiſes up the earth which incommodes it, and which produces thoſe ſmall hills ſo common in fields. After getting rid of the earth in this manner, it proceeds forwards, and continues its labour as before. The farther it goes the more hills are produced. At each period of its labour it throws up four or five.

In places overgrown with graſs and ſhrubs, the mole is often contented with only forcing a paſſage through between the roots; and when the earth in gardens has been newly watered, it keeps itſelf at the depth of ſcarcely half an inch under the ſurface. This animal ſhews an equal averſion to great cold and violent heat; and in order to avoid both, it forces its way, when either prevail, to the greateſt depth in the earth.

It continues its labour at all times, becauſe it is neceſſary for it to procure nouriſhment. It is abſolutely falſe that it ſleeps throughout the winter, as ſome naturaliſts have aſſerted; for it throws up the earth in the coldeſt ſeaſon, as well as during the ſummer. It is moſt buſily employed towards the end of winter, and at that period forms the greateſt number of hills. To this it is impelled by more than one reaſon. In the firſt place, it muſt provide nouriſhment for its young; ſecondly, it finds it eaſieſt at that time to dig its way through the earth; and laſtly, as the air begins to be milder, the animal then recovers that ſtrength which it had loſt during the intenſe cold. At this ſeaſon, therefore, it is moſt proper to purſue means for extirpating this animal, as it can be deſtroyed with greater eaſe while employed at its labour.

The male is much ſtronger than the female, and the hills thrown up by the former are much larger as well as more numerous. The periods when the mole is moſt buſily employed in digging are in the morning, at ſun-riſe, at noon, and at ſun-ſet. In dry weather moles are obſerved to throw up the earth for the moſt part only at ſun-riſe, and in winter when the earth has been ſomewhat heated by the ſun's rays.

A perſon may eaſily diſcover how many moles are contained in a certain ſpace of ground, by counting the freſh raiſed mole-hills which have no communication with each other. I muſt remark alſo, that this animal has very bad ſight, being almoſt totally blind; but its hearing, on the other hand, is ſo much the more acute.

I ſhall now proceed to the method of deſtroying them. Immediately at day-break it will be neceſſary to make a tour round the garden or meadow, from which it is wiſhed to extirpate the moles; for at that time they will be all found at work, as may be ſeen by the hills newly thrown up. If the perſon is then cloſe to the hill, he muſt proceed as the gardeners do, and turn up with a ſtroke of the ſpade the hill together with the digger. The paſſage is then cut through

before

before the animal is aware of the attack, and therefore it has not power to eſcape. If the mole-hill be freſh, even though the animal may not be throwing up earth, the perſon ought not to loſe his time in waiting, but ſhould immediately proceed to the operation above mentioned.

If you find a freſh hill ſtanding by itſelf, which ſeems to ſhew by its ſituation that it has no communication with any other, which is always the caſe when the mole has worked from the ſurface downwards in endeavouring to procure a more convenient habitation, after the hill has been turned up with the ſpade, a bucket of water ſhould be poured over the mouth of the paſſage. By theſe means the animal, which is at no great diſtance, will be obliged to come forth, and may be eaſily caught with the hand.

You may diſcover alſo whether a hill has any communication with another, if you apply your ear to it, and then cough or make a loud noiſe. If it has no communication with the neighbouring hills, you will hear the terrified animal make a noiſe by its motion. It will then be impoſſible for it to eſcape; and you may either pour water into the hole, or turn up the hill with a ſpade until the mole is found; for in general it never goes deeper into the earth than from fifteen to eighteen inches.

When any of the beds in a garden have been newly watered, the mole, attracted by the coolneſs and moiſture, readily repairs thither, and takes up its reſidence in them, making a paſſage at the depth of ſcarcely an inch below the ſurface. In that caſe it may eaſily be caught. When you ſee it at work, you need only tread behind the animal with your feet on the paſſage to prevent its retreat, and then turn up the hill with a ſpade; by which means you will be ſure to catch it.

When you dig after it with a ſpade, the animal forces its way downwards into the earth in a perpendicular direction, in order that it may better eſcape the threatened danger. In that caſe it will not be neceſſary to dig long, but to pour water over the place, which will ſoon make the animal return upwards.

People in general are not aware of the great miſchief occaſioned in fields and gardens by theſe animals. We are however informed by Buffon, that in the year 1740 he planted fifteen or ſixteen acres of land with acorns, and that the greater part of them were in a little time carried away by the moles to their ſubterranean retreats. In many of theſe there were found half a buſhel, and in others a buſhel. Buffon, after this circumſtance, cauſed a great number of iron traps to be conſtructed, by which in leſs than three weeks he caught 1300. To this inſtance of the devaſtation occaſioned by theſe animals, we may add the following: In the year 1742 they were ſo numerous in ſome parts of Holland, that one farmer alone caught between five and ſix thouſand of them. The deſtruction occaſioned by theſe animals is however no new phenomenon. We are informed by hiſtory, that the inhabitants of the iſland of Tenedos, the Trojans, and the Æolians, were infeſted by them in the earlieſt ages. For this reaſon a temple was erected to Apollo Smynthius, the deſtroyer of moles.

VII. *A curious Fact in the Natural Hiſtory of the common Mole*, Talpa Europæa *Linn.* *By* ARTHUR BRUCE, *Eſq. Secretary to the Natural Hiſtory Society of Edinburgh. From* Tranſactions of the Linnean Society, *Vol. III.* 1797.

THAT the mole does, in common with other quadrupeds and man, poſſeſs that ſpirit of curioſity which prompts to emigration and even to tranſmarine expeditions, I found out laſt ſummer from the beſt authenticated facts.

In viſiting the loch of Clunie, which I often did, I obſerved in it a ſmall iſland at the diſtance of 180 yards from the neareſt land, meaſured to be ſo upon the ice. Upon the iſland,

iſland, lord Airly, the proprietor, has a caſtle and ſmall ſhrubbery. I obſerved frequently the appearance of freſh mole-caſts, or hills. I for ſome time took it to be the water mouſe, and one day aſked the gardener if it was ſo? No, he ſaid, it was the mole; and that he had caught one or two lately. But that five or ſix years ago he had caught two in traps; and for two years after this he had obſerved none. But about four years ago, coming aſhore in a ſummer's evening in the duſk, the 4th or 5th of June, 10 o'clock P. M. he and another reſpectable perſon, lord Airly's butler, ſaw at a ſmall diſtance upon the ſmooth water ſome animal paddling to, and not far diſtant from, the iſland. They ſoon, too ſoon! cloſed with this feeble paſſenger, and found it to be our common mole, led by a moſt aſtoniſhing inſtinct from the neareſt point of land (the caſtle-hill) to take poſſeſſion of this deſert iſland. It was at this time, for the ſpace of about two years, quite free from any ſubterraneous inhabitant; but the mole has for more than a year paſt made its appearance again, and its operations I was witneſs to.

In the hiſtory of this animal I do not, at preſent, recollect any fact ſo ſtriking; eſpecially when we conſider the great depth of the water, both in ſummer and winter—from ſix to ten, fifteen, and ſome places as deep as thirty or forty feet, all round the iſland.

Edinburgh,
April 26, 1793.

VIII. *Experiments and Obſervations tending to ſhow the Compoſition and Properties of Urinary Concretions. By* GEORGE PEARSON, *M. D. F. R. S. Read before the Royal Society, December* 14, 1797. *From the* Philoſophical Tranſactions.

I. *Hiſtorical Obſervations.*

THE notion generally entertained, of the nature of urinary concretions, conſiſted with the names given them*, till the laſt twenty years; although the experiments of Slare, Frederic Hoffman, and Hales, long before ſhowed that theſe ſubſtances commonly conſiſt of animal matter. Galen indeed imagined that φλεγμα, or viſcid animal matter, is the baſis of animal concretions; but, in his days, earth was believed to be the baſis of animal matter. Alkaline medicines were, however, employed by the Greek phyſicians in diſeaſes from calculi.

The experiments of the alchemiſts alſo made it appear, that earth was only a part of the matter of concretions. It was probably the obſervation of the depoſition and cryſtallization of ſaline bodies, which ſuggeſted the notion of urinary calculi being of the nature of tartar. Such was the opinion of Baſil Valentine, and after him of Hochemer, better known by the name of Paracelſus; but, whether the latter adopted the denomination *Duelech* from its import, or from caprice, has not been explained. Van Helmont, a century after his prototype Paracelſus, being ſtruck with the experiment in which he diſcovered the concretion of ſalts in

* Urinary concretions have obtained their denominations, like moſt other things, from their obvious properties. Accordingly, in our language, they are popularly known by the names ſtone and gravel, or ſand, from their reſemblance to the ſtates of earth ſo named: and we find names of the ſame import in other languages, ſuch as λιθος, (ARETÆUS;) λιθιασις, (CÆLIUS AURELIANUS;) ψαμμος, (ARETÆUS;) λιθιδια, (various authors); *calculus*, (CELSUS and PLINY); *ſabulum*, (various authors). In other languages, and eſpecially in thoſe now ſpoken, it is unneceſſary to notice names which have the ſame meaning.

diſtilled

distilled urine by alcohol, was led to depart from his adored master's opinion, with respect to the nature of calculi; although he acknowledges the merit of Paracelsus, in having discovered the solvent *Ludus*, (a calcareous stone also called *Septarium*,) which Van Helmont says is preferable to alkaline lixivium. He also says, that when the archeus spirit of urine meets with a volatile earthy spirit, and does not act in a due manner, a concretion will be formed; but, in a healthy state, although all urine contains the matter of urinary calculi, no concretion can take place, because the archeus, or vital power of the bladder, counteracts its formation.

As to the kind of earth composing calculi, the only distinction of earths, till about the last half century, was into absorbent and non-absorbent; but, since the absorbent earths were distinguished into calcareous, magnesia, and alumine or clay, the calcareous was considered to be the earth of urinary concretions; apparently however for no other reason but its obvious properties, and its extensive diffusion through the whole animal kingdom.

At length, *viz.* in 1776, the experiments of the wonderful Scheele were published in Sweden, but were scarcely known in this country till 1785. These experiments exploded the opinion of the earthy nature of calculi, and substituted that of their consisting of a peculiar acid, resembling the succinic, and of a gelatinous matter, without any earth. Afterwards about $\frac{1}{200}$ of their weight of lime was found by Bergman; which, for a cause now well known, had eluded the acuteness of Scheele. Although the experiments of Scheele were confessedly unquestionable, and were ably supported by the learned Bergman, some very eminent chemists, having obtained different results by their own experiments, adopted a different opinion of the composition of these concretions. The immortal, and ever to be deplored, Lavoisier supposed these substances to consist of acidulous phosphate of lime and animal matter, many of them being partially

 fusible;

fufible; but ftill it was the unrivalled Scheele who difcovered that the urine of healthy perfons contains fuperphofphate, or acidulous phofphate, of lime; and who alfo indicated the experiment which verified his opinion, that phofphate of lime is the bafis of bone.

Experiments have been likewife made, for the moft part in a rather defultory way, and moft of them by perfons but little practifed in chemical inquiries, which at leaft afford evidence, that urinary concretions are very different, with refpect to the proportion of the ingredients in their compofition, and perhaps alfo in kind. M. Fourcroy, who however muft not be claffed with inexperienced chemifts, I believe firft obtained pruffic acid by fire, and by nitric acid, from thefe concretions; and fhowed that they fometimes contain phofphate of ammoniac and of foda; which may be diffolved out of them by water. M. Fourcroy alfo fays, he found magnefia in the inteftinal calculus of a horfe; which calculus was a triple combination, of one part of phofphate of ammoniac, two parts of magnefia, and one of water, befides traces of animal and vegetable matter.

Dr. Link, in a very elaborate differtation, publifhed at Gottingen, in 1788, on urine and calculi, concludes that urinary concretions confift of phofphoric acid, lime, ammoniac, oil, the bafes of different kinds of gazes, together with the acid fublimate of Scheele, although he did not fucceed in obtaining it.

It is a proof of Dr. Black's fagacity, that he fhould have been able to perceive, from a few experiments, that urinary concretions confifted of animal matter and the earth of bone, before the compofition of this earth was demonftrated by Gahn.

In this hiftorical fketch it fhould be noticed, that alkaline fubftances, though ufed by the Greek phyficians, and afterwards by the alchemical phyficians, appear to have been laid afide by the regular practitioners, for a century or two preceding their revival, by the famous Mrs. Stephens, in 1720.

Her

Her prefcription brought into vogue the theory of thefe medicines operating by their caufticity. The fuccefsful ufe, by Mr. Colborne, of potafh faturated with carbonic acid, according to the difcovery of Bewley and Bergman, and the ftill further improvement in practice, from the ufe of foda, as well as potafh, fuper-faturated with carbonic acid, by the difcovery of a peculiar method by Mr. Schweppe, have completely refuted the theory of the agency of alkalies on the principle of caufticity.

It appears, from the preceding brief hiftory, as well as from the confeffion of the lateft and beft writers, that the experiments hitherto made, rather "afford indications of what remains to be done, than furnifh demonftrations of the nature of animal concretions." It is alfo too obvious to need explanation, that more efficacious and innocent practice, in difeafes from thefe concretions, can only be difcovered by a further inveftigation of their properties. It is with this view, as well as for the fake of chemical philofophy, that I think it my duty to fubmit to the Society fome of the obfervations I have made, in the courfe of inquiry on this fubject.

The obfervations which I fhall now offer, are principally on a fubftance, which my experiments inform me is very generally a conftituent of both urinary and arthritic concretions. It is a fubftance obtained by diffolving it out of thefe concretions, by lye of cauftic fixed alkali, and precipitating it from the folution by acids. In this way, Scheele feparated this matter; but he did not confider its importance, nor of courfe at all inveftigate its properties. He does not even feem to have been aware that it was a diftinct conftituent part of the urinary concretion; for, when he relates the experiment of precipitating matter from the nitric folution of calculus by metallic falts, no diftinction is made between the precipitations in this experiment, and that in the former: yet we can now fhow, that in the one cafe the precipitate is a peculiar animal oxide, and in the other they are metallic phofphates.

phosphates. As Scheele obtained an acid sublimate, it has been imagined by some writers, that the precipitate by any acid (even by the carbonic) from the alkaline menstruum, was an acid; the same as that obtained by sublimation, and which, in the new system of chemistry, has been denominated *lithic acid*. The following experiments show that these substances are different species of matter.

II. *Experiments.*

250 grains of a white, smooth, laminated, urinary calculus, and the same quantity of a nut-brown one, with an uneven surface, both of which were of a roundish figure, were pulverised together*. 300 grains of these pulverised calculi were triturated with three ounces and a half, by measure, or five ounces, by weight, of lye of caustic soda. The mixture became thick, and copiously emitted ammoniacal gaz. After digestion for a night, and then boiling, with the addition of five ounces of pure water, I obtained, by filtration, five ounces of clear colourless liquid. Boiling water was repeatedly poured upon the strainer, till what passed through it was almost tasteless, and remained clear, on the addition of diluted sulphuric acid.

(*a*) The matter remaining on the strainer, being dried, was an impalpable, white, tasteless, heavy powder, which weighed 96 grains.

(*b*) The five ounces of filtrated liquid, having been set apart, on standing, deposited a white, opaque, granulated, soap-like matter, from a colourless clear liquid. The liquid being decanted, the deposit was dried, and was then an opaque, brittle, soap-like matter, which dissolved readily in water, giving a clear but not viscid solution, and

* The object of these experiments being principally to investigate the properties of one of the constituent parts of urinary concretions, which part was previously determined (by the test of nitric acid), to exist in both these, it can be no objection to the experiments, that I made use of a mixture of two calculi.

tafting weakly of foda. This foap-like matter weighed 280 grains.

(*c*) The decanted liquor, (*b*,) being mixed with the above filtrated liquors, on evaporation to three ounces, afforded no depofit on ftanding, although it was a very heavy and foapy liquid to the feel; but, on adding diluted fulphuric acid gradually, till it ceafed to become turbid, a fediment was depofited, which was a very light, white, impalpable powder, in weight, when dried, 26 grains. The liquid from which this powder was precipitated, being evaporated, afforded nothing but fulphate of foda, and a few grains of cryftals, which feemed to be phofphate of foda. There was alfo a blackifh matter, which burnt like horn, or other animal matter, and did not leave a pink or rofe-coloured matter, on evaporating the folution of it in nitric acid to drynefs, but left a carbonaceous refidue; whereas, the white precipitate, fo treated, afforded a beautiful pink matter.

(*d*) 250 grains of the foap-like matter (*b*) being diffolved in eight ounces of pure water;

1. A little of this folution, further diluted by one ounce of water, grew milky on adding a few drops of nitric acid, but became lefs fo on ftanding. On adding more nitric acid, and heating it, the mixture became quite clear: by adding a few drops of lye of cauftic foda, a very flight curdy appearance took place.

2. On adding, to the fame diluted folution, a little of the diluted fulphuric or muriatic acid, milkinefs enfued, and remained, although the acids were added till the mixture was extremely four. On adding lye of cauftic foda, much more than to faturate the fuperabundant acid, the mixture became clear again; and, on adding the acids a fecond time, the milkinefs was reproduced. It was found that the milkinefs could be produced and deftroyed, or clearnefs be produced, by the alternate addition of the acid and alkali, for an unlimited number of times. If the nitric acid however was ufed, at length no milkinefs could be induced. If carbonate of

of ſoda was added, in place of the cauſtic ſoda, the mixture could not be made clear.

3. Lime water was rendered turbid by this ſolution, but I neglected to examine the precipitated matter.

4. A little of the ſolution, with the addition of a few drops of concentrated nitric acid, being evaporated to dryneſs, ſometimes a pink, and at other times a blood-red, or roſe-coloured matter was left; which, by further application of fire, became black.

5. Carbonic acid, digeſted and ſhook with this ſolution, did not render it turbid.

6. To the whole of the remaining ſolution was added diluted ſulphuric acid, to ſaturate the alkali. On ſtanding, a copious precipitate took place, from a clear liquid; which precipitate, being waſhed and dried, was a maſs of very light, mica-like, whitiſh cryſtals, amounting to 123 grains. It was eſtimated that the ſolution uſed in the Experiments 1.—5. would have produced 12 grains, and that the 30 grains of ſoap-like matter, (*b*,) not decompounded, would have yielded about 14 grains more.

(*e*) The precipitate, (*d*, 6.)

1. Had no taſte, nor ſmell, and did not diſſolve in the mouth.

2. About one part of it only diſſolved in 800 parts of boiling water; which ſolution did not redden paper ſtained with turnſole, nor the ſolution and tincture of this teſt; neither did it change turnſole paper, reddened by acid, to a blue colour. On cooling, the greateſt part of what had been diſſolved was depoſited, in a cryſtalliſed ſtate, equally on the ſides and bottom of the veſſel. This cryſtalliſed matter had the properties abovementioned (*d*). Boiling water was found to diſſolve a much greater proportion of *urinary ſtone*, and alſo of *gravel*, than of this precipitate.

3. Lye of mild potaſh, or ſubcarbonate of potaſh, being dropped into the ſolution (*e*, 2.) with its cryſtalliſed depoſit, the cryſtals at firſt ſeemed to diſſolve; but, on ſtanding, a great

great part of the matter was depofited, and the liquid remained turbid.

4. The precipitate being boiled with lye of carbonate of foda, more feemed to be diffolved than in pure water; but the folution was not clear, and, on evaporating it nearly to drynefs, and pouring cold water upon it, on a paper ftrainer, fcarcely any thing but the foda paffed through with the water; the precipitate remaining behind on the paper. The refult was the fame, when this experiment was made with a lye of carbonate of ammoniac. The refult was alfo the fame, with water in which red oxide of mercury had been boiled; which was alfo boiled with this precipitate, and filtrated after cooling.

5. A little of the precipitate being triturated with quicklime, hot water was poured upon it. The filtrated liquor gave the precipitate back again, on adding muriatic acid.

6. The precipitate expofed to flame, with the blowpipe, turned black, emitted the fmell of burning animal matter, and evaporated or burnt away without any figns of fufion; ftaining the platina fpoon black.

7. Five grains of the precipitate, in half an ounce of water, were left to ftand in a warm room, during the months of Auguft and September laft, without any figns of putrefaction appearing, or any obvious change taking place.

8. Twenty-four ounces of boiling water were faturated with the precipitate, and divided into fix portions; from each of which, on cooling, moft of it again precipitated.

The firft portion, on boiling with a little lye of carbonate of foda, (the pneumatic apparatus being affixed,) difcharged no carbonic acid into lime water; but a tranfparent folution was produced, and, on cooling, very little was precipitated.

The fecond portion was, in the fame manner, boiled in a little lye of cauftic foda; which gave a tranfparent folution on cooling, without any precipitation.

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The third portion being boiled with lime water, very little more seemed to be dissolved than in pure water.

The fourth portion being boiled with 4 grains of subphosphate of lime, or calcined bone, no more seemed to be dissolved on account of this addition.

Nor was more dissolved in the fifth portion, by the addition of 4 grains of phosphate of lime, made by dropping phosphoric acid into lime water.

And the result was the same with the sixth portion, to which were added 4 grains of superphosphate of lime, made by adding phosphoric acid to lime water, so as just to make a clear solution, and then evaporating the solution.

9. Urine seemed to dissolve, or at least to suspend, a greater quantity of the precipitate than mere water; so likewise did water with a little sulphate of soda.

10. The precipitate did not render solution of hard soap at all curdy; but, on adding the precipitate to solution of sulphuret of potash, it became very turbid.

11. The precipitate produced a strong effervescence, even in the cold, with nitric acid, but the fumes were not those of nitrous acid: there was a clear solution, which, on evaporation to dryness, afforded black matter, surrounded by a pink, or blood-red margin.

12. The substance, with sulphuric acid, turned black, and emitted fumes copiously, which were scarcely those of sulphureous acid; and, on evaporation, a black mark only was left.

13. I first digested, and then boiled, in water, the precipitate with prussiate of iron; but the filtrated liquor afforded no precipitation with sulphate of iron.

14. Two drachms, by measure, of nitric acid, of the specific gravity of 1,35, were poured upon 7 grains of the precipitate. A violent effervescence took place, which was soon succeeded by a complete solution.

A few drops of this solution, being evaporated on glass, left

left a black mark, ſurrounded by a pink margin. A few drops of nitric acid being evaporated from this reſidue, nothing but a ſtill leſs black mark, and a few red ſpots remained.

Nitric acid being added a third time, nothing but a black mark, ſtill ſmaller, remained; which entirely diſappeared, on evaporating this acid from it a fourth time.

I found that a few drops of this ſolution, ſo diluted that they did not contain the $\frac{1}{100}$, or even a much ſmaller part, of a grain of the precipitate, on evaporation, left a pink ſtain on glaſs.

The whole of the reſt of the ſolution was diſtilled in a very low temperature, ſo that a drop only fell about every half-minute, till a thick browniſh ſediment remained, with a red margin. A ſimilar diſtillation was performed, with the diſtilled liquor, a ſecond time, when there remained a little whitiſh thick matter. On a third diſtillation, as before, with the diſtilled liquor, towards the cloſe white fumes aroſe; and about half a drachm of liquid, which now remained in the retort, being left to ſtand, priſmatical cryſtals, decuſſating each other, were formed. They had a ſharp taſte, but were ſcarcely ſour; were very ſoluble in the mouth, and evaporated in white fumes, leaving a very ſlight black ſtain.

15. Twenty grains of the precipitate were introduced into a tube, $\frac{1}{8}$ of an inch wide in the bore, ſealed by melting at one extremity; which extremity was coated, and the tube was fitly bent for retaining ſublimate, and collecting gaz. The temperature, from the fire applied, was at firſt very low, but was gradually increaſed, ſo as to make the coated part, containing the charge, red hot. At firſt, the precipitate turned black, and a little water appeared. Secondly, gaz came over, which had the ſmell of empyreumatic *liquor cornu cervi*. Thirdly, a brown ſublimate appeared, and gaz as before, but alſo with pruſſic acid gaz. Fourthly, black matter,

matter, ftaining the tube, as if from tar, or animal oil. On cooling, there was found a refidue, of nearly three grains, of pure carbon. The fublimate was principally carbonate of ammoniac; the reft was animal oil. The gaz difcharged was nearly half its bulk, or 5 cubic inches by meafure, carbonic acid; and the remaining 5 cubic inches were nitrogen gaz, containing pruffic acid and empyreumatic oil.

I treated in the fame manner, the fame quantity of reddifh cryftals, depofited fpontaneoufly from urine. The refult was not very different from that of the former experiment. The gaz was more offenfive, fmelling like putrid urine, and the carbonaceous refidue was more copious, and contained lime and phofphoric acid; at leaft the lixivium of it became white, on dropping into it oxalic acid; and it became flightly curdy, on adding lime water.

I treated in the fame manner, fome quite round and fmooth concretions, of the fize of black pepper feeds. The products were the fame as the former, but the gaz was ftill more offenfive, and in fmaller quantity; and the carbonaceous matter was more copious.

I, in the fame way, fubjected to experiment 20 grains of a nut-brown light calculus, which I had previoufly afcertained to contain the matter above defcribed, which was precipitated from cauftic foda by acids. The products were of the fame kind as the former; but I could find no trace of phofphoric acid in the refidue, which I did of lime, and the gaz was lefs offenfive. The carbonaceous refidue was not, in weight, 3 grains.

It will be proper, before I proceed further, to point out fome of the more obvious conclufions from the above experiments.

1. It appears that at leaft one half of the matter of the urinary concretions fubjected to the above experiments united to cauftic foda, and was precipitated from it by acids. (II. *a—d.*)

2. This

2. This precipitate does not indicate acidity to the moſt delicate teſts; (*e*, 2.) and, as it is inodorous, taſteleſs, (*c*, 1.) ſcarcely ſoluble in cold water, (*c*, 2.) does not unite to the alkali of carbonate of potaſh, of ſoda, or of ammoniac, (*e*, 3, 4.) nor to oxyde of mercury, (*e*, 4.) nor to the lime of lime water, (*e*, 8.) nor decompound ſoap, (*e*, 10.) or pruſſiate of iron, (*e*, 13.) and, as its combination with cauſtic ſoda reſembles ſoap, more than any double ſalt known to conſiſt of an acid and alkali, this precipitate does not belong to the genus *acids*.

3. As this precipitate could not be ſublimed, without being decompounded, like animal matter, (*e*, 15.) and alſo for the reaſons mentioned in the laſt paragraph, it cannot be the ſame thing as the *acid ſublimate* of Scheele, or the ſuccinic acid.

4. As it does not appear to be putreſcible, nor form a viſcid ſolution with water, it cannot be referred to the *animal mucilages*.

5. On account of its manner of burning in the air, under the blowpipe, (*e*, 6.) and its yielding, on expoſure to fire in cloſe veſſels, the diſtinguiſhing products of animal matter, (eſpecially ammoniac and pruſſic acid,) as well as on account of its affording a ſoap-like matter with cauſtic ſoda, this precipitate may be conſidered as a ſpecies of animal matter; and, from its compoſition being analogous to that of the ſubſtances called, in the new ſyſtem of chemiſtry, *animal oxides*, it belongs to that genus. Its peculiar and ſpecific diſtinguiſhing properties are, *imputreſcibility*, *facility of cryſtalliſation*, *inſolubility in cold water*, and, that moſt remarkable property of all others, *producing a pink or red matter, on evaporation of its ſolution in nitric acid**.

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* It is much to be wiſhed that we poſſeſſed equally delicate teſts of the other ſpecies of animal matter, which are confounded together, although, from their obvious properties, there is reaſon to believe they are of very different

I do not avail myself of various other conclusions in this place, because they relate especially to the agency of medicines for preventing and removing concretions; and of course do not properly fall within the views of the Royal Society.

Having found the above precipitate to be an oxide, and not, as is commonly supposed, an acid, I thought it probable that, like other analogous oxides, it was *acidifiable*, and I suspected that I had really rendered it into the acid state, by the nitric acid; which, in the above experiments, (*e*, 14.) had imparted oxygen to it, and thereby rendered it soluble, deliquescent, pungent, and volatile. This change also would account for the nitric solution not affording the precipitate.

In order to obtain, for examination, an adequate quantity of this supposed acid, the following experiments were instituted, with the three acids (*viz.* the oxymuriatic, the nitro-muriatic, and the nitric), which can acidify oxides analogous to the present one.

Experiment 1. Twenty-five grains of the above animal oxide, (for so I will now venture to call it,) and three ounces of nitric acid, of the specific gravity of 1,25, were put into a retort, and the hydro-pneumatic apparatus was adjoined.

At a very low temperature, a clear solution was made. First, soon after the solution began to boil, 23 ounces, by measure, of colourless gaz came over, which were succeeded (secondly), by white fumes, filling the apparatus, and 23 ounces more of gaz. Thirdly, a white sublimate ascended, and there was a strong smell of prussic acid. The sublimate was very readily washed out, being very soluble, and tasted pungent or sharp, but not sour. Fourthly, the distillation being renewed, more white sublimate appeared, but only 3

different kinds as is the case with the matter of the brain, liver, voluntary muscles, mucus, &c. Mr. Hunter has discovered a distinguishing specific property of pus, and one is here indicated for the oxide of urinary concretions.

ounces

ounces more of gaz came over; and then the retort only contained a dark-brown ſolid matter.

The firſt portion of gaz, *viz.* 23 ounces, conſiſted of about equal bulks of carbonic acid and atmoſpherical air. The ſecond portion, *viz.* 23 ounces, was two-thirds of its bulk carbonic acid, and the reſt nitrogen gaz. The third portion, or 3 ounces, was atmoſpherical air, with a little carbonic acid.

Nitric acid was poured, in the ſame quantity as before, into the retort. An effervеſcence immediately took place, which was ſucceeded by a tranſparent ſolution. The diſtillation yielded gaz of the ſame kind as before, but in ſmaller quantity, with white fumes, and white ſublimate. When only about 4 drachms, by meaſure, of liquid remained in the retort, a little of it was evaporated; and, when reduced to a ſolid matter, it turned black, and took fire, leaving a carbonaceous reſidue; but, before this, a margin of beautiful pink matter appeared.

Nitric acid was poured, as before, into the retort, for the third time, but very little gaz aſcended, and much leſs white fumes than before. The diſtillation proceeded, till about one drachm-meaſure of liquid remained in the retort: this being left to ſtand, priſmatic cryſtals were formed in a very ſmall quantity of liquid. Theſe cryſtals did not taſte ſour, but ſharp, and they reddened turnſole paper. Adding a little ſoda to a part of them, to ſee whether I could form a neutral ſalt, I was ſurpriſed by the extrication of ammoniac. To another portion of cryſtals I added ſulphuric acid, which diſengaged nitric acid. A third portion of cryſtals, being expoſed over a lamp, wholly evaporated, without leaving a mark behind. The remaining matter in the retort being examined, was found to be nitrate of ammoniac. It was plain that the nitric acid had, by parting with oxygen to the carbon of the oxide, formed carbonic acid. The carbon being thus carried off, of courſe the nitrogen and hydrogen of the oxide uniting produce ammoniac; which, uniting with

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the redundant nitric acid, compofes nitrate of ammoniac; but great part of the nitrate of ammoniac was carried off in the vapour ftate, exhibiting white fumes, and fublimate, as above obferved.

The mode of making the experiments with the other acids was of courfe different from the former experiment.

Experiment II. Twenty-five grains of the above animal oxide, and half an ounce of water, were put into a bottle capable of containing three pints; a ftream of oxymuriatic acid gaz, from manganefe and muriatic acid, was made to pafs into the bottle, and upon the charge, for twelve hours; and, for twenty-four hours more, oxymuriatic gaz kept iffuing, but in fmaller quantity, and circulating through the bottle. The oxide, by this time, was completely diffolved. Upon adding lime to a little of the folution of it, ammoniac was difengaged; and, upon adding fulphuric acid, there was a difengagement of oxymuriatic acid. On evaporation, however, I obtained nothing but muriate of ammoniac, with which was mixed a little manganefe.

In this experiment, I could not doubt that the carbon had been carried off, in the ftate of carbonic acid, by the oxygen of the oxymuriatic acid; and thus ammoniac was compounded, from the union of the two remaining conftituent parts of the oxide, *viz.* the nitrogen and hydrogen. The oxymuriatic acid, united to the ammoniac, parted with oxygen, and became muriatic acid during evaporation; hence, muriate of ammoniac was formed.

Experiment III. The above experiment was repeated, only the gaz was nitro-muriatic gaz, from a mixture of nitric and muriatic acids. The refult was the fame as in the laft experiment, except that the product was a mixture of nitrate, and muriate, of ammoniac.

I made other experiments of the fame kind; but their refults were fo nearly the fame as thofe above related, that I fhall not give an account of them. By the unexpected iffue of thefe experiments, all my hopes of acidifying the

animal

animal oxide were exploded; but I am indebted to that purſuit for the curious diſcovery of the change of the moſt common baſis of urinary concretions, (the animal oxide,) into ammoniac and carbonic acid, by the oxygen of the above acids; which will be found extremely important, as it enables us to interpret many phænomena, in a variety of caſes beſide the preſent. It now appears, that the inflammation mentioned in one of the above experiments, (and which alſo happened in ſeveral others,) on evaporation of the nitric ſolution of the animal oxide, was from the nitrate of ammoniac, the *nitrum flammans* of the old chemiſts, compounded in thoſe experiments. This inflammation takes place ſometimes, on evaporation of nitric ſolutions, both of urinary concretions, and of urine itſelf evaporated to the ſtate of ſoft extract, on account of the ammoniac already exiſting in theſe ſubſtances. The compoſition of ammoniac alſo explains the diſappearance of the whole matter of ſome ſorts of urinary concretions, a very ſmall reſidue of black matter excepted, by repeated affuſion and evaporation of nitric acid, from the ſolution of them in this menſtruum.

It remains for me to give an account of the 96 grains of powdery matter left on the paper ſtrainer, (*a*;) which are the inſoluble portion, in lye of cauſtic ſoda, of 300 grains of urinary concretions.

1. A ſmall portion of the inſoluble matter, being expoſed to flame with the blowpipe, did not turn black, nor yield any ſmell of animal matter; but it became whiter, and I could juſt agglutinate the powder into one maſs, although I was unable to render it fluid.

2. The filtrated liquid, from a little of the matter boiled in water, became very turbid and white with oxalic acid: with lime water it grew barely curdy; and it did not alter the colour of turnſole, or of violet juice.

3. The matter diſſolved completely in muriatic acid, and alſo in nitric acid, without efferveſcence.

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This nitric ſolution, having been evaporated, to carry off moſt of the free acid, inſtantly became very curdy on the addition of lime water.

It grew thick and white on adding ſulphuric acid, yielding a copious precipitate of ſulphate of lime. One portion of the ſupernatant liquor upon this precipitate, on evaporation, afforded an extract-like matter; which readily melted, as phoſphoric acid does when it is mixed with a little earthy matter. To the other portion of this ſupernatant liquor was added liquid cauſtic ammoniac, producing a precipitate which afforded no ſulphate of magneſia with ſulphuric acid.

From theſe experiments it appears, that the above 96 grains of inſoluble matter conſiſted of phoſphate of lime. Accordingly, the 300 grains of urinary concretions examined, appear to contain,

	grains
Peculiar animal oxide - - -	175
Phoſphate of lime - - -	96
Ammoniac, (and moſt probably phoſphoric acid united to the ammoniac,) water, and common mucilage of urine, which were not collected and weighed, by eſtimation - - -	29
	300

[To be continued.]

IX. *Chemical Conſiderations on the Uſe of the Oxyds of Iron in dyeing Cotton. By* J. A. CHAPTAL. *From the* Annales de Chimie, *Vol. XXVI.*

THE oxyd of iron has ſuch an affinity with cotton thread, that, if the latter be plunged in a ſaturated ſolution of iron in any acid whatever, it immediately aſſumes a chamoy yellow colour, more or leſs dark according to the ſtrength of the liquors,

liquors. It is both a curious and eaſy experiment, that when cotton is made to paſs through a ſolution of the ſulphat of iron, rendered turbid by the oxyd which remains ſuſpended in the liquor, it will be ſufficient to dip the cotton in the bath to catch the laſt particle of the oxyd, and to reſtore to the liquor the tranſparency it has loſt. The ſolution then, which before had a yellowiſh appearance, becomes more or leſs green, according as it is more or leſs charged.

The colour given to cotton by the oxyd of iron becomes darker, merely by expoſure to the air; and this colour, ſoft and agreeable when taken from the bath, becomes harſh and ochry by the progreſſive oxydation of the metal. The colour of the oxyd of iron is very faſt: it reſiſts not only the air and water, but alſo alcaline leys, and ſoap gives it ſplendour without ſenſibly diminiſhing its intenſity. It is on account of theſe properties that the oxyd of iron has been introduced into the art of dyeing, and been made a colouring principle of the utmoſt value. But I have been able to give a new extenſion to the applications of this oxyd; and I ſhall here confine myſelf to the only reſults I have obtained worthy of entering into the operations of the dye-houſe, and which have been employed with ſucceſs for ſeveral years in my manufactory.

In order that the oxyd of iron may be conveniently applied to the cotton thread, it is neceſſary to begin by effecting its ſolution, and in this caſe acids are employed as the moſt uſeful ſolvents. Dyers almoſt every where make a myſtery of the acid which they employ; but it is always the acetous, the ſulphuric, the nitric, or the muriatic. Some of them aſcribe great differences to the ſolution of iron by the one or the other acid, but in general they give the preference to the acetous. This predilection appears to me to be founded much leſs on the difference of the colours that may be communicated by the one or the other ſalt, than on the different degrees of corroſive power which each exerciſes

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on the ſtuff. That of the ſulphat and muriat is ſo great, that, if the ſtuff be not waſhed when it comes from the bath, it will certainly be burnt; whereas ſolutions by the acetous or any other vegetable acid are not attended with the like inconvenience.

Iron appears to be at the ſame degree of oxydation in the different acids, ſince it produces the ſame ſhade of colour when precipitated; and any acid ſolvent may be employed indiſcriminately, provided the nature of the ſalt and the degree of the ſaturation of the acid be ſufficiently known; for the ſubſequent operations may be then directed according to this knowledge, and the inconveniences which attend the uſe of ſome of theſe ſalts may be prevented. This without doubt is a great advantage which the man of ſcience enjoys over the mere workman, who is incapable of varying his proceſs according to the nature and ſtate of the ſalts which he employs.

In this paper I ſhall confine myſelf to making known the colour that may be obtained from the oxyd of iron, 1ſt, employed alone on ſtuff which has received no previous preparation; 2d, employed together with madder on ſtuff prepared to receive the Adrianople red.

1. If the ſulphat of iron or any other martial ſalt be diſſolved in water, and cotton be dipped in the liquid, the cotton will aſſume a chamoy colour, more or leſs dark according as the ſolution is more or leſs charged. The affinity of the cotton to the iron is ſo great, that it attracts the metal, and takes it in a great meaſure from the acid by which it was diſſolved.

2. If the iron of a pretty ſtrong ſolution be precipitated by an alcaline liquor that ſhews five or ſix degrees (by the areometer of Baumé), the reſult will be a greeniſh blue magma. The cotton macerated in this precipitate aſſumes at firſt an unequal tint of dirty green; but mere expoſure to the air makes it in a little time turn yellow, and the ſhade is very dark.

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It is by ſuch or almoſt ſimilar proceſſes that dyers communicate, what is called among workmen, an *ochre* or *ruſt colour*. But theſe colours are attended with ſeveral inconveniences to the artiſt. 1. Strong ſhades burn or injure the cloth. 2. This colour is harſh, diſagreeable to the eye, and cannot be eaſily united with the mild colours furniſhed by vegetables. I made attempts therefore to avöid theſe inconveniences, and ſucceeded in the following manner: I tread the cotton cold in a ſolution of the ſulphat of iron, marking three degrees, wring it carefully, and immediately plunge it in a ley of potaſh at two degrees, upon which I have poured to ſaturation a ſolution of the ſulphat of alumine: the colour is then brightened, and becomes infinitely more delicate, ſoft, and agreeable. The ſulphat no longer attacks the tiſſue of the ſtuff; and after the cotton has been left in the bath for four or five hours, it is taken out to be wrung, waſhen and dried. In this manner we may obtain every ſhade that can be wiſhed, by graduating the ſtrength of the ſolutions. This ſimple proceſs, the theory of which preſents itſelf to the mind of every chemiſt, has the advantage of furniſhing a colour very agreeable, exceedingly fixed, and, above all, extremely economical. I employ it with great advantage in dying nankins, the colour of which has infinitely more fixity than that of the Engliſh (dyed) nankins*. It poſſeſſes over the latter the advantage of reſiſting leys; and the only fault I have diſcovered in it is, that it becomes brown by the action of aſtringents.

I thought for ſome time that it would be poſſible to combine this yellow with the blue of indigo, to obtain a durable green: but hitherto I have been deceived in my hopes; and it reſults from different trials which I made on this ſubject, that there is not a ſufficient affinity between the blue of

* Was the author aware that the Engliſh nankins are made from a cotton wool of the natural colour that requires no dyeing proceſs? Some jeans and other ſtuffs are dyed by means of oxyd of iron: to theſe, perhaps, he alludes. Edit.

indigo

indigo and the oxyds of iron. I obtained only a dirty earthy green of different ſhades, and exceedingly poor. The oxyd of iron combines on the other hand very eaſily with the red of madder, and produces a bright violet or plum (*pruneau*) colour, the uſe of which is as extenſive as beneficial in the cotton manufactory. But if we ſhould confine ourſelves to apply theſe two colours to cotton, without having employed a mordant capable of fixing the latter, the colour would not only remain dull and diſagreeable by the impoſſibility of brightening it, but it would ſtill be attended with the great inconvenience of not reſiſting leys. We muſt begin then by preparing the cotton, as if to diſpoſe it for receiving the Adrianople red; and when it has been brought to the operation of galling, it is to be paſſed through a ſolution of iron, more or leſs charged according to the nature of the violet required: it is then to be carefully waſhed, twice maddered, and brightened in a bath of ſoap.

When a real velvety rich violet is required, it is not to be paſſed through the ſolution of iron till it has been previouſly galled; the iron is then precipitated in a blueiſh oxyd, which combined with the red of madder gives a moſt brilliant purple, more or leſs dark according to the ſtrength of the galling and of the ferruginous ſolution. It is very difficult to obtain an equal colour by this proceſs, and in manufactories an equal violet is conſidered as a maſter-piece of art. It is generally believed that it is only by well-directed manipulations that it is poſſible to reſolve this problem, of ſo much importance in dyeing. But I am convinced that the great cauſe of the inequality in this dye is, that the iron depoſited on the cotton receives an oxydation merely by expoſure to the air, which varies in different parts of it. The threads which are on the outſide of the hank are ſtrongly oxydated, while thoſe in the inſide, removed from the action of the air, experience no change. It thence follows, that the inſide of the hank preſents a weak ſhade, while the exterior

exterior part exhibits a violet almoſt black. The means to remedy this inconvenience is, to waſh the cotton when it is taken from the ſolution of iron, and to expoſe it to the madder moiſt. The colour will become more equal and velvety. The ſolvents of iron are almoſt the ſame for this colour as for the yellow colour already mentioned.

I ſuppreſs here every thing that regards manipulation, that I may attend only to chemical relations; and on that account I ſhall mention an obſervation which may ſerve to guide the artiſt in brightening the violet on his cotton. The red of madder and the oxyd of iron depoſited on the ſtuff determine the violet colour. This colour becomes red or blue, according as either of the two principles predominates. The dyer knows by experience how difficult it is to obtain a combination which produces the tone of colour deſired, eſpecially when it is required to be very full, lively and durable. This object, however, may be obtained, not only by varying the proportions of the two colouring principles, but alſo by varying the proceſs of brightening. The only point is, to be acquainted with the two following facts; that the ſoda deſtroys the iron, while the ſoap, by ſtrong ebullition, ſeizes in preference the red of the madder. Hence it is, that the colour may be inclined to red or blue, according as you brighten with one or the other of theſe mordants. Thus, cotton taken from the madder dye, when waſhen and boiled in the brightening liquor with 30,00 of ſoap, will give a ſuperb violet; whereas you will obtain only a plum colour in treating it with ſoda.

The oxyd of iron precipitated on any ſtuff unites alſo very advantageouſly with the fawn colour furniſhed by aſtringents, and by varying the ſtrength of mordants an infinity of ſhades may be produced. In this caſe, it is leſs a combination or ſolution of principles, than the ſimple mixture or juxta-poſition of the colouring bodies on the ſtuff. By means of a boiling heat, we may combine in a more intimate manner the oxyd of iron with the aſtringent principle; and

then

then it is brought to the ſtate of black oxyd, as has been obſerved by our colleague Berthollet. It is poſſible alſo to embrown theſe colours, and to give them a variety of tints, from the bright grey to the deep black, by merely paſſing the cottons impregnated with the aſtringent principle through a ſolution of iron. The oxyd is then precipitated itſelf by the principle which is fixed on the ſtuff.

An obſervation, which may become of the utmoſt value for the art of dyeing, is, that the moſt uſual aſtringent vegetables all furniſh a yellow colour, which has not much brilliancy, but which has ſufficient fixity to be employed with advantage. This yellow colour is brightened in the ſeries of vegetables, in proportion as the aſtringent principle is diminiſhed, and the vivacity of the colour is augmented in the ſame proportion. It is difficult then to obtain yellow colours which are at the ſame time durable and brilliant. Theſe two valuable qualities are to each other in an inverſe ratio; but it is poſſible to unite the colouring principles in ſuch a manner as to combine ſplendour with fixity. Green oak bark unites perfectly with yellow weed, and ſumach with green citron. It is by this mixture that we may be able to combine with the oxyd of iron vegetable colours, the ſplendour of which is equal to their durability.

I ſhall conclude theſe reflections with an obſervation in regard to the employment of aſtringents in the dyeing of cotton. It has been pretended, that by increaſing the proportions of ſumach and the bark of alder tree or oak, theſe ſubſtances might ſupply the place of gall-nuts in dyeing cotton red. I ſhould have received the more pleaſure from this diſcovery, as galls tend to render our colours conſiderably dearer, and as I could have procured ſumach at a very low price, ſince it grows almoſt every where in the dry parts of our ſouthern diſtricts. But I can ſafely aſſert, that it is impoſſible to employ theſe as ſubſtitutes, in whatever doſes they may be uſed. The colour is always much paler, poorer, and leſs fixed. I know that the caſe is not the ſame in re-

gard

gard to dyeing wool and silk, in which it may be employed with success; and in giving an account of this difference, I think the cause of it may be found in the nature of the gall-nuts. 1. The acid which they exclusively contain, as Berthollet has proved, facilitates the decomposition of the soap with which the cottons have been impregnated, and the oil then remains fixed in their tissue, and in a greater quantity, as well as in a more intimate combination. 2. The gall-nuts, which owe their development to animal bodies, retain a character of animalisation, which they transmit to the vegetable stuff, and by these means augment its affinities with the colouring principle of the madder; for it is well known of what utility animal substances are to facilitate this combination. This animalisation becomes useless in operating upon woollen or silk.

X. *Description of a Thermometer which marks the greatest Degrees of Heat and Cold, from one Time of Observation to another, and may also register its own Height at every Instant. By* Alex. Keith, *Esq. F.R.S. and F.A.S. Edin. From the* Transactions of the Royal Society of Edinburgh, *Vol. IV.* 1798.

THERMOMETERS have hitherto been defective for meteorological purposes, in so far as they only point out the degree of heat at the moment of inspecting them, but do not shew what the difference has been, from the time of one observation to another.

The ingenious Robert Hook, in the end of the last century, mentions his intention of making a thermometer for the above purpose; but it does not appear that it was ever executed: neither does he explain how it was to have been done.

The thermometer, invented by Mr. James Six, as described in the 72d volume of the Philosophical Transactions of the Royal

Royal Society of London, is made to ſhew its greateſt riſe or fall from one period of obſervation to another. This is done by means of two ſmall pieces of black glaſs, which float on two different ſurfaces of mercury, within two glaſs tubes hermetically ſealed. Theſe floats, when raiſed to their greateſt height, adhere to the ſides of the tube, by means of a ſpring of glaſs, and become ſtationary, although the mercury falls. After the obſerver has noted the temperature, he, by a magnet held in his hand, draws down the float to the ſurface of the mercury, in conſequence of a ſmall bit of ſteel wire being incloſed in the float, and the inſtrument is prepared for another obſervation. This is an ingenious invention, but requires too delicate workmanſhip to be fit for common uſe: beſides, it cannot be made to record the degrees of heat at intermediate periods.

The thermometer lately invented by Dr. Rutherford, of Baliliſh, and deſcribed in the 3d vol. of the Edinburgh Tranſactions, is alſo an ingenious contrivance, but has the ſame defect of marking only the extreme points to which the liquor has riſen or fallen in two ſeparate glaſs tubes.

Some years ago it occurred to me, that an air thermometer might be uſed for the purpoſes required; and accordingly I read to this ſociety a deſcription of the inſtrument. But having formed another inſtrument of a more ſimple conſtruction, I beg leave to give a deſcription of it.

AB, fig. 1. (Plate I.) is a tube about 14 inches long, and $\frac{3}{4}$ of an inch calibre, of thin glaſs, ſealed or cloſed at top. To the bottom, which is bent upwards, there is joined a glaſs tube 7 inches long, and $\frac{4}{10}$ths of an inch calibre, open at top. The tube AB is filled with alcohol, and from B to E is filled with mercury.—As liquids are incompreſſible by weight in any perceptible degree, neither the alcohol nor mercury will be affected by the weight of the atmoſphere.

FD is a ſcale of braſs or ivory, about $6\frac{1}{2}$ inches long, divided in the uſual way. E is a ſmall conical piece of ivory or glaſs, of a proper weight, made to float on the ſurface of the

the mercury in the fmaller tube; to which float is joined a wire, termed the float-wire, reaching to H, having a knee bent at a right angle, which raifes one index, and depreffes another, according as the mercury rifes or falls. This part of the apparatus is defended from wind or rain by means of a glafs tube $7\frac{1}{2}$ inches long, clofed at top and open at bottom, fo wide as to flide eafily over the fcale, and, by means of a brafs rim cemented to it, made to fit exactly to the circular bafe of the fcale. This cover need not be taken off, except when the inftrument is to be prepared for an obfervation. [The operation of the float and indexes will be better underftood from fig. 4, where a fimilar apparatus, but belonging to a newly invented barometer, is reprefented on a larger fcale.]

F G is the fcale fixed to a circular piece of wood or brafs D, through which the fmall tube is made to pafs. From G to F is a piece of the fmalleft gold wire ftretched along the fcale, fixed at the ends by two pins. L L are two indexes, formed of thin black oiled filk, pierced by the fmall wire in fuch a manner as to flide upwards and downwards with a very fmall force, not more than two grains. H, the knee of the float-wire before defcribed, is made to encompafs the fmall wire between the two indexes, fo that, when the float rifes, the upper index is moved upwards, and, when it defcends, it leaves the upper index ftationary, and pufhes down the lower one, which is alfo left ftationary when the float rifes. When the inftrument is to be prepared for an obfervation, the one index is to be pulled down, and the other raifed, by means of a bit of wire, bent for the purpofe, until both of them touch the knee of the float-wire: and when it is again obferved, the upper index will point out the greateft degree of heat, and the lower the greateft degree of cold, fince the time they were fet.

If this thermometer is to be adapted to a piece of clockwork, in order to record the degrees of heat at each hour and minute of time, it ought to be made of larger dimenfions.

fions. The large tube may be 40 inches long, and not increafed in diameter; but the fmall tube ought to be enlarged in diameter, and not in length. The alcohol will thus be affected by heat or cold in as fhort a time as that before defcribed.

It is unneceffary to explain the clock-work. It is fufficient to fay, that a hollow cylinder of any light fubftance, 7 inches long and 5 inches diameter, is made to revolve upon a vertical axis once in 31 days or a month; a piece of fmooth vellum or paper is put round this cylinder, pafted only at the joining, but fo as to make it adhere clofe to the cylinder: on this are drawn 31 equal perpendicular divifions, numbered at top, 1, 2, 3, &c. each of which is fubdivided into fix parts, to anfwer to 4 hours. The length of this cylinder is divided by lines furrounding it, or zones, in fuch number as to correfpond to the fcale of Fahrenheit's therm. viz. from 0 to 100°. Thefe divifions ought to be engraved on copper, and a number of impreffions thrown off on fmooth or vellum paper, in order that one may be ready to put on each month.

MN, fig. 2. reprefents the cylinder covered with one of thefe impreffions. PP is the fcale fixed to the frame in which the cylinder turns. The divifions on this fcale correfpond to thofe on the cylinder.

Q is a piece of black lead pencil, joined to the end of the float-wire, in place of the knee before mentioned. This pencil is made to prefs lightly on the cylinder, by means of the fmall weight R. And as the pencil rifes or falls by heat and cold, it marks the degrees on the fcale of the cylinder; and the cylinder being conftantly revolving, the divifion for each day and parts of a day will fucceffively be marked by the pencil, which will leave a trace, defcribing an undulated line, diftinctly delineating the temperature of each day through the month. Thefe papers, when taken off and bound together, will make a complete regifter of the temperature for the year; or, if they are pafted to one another, in in their order, they will form a thermometrical chart, by which the variations of heat and cold, during the year, may all be ſeen and compared by one glance of the eye.

By inſpecting fig. 2. the effect of the inſtrument may be ſeen. It appears that the paper had been put on the cylinder the firſt day of the month, at mid-day, when the thermometer ſtood at 45°; that it fell gradually till mid-night to 25°; thereafter it roſe till the 2d, at 1 P. M. when it ſtood at 42°; then it deſcended at mid-night to 35°; that on the 4th at noon it roſe to 50; and at noon the 10th of the month it ſtands at 40°.

If 3 inches be added to the length of the cylinder, it may be made to delineate the variations of the barometer as well as the thermometer, and thereby to form a complete chart or view of the progreſs of both of them. And if inſtruments of this kind were kept in different parts of the country, and their charts compared together, it would afford much information with regard to meteorology.

XI. *Deſcription of a Barometer, which marks the Riſe and Fall of the Mercury from two different Times of Obſervation; invented by* ALEX. KEITH, *Eſq. F. R. S. and F. A. S. Edin. From the* Tranſactions of the Royal Society of Edinburgh, *Vol. IV.* 1798.

ABCD, fig. 3. (Plate I.) is a glaſs tube bent in the manner repreſented, open at D, and hermetically ſealed at A. From A to B is 8 inches long, and about $\frac{3}{4}$ of an inch calibre. From B to C $31\frac{1}{4}$ inches long, and about $\frac{1}{4}$ inch calibre. And from C to D $4\frac{1}{2}$ inches long, and $\frac{1}{2}$ inch calibre. The tube is filled with mercury, the length from A to E being $29\frac{1}{2}$ inches. When the tube is hung perpendicularly, the mercury will fall from B towards E, leaving a vacuum from A to B. When the atmoſphere becomes heavier, the mercury falls in the tube D C, and when lighter it rifes. The range of the fcale is about 3 inches, being equal to that of a common barometer of the beft conftruction, which has a bafon with a very broad furface. This inftrument moves in a direction contrary to that of the common barometer, the one rifing while the other falls.

Fig. 4 reprefents the tube D C, &c. on a larger fcale. This part of the inftrument is conftructed exactly in the fame way as the fcale, float, &c. of the thermometer defcribed in the article immediately preceding the prefent. F is the float, having the float-wire fixed to it, terminating in a knee at a right angle between the indexes L L, where it embraces a very fmall wire ftretched along the fcale, and thereby raifes or lowers them as the mercury rifes or falls in the tube D C.

The barometer is prepared for obfervation, by bringing down the one and raifing the other index till both touch the knee of the float-wire. When next obferved, the upper index will point out the greateft depreffion of the mercury —or lightnefs of the atmofphere; and the lower the greateft rife of the mercury—or weight of the atmofphere fince the fcale was prepared.

By this means, the variations of the atmofphere are much more truly pointed out than by the common barometer; for it often happens, that, during tempeftuous weather, or before it, the mercury both rifes and falls within a few hours, or during the night-time; which variations cannot be noticed by any of the barometers now in ufe. The fudden fall and rife, or even the rife and fall of the mercury, always denote an extraordinary agitation in the atmofphere. By a common barometer the mercury may be at the fame height in the morning that it was the night before; which leads to a conclufion, that as there has been no agitation of the mercury, there will be calm or fettled weather: but this new barometer will often fhew in fuch cafes, that the one

one float has been raifed $\frac{2}{10}$, and the other depreffed as much; which, inftead of indicating calm weather, denotes that tempeftuous weather may be expected.

The weight of the atmofphere at great heights might be difcovered, by fufpending this inftrument to an air-balloon.

XII. *On the different Properties of Metal and Wooden Springs.*

THE fpring is, in a variety of pieces of mechanifm, not only a very ufeful auxiliary, but in fome (as in pocket-watches, gun-locks, &c.) an indifpenfible requifite. But from the difficulty of getting fprings to ftand, as the workmen exprefs it, to their temper, they are not fo frequently applied to the purpofes of mechanics as otherwife they might be. Great judgment and fkill, as every one knows who is converfant with the fubject, are required to give to a metal fpring its due degree of temper; for, if made too hard, it fnaps; if not hard enough, it fets. Metal fprings, however, frequently fail from another caufe, which is very little underftood; in confequence of which, the failure is ufually attributed, though, as prefently will be feen, unjuftly, to the unfkilfulnefs of the workman. It is a circumftance not commonly obferved refpecting a metal fpring, that if it has not fomething to ftop againft, but is fuffered to vibrate after performing the requifite action, it will, in a fhort fpace of time, if the action be frequently repeated, either break or fet. Whence this property arifes is not at prefent the object of enquiry. It is mentioned that, in cafes which will admit of it, this inconveniency may be guarded againft. In thofe cafes in which the vibration cannot conveniently be avoided, a wooden fpring, which is not fubject to the like inconveniency, is the beft, and, perhaps, the only fubftitute. A wooden fpring is, in the property alluded to, the reverfe of a metal one: if ftopped in its vibration, it foon fets or breaks;

if permitted to vibrate, its temper or elasticity suffers not the smallest diminution.

A gentleman, some few years ago, established a mill for a manufacturing purpose, in which, having occasion to apply springs under the circumstances mentioned above, he at first attempted to make use of metal ones, but in vain, being never able to make them stand a single day's work. He tried every kind of steel, and employed many different workmen, but still without success. Merely as a temporary expedient, till such time as he could get a fresh supply of steel springs, he one day tried a wooden one, which, to his agreeable surprise, completely answered his purpose; and from that time, as may be concluded, he never used any other than wooden ones. The experiment was perfectly decisive: the springs were in daily action for four years successively, making, in a common way, from forty to fifty strokes in a minute on an average. At the expiration of the four years, those springs which had escaped accidents were as elastic, and as strong, as when first put into action. The wood they were made of was red deal, clean grained, and perfectly free from knots.

To many manufacturers who employ machinery for various purposes, in which springs, that must be suffered to vibrate, form a part, this information, which may to some appear trivial, will be found highly useful.

XIII. *The Process suggested by* JAMES CARMICHAEL SMYTH, *M.D. F.R.S. Fellow of the Royal College of Physicians, and Physician Extraordinary to his Majesty, for determining the Effect of the Nitric Acid in destroying Contagion. Extracted from* An Account of the Experiment made at the Desire of the Lords Commissioners of the Admiralty on board the Union Hospital Ship. 1796.

THE subject of this article is of the greatest importance, and the facts which have been established by the experiments

ments made on board the Union and other ships at Sheerness, are worthy of attention, and cannot be too strongly recommended to the notice of every person who wishes to be master of a simple and efficacious method for destroying contagion, or preventing it from breaking out, where there may be reason to fear, from concurring circumstances, that there is a danger of such an evil manifesting itself.

The experiment on board the Union was conducted by Mr. Menzies, late surgeon to his majesty's sloop Discovery, and by Mr. Bassan, surgeon of the Union; and when it is considered, that fresh contagion was daily pouring into the hospital from the Russian vessels, which were at that time lying in the Downs, and which had brought with them a species of fever that might in every sense of the word be termed an epidemy, it will be allowed, that the success which attended it was such that it cannot be too generally known.

The wards were extremely crowded, and the sick of every description lay in cradles, promiscuously arranged, to the number of nearly two hundred; of which, about one hundred and fifty were in different stages of the above malignant fever, which was extremely contagious, as appeared evident from its rapid progress and fatal effects, among the attendants on the sick, and the ship's company.

The utensils and materials provided for the process were the following: A quantity of fine sand, about two dozen quart earthen pipkins, as many common tea-cups, some long slips of glass to be used as spatulas, a quantity of concentrated vitriolic (sulphuric) acid, and a quantity of pure nitre (nitrat of potash).

The process was conducted in the following manner: 1st, All the ports and scuttles were shut up; the sand, which had been previously heated in iron pots, was then scooped out into the pipkins by means of an iron ladle; and in this heated sand, in each pipkin, a small tea-cup was immersed, containing about half an ounce of the sulphuric acid, to which, after it had acquired a proper degree of heat, an equal quantity of nitrat of potash in powder was gradually

 added,

added, and the mixture ſtirred with a glaſs ſpatula till the vapour aroſe from it in conſiderable quantity*. The pipkins were then carried through the wards by the nurſes and convaleſcents, who kept walking about with them in their hands, occaſionally putting them under the cradles of the ſick, and in every corner where any foul air was ſuſpected to lodge. In this manner they continued fumigating, until the whole ſpace between decks was fore and aft filled with the vapour, which appeared like a thick haze.

The vapour at firſt excited a good deal of coughing among the patients, which gradually ceaſed as it became more generally diffuſed through the wards: part of this effect, however, was to be attributed to the inattention of thoſe who carried the pipkins, in putting them too near the faces of the ſick; which cauſed them to inhale the ſtrong vapour, as it immediately iſſued from the cups.

The body-clothes and bed-clothes of the ſick were, as much as poſſible, expoſed to the nitrous vapour during the

* That the fumes of the mineral acids poſſeſſed the property of ſtopping contagion was proved by Guyton as far back as the year 1773, who, by means of the fumes of muriatic acid extricated from the muriat of ſoda (ſea ſalt) by the ſulphuric acid, purified the air of the cathedral of Dijon, which had been ſo much infected by exhumations that they were obliged to abandon the building. The proceſs was afterwards publiſhed under the form of "Inſtructions for purifying the air in the military hoſpitals of the French republic;" a copy of which appeared in the Journal de Phyſique, Ventoſe, an 2. ere Franç. The proceſs conſiſted in removing the patients, heating ſome common ſalt, previouſly moiſtened with water, upon a ſtove, and then pouring ſulphuric acid upon the hot ſalt. In an inſtant the ſulphuric acid begins to act upon the ſalt, combines with its ſoda, and diſengages its acid, which riſes in the ſtate of vapour. The operator then leaves the room, and ſhuts the door; and, after twelve hours, returns, and opens the windows, to admit freſh air.

Dr. Smith deſerves great praiſe for his meritorious perſeverance till he got the uſe of acid fumes introduced into the Engliſh hoſpital ſhips; and his ſubſtituting nitre for common ſalt was a happy improvement; for, though acid fumes were known to prevent infection, there was no proof of their having contributed, at the ſame time, to the recovery of the ſick, till theſe experiments were made according to inſtructions drawn up by him. Edit.

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fumigation; and all the foul linen removed from them was immediately immersed in a tub of cold water, afterwards carried on deck, rinsed out, and hung up till nearly dry, and then fumigated before it was taken to the wash-house: a precaution extremely necessary in every case of infectious disorder. Due attention was also paid to cleanliness and ventilation.

It took about three hours to fumigate the ship. In about an hour after, the vapour having entirely subsided, the ports and scuttles were thrown open for the admission of fresh air. It could be plainly perceived, that the air of the hospital was greatly sweetened even by this first fumigation. The process was repeated again next morning; and the people employed, being now better acquainted with it, were more expert, and finished the whole in about an hour's time. In an hour afterwards, the vapour having entirely subsided, the fresh air was freely admitted into the hospital as before. Fewer pipkins were employed for the evening fumigations than for those of the mornings, as the fresh air could not be admitted so freely after the former as the latter.

The pleasing and immediate effect of the fumigation in destroying the offensive and disagreeable smell, arising from so many sick crowded together, was now very perceptible, even to the nurses and attendants; the consequence of which was, that they began to place some degree of confidence in its efficacy, and approached the cradles of the infected with less dread of being attacked with the disorder: so that the sick were better attended, and the duty of the hospital was more regularly and more cheerfully performed. In short, a pleasing gleam of hope seemed now to cast its cheering influence over that general despondency, which was before evidently pictured in every countenance, from the dread and horror each individual naturally entertained of being, perhaps, the next victim to the malignant powers of a virulent contagion.

It is a remarkable fact, that from the 26th of November

1795, when the fumigation was firſt reſorted to, till the 25th of December, not a perſon on board was attacked with the fever, though, in the three months preceding, more than one third of all the people in the ſhip had been ſeized with the diſtemper, and of theſe more than one in four were carried off by it; and the probability is, that the ſickneſs and mortality would have gone on, increaſing in proportion to the diffuſion of the contagion, and to the increaſing deſpondency of the people, who conſidered themſelves as ſo many devoted victims.

The advantage of the fumigation was not felt by the ſhip's company and attendants alone, whom it preſerved from the baneful effects of the fever: the ſick and convaleſcents derived almoſt an equal benefit from it. The ſymptoms of the diſeaſe were meliorated, and loſt much of their malignant appearance; and the advantage of a pure air, and free from ſtench, to convaleſcents, may be readily conceived.

Great confidence is always dangerous. It proved ſo on the preſent occaſion. On the 17th of December they imagined themſelves ſo ſecure, that they diſcontinued the cuſtom of fumigating morning and evening, thinking that once a day was ſufficient; on the 25th, one of the nurſes ſuffered a ſlight attack; and on the 26th, a marine, who, for a week before, had been in a ſtate of intoxication, was ſeized with the fever, of which he died. Theſe two accidents gave immediate alarm: they returned again to the practice of fumigating twice a day; and from that time to the extermination of the diſorder, there was not an inſtance of a perſon ſuffering from contagion on board the ſhip.

The ſucceſs of the experiment was not confined to the Union: the power of the nitrous vapour to deſtroy contagion was equally diſplayed on board the Ruſſian ſhips in which it was employed. The ſafety too with which it may be employed, in any ſituation, without inconvenience or riſk of fire, is another great recommendation in its favour.

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From the deſcription that has been given of the proceſs, no perſon can be at any loſs in reſorting to the ſame kind of fumigation. It is only neceſſary to obſerve, for the ſake of thoſe who may not be verſant in chemical purſuits, that the ingredients ought to be pure, and that metal veſſels or rods muſt not be employed. Any kind of metal getting among the ingredients would cauſe the vapour to be very noxious, inſtead of ſalutary. The fumes that riſe ſhould be white; if they are of a red colour, there is reaſon to ſuſpect the purity of the ingredients.

The importance of this diſcovery need not be inſiſted on: it is equally applicable to every ſpecies of putrid contagion, even to the plague itſelf. It ſhould therefore be uſed in all hoſpitals and pariſh workhouſes; and ſhould be conſtantly reſorted to by the proprietors of all large works, on the firſt appearance of infectious diſeaſe among the people employed in them:—indeed, it ſhould be employed even as a preventive in all ſituations, where a number of people, from the nature of their buſineſs, are obliged to be crowded together, or where, from local circumſtances, there are reaſons for ſuſpecting that the purity of the air is injured by noxious exhalations or other cauſes. If there be any circumſtances in which its utility might be called in queſtion, it can only be in caſes of inflammatory diſeaſes; for, in ſuch, ſuperoxygenation has been found hurtful.

XIV. *Deſcription of an improved German Key for extracting Teeth. By Mr.* CHARLES BROWN, *Surgeon. Communicated by the Inventor.*

THE obſervations with which you accompanied the announcement of my improvement in your laſt number, renders any introduction to the deſcription of the inſtrument unneceſſary.

The handle A (Plate II.) is made of ivory, very large and heavy, with the view of giving greater purchaſe to the operator.

B is

B is a circular milled projection on one end of the lever BK, and ſerves as a thumb-piece to be preſſed into the ſhank againſt a ſpring placed below the ſame end of the lever; by which means the end K is raiſed ſo as to unlock the claw when it is wiſhed to be turned to another ſide of the inſtrument.

H ſhews a ſection of this part of the inſtrument, where I repreſents the ſpring that is acted upon by preſſing down the thumb-piece B, ſo as to raiſe the end K of the lever, to diſcharge it from the notch in the heel of the claw when the latter is wiſhed to be moved to a new poſition.

C, the claw, is made to come off flat at its lower extremity, and roughed on the inſide, which, with the ſhoulder E, forms a bed to receive the tooth.

D, the bolſter, is made concave, to anſwer to the convexity of the teeth.

G, the heel of the claw, has four, ſix, or a greater number of notches round it, fitted to receive the end K of the lever.

The improvements introduced into this inſtrument are ſuch as I hope will be found to remedy the defects complained of in all former ones; and the facility with which a tooth can be drawn by its means, will, I am ſure, render its adoption in practice univerſal, as ſoon as it ſhall be generally known.

XV. *On the Uſe of the new Metal called Chrome, the Oxyd of Chrome, and the Chromic Acid. By Cit.* VAUQUELIN. *From the* Journal des Mines, *No. XXXIV.*

THE fragility of chrome, the reſiſtance it offers to the action of fire, and the ſmallneſs of the maſſes in which it has hitherto been naturally found, do not leave us any hopes that this metal can ever be of great utility in the arts. This aſſertion, however, may be going rather a little too far; for a new ſubſtance, the properties of which do not at firſt ſeem likely

likely to be of much benefit to ſociety, is ſometimes found, after a certain period, to be applicable to many important purpoſes in the arts and the ſciences.

The acid and the oxyd of this metal, however, may be of the greateſt utility. The former, on account of the beautiful emerald green colour which it communicates, even to enamel, without undergoing any alteration in its ſhade, will furniſh painters in enamel with the means of enriching their pictures, and of improving their art; and the ſecond, by the beautiful cinnabar red colour which it aſſumes and preſerves in its combination with mercury, the orange red colour which it gives with lead, and the carmelite red which it communicates to ſilver, may become exceedingly valuable to painting in oil and in water colours.

It will be no leſs uſeful in chemiſtry, by furniſhing an excellent re-agent to detect the ſmalleſt quantities of mercury, ſilver, and lead, diſſolved in acids, by the different colours it produces in them when its action is aſſiſted by an alkali. But in the ſame manner as this acid ſerves to diſcover the preſence of the above-mentioned metals; the latter, in their turn, may ſerve to diſcover the chromic acid, if it has been previouſly put in a condition to produce the effects before mentioned.

If abundance of the chromic acid ſhould one day be found in any other combination than that of lead; were it extracted by means of the carbonat of potaſh, we might make the red lead artificially, and furniſh, in great plenty, an excellent orange red colour for painting, which is ſold very dear in Siberia, where it is employed for that purpoſe with great effect. In this reſpect great benefit might be derived from the red lead, which is diſſeminated in ſmall cryſtals or laminæ, in the fiſſures of quartzy and free-ſtone matrices *, where they are commonly found, by reducing them

* As many of our readers may not be acquainted with the hiſtory of this red lead, we ſhall give the following ſhort account of it: The foſſil known under

them to powder, and afterwards boiling it in a solution of the carbonat of potash, and mixing with the nitrat of lead this solution, after its excess in alkali has been saturated with the nitric acid. By this process red lead may be formed as beautiful as the natural, and perfectly free from the matrix.

There is reason to presume that chrome, in the state of an oxyd, or in that of an acid, will be found either free or in combination with other substances; for the analysis of the emerald of Peru has shewn to me that its colouring principle is supplied by the oxyd of this metal; which is a very agreeable presage for the goodness and fixity of this colour, since we know that the emerald may be exposed to the most violent degree of heat without being discoloured.

I have found also that the yellowish green velvety crystals, which often accompany the red lead of Siberia, are formed of chrome and lead, both united in the oxyd state. In certain fragments of red lead there may be seen also green crystals, which have the same form, the same dimensions, and

under the name of *red lead* was discovered by M. Pallas, in 1770, in the gold mine of Beresof, near Ekaterimbourg in Siberia, under the form of prisms with four planes, with, or without, terminating pyramids of a beautiful orange red colour, generally fixed in a quartzy matrix, to which they adhere so strongly that it is difficult to detach them.

From the above mine have been procured all the specimens of this substance preserved in the cabinets of Europe, which shews that it was formerly very abundant; but we are assured that for some years it has become exceedingly scarce, and that it is sold at present for its weight in gold, especially when pure and of a regular form. Specimens which do not possess a regular form, or which have been reduced to fragments, are applied to the purposes of painting, in which art it is exceedingly valuable, on account of its beautiful orange yellow colour, its durability in the air, and the facility with which it can be mixed with oil. Professor Pallas expresses himself thus, in speaking of this mineral, in his Travels during the year 1770, under the article of the gold mine of Pischminskoi, vol. ii. p. 235. "A very remarkable kind of mineral red lead, not found in any other mine of the Empire or elsewhere, is dug up here. This lead ore is heavy, of different colours, sometimes that of cinnabar, and very transparent. It and the ſame diſpoſition in the matrix, as thoſe of the red lead, and which are only a combination of the oxyd of chrome and the oxyd of lead. It is probable that theſe combinations originally exiſted in the ſtate of the chromate of lead, and that at length a portion of oxygen taken away by cauſes with which we are unacquainted, made them paſs to that of oxyd, and converted the red into green.

XVI. *Experiments and Obſervations on the Phoſphoreſcence of the Luciole,* Lampyris Italica. *By Dr.* Carradori. *From the* Annales de Chimie.

THESE winged inſects, which during the calm nights of ſpring fly about in the air, where they appear like ſparks of fire, that attract the curioſity of children and afford them amuſement, cannot fail in a more particular manner to excite the curioſity of the philoſopher.

It adheres in long or ſhort cryſtals in the fiſſures of quartz, as well as on the edges of the ore, which is a ſandy kind of ſtone. It has very frequently, and wherever the ſpace has permitted, the ſame ſize and the ſame priſmatic form, with four flat facets, having two extremities irregularly blunted. It is found alſo in ſmall irregular twiſted pyramids, attached to a quartz like ſmall rubies. When well ground with water, it gives a beautiful ſubſtance of a dark yellow colour, which may be employed in miniature painting. In all the experiments made on this lead ore in the laboratories of Ekaterimbourg, a ſmall grain of ſilver has always been obtained. It is difficult at preſent to procure the quantity neceſſary for extenſive experiments, as the workmen cannot labour where this lead ore is found, for want of good air. There are found in the mixed matrices of quartz, where this rare and curious mineral is formed, ſmall cryſtals pointed at both ends, and of the colour of ſulphur. They reſemble native ſulphur, and they are conſidered as ſuch by the miners; but they do not burn in the fire, and do not flaſh when applied to a flame, like the lead ore. They may conſiſt perhaps of metallic ſpar, but it is difficult to procure the quantity neceſſary for experiments. Theſe ſmall cryſtalliſations are found both on the quartz and the ſand-ſtone." Edit.

The light of the luciole does not depend on the influence of any external cause, but merely on the will of these insects. While they fly about at freedom their shining is very regular; but when they are once in our power, they shine very irregularly, or do not shine at all. When they are molested they emit a frequent light, which appears to be a mark of their resentment. When placed on their backs they shine almost without interruption, making continual efforts to turn themselves from that position. In the day-time it is necessary to torment them in order to make them shine, and thence it follows that the day to them is the season of repose. The luciole emit light at pleasure from every point of their bellies, which proves that they can move all the parts of their viscera independently of each other. They can also render their phosphorescence more or less vivid, and continue it as long as they please.

The faculty of sparkling does not cease on their bellies being torn, or opened by an incision. Carradori saw part of the belly of one separated from the rest of the body, the light of which was almost extinguished, grow luminous all of a sudden for some seconds, and afterwards become gradually extinct. He sometimes saw a like portion, which had been separated, pass suddenly from the most brilliant state to that of total darkness, and afterwards resume its former brightness. Carradori ascribes this phenomenon to a remainder of irritability, or a stimulus produced by the air, which appears the more probable, as a mechanical irritation produced the same effect.

A slight compression deprives the luciole of their power of ceasing to shine. The author is inclined to believe that the movement by which they conceal their light, is executed by drawing back their phosphoric substance into a particular membrane or tunic. He supposes also that the sparkling consists in a trembling or oscillation of the phosphoric mass. He is of opinion that there is no emanation of a phosphoric substance, and that the whole phenomenon takes place in the

the interior part of the luminous viscera. When the shining is at its greatest degree of height, it is so strong that a person may by it easily distinguish the hours on the smallest watch, and the letters of any type whatever.

The phosphoric part of the luciole does not extend farther than to the extreme rings of the belly. It is there enclosed in a covering composed of two portions of membranes, one of which forms the upper, and the other the lower part of the belly, and which are joined together. Behind this receptacle is placed the phosphorus, which resembles a paste, having the smell of garlic, and very little taste. The phosphoric matter issues from a sort of bag on the slightest pressure; when squeezed out, this matter loses its splendour in a few hours, and is converted into a white dry substance. A portion of the phosphoric belly put into oil, shone only with a feeble light, and was soon extinguished. In water, a like portion shone with the same vivacity as in the air, and for a much longer time. The author thence concludes that the phosphorescence of the luciole is not the effect of slow inflammation, nor of the fixation of azotic gaz as Gœttling thinks, as the oil in which they shine does not contain a single air-bubble: besides, the phosphorus of these insects shines in a barometrical vacuum. The observation made by Foster, that the luciole diffused a more vivid light in oxygen gaz than in atmospheric air, does not, according to Carradori, depend upon a combustion more animated by the inspiration of this gaz, but on the animals feeling themselves, while in that gaz, in a better condition. "Whence then arises," says the author, "the phosphoric light of the luciole? I am of opinion," adds he, "that the light is peculiar and innate in these insects, as several other productions are peculiar to other animals. As some animals have the faculty of accumulating the electric fluid, and of keeping it condensed in particular organs, to diffuse it afterwards at pleasure, there may be other animals endowed with the faculty of keeping

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in a condensed state the fluid which constitutes light. It is possible that by a peculiar organisation they may have the power of extracting the light which enters into the composition of their food, and of transmitting it to the reservoir destined for that purpose, which they have in their abdomen. It is not even impossible that they may have the power to extract from the atmospheric air the luminous fluid; as other animals have the power of extracting from the same air, by a chemical process, the fluid of heat."

Carradori discovered that the phosphorescence of the luciole is a property independent of the life of these animals, and that it is chiefly owing to the soft state of the phosphoric substance. Its light is suspended by drying, and it is again revived by softening it in water; but only after a certain time of desiccation. Reaumur, Beccaria, and Spallanzani observed the same thing in regard to the *pholades* and the *medusa*.

By plunging the luciole alternately into lukewarm and cold water, they shine with vivacity in the former, but their light becomes extinct in the latter; which, according to the author, depends on the alternate agreeable and disagreeable sensation which they experience. In warm water their light disappears gradually. Dr. Carradori tried on the luciole and their phosphorus the action of different saline and spiritous liquors, in which they exhibited the same appearances as other phosphoric animals. These last experiments prove that the phosphoric matter of the luciole is only soluble in water.

XVII. On

XVII. *On a new Insect called* Antiodontalgicus, *and the Property possessed by it, in common with some other Insects, of curing the Tooth-ache.*

PROFESSOR GERBI, in a small work published at Florence, in 1794 *, gives the description and figure of an insect, which is a kind of *curculio*, that, from its property of allaying the tooth-ache, has received the epithet of *antiodontalgicus*, and which is found on a species of thistle, *carduus spinosissimus*, of which a figure is likewise given. This thistle is compared by Professor Gerbi to the thistle of Boujarti, and is perhaps a variety of the *cnicus*. Its flowers, when analysed, gave the acid of galls, the muriatic acid, oxalat of lime, extractive matter, and a very little resin. On the bottom of the calyx, which supports the flowers, there are often found excrescences like the gall-nut, which are at first spheroidal, afterwards cylindric, and at length assume the figure of two hemispheres: they consist of the like component parts, but contain more resin, and far more oxalat of lime; as the gall apple of the oak, according to the experiments of M. Branchi, which are here mentioned, contains more of the acid of galls than the bark and other parts of the oak, in which he could discover no sulphuric acid. The insect, according to the author's observations, eats not only the parenchyma, but also the vessels and fibres of the leaves. The egg, before the worm makes its appearance, is nourished by the sap of the plant, and of the above excrescences, in which it resides, by means of the attractive power that the egg possesses for certain vegetable juices and substances. The excrescences arise by the accumulation of a solid substance, which is precipitated from the nourishing juices of the thistle, diminished by nourishing the egg and the worm. This insect, the eggs of which are

* Storia naturale di un nuovo insetto di Ranieri Gerbi. Florence 1794. 8.

 deposited

depoſited in theſe excreſcences, is, together with the *curculio* of the centaury, a new ſpecies. It is of a longiſh figure; covered below with ſhort yellow hair, and above with golden yellow velvety ſpots. Its corſlet is variegated with ſpecks; and the covering of its wings with ſpecks and ſtripes. It has a ſhort proboſcis, and ſhews ſome likeneſs to the *curculio villoſus* of Geoffroy. Its larva repreſents a ſort of ichneumon. By chemical analyſis it exhibits ſome traces of common ſalt; by diſtillation with a ſtrong dry heat, ſome volatile lixivious ſalts; and it contains, beſides theſe, ſome gelatinous, and a little ſebaceous and ſlimy extractive matter. If about a dozen or fifteen of theſe inſects, when in the ſtate of larva, or even when come to perfection, be bruiſed and rubbed ſlowly between the fore-finger and thumb until they have loſt their moiſture, and if the painful tooth, where it is hollow, be touched with that finger, the pain ceaſes ſometimes inſtantaneouſly. This power or property the finger will retain for a year, even though it be often waſhed and uſed. A piece of ſhamoy leather will ſerve equally well with the finger. Of 629 experiments, 401 were attended with complete ſucceſs. In two of theſe caſes the hollow teeth aroſe from ſome fault in the juices: in the reſt they were merely local.

If the gums are inflamed, the remedy is of no avail. According to Profeſſor Gerbi, the hollowneſs in the teeth ariſes from an acrid matter which irritates the nerves, and which is neutraliſed by the juices of the inſect.

This property of curing the tooth-ache has been diſcovered in other inſects, as appears by a paper of Dr. Corradori, inſerted in the *Giornale ſiſcio-medico* of Brugnatelli, Part I. The experiments were made in the town of Prato, where the property of ſome inſects to cure the tooth-ache had been known among the peaſants, even before any thing was publiſhed on the ſubject by Gerbi and Comparini. A certain Luigi Mari is here made to aſſert, that he laid hold of about a dozen of theſe inſects with his fingers, and heaped them

them over each other, by which means his fingers, for a whole year, though he daily washed his hands, were endowed with the property of curing the tooth-ache, by merely touching the affected tooth. The author of the letter affirms, that the following method will always afford relief. The insect described by Rossi, in his *Fauna Etrusca,* under the name of *carabus chrysocephalus,* is to be held for some minutes between the thumb and the fore-finger, and the diseased tooth and the gums are to be afterwards touched with that finger. If the pain does not cease on the first touching, the finger is to be well dried, and must be applied to the insect again, and then to the tooth; and this is to be continued alternately till the pain ceases entirely. M. Cypriani asserts, that he cured every case of the tooth-ache, without exception, by this method, within the space of eight or nine minutes.

More insects possess the like property, and experiments made with the following were equally successful. The *carabus ferrugineus* of Fabricius; the *coccinella septem punctata* (the lady bird); the *chrysomela populi,* and the *chrysomela sanguinolenta.* It would appear that this property belongs to various kinds of the *coleoptera.*

The idea of these insects being endowed with the property of curing the tooth-ache is not confined to Italy; for Dr. Hirsch, dentist to the court of Weimar, asserts (*Verkundiger,* September 24, 1798,) that he employed them with the happiest effect, except in some cases where his patients were females. Dr. Hirsch says, that he took that small insect, found commonly among corn, *coccinella septempunctata,* and bruised it between his fingers. He then rubbed the fingers with which he had bruised it, till they became warm at the points, and touched with them the unsound parts of the gums, as well as the diseased tooth. Dr. Hirsch adds, that he made the same experiment a few days after, with equal success, though he had not bruised a new insect with his fingers. He seems to think, though the other authors we have quoted do not mention the circumstance, that, to insure the efficacy of the process, the insect should be alive; because when dead, its internal parts, in which he presumes the virtue chiefly resides, become dried up, leaving only the wings and an empty shell; and therefore proposes to physicians, to turn their attention to the finding out of some method for preserving the virtue of the insect, so that its efficacy may be in full vigour throughout the year.

Professor Gerbi's work on the virtues said to be possessed by the *antiodontalgicus* was first announced in this country by Dr. Beddoes, in a paper published in the *Monthly Magazine for November* 1796; but in such a cautious manner as evidently to shew that he was afraid an improper degree of credulity might be ascribed to him. He has however proposed, that impregnated shamoy leather should be imported by the way of Leghorn; but as the virtue seems to belong to several coleoptera in this country, such an importation is unnecessary. The impregnating of leather (other substances might also be tried) by rubbing it with the insects, seems a good way of realising what has been proposed by Dr. Hirsch.

The fear of having credulity imputed should never hinder the publication of physical facts, announced by men of learning and reputation, however unaccountable they may appear; for, no one will pretend that we already are acquainted with all the laws of nature: on the contrary, they ought to be made generally known, that their truth or falsehood may be established by numerous experiments, especially when, as in the present instance, the means are so much within the reach of every person who may wish to determine the matter for himself.

While on the subject of tooth-ache, we may add, for the information of those who have not perused Dr. Beddoes' ingenious publications on the medicinal effects of factitious airs, that charcoal has been found to relieve the pain. Mr. Sandford, to a letter on the virtues of charcoal, addressed to Dr.

Dr. Beddoes, ſubjoins the following P. S.—" A lady to whom I recommended the uſe of charcoal-powder as a dentifrice, was ſubject at times to violent tooth-ache, from one of the dentes ſapientiæ that was become carious. She one day, when in great pain, filled the cavity of the tooth with the charcoal dentifrice, and was ſurpriſed to find herſelf in a few ſeconds free from pain. It might probably be urged, that any ſubſtance filling the hollow of the tooth mechanically, and thereby preventing the acceſs of atmoſpheric air, would produce the ſame effect: but I am rather inclined to attribute the *temporary* good effect experienced in this caſe, to the power of the charcoal *.

XVIII. *Deſcription of the Gazometer invented by M. Van Marum and his Apparatus for producing Water by the Combuſtion of Hydrogen in Oxygen Gaz. From the* Annales de Chemie, *Vol. XII.*

The veſſel 11 inches in diameter, containing the air or gaz to be employed, is repreſented by A. The mouth of it is cloſed by a braſs cover ſcrewed upon it, and furniſhed with three cocks B, C, D. On the cock B is ſcrewed a copper ſyphon E F, having its end F ſcrewed upon another braſs tube open at the bottom, repreſented by the dotted lines G G, and which deſcends within the braſs cylinder H, which is open at the top. To the lower part of the cock B is cemented a glaſs tube I I, which is open at the lower end near the bottom of the glaſs. When the cock B is opened, the tubes G G, F E, I I, make only one ſyphon; from which, when it is completely full, and the water in both veſſels does not ſtand on the ſame horizontal line, the water

* Any of our readers who try this ſimple application, will oblige us by communicating the reſult, to determine, whether charcoal be a remedy for the tooth-ache, or whether we muſt attribute the above caſe to a natural ceſſation of pain.

will be conveyed from that veſſel where it has the greateſt height into the other, until the water in both be of the ſame height. For example, when the water in the cylinder H ſtands at K, and in the glaſs A at L (in which caſe we muſt ſuppoſe the cock D open that the air may eſcape), the water will continue to flow from H into A till it ſtands at the ſame horizontal line.

The higher the water K is raiſed in H the greater is the weight of the column, and the quicker the eſcape of the air. By theſe means M. Van Marum obtains what Meſſieurs Lavoiſier and Meuſnier call preſſure in the gazometer, merely by the higher level of the ſurface K over L. That the height of the water in H may be obſerved, a glaſs tube M M about 1½ inch in diameter, and connected with it, is placed between H and A, in which the water will always have the ſame altitude as in H. An ivory ſcale, divided into inches and lines, faſtened to a cork ball, floats upon this water, and ſerves to ſhew the difference of the altitudes of the water at L and K.

The cock N, fitted to the top of the open cylinder O, ſerves, together with the cock P, to preſerve the preſſure perfectly uniform. Suppoſe, for example, that a conſtant preſſure of water of two inches high was required, as much water muſt be ſuffered to flow continually into H as is equal in bulk to the quantity of water that this preſſure of two inches forces from H into A. For this purpoſe, fill the cylinder O with water to the height of four inches, and turn the cock N until the preſſure of the four inches of water, which is maintained by the cock P, forces through N into H a quantity of water exactly equal to the quantity that the preſſure of two inches forces from H into A. The index Q of the cock N, and the ſcale R S, ſerve to give to the cock N the exact opening required; this having been determined beforehand, and the ſcale divided accordingly.

The cock N begins to open when the index R is turned towards S; and, for this reaſon, the gradation of the ſcale begins

begins at R. When the index is in a vertical poſition, the cock is completely open.

As it might perhaps be difficult to give to the cock P, which is connected with a ciſtern of water, ſuch an opening as not to permit more water to flow through it than neceſſary for preſerving a height of four inches in the cylinder O, a waſte pipe T T is applied at this height, which ſuffers all the ſuperfluous water of the cock P to run off. In order that it may be more conveniently obſerved, whether the cock P has a ſufficient opening for maintaining a four-inch column of water, a glaſs tube U, marked at the required height, is applied on the outſide, connected with the cylinder O.

To fill this gazometer, nothing more is neceſſary than to let water run out from the cylinder H. For this purpoſe, the cock V muſt be opened until the water in H ſtands lower than that in A. The cock D, and the cock W, ſtanding over the bell X, are then opened. The air contained in X riſes through the pliable tube Y Y into A. This filling may be continued, by leaving the cock V open, that the water which proceeds through the ſyphon from A to H may run out, and the ſurface of the water in H ſtand always a few inches lower than that in A. At the ſame time the bell X is to be ſupplied with new gas in the uſual manner. When the operation of filling is completed, the cock V is to be ſhut, and that at Z opened; the lower part of the opening of the key of which is in the ſame horizontal line with zero of the ſcale, which ſhews in cubic inches the altitude of the water in A. By theſe means the water falls no lower in A than to the above-mentioned line; and A is conſequently filled with air to the beginning of the ſcale *a b*. Before the cock D is ſhut, care muſt be taken that the water in the bell X do not ſtand higher than the water that ſurrounds it in its tub, which may be effected, if the bell be depreſſed in the tub till the internal and external altitude of the water be perfectly equal; and the air in A will then be of the ſame denſity as that of the atmoſphere.

The gazometer is furnished with a thermometer *f g*, which is so cemented with sealing wax into a piece of copper *e*, that the bulb of it is within the gazometer. By these means the temperature of the air used may be known, and its weight accurately ascertained. The tripod on which the gazometer stands facilitates the adjustment of the apparatus, and a brass bottom screwed upon the tripod is furnished with a brass rim or lip to receive the glass A and keep it fast in its place. Exactly at the upper level of this rim the scale *a b* commences. The scale is of ivory, and fastened on a slip of brass, and at the ends are two square pieces of brass, by which it is made fast, by means of two screws, to the cover at the top, and to the before-mentioned lip. The scale is divided in the common method, by pouring equal measures of water (suppose 2 cubic inches) into the glass, and marking the height of each on the scale, or, as the glasses are nearly cylindrical except at the neck, it may be sufficient to use at once 32 cubic inches, and divide the height into 16 equal parts; the neck of the vessel must be divided, as above, by 2 cubic inches at a time.

To explain the use of the gazometer it is only necessary to shew how the syphon G F E I is filled at the commencement of the experiment. This is done almost in the same manner in which M. Lavoisier filled the syphon, which he employed in order to fill the lamp used in the experiment respecting the combustion of oil *. The method is as follows:—The two cocks N and P are to be opened at the same time, and to be kept so until the cylinder H is completely filled with water. The pipe G G, which is open both above and below, as the crooked pipe F E is not yet joined to it at F, will be filled at the same time with the cylinder. The tube G G is then to be shut below by the cock *b*. This cock is fixed into a piece of brass, which is fastened in the cylinder H by four screws, the heads of which may be seen at *i, i, i, i*. To this piece of metal, made hollow in a perpendicular direc-

* See his Chemistry, Paris edit. 1789, page 495.

tion,

tion, is ſoldered the tube G G, which touches the inſide of the cylinder H, and is made faſt at the top by a piece of braſs, which is ſcrewed to the interior edge of the cylinder by two ſcrews, the heads of which are ſeen at K. As ſoon, therefore, as *b* is ſhut, the crooked pipe FE is to be ſcrewed to G G and the cock B. The cock B is ſhut, the ſcrew *j* is to be unſcrewed to open the tube at that place, and water poured by means of a funnel into the orifice thus opened. As ſoon as the pipe E F is full, the orifice is again ſhut. The cock *b* being then opened, and afterwards B, ſo much water runs from H, through the ſyphon G F E I, that A will be completely filled, if care be taken, by opening the cocks N and P, that the water in H ſtand always higher than that in A. To haſten the filling of the glaſs A, it will be convenient to fill the cylinder H almoſt entirely.

In order that the bent pipe E F may be faſtened air tight to the cock B, and the tube G G, without turning it round, each end of E F is ground to fit conically the places intended to receive them, and is preſſed home by the following contrivance: Fig. 2. repreſents a ſection paſſing through the axis of this part of the apparatus. The part *a a*, which is furniſhed with a ſhoulder, is ſlipped into the hollow *c* of the cock B; and the female ſcrew *d d*, by means of its ſhoulder *f f*, when turned upon the ſcrew *e e*, preſſes the conical part *a a* into *c*. The conical piece of the other end F of the pipe E F, is adjuſted in the ſame manner into a piece of copper ſoldered to the tube G G. All the tubes of this apparatus are adjuſted to their reſpective cocks in the ſame manner. It will be ſufficient to greaſe ſlightly the ſurface of any of theſe conical pieces, before it is put in its place, to prevent all communication with the air of the atmoſphere.

The balloon, for the compoſition of water, placed upon its tripod between the gazometers, differs from that of Lavoiſier, principally in the manner of ſhutting it in order to prevent the entrance of air. For this purpoſe there is a rim of copper *a a* (*fig.* 3.) fixed on the neck of the balloon, by means

means of plaſter of Paris, which, that it may afford no paſſage to the atmoſpheric air, is coated over with common cement above the edge of the band *a a*, as may be ſeen at *b b*; and this cement is covered with a ſtripe of linen *c c*, a quarter of an inch in breadth, dipped in the white of an egg mixed with lime. The rim of copper *a a*, has a copper ring *d d*, ſoldered to it at right angles; and on which the plate of copper *e e* is ground, in ſuch a manner that it is ſufficient to greaſe ſlightly the upper ſurface of the ring *d d*, when a vacuum is to be made, taking care to apply ſo little greaſe that it may not penetrate into the balloon. To exhauſt the balloon there is a cock which communicates by a bent tube with an air pump placed behind the balloon; and to prevent the working of the air pump from ſhaking the balloon, this bent tube is made in part of elaſtic gum.

The plate of copper *e e* is kept down upon the ring *d d* by ſix ſcrews, two of which may be ſeen at *f f*, placed at equal diſtances around the neck of the balloon, and by means of which the plate *e e* may be made to preſs very ſtrongly on the ring *d d*, on turning theſe ſcrews by the help of a key. Both of the gazometers are made to ſhut in the ſame manner.

The inferior ſurface of the plate *e e* is covered, as far as it covers the opening of the balloon, by a thin plate of pure ſilver, in order that the vapours formed during the experiment may not touch the copper. For the ſame reaſon the bent tube *l m*, in the balloon, is alſo made of pure ſilver. At the extremity of this tube is a piece of platina, having a very ſmall aperture, ſcarcely ſufficient to afford a paſſage to a very fine needle. The part *n*, which ſerves as a conductor to kindle the hydrogen gaz by an electric ſpark, is alſo made of platina, as far as it is not encloſed in the glaſs tube *o o*, by which it is inſulated. I have preferred platina for theſe two parts, in order to prevent the oxydation of the metal, which the heat produced by the combuſtion of the hydrogen gaz in oxygen might occaſion. The tubes *p p p p*, which

ſerve

ferve to conduct the gazes into the balloon, are made of glafs, and cemented into the copper tubes *q q*, which have conical extremities like thofe above defcribed to fix them on the cocks. Thefe glafs tubes are raifed a little above the edge of the cylinder H, to prevent the water from paffing into the balloon, fhould you happen to fill one of the glaffes A, and neglect to fhut well the cock C.

It will be proper to make the glaffes A, pretty large, if they can be procured fo, in order that the gazometers may contain the more air. It will however be beft to make them rather high (28 or 30 inches) than wide, in order that the exactnefs of the fcale *a b* may not be diminifhed. M. Van Marum anfwers an objection which he fays may poffibly be urged againft this apparatus, namely, that the combuftion is obliged to be fufpended every time that the gazometers need to be replenifhed with either oxygen or hydrogen. He fays this is no folid objection, as he finds that, fince he ufed platina for conveying the electric fpark, he never fails to kindle the hydrogen the firft moment it enters the balloon; and that, befides, the combuftion of a cubic foot of hydrogen gaz, in order that the water produced may not contain acid, ought to take fix hours. Thofe who wifh to make experiments of longer duration, have only to attach two other gazometers; by which means, while the one fet is emptying, the other may be replenifhed.

For this purpofe it will be neceffary to have, inftead of the cock *u*, two cocks Z 1, Z 2, (fig. 4) fcrewed to a piece of copper fixed to the cover of the balloon; and by which each of thefe cocks has a communication with the bent tube *l m*, by means of two holes *x*, *x*, which proceed obliquely through this piece, and end in the tube *l*. The firft gazometer, which communicates with the balloon by the cock Z 1, being almoft emptied, the cock Z 2, of the fecond gazometer, may be opened, after having made the preffure in the fecond gazometer equal to that in the firft. It is evident that the preffures of thefe two gazometers being equal,

equal, the velocity with which the hydrogen gaz enters the balloon, will not experience the leaſt change. When the firſt gazometer is entirely empty, the cock Z 1 is ſhut, and the firſt gazometer is filled; and the cock Z 1 is not opened till a little before the ſecond gazometer is totally emptied. The ſecond gazometer is then to be filled again, and in this manner the combuſtion of hydrogen gaz may be continued by theſe gazometers to any length of time without interruption. To introduce the oxygen gaz without interruption into the balloon by means of two gazometers, it will be ſufficient that the two cocks, which form a communication between the gazometers and the balloon, be immediately fixed in the covering of the latter.

Both halves of the apparatus being ſimilar, the letters of reference are only marked on that part which is given in outline upon the plate.

XIX. *On the Choice of Steel, and the Methods of hardening and tempering it. By Mr. S. Varley. Communicated by the Author.*

It ſeldom happens that theory and practice are united in the ſame individual: the man of ſcience often labours under a great diſadvantage (notwithſtanding his excellent theories) for want of the experience of the practitioner, and the practical man ſeldom has a theory to guide him. He knows from experience that certain things or operations will produce a particular effect, but can give no reaſon why. His application to buſineſs has not allowed him time to ſearch into cauſes, nor to reaſon upon effects; and it would be difficult to perſuade this uſeful claſs of men how much theoretical knowledge might be gained by applying their leiſure hours to ſtudy, and how much pleaſure might be derived from thus uniting theory with practice, which ſo mutually aſſiſt each other.

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I was led to these reflections by reading Mr. Collier's paper on iron and steel (inserted in the first number of your excellent magazine), in which he gives some methods of hardening and tempering steel; and concludes by saying, that the springs for penknives are covered over with oil before they are exposed to the fire to be tempered, but gives no reason for that application. I shall therefore endeavour to supply that defect, and add some other observations on the management of steel, conceiving that any useful hint on a subject so universally applicable to the manufactories of this country will be of general benefit. It is a subject of the first importance to the practical mechanic: take this useful substance away, and he would be utterly incapable of proceeding one step forward, and would soon be convinced that steel is of more value than gold itself.

For ordinary purposes, the method noticed by Mr. Collier will answer very well, both for hardening and tempering; but in many cases it is necessary that the steel should be of the best quality, and be both hardened and tempered in such a manner as to preserve the greatest hardness possible without brittleness; and steel is of more or less value in proportion as it possesses this property in a greater or less degree.

Steel, when soft, can be wrought into almost any form as well as iron, welding excepted, of which the better sorts, particularly cast steel, are incapable. It can be forged, filed, turned in a lathe, drawn into wire, rolled into large plates, &c. &c. and, when by these means brought into the desired form, it can then be made so hard as to be capable of cutting the hardest substances (the precious stones excepted), while at the same time it is almost proof against being itself worn by friction: but in this state it is brittle, like all other hard substances, and for many purposes must have this brittleness lessened, and this is what is termed by workmen, tempering, and consists in giving it certain degrees of heat according to the temper desired, which may be produced in any degree until the whole effect of hardening is destroyed, and the steel

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is reduced to its soft state. On each of these operations I shall offer a few remarks, proved by long experience; and, first, on the choice of steel for such purposes as require the best that can be procured for making cutting instruments, such as gravers, punches, turning tools, chisels, &c. &c. to be employed in turning or cutting tempered steel, and substances that are too hard to be cut by tools made of ordinary steel: for these purposes cast steel is undoubtedly the best; but even this sort differs in quality.

The general mode of choosing such as is most suitable for the above purposes is to break a bar, and observe its fracture, and to select the closest grained; but this mode is not always certain, owing to the difference made in the fracture by the steel being hammered under a greater or less degree of heat, steel being much improved by being hammered under a low heat, and even when cold; and when overheated, being quite spoiled for the above purpose. It is owing to this circumstance that the best sorts of cast steel are incapable of being welded as above mentioned. Another method is, to harden with as low a heat as possible a piece of steel, and then to break it, and observe its fracture: but this is not wholly to be depended upon; for some steel breaks with a very close grain, and yet is not of a good quality. But the surest method is to have one end of a bar drawn out into a small rod under a low heat, an obscure red for instance, or but little above; then heat it as before, and suddenly plunge it into pure cold water: if it proves hard, and requires a great force to break it, it is good, let its fracture be what it may*; and I have always found that the specimens that hardened with the lowest heat, and when in that state required the greatest force to break them, proved the best steel. Having thus selected steel fit for the required use,

* This circumstance deserves particular attention, as workmen, in general, reject such steel as breaks with a coarse fracture, even though it be of such a quality as to require a great force to break it, after being hardened.

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and, with the precautions already noticed, given it the proper form, it may be hardened; but the fame method will not anfwer for all purpofes. Some pieces, from their fize and figure, are very difficult to be hardened; if they are large, they heat the water in immediate contact with them, and the heat is communicated to the reft of the water, fo faft that it prevents the pieces from being cooled quick enough to produce the defired effect: this is in part prevented by continually moving the piece about in the water; but when too large to be hardened by this method, a ftream of water muft be employed; and for fuch pieces as the face of large anvils, a birch broom is ufed with advantage to break the bubbles that are formed by the continual difengagement of air, and which, if not fwept away, would prevent that intimate contact and uniform fucceffion of the ftream neceffary to produce the degree of hardnefs required. Other articles, from their length, are difficult, and almoft impoffible to be made hard without bending, or otherwife altering their figure: this circumftance occafions a great deal of trouble; and many a piece of work is fpoiled, after a good deal of labour has been beftowed upon it. The method that has fucceeded beft with me is, either to inclofe the piece or pieces intended to be hardened in an iron cafe or box, open at one end (for the more ready dropping the pieces into the water), and giving it a flow, yet regular heat; then to take the cafe out of the fire, and drop the pieces into the water in fuch manner as will allow them to come as little as poffible in contact with the air. This method anfwers two good purpofes at once, caufing the heat to be more equally applied, and preventing the contact of the air, and of courfe any fcaling; and when the work has been polifhed and well defended from the air, it comes out nearly as clean as it was before. When the greateft poffible hardnefs is required, it may be obtained by ufing quickfilver inftead of water; but this can only be employed for fmall articles. For fome purpofes fteel is required to have a fuperior degree

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of hardneſs given to its ſurface, ſuch as in the caſe of files, &c. This is obtained by uſing a coarſe powder made of leather ſlightly burned, hair or horn, either in raſpings or in powder: this is mixed with a little common ſalt, and the files, when juſt red hot, are thruſt into a heap of this powder, ſome of which adhering to their ſurface is carried into the fire with them, and gives them a caſe hardening: the ſalt fluxes upon their ſurface, and defends them from the air while paſſing from the fire into the trough of water, into which they are plunged to harden. The workmen ſay, the longer this water is uſed for this purpoſe the better.

We are now come to the laſt proceſs called tempering, for one method of which ſee Mr. Collier's paper; but that method cannot be conveniently applied in all caſes, and has ſeveral diſadvantages, ſome of which I ſhall mention. Firſt, each piece muſt be made bright that the change of colour may be better ſeen, and muſt be heated ſingly or nearly ſo; and pieces of irregular figure cannot be made to receive an equal degree of heat in all their parts, ſo that ſome will be ſofter than others. Theſe circumſtances would retard the manufactory of many articles very much, and prevent their being afforded at the preſent prices, ſuch as the ſprings of gun locks, door locks, various articles in clock and watch work, &c. &c. The neceſſity of making them bright enough to mark the change of colour is obviated by ſmearing them with oil or tallow, which helps to apply the heat more uniformly, and marks the temper as well as by obſerving the colour, or nearly ſo; or by putting the things to be tempered into a proper veſſel, and adding ſo much oil or tallow as will cover them, and then holding them over the fire or the flame of a lamp until a ſufficient heat is given. By this means the moſt irregular pieces may be uniformly heated, and great numbers may be done at one time, and with great certainty: thus are clock and watch pinions, watch verges, balances, &c. tempered; ſometimes many dozens at once; and no more time is neceſſary for the whole

whole than would be for one fingle article. The requifite temper may be known by the following circumftances: When fuch a heat is given that the tallow is firft obferved to fmoke, it indicates the fame temper as that called a ftraw colour: this will reduce the hardnefs but little; but if the heat is continued until the fmoke becomes more abundant, and of a darker colour, it will be equal to a brown, and indicates a temper that may be wrought—that is, which may be turned or filed, but with difficulty, and only when a mild fort of fteel is employed. If the tallow be heated fo as to yield a black fmoke, and ftill more abundant, this will denote a purple temper; and if the fteel is good, it will now work more pleafantly, though ftill hard enough to wear well in machinery. The next degree may be known by the tallow taking fire if a lighted body is prefented to it, but yet not fo hot as to continue to burn when the light is withdrawn; this would equal a full blue colour. Increafe the heat till the tallow continue to burn, being once lighted, and this will denote a pale blue: and if the whole of the tallow be allowed to burn away, or to burn dry, as the workmen call it, it gives what clock-makers moftly ufe for their work. Farther tallow is ufelefs; a fmall degree of heat more would juft be feen in a dark place, or the loweft degree of a red heat: fuch is the temper given to the fprings for coaches, &c. Thus I have given a reafon why oil or tallow is made ufe of, and given you the parallel degrees of temper which by a dry heat are obferved by the change of colour only. The method of hardening in quickfilver is of great ufe where a fuperior degree of hardnefs is required; and good fteel fo hardened, when the precautions before mentioned are duly attended to, will cut glafs like a diamond, and turn or cut other fteel at fo high a temper as to differ but little from quite hard.—Perhaps at a future time I may give you a method by which this hardeft of fteel may alfo be worked with confiderable eafe, and the cafes in which I have applied it to advantage.

INTELLIGENCE.

LEARNED SOCIETIES.

GERMANY.

ON the 9th of August last the Academy of Sciences at Berlin held a public sitting in honour of his Majesty's birthday, on which occasion the following prize questions were announced:——

MATHEMATICS.

The mathematical class had proposed for the year 1798 the following prize-question:

"As the labours of the ablest astronomers have left several points respecting the variation in the obliquity of the ecliptic to be explained, the Academy invites the Learned to turn their attention to this subject once more, and will adjudge the prize to that paper which shall contain the most interesting researches on it.

"One paper only on this question has been transmitted to the academy, with the motto *Tamen usque recurret*; the author of which seems well acquainted with the subject, and fully capable to examine it thoroughly. In many places he has followed the calculations of M. Schubert, published in the tenth volume of the New Transactions of the Imperial Academy of Petersburgh; and has brought together, in a small compass, a great many interesting results. As the shortness of the time, however, did not permit him to give his own observations at sufficient length, and as the object of the academy was to see removed, as far as possible, the difficulties with which the subject is still attended, it has resolved to propose the question again for the year 1802, with a double prize; and, to place its meaning in a clearer point of view, requests the learned, and the author of the above-mentioned paper in particular, to attend to the following confiderations:—In regard to obfervations of the obliquity of the ecliptic, aftronomers do not appear to be yet fully agreed. The academy wifhes, therefore, that thefe obfervations may be carefully examined, and particularly that the following queftion may be explained: How far can the old obfervations be employed with advantage, and how far back may we venture to go in making ufe of them?—In regard to the theory, one of its moft important principles, without doubt, is to determine the maffes of the perturbing planets, and efpecially of Venus. The academy defires that thefe may be deduced from principles independent of the obliquity of the ecliptic; and, above all, that the candidates will endeavour to difcover how the mafs of Venus may be determined from confidering the motion of the nodes, notwithftanding the difficulties which the movement of the ecliptic oppofes to this refearch; and alfo how a fmaller mafs affigned to Venus than that found by M. de la Grange, would agree with the motion of the apogeum of the fun, as the contrary feems to arife from the formulæ of that great geometer. Laftly, how far Herfchel's obfervations of the fatellites of Uranus are fufficient to determine the mafs of that planet.—The application of the general folution of the problem would become much more ufeful, if none of the planets were omitted to be taken into confideration; for in that cafe the equations, which arife, might be compared with thofe obtained by M. de la Grange, by his folution. And, on this occafion, the queftion propofed by himfelf will occur, viz. Whether the maffes of the planets, let them be what they may, provided they are pofitive, will give the equations at all times with pofitive and unequal roots?—In regard to the mean values, the *maximum* and *minimum*, the periods of the variation, &c. fhould any direct method be difcovered of determining them, it would be neceffary that the author, confidering the complex nature of analytical expreffions, fhould be as accurate in his calculations as poffible; but if they are determined by repeated trials, it is

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required that the author will at least bring proofs *à posteriori*, that the results found are subject to no doubt. To conclude, the academy is far from requiring that all these conditions should be fully and completely complied with. It will, without hesitation, adjudge the prize to that paper which shall present new and satisfactory conclusions in regard to one article only of so abstruse a matter; for it has given such extent to the question, merely to open a wider field to those who are fond of employing their time in astronomical researches."

BELLES LETTRES.

The class of the Belles Lettres has announced the following prize-question for the year 1800;

On the Goths and Gothicism.

"1. Had the Goths, as a nation particularly distinguished among those which overturned the Roman empire in its decline, any thing peculiar either in their disposition, laws, manners, and customs, or in regard to their literature and arts?

"2. Are the expressions *Gothic* and *Gothicism* any thing else than appellations employed at later periods to indicate the general state of the arts and sciences after the downfall of the Roman empire, and in the middle ages? And,

"3. If this be true, when did the above expressions begin to be introduced into common use?"

PHYSICS.

The Physical class has announced the following questions:

"The late M. Cothenius having left to the academy, of which he was a member, a legacy of a thousand dollars, and two years interest due on the same, to be distributed as prizes for answers to questions in agriculture, economy, and gardening, the physical class, to which the disposal of this money was entrusted, finds itself at present enabled to propose two questions, at the same time, in regard to the above subjects,

subjects, and to offer for the best paper on either a prize of a hundred dollars, to be adjudged in the year 1800.

"1. As it is a certain fact that the base of carbon contained in the usual animal and vegetable manures is one of the principal articles of nourishment to plants, what other substances are there which may be substituted in agriculture for common manure, and may be employed with the like essential advantage for promoting vegetation?

"It is requested that those persons who propose answering this question, of so much importance to agriculture, will ground their proofs not merely on theory alone, but in particular on experiments properly made and accurately observed.

"2. By what process, and from what seeds, such as those of flax, poppies, the sun-flower, or other oily seeds, which can be procured without great expence, or be cultivated in abundance, can an oil be extracted, to supply with advantage the place of olive oil, and which can be preserved a sufficient length of time in a good condition?—The goodness and quality of oil procured by expression, depends, without doubt, not only on the nature of the seeds, but also on the process employed to obtain it. The physical class wishes, therefore, that those desirous to answer this question will attend to two circumstances, viz. to the seed, that it may be of a kind fit for yielding good oil, and also to the process best calculated to produce it as pure as possible."

Letter from his Prussian Majesty to the Academy of Sciences at Berlin. Read in the Sitting of the 19th of April.

AFTER procuring the necessary information respecting the present state of the Academy of Sciences at Berlin, it appears to me requisite to make some changes, calculated to ensure to that institution an existence equally honourable and useful for the public good.

I cannot conceal from the academy, that its labours, taken in the aggregate, have always appeared to me too little directed towards the public benefit. It has confined itself too much to the discussion of abstract subjects, and to enriching metaphysics with speculative theories and learned discoveries; and has not paid sufficient attention to direct its labours to objects of real utility, the improvement of the arts and sciences; a service by which the Academy of Paris, for example, notwithstanding its many defects and vicious organisation, formerly distinguished itself. I could wish then that the Academy of Berlin would *humanise* itself more, if I may use the expression, than it has hitherto done, by giving encouragement to efforts that contribute to the happiness of common life, to the improvement of every thing that concerns its wants, and to its conveniences, by the constant application of the theory of the sciences to things, rather than to speculative meditations; that it would excite the national industry, which so often makes attempts in new channels without success for want of the necessary knowledge, by furnishing it with the principles suited to that art which it exercises; that it would endeavour to purify the different systems of moral and literary education from many vague and erroneous principles, which fashion, and the imagination of some enthusiastic pedagogues, have introduced, and which must degrade future generations; and that it would combat the prejudices and delusions of the people, as well as the licentious and destructive efforts of the false philosophers of the present day.

It is by directing the labours of the different classes of the academy towards objects of this nature, and towards a multitude of others, the influence of which is equally salutary to the state and to its subjects, that this institution can acquire the most glorious titles to the gratitude of the public. The talents of its members authorise me to entertain great hopes, and seem to have need only of permanent impulse in a good internal direction. It belongs to the academy to call forth the principles of it from its own bosom. The following are a few general points, which may ferve as a basis for a new arrangement. The academy, after having maturely weighed them, will make the application of them in detail, and will draw up articles of regulation, which it will take care to lay before me to receive my approbation and signature.

The ancient regulations of the academy, above all that of the year 1746, will be retained, and put in force so far as they are not abrogated by the new.

I shall take care to appoint a president distinguished by his rank and literary talents. His duty, above all, being to maintain the established order, to concentrate and direct the labours and talents of the different members towards objects useful to the public and honourable to the academy, to watch over the administration of its finances, and be its organ with my person, it will be necessary to fix the extent and limits of his functions by an express article.

The economical commission of the academy, which has hitherto subsisted, shall be abolished, and its place supplied by a directory *. The members who composed the commission shall however be maintained in the enjoyment of their pensions.

The directory shall be formed of a president, the four directors † of the classes, and two members, to be chosen not from the academy, but men of business, equally distinguished by their literary merit, and capable of preserving the necessary order in the economical state of the academy. I propose for filling these places, Suarez ‡ privy counsellor of justice, and Borgstede § privy counsellor of finances, who at the same time will be elected members of the academy.

Every thing which relates to the general direction of the academy as a body, to the maintenance of internal order,

* The ex-minister J. Ch. Wöllner assisted at the sitting of March 29, as chief of the economic commission for the last time.

† H. B. Merian, J. Bernoulli, F. K. Achard, and Ch. G. Selle.

‡ Died on the 14th May 1798.

§ Installed in the sitting of May 3.

the management of its finances, and, above all, the direction of the academy towards objects of public utility, ſhall be the province of the directory. Its deliberations ſhall be decided by a plurality of votes. Each member ſhall have one, and the preſident two.

The influence and rights of the directors in their claſſes ſeem alſo to require to be more particularly defined and regulated; and the academy will take care to make proviſion on this head by an article in its regulations.

The members of the academy ſhall be either honorary, or ordinary. The former, not being properly obliged to engage in its labours, cannot enjoy any of the lucrative advantages of the academy, except in regard to medals in caſe they are preſent. The ordinary members ſhall be divided as hitherto into four claſſes.

Each claſs ſhall be compoſed of a director and ſix members, which will form a whole of 24 academicians, beſides the members of the directory. It will be proper to adhere in future to that number, and not to admit new members but when there are vacancies. There can therefore be no new election but when the members of each claſs are below ſix in number. As at preſent there are claſſes which have more, it may perhaps be poſſible to transfer ſome of them to the claſſes which have not the fixed number, or to thoſe which have fewer ſupernumeraries, in order to eſtabliſh a kind of equality between the claſſes, and by theſe means to approach as near as poſſible to the order to be obſerved in future. In the laſt place, the right of electing its members ſhall be preſerved to the academy; and this election ſhall be determined by a plurality of voices of all the members. I, however, reſerve to myſelf that of confirming or rejecting.

The large public library at Berlin, as well as the collection of natural curioſities, ſhall be united in future with the academy, and entruſted to its direction. It will be therefore neceſſary to determine, by a regulating article, the arrangements to be made in that reſpect; and as it will be requiſite

that

that the principal librarian be an academician, the academy will have the leſs heſitation to admit Dr. Bieſter * among its members, as his knowledge and literary merit have already enſured him the ſuffrages of the public.

To conclude, though I am diſpoſed to preſerve to the academy the enjoyment and adminiſtration of its funds and revenues, I, however, reſerve to myſelf the right of deciding more particularly on this ſubject, after the new ſtate of its economy for the next year ſhall have been preſented to me for ſignature. In regard to that of the current year, which accompanied the letter of the 28th, it is herewith returned.

FREDERICK WILLIAM.

1798. Received April 11th.

Electoral Academy of the Uſeful Sciences at Erfort.

IN the ſitting of January 2d, 1798, a paper was read by F. von Dalberg, *On the gamut and muſical ſyſtem of the antient Hindoos.* The author took as the grounds of his diſſertation a paper of the late Sir William Jones, publiſhed in the *Aſiatic Reſearches*, and combined with it what he had learned during his reſidence in Italy and England, partly from the converſation of Richard Johnſon, the friend of Sir William Jones, and of others; and partly from manuſcripts. He brought as proofs, that the Hindoos were acquainted with the art of noting muſic, not only ſeveral of their muſical pieces and a figure of their principal inſtrument called *vina*, but alſo their mythology, in which their principal tones and notes are perſonified as deities, which have been hitherto unknown. M. von Dalberg obtained figures of theſe, collected by Johnſon in India, in order that they might be engraved. In the writings of the Hindoos every thing is perſonified. According to their ideas, muſic, like all the other fine arts, came from heaven. They conſider muſical tones as real beings which marry other tones; and hence

* Inſtalled in the Sitting of April 26.

arises

arises the affinity of the gamut or musical scale, &c. This paper will be printed.

At the same time was read a paper transmitted to the academy by Major George Vega, entitled, "Mathematical considerations on the directions of gravity, the length of a pendulum that swings seconds, the method of determining the latitude from the true elevation of the pole, and the length of a degree of the meridian in different latitudes, by means of a solid globe revolving with an equable motion round an immoveable axis; as also on the form of the surface of the water in a state of equilibrium on such a globe; and on the necessity of correcting the apparent latitudes or altitudes of the pole, in order to obtain the real latitudes, both by calculating the distances of places from their longitude and latitude, and also by delineations made on a portion of such a globe, upon any projection at pleasure, regard being had to the spheroidal form of our earth."

M. Burckhardt transmitted to the academy a paper under the following title, which was also read: "On the employment of combinatory analysis for determining the sines, tangents, &c. of the sum of several angles, when the sines, tangents, &c. of single angles are given."

A paper was transmitted likewise from M. Topfer, on the doctrine of combination, and its application to analysis.

In the sitting of February 3, was read a paper on the Ηθικα Μεγαλα, transmitted by Dr. W. G. Tennemann at Jena. In this paper, which will appear in the Transactions of the Academy, the author endeavours to shew, that the so called *magna ethica* of Aristotle are an extract from those of Nicomachus.

Some remarks were then read by M. Zizman on the cultivation and employment of the monarda (oswego-tea) as a spice. The author found the *monarda fistulosa* and *didyma* Linn. to be plants, the leaves, flowers, and, in particular, the seeds of which might be substituted for many

kinds

kinds of fpiceries. The leaves, befides other ufes, may be employed as tea; the flowers improve the tafte of brandy, and give it a flavour like that of peaches, &c. The moft important part, however, is the feeds. The author defcribed the method of cultivating this plant, and alfo of preferving it.

Profeffor Trommfdorf at Erfort tranfmitted a paper entitled, "Collections towards a more accurate knowledge of the nature of Strontian earth."

FRANCE.

IN the public fitting of the National Inftitute Vendemiaire 15, after an account had been read, by the fecretary of each clafs, of the labours of the Inftitute, C. Camus gave an account of the labours undertaken by the Inftitute as a body, or executed under its direction.

C. Cuvier read a learned though fimple and clear memoir on an animal, bones of which are found in the plafter ftone in the neighbourhood of Paris. He began by explaining how a fingle bone, efpecially if it belong to the head, or an articulation, is fufficient to make known very nearly the whole ftructure of an animal, refpecting which naturalifts have no other knowledge. A tooth, for example, faid he, indicates whether an animal is carnivorous, or feeds upon vegetables. If it is carnivorous, its ftomach is formed in a certain manner; the animal unites with the means of attack and defence the agility neceffary to reach its prey: its feet muft have a certain form: in a word, it has all the habits common to that kind of animals, &c. After explaining this principle, C. Cuvier applied it to the bones found in the quarries of plafter ftone, and which are fo abundant that not a decade paffes but the workmen break feveral of them in digging out the ftones. He examined a great many of thefe bones, and thinks himfelf authorifed to affert, that they belong to a graminivorous animal fimilar to the camel, not now exifting alive in any known country.

C. Dé-

C. Défessarts produced some new facts in support of his system, that the natural small-pox may be rendered much more favourable by the proper use of some mercurial applications. He, however, expressed a wish of seeing inoculation become more general, and that this cruel malady may be altogether destroyed by weakening its malignity.

C. Bougainville, distinguished both as a writer and a navigator, read the first part of his Historical Essay on Ancient and Modern Navigation in high northern latitudes.

C. Langles read a memoir on the language and literature of the Arabs.

C. Lacepede shewed, from the industry displayed by birds in the structure of their nests, the measure of the different degrees of their instinct, and of the attachment they have to their females and young.

A friend read for C. Rœderer an explanation of the motives which induced his class to propose as the subject of a prize, "An examination of the institutions best calculated to lay a foundation for morality among nations."

C. Fourcroy gave the result of some experiments which he made in concert with C. Vauquelin, to analise the stone formed in the human bladder. These two chemists think it possible to dissolve in the living subject this fatal accumulation, which occasions the most acute pains; and they hope that the result of their labours will render unnecessary in most cases the dangerous operation of cutting *. This will form a new benefit of chemistry, already so useful in its application to the arts of industry.

The sitting was terminated by C. Ducis reading his *Epitre à Vien* on the great revolution which has taken place in painting since the middle of the present century, a revolution which he chiefly ascribed to the precepts and examples of Vien.

* Water impregnated with carbonic acid gas, and drank for some time as a common beverage, has been found to dissolve the stone. EDIT.

MISCEL-

MISCELLANEOUS.

BOTANY.

THE plants brought from America and the Weſt Indies by Captain Baudin, and contained in a hundred and fifty boxes, are in a high ſtate of vegetation. Several of them have produced flowers, ſuch as a ſpecies of bignonia, (*bignonia pentaphylla* L.) Its flowers, of a fleſh colour, are larger than thoſe of the *catalpa*, and have the ſame form. A kind of *tournefortia*, which appears new; an *euphorbia*, the leaves of which are of an agreeable green colour, and have a little reſemblance to thoſe of the ſumach; and, laſtly, the *jatropha goſſipifolia* L. The laſt has begun to exhibit fruit.

Among this great variety of foreign trees there are ſome which it is hoped may be naturaliſed in the ſouthern departments of France, ſuch as the alligator pear (*laurus perſea* L), a tree which the Spaniards tranſplanted from the New World to the kingdom of Valencia, where it produces fruit. Its fruit is pulpy, of the ſize of a very large pear, and is eat with ſalt and pepper. The papaw tree (*carica papaya* L). There are alſo ſeveral alimentary plants, ſuch as two kinds of yams, *dioſcorea alata* and *dioſcorea aculeata*, with the white and red potatoe, *convolvulus batatas*, &c.

Among the curious plants are remarked in particular a ſpecies of fern, the ſtem of which is three feet and a half in height and three inches in diameter, and is at preſent terminated by two leaves more than two feet in length, and having very fine and equal diviſions.

The four kinds of palms begin to ſhoot, and above all the cabbage palm. Theſe majeſtic trees ſeem likely to become naturaliſed to the climate of France.

A SINGULAR PHENOMENON IN REGARD TO CREAM.

The following ſingular phenomenon is announced in the *Journal de Phyſique, Thermidor 6th*, 1798, by Cit. de Serain *officier de ſanté* at Saintes.—“ This ſummer I was witneſs

neſs to an extraordinary fact, to me totally new, and which, in my opinion, cannot eaſily be accounted for. One day when ſome people in this neighbourhood were preparing to churn butter, they were aſtoniſhed to find all the cream of a fine Pruſſian-blue colour. The caſeous part was only blueiſh. Every attempt to diſcover the cauſe of this extraordinary colour was fruitleſs, though the cream exhibited the ſame appearance for nearly three months. It cannot be aſcribed to the veſſels in which the milk was generally preſerved, as they were always kept perfectly clean, and covered with fir-boards. The cows were in exceeding good health, and fed on meadows on which they had grazed for ſeveral years. This milk was uſed as food without any hurt enſuing, and it betrayed no particular taſte; but the cream and caſeous parts were thrown away, as they inſpired ſome dread. The cream gradually changed its colour; but this could not be aſcribed to the means employed during the continuance of the phenomenon, means indeed ſo ridiculous that I do not think it worth while to detail them.

"In the Ephemerides of the Curious of Nature, Dec. 2d, 1688, we find inſtances of milk being coloured green, black, red, and yellow; but I am acquainted with no obſervation ſimilar to that above mentioned."

MEDICINE, SURGERY, &c.

A ſmall work, conſiſting of 30 pages octavo, has been lately printed at Vienna, and diſtributed gratis: entitled, "An account of the ſimple means employed in the Hoſpital of St. Anthony at Smyrna to cure the Plague, and preſerve People from its infection. By Leopold Count von Berchtold, knight of the military order of St. Stephen of Tuſcany." Mr. Baldwin, the Britiſh conſul at Cairo, having found by repeated experiments that rubbing the whole body with warm oil was the ſureſt means to cure the plague, as well as to guard againſt its infection; a Franciſcan clergyman, overſeer of the Hoſpital of St. Anthony, had, in conſequence of this information, employed the ſame means

means with the happieſt effects. To make known this diſcovery, of ſo much importance to thoſe nations that carry on trade in the Levant, and with the coaſt of Barbary, Count Berchtold reſolved to publiſh the proceſs; of which 3000 copies have been printed in the German, as many in the Italian, and 6000 in the Turkiſh language. The work contains an account of the method of uſing the oil, with ſome obſervations on the regimen proper for patients attacked by this diſeaſe; and an Appendix, containing certificates of cures already performed, and a liſt of the places where the above method has been practiſed with ſucceſs.

In a little tract juſt publiſhed by Dr. Tazwell (ſecretary to Mr. Geary, the late American miniſter,) at Paris, a new method is announced of employing the nitrous acid in the ſyphilis, which we are informed has been uſed with great ſucceſs at Paris. As it is there conceived to be an improvement upon the preſent modes of adminiſtering oxygen in ſyphilitic ulcers, &c. and as the practice with the nitrous acid is at preſent a ſubject of ſome controverſy, it may not be unworthy of the attention of our medical readers. Dr. Tazwell's formula is as follows:

Oxygenated Ointment (invented by Alyon).

℞. Take hogs lard lib. j. melt it over a ſlow fire, and then add of nitric acid (of 32 degrees) ℥ ij. Keep carefully ſtirring the mixture over the fire with a glaſs rod till it begins to boil, and then ſet it by to cool.

It is of great benefit in caſes of ſyphilitic ulcers, herpes, and pſora.

The author adds the following note: "This preſcription was communicated to me in the month of Prairial, laſt year, by my worthy friend the inventor, who has ſince publiſhed it in his work entitled *Eſſai ſur les proprietes medicinales de l'oxygen,* which has juſt appeared.

M. Herbolt, an eminent accoucheur at Copenhagen, ſays he, has made a diſcovery highly intereſting to humanity.

Repeated

Repeated experiments have convinced him that one of the moſt frequent cauſes of the apparent death of ſo many new-born children, ariſes from the trachea being filled with water; and that they might in general be ſaved, by giving them ſuch a poſition that the water ſhould run out. Of thirteen children conſidered as dead, and which were committed to his care, twelve were reſtored to life by the above ſimple means.

The above is announced in a foreign Journal, but appears evidently to be founded upon ſome miſtake. By the experiments of Dr. Goodwyn it appears impoſſible that water can of itſelf in any caſe enter the trachea: even drowned people are not ſuffocated by this means, but by the mere excluſion of the oxygen of the atmoſphere neceſſary to ſupport animal life. In thoſe experiments in which water has been forced into the trachea, it has always been abſorbed, if the animal was ſuffered to live.

In our laſt Number, (p. 426.) by a miſtake of the Printer, the following obſervation was omitted after the article on the production of cold by compreſſed air:

The explanation given of the phenomena in the Journal de Phyſique, from which we extracted this article, is inadmiſſible in the preſent inſtance; for it has been proved by Dr. Darwin's experiments, publiſhed in the Philoſophical Tranſactions, that cold is produced by compreſſing air even where water is not preſent, and that the heat of the air is abſolutely ſqueezed out by condenſation, and paſſes out through the ſubſtance of the condenſer. The compreſſed air therefore, when allowed to eſcape, muſt rob water, or any ſubſtance with which it comes in contact, of a portion of its heat.

THE

PHILOSOPHICAL MAGAZINE.

NOVEMBER 1798.

I. *Description of the* Equus Hemionus *or* Dſhiggetai *of the Eaſtern Deſerts of Middle Aſia**. *By Profeſſor* PALLAS. *From* Neue Nordiſche Beytrage, *Vol. II.*

NATURALISTS hitherto have diſtinguiſhed only three ſpecies of the genus horſe, or animals which have not cloven hoofs, viz. the horſe and the aſs, which are both found wild in the deſert regions of Aſia, and the beautiful ſtriped zebra †, which, with ſo many other ſingular animals, is peculiar to Africa. I have had an opportunity, however, of becoming acquainted with a fourth ſpecies (Plate V. fig. 2.) the Mogul name of which has been long known in Europe. But reſpecting this animal zoologiſts as yet have been under great doubts; becauſe the accounts given of it were either defective or little to be depended on, as might readily be ex-

* See Profeſſor Pallas's Travels, in the original, p. 217; and *Nova Comment. Petropol.* tom. xix. p. 394. tab. 7. Equus Hemionus.

† It has been proved by Dr. Sparmann that thoſe animals, before conſidered by naturaliſts as the males of the zebra, are a particular ſpecies, which rove about in herds; and, conſequently, form the fifth kind of *ſolidungula.* They are called, at the Cape, by the Hottentot name of *quagga.*

 pected

pected in regard to an animal ſo ſwift, and at the ſame time ſo ſhy, that it carefully ſhuns all inhabited diſtricts, and is ſcarcely ever to be found but in the mountainous deſerts of Eaſtern Tartary, between Siberia, India, and China. I have thought proper to give to this animal the Greek name *hemionos*; which the ancient Greeks applied not only to the mule, but alſo to a wild timid ſpecies, capable of propagating, ſimilar in form to the mule, which were, in ſome meaſure, known to them, and which probably were the ſame as the *dſhiggetai*. Ariſtotle is the firſt author who mentions this animal, in the ſixth book of his Natural Hiſtory, where he diſtinguiſhes it very clearly from that produced between the horſe and the aſs, or the aſs and the mare; and he gives it the name of *hemionos*, becauſe this ſpecies, which were then found in a wild ſtate in Syria, and exceedingly timid, had as great a reſemblance to the mule as the wild aſs has to the tame *. This ſuppoſed ſpecies of wild half-aſs, nine of which were brought to Phrygia, under the reign of Pharnaces, where they were long preſerved, and of which three were alive at the time when Ariſtotle wrote, propagated regularly, and were therefore a peculiar ſpecies and not a baſtard race. The ſame author mentions this circumſtance expreſsly, and alſo Syria the native country of the animal, in the twenty-fourth chapter †. This animal, admitted by Theophraſtus, is mentioned likewiſe by Pliny ‡, who gives Theophraſtus as his authority; and it is probable alſo that Ælian alludes to it in a paſſage where he ſays: "In India there are herds of wild horſes and wild aſſes; and the wild

* Εισι δὲ εν Συρίᾳ οἱ καλέμενοι ἡμίονοι, ετερον γενος των εκ συνδυασμȣ̃ γινομενων ἵππȣ και ὄνȣ, ὅμοιοι δε την ὄψιν, ὥσπερ καὶ οἱ ἄγριοι ὄνοι προς τȣς ἡμέρȣς, απο τινος ὁμοιότητος λεχθεντες εισὶν, ὥσπερ οἱ ὄνοι αγριοι και ἡμίονοι, την ταχυτητα διαφέροντες, αὗται αἱ ἡμιονοι γεννῶσιν εξ ἀλληλων· σημεῖον δὲ ἦλθον γαρ τινες εις Φρυγιαν επι Φαρνακȣ τȣ Φαρναβαζȣ πατερος, και διαμενȣσιν ἔτι· εισι δε νυν μεν τρεῖς, το παλαιὸν δ' ἐννέα ἦσαν ὥς φασιν. Ariſtot. Hiſt. Animal. lib. vi. cap. 36.

† Αἱ δε εν τη Συρίᾳ τη υπερ Φοινίκης ἡμίονοι και ὀχευονται και τικτȣσιν. Lib. vi. cap. 24.

‡ Hiſt. Nat. lib. viii. cap. 44.

mares

mares copulate readily with the latter, and produce mules of a red fox colour, which are exceedingly ſwift. They are very untractable; and when caught in gins are ſometimes carried to the king of the Praſians. Thoſe of two years old, or under, can be tamed; but the old ones are as wild as the fierceſt of the carnivorous animals *."

For the earlieſt account of the exiſtence of this ſpecies of the horſe in modern times, we are indebted to the diligent Meſſerſchmidt, who from the year 1720 to 1726 travelled through Siberia, by command of Peter I. for the purpoſe of making diſcoveries in natural hiſtory. Beſides this traveller and Gmelin, who explored the ſame diſtricts twenty years after, no one before me has had an opportunity of examining this animal with the eye of a naturaliſt. Meſſerſchmidt diſtinguiſhes the dſhiggetai, very properly, from the horſe and the aſs; and notices it in his *Xenium Iſidis Sibiricæ*, or Catalogue of the natural productions of Siberia; the manuſcript of which is ſtill to be ſeen in the academy of Peterſburgh †, under the name of *Mulus dauuricus fœcundus Ariſtotelis, Cappadocicus Ereſii*, which name was employed in the printed catalogue of the collection of natural curioſities at Peterſburgh, where a ſtuffed ſkin of it, deſtroyed afterwards by a fire, was preſerved, and which Buffon has improperly taken for an obſcure definition of the *onager* or proper wild

* Εν Ινδοις ἵππων τε ἀγρίων καὶ ὄνων τοιότων ἐισὶν ἀγέλαι· ὀχεῦν αναβαίνοντων ονων τας ιππυς ὑπομένειν ἐκείνας λέγυσι, καὶ ἥδεσθαι τῇ μίξει, καὶ τίκτειν ἡμιονυς πυρσὺς την χρόαν καὶ ἄγαν δρομικὺς, δυσλόφυς δὲ καὶ γαργαλεῖς ἄλλως· ποδάγρα ς δὲ τυτυς αἱρῦσι εἶτα ἀναγεσθαι τῷ τῶν Πραισίων βασιλεῖ φασι· καὶ διετεῖς μὲν ἑαλωκότας μὴ ἀναίνεσθαι την πώλευσιν, πρεσβύτατυς δὲ μὴ διαφέρειν τῶν καρχάρων θηρίων καὶ σαρκοφάγων μηδε ἕν. Ælian. de Animal. lib. xvi. cap. 9.

† *Catalogus Muſæi Petropolit.* tom. i. par. 1. p. 335. In the abovementioned *Xenium Iſidis*, Meſſerſchmidt gives to this animal, beſides the Mogul name, which he writes *tzigitai*, the Tangut appellation *kſching*, and the Indian *kitſchara* or *dſhengli-kitſcharah*. But when he wiſhes to apply to it alſo the *parad* of the Bible, the *hamar iwaſchi* of the Arabians, the *thar-kurah* of the Perſians, and the *kolan* or *kulann* of the Tartars, he evidently confounds the *onager* or wild aſs with the *dſhiggetai*.

ass*. The description given of this animal by Messerschmidt, which, as he says in his journal, was made from three that had been shot, is all, except what is inserted in the said journal, unfortunately for the farther osteology of the *dshiggetai*, now lost; and this description, as well as the journal, has never yet been printed.

Gmelin, when in Dauuria, did every thing in his power by sending out hunting parties to procure one of these animals, but without success†. Afterwards, however, by the care of his friend and fellow-traveller Müller, he had an opportunity, in returning from the Lena, to draw up a description of this animal at Irkuzk; but this description, which still lies in manuscript among other papers, is so unintelligible, that it is almost useless for the naturalists of the present day. Zoology, in general, was not Müller's principal talent; and however much service he may have rendered to botany, his descriptions of animals, as may be seen by the specimens published, are exceedingly defective. During my travels through Siberia, I considered this animal as almost unknown; for the Jesuit missionaries, who on various occasions have made excursions from China into the Mogul provinces, say little more of it, in the accounts of their travels, than merely to mention its name‡.

I was at great pains therefore, and spared no expence during my travels, particularly when in the neighbourhood of the solitary deserts on the borders of the Russian empire, to procure the *onager* or wild ass, as well as the *dshiggetai*, and to acquire a more accurate knowledge of these animals. All my exertions, however, were attended with no success, till I arrived, in the spring of the year 1772, in the most distant district of Dauuria, which begins between the rivers

* Hist. Nat. tom. xxiv. p. 6, note.

† *Reise durch Sibirien*, part 2, p. 107, where a short but accurate description of this animal is inserted from the information of the Moguls.

‡ Wild mules are mentioned under the Chinese name of *ye-lo-tsee*, which expresses that appellation, by Du Halde in his Description of China.

Onon

Onon and Argun, and extends southwards towards the country of the Moguls and the great desert of Gobi. In these wastes, which are very thinly inhabited, where Messerschmidt and Gmelin became acquainted with the dshiggetai, I was so fortunate as to obtain a description of this rare animal. The neighbourhood of the river Argun is the part within the boundaries of Siberia where these animals are still to be found; for they have long since retired from the rest of Dauuria, where they once abounded, to the Mogul deserts, on account of the increase of population in the former. They frequent, in general, the whole extent of the desert of Gobi, as far as the boundaries of Thibet and India; but they are most abundant in the dry plains near the lake Tarei, which afford plenty of herbs and pools of salt water, and in the hilly districts of Abagaitu. The rest of Dauuria abounds with rocky and high mountains covered with snow, which, as well as districts covered with wood, these animals never frequent.

These animals were found formerly in herds in the districts near the Argun. At present, however, none are seen there but single ones which have strayed, or small dispersed herds, except when great drought takes place in the Mogul districts, and drives them northwards. In the country of the Moguls, on the other hand, and particularly in the above-mentioned desert of Gobi, they are at all times collected into large herds; and are well known to the Moguls and the Tungusians under the name of *dshiggetai*, which signifies *long-eared*. They must also extend themselves to the country of Soongarey, because they were known to the Soongarey Calmucs, whom I had an opportunity of conversing with on the Wolga, under the above name, as an animal totally different from the wild ass; which they call *kulan*, and which by the wild Cossacs is called *takia*. But in the western part of Great Tartary it appears, that the dshiggetai is never found; for the Kirgisians are acquainted with no middle animal between the wild horse and their kulan or

 wild

wild afs. It is not improbable that the great Altai mountains form the boundaries of its native country on the eaft towards the extenfive ridges of Thibet and India; for the accounts of travellers who have fpoken of wild affes in Syria and Perfia, are not accurate enough to enable us to judge whether the dfhiggetai is found in thefe countries, which I very much doubt.

The dfhiggetai feeks the open dry plains and the declivities of mountains covered with good nourifhing herbs and grafs, as is the cafe with all Dauuria and the country of the Moguls, which are full of mountains. It is faid that they feldom approach the water, and that they can continue a long time without drinking; which, to an animal deftined to live in deferts, where often for a hundred werfts there is not to be found a drop of drinkable water, is a very neceffary property.

The onager and the wild horfe have yielded to the perfeverance and courage employed by man to tame them, and render them fit for being draught animals, and animals of burthen; but the dfhiggetai, like the African zebra*, has never yet been tamed, though the Moguls, who are born horfemen and fhepherds, have often tried to breed foals of this fpecies which they have caught. I am however of opinion, that we ought not to abandon all hope of rendering the dfhiggetai a domeftic animal, if ferious attempts were made in Dauuria on foals when caught and fhut up in proper enclofures, which no wandering people have an opportunity of doing. Should fuch an attempt fucceed, mankind would procure in this animal, if broke for riding, not only the fleeteft and fwifteft hunter, but give to the eaftern part of Afia, India and China, in particular, where the common horfe, as is well known, does not thrive, a far more ufeful draught animal, becaufe thefe regions are as it were its na-

* The opinion entertained of the impoffibility to tame the zebra has been however contradicted by the one reared at Lifbon and taught to draw in a carriage. The cafe perhaps will one day be the fame with the dfhiggetai.

tive

tive country. That the fruitlefs attempts made by the Moguls do not prove the intractablenefs of the dfhiggetai appears probable from this circumftance, that the Kirgifians affert the fame thing, on account of the fruitlefs attempts they have made in regard to the onagers or wild affes, which wander through their territories in thoufands; though the people of the eaft, who live in fettled habitations, have not only made thefe animals domefticated fince time immemorial, but, as we fee by Varro, Columella, Pliny, and the teftimony of other authors, employed with great advantage, inftead of mules, wild affes, which they caught and tamed. Varro fays exprefsly *, that the wild afs is exceedingly proper to be ufed inftead of the mule, becaufe it can be eafily tamed, and never returns again to its wild condition.

Hitherto the dfhiggetai has been only an animal of the chace for the Moguls and Tungufians, who confider its flefh as their greateft dainty, and employ the fkin to make boots. It is, however, difficult to kill it; for, on account of the keennefs of its fight and the acutenefs of its fmell, by the latter of which, if to the leeward, it can difcover a man at the diftance of feveral werfts, it feldom lets the hunters get within fhot. When running, it is impoffible for the fleeteft horfe to overtake it; and therefore it is feldom caught during the hunting excurfions of the Moguls, which they call *oblaw*, but muft be fhot, by lying in wait for it; which can be beft done in the neighbourhood of the ftreams or pools to which it repairs to drink, or of the fpots where it comes to lick falt. The Moguls, however, are faid to have remarked, that during rainy and ftormy weather the dfhiggetai becomes, as it were, ftupid, and neither fees nor fmells the hunters fo well as at other times. The ftallions, which conduct herds more or lefs numerous of females and young ones of from one to two years old, are exceedingly vigilant; keep their females together with the moft jealous care; drive from the herd the young ftallions which begin to fhow a defire for the females;

* De Re Ruft. lib. ii. cap. 6.

and are always on the watch to guard against being surprised. When they observe any thing uncommon at a distance, the male immediately springs forwards; endeavours, by making a tour, to approach so near the object as to discover the danger, and for that purpose advances two or three times towards the hunters, who lie close to the ground on their bellies. On such occasions some of them are shot; the herd then disperse, and for some time afford good sport to the huntsmen. If the male, however, observes the danger, he makes the herd which he left behind him betake themselves to flight with incredible velocity. The Moguls speak of this velocity with astonishment; and, in general, the dshiggetai is considered as the swiftest of all the wild animals of their country: for this reason the people of Thibet assign it, instead of a riding horse, to *chammo*, their god of fire and of war.

The dshiggetai always carries its head erect, as represented in the plate; when running, throws it entirely back, in order that it may see better behind it; and bears its tail erect. It has a particular kind of neighing, which is louder and shriller than that of a horse. The herds by which old males are attended consist often of more than twenty males and females; though, in general, they are less numerous, as many males have no more than five or ten females. Young males driven from old herds generally follow them at a distance, till they have enticed from them one or more females, or have found some that have strayed from other herds, and thus procure to themselves a few followers. At the covering season the old males separate from their herds the young females not yet hot. The Moguls are said to have remarked also, that these half-asses sometimes entice away mares from the troops of tame horses which wander about in these districts, and add them to their seraglio. Of this, however, I am not fully convinced; though, on account of the great similarity and likeness in regard to size which the dshiggetai has with the Mogul horses, procreation must be much easier between

between them than between the horse and the ass, and must be always more fruitful; so that if the horse were not known in his wild state, and if characterising marks of a particular species were not visible in the dshiggetai, on account of this great similarity, we might with much more reason consider the dshiggetai for the wild stock of our horse than the younger Gmelin considered the wild horse as the common stock of the horse and ass *, which, however, besides the mouse colour observed by Gmelin, which is not always uniform, has nothing in common with the ass.

[To be concluded in the next Number.]

II. *Observations on Animal Fat and the Causes of Corpulency. By Dr.* COINDET. *From the* Journal de Physique, Vendemiaire An. 7.

ANIMAL fat examined by the microscope seems to exhibit yellowish vesicles, formed of a very thin and transparent pellicle, which contain an oily fluid. No pores can be observed in it, and no person but Malpighi has been able to discover what are called its adipose ducts *(ductus adiposi)*. In certain cases, however, fat is absorbed, and in general it seems to undergo constant changes: the skins of the negroes after violent exercise exhale an oily odour.

The vesicles of fat are different in different animals. Wolf of Petersburgh observed that the fat of a pullet is contained in vesicles smaller than those of any other animal: those of the goose are larger, and ranged with more regularity. The next in order are those of man; but, according to Wolf, the most considerable are those of the hog. These vesicles are contained in the interstices or small spaces in the cellular tissue,

* See Sam Gott'. Gmelin's *Reise durch Russland*, part i. p. 47. Compare, also, what I have said of wild horses in my Travels, part i. p. 211, 272; part ii. p. 642, and part iii. p. 509.

tissue, but are not found equally dispersed throughout every part of the body. Fat is found in a pretty considerable quantity in certain cavities of the body, as in the orbits of the eyes, near the reins, in the epiploon, sometimes at the point of the heart, &c. In man there is none about the lungs, the penis, or the brain. Some is contained in the last-mentioned organ in the cold-blooded animals: in the sea-dog, the ray, and many other fishes, the fat is mixed with the parenchyme of the liver, to which it gives considerable bulk: in birds and animals that feed on vegetable substances, it is found around the reins. The fat of fishes is more liquid than that of carnivorous quadrupeds: that of frugivorous animals has more consistence than the fat of others.

The quantity of fat varies much according to the different classes of animals; and, if we compare the quantity of fat with the bulk of the body, it will be found that fishes exhibit the largest proportion; then amphibious animals, and then the frugivorous. The carnivorous present the least. But these are only general observations, which are subject to many exceptions.

All the uses of fat are not yet known; but we know that in some cases it becomes exhausted, and supplies the place of aliment. Thus, animals which remain in a state of torpor for several months without taking nourishment, lose their plump appearance; from which it would seem that this is a resource provided for them by nature. May it not perhaps serve to preserve animal heat? The circumstances which contribute to its formation are still more obscure, and have given rise to many ingenious ideas dignified with the name of hypotheses. One of the most probable is that of Dr. Beddoes*, which appears to me to clear up many facts

* Dr. Coindet has done little more than abridge from Dr. Beddoes's *Observations on Calculus*, &c. though he prefixes his own name to this paper, and thus casually introduces the name of the latter, as if his writings only tended to confirm, when, in fact, they are the foundation of the doctrines here brought forward. EDIT.

hitherto

hitherto inexplicable, though it is fubject to many exceptions, as every hypothefis muft be. The foundation on which it refts is, that whenever there is a certain diminution of oxygen in the animal fyftem, fat will be produced. The following obfervations feem to fupport this affertion: The chemical analyfis of fat fhows that fix parts of it contain near five of carbon and one of hydrogen, and fome febacic acid. The fat parts of animals differ from the flefhy parts only in this, that the latter contain more oxygen and azot. By this is explained the change of mufcles into a fubftance like fpermaceti, as profeffor Fourcroy remarked in the burying ground of the Innocents at Paris. It has been obferved alfo, that the fat augments at the expence of the mufcles in the living body, and *vice verfa**.

This want of oxygen confidered as a caufe of corpulency is indicated by the analogy which exifts between obefity and the fea fcurvy, which feems to be owing only to a gradual abftraction of a part of the oxygen in the fyftem. The fea fcurvy is never announced by meagrenefs; on the contrary, a fullnefs of the habit is the firft fymptom of that malady. Dr. Trotter obferves, that when a negro grows rapidly corpulent, he does not fail to be attacked by the fcurvy; from which, to make ufe of a comparifon of Dr. Beddoes, it appears that corpulency is to the fcurvy what cachexy is to the dropfy. All the fymptoms of the fcurvy prove that it arifes from a privation of oxygen: thus the furface of the body is covered with livid fpots, the arterial blood is very little florid, and, after death, the left auricle is found filled with venous blood, which Dr. Goodwin found in animals that had been deprived of life by oxygen. Dr. Lind fays, that when death has been fudden, and that no effufion is found in the cavities of the body, the auricles and the ventricles are filled with blood, and efpecially the left fide of the

* Very fat hogs have fcarcely mufcle enough to perform locomotion. EDIT.

heart;

heart; which is a very remarkable circumstance, since that side rarely contains much blood after death.

According to the experiments of Saussure and Humboldt, it appears that the atmosphere of the high mountains contains less oxygen than that of the lower regions; and this explains why la Condamine was attacked with scorbutic symptoms on the summit of Pinchina. Much sleep and inactivity are powerful causes of corpulency. In that state respiration is less frequent, a smaller quantity of oxygen is absorbed, and the absorption of fat is diminished, while the secretion of it is continually taking place. Leanness is produced by a contrary state, that is to say, by the effect of exercise: more oxygen is then introduced into the system, and the fat is absorbed in common with the other fluids.

People in the country know very well from experience, that when they wish to fatten poultry they must keep them in darkness, and mix with their food substances proper for prolonging their sleep, such as tares or spiritous liquors *. An observation which appears curious is, that the age when the secretion of fat is most considerable is towards the fortieth year; a time when the arterial system ceases to act such a conspicuous part in the animal economy, either because it is then ossified, or in part obliterated, while the venous system, becoming more and more developed, seems to acquire that influence so considerable in old age. Do arteries the action of which is visibly diminished, furnish at that period less oxygen to the system; and may not that be the cause of the corpulency of middle-aged people?

It may be objected that children, whose venous system is not yet developed, have however a remarkable plumpness. But this difficulty has been resolved in the following manner: The venous blood when it arrives at the lungs undergoes there chemical changes, too well known to require to be

* In Portugal, fowls are not only kept in the dark, but their feet are fastened to the floor, so as totally to prevent their walking. Edit.

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here particulariſed. It may happen that, according as reſpiration is more or leſs perfect, the blood may loſe a greater or leſs quantity of carbon and hydrogen. In proportion as it loſes leſs, the ſecretion of the fat will be more abundant: this then will afford an explanation of the enormous quantity of fat found in amphibious animals, fiſhes, &c. in which reſpiration is not ſo perfect, becauſe, being ſurrounded by water, they are not in contact with ſo conſiderable a quantity of oxygen as animals that breathe in the open air. They retain then more hydrogen and carbon, which paſſing into the arteries, occaſion that conſiderable ſecretion of fat, and probably produce that voluminous ſize of liver, found in fiſhes in which circulation is ſuch that almoſt all the blood goes into the liver, either to operate there a ſecretion of fat or of bile, the conſtituent parts of which do not differ much from thoſe of the former.

Children do not reſpire in the uterus, as the foramen ovale is not obliterated till towards the third or fourth year of their life, and ſometimes later: they have for the ſame reaſon a very full habit of body. What appears to confirm this opinion are the obſervations quoted in the Medical Tranſactions of London, and thoſe of Profeſſor Sandifort of Leyden, of individuals remarkable for their corpulency; in whom it was found, by diſſection, that the foramen ovale was not cloſed up; that is to ſay, that the greater part of the venous blood paſſed directly from the right into the left ventricle, to be tranſmitted into the aorta, and from thence into the whole ſyſtem, without having undergone there any of thoſe changes which are effected on the blood by reſpiration *. The lungs in ſuch individuals were diminiſhed in ſize, and in a ſtate of collapſion, which indicated that they had not diſcharged all the functions of reſpiration. This theory ſeems to throw much light on the enormous ſize of the liver

* To theſe cauſes may be added the frequent ſleep of children, oftimes in an atmoſphere of diminiſhed purity. Edit.

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in a fœtus, and which no one hitherto has been able to explain.

Diseases of the liver, such as schirrous tumours, &c. generally attack people who are more or less corpulent. The blood of persons very plethoric, or very fat, is commonly of a darker colour and more viscous than that of lean people, which is generally very florid. The means of cure afford a very strong argument in favour of this hypothesis; for, though obesity be rarely the subject of medical treatment, yet some physicians have treated it like the scurvy, with vegetable acids, pulse, &c. as affording more oxygen. It has been remarked, that people who habitually drink cyder are more meagre than those who use beer, porter, or other liquors of the same kind.

There are some countries, the inhabitants of which are in general corpulent, as is the case in Holland, and some parts of England; while in others, as France, for example, the greater part of the inhabitants are thin. Does this arise from the difference of food, or is it not rather owing to the greater or less purity of the air? that is to say, to a greater quantity of oxygen contained in the atmosphere? The above facts appear to explain the different causes of obesity, and to throw great light on the means of curing various diseases, which have hitherto baffled all the efforts of medicine.

III. *On the colouring Matter of vegetable Juices and the Action exercised on it by metallic Substances and their Oxyds, with a new Process for obtaining Lakes of more intense and solid Colours. By Cit.* GUYTON. *Read in the* National Institute 15 Vendem. An. 6.

LINNÆUS, the great naturalist of the north, said, that the red colour of vegetables announced in them the presence of an acid. It had been long observed, that the juice of the flower

flower of the violet acquired in tin veſſels a beautiful blue ſhade, and the uſe of it was recommended in pharmacy for the preparation of ſyrup of violets. The original colour of ſyrup which had been changed was upon this principle reſtored by long digeſtion in tin; but few philoſophers paid any attention to enquire into the cauſe of theſe phenomena, and my colleague Berthollet mentioned only as a probability in his Elements of Dyeing, that this effect reſulted from a combination of the acid with the oxyd formed at the ſurface of the tin. Such was the ſtate of our knowledge on this ſubject, when, ſtruck with the difference in the colour of two preparations of the ſame fruit, I undertook a continued examination of the circumſtances in which theſe changes took place.

I ſhall omit giving a detailed account of the comparative experiments to which I ſucceſſively ſubjected almoſt all the acid coloured fruits, ſuch as the cherry, the gooſeberry, the plum, as well as the petals of flowers, turnſol, braſil wood, turmeric, &c. by treating them in veſſels of glaſs, porcelain, metal, and metallic mixtures, or by holding them in digeſtion, either on plates of metal perfectly clean, or on metallic oxyds. I ſhall confine myſelf at preſent to reſults which may ſerve to throw ſome light on the theory of vegetable colours, or to furniſh the means of applying them with advantage to proceſſes in the arts.

My experiments proved that the red colour of fruits evidently ariſes from the re-action of their peculiar acid on their colouring matter. That tin, in reviving or reſtoring the colour of violets, only reſumes by its greater affinity the acid which made it turn red. That it is not only tin or its oxyd, as has hitherto been ſuppoſed, which exerciſes this affinity; but that lead, biſmuth, antimony and zinc produce the ſame effect; that it is ſtill more rapid and complete with iron; and that the contact of all theſe metals inclines to violet, very ſenſibly, infuſions which otherwiſe would be of a bright and ſtrong red. That the green and acid part of fruits does

not

not hold the colouring principle, difpofed to become red with acids; and that the coloured part conceals the portion of the acid neceffary for maintaining the ftate of re-action, which determines its fhade. That if this colouring principle is modified in fome vegetables fo as to refift more or lefs acid or alkaline re-agents, as brafil wood in regard to acids, and turnfol in regard to alkalis, it may be brought back to that condition; which feems to indicate that, if not effentially, it is at leaft originally of the fame nature. That all metallic oxyds are not equally proper to feize and fix vegetable colours; that fome of them feem to attack the latter with the greateft eafe, while others retain them only in a very weak manner. In the laft place, that the new metal called tungften carried to the utmoft degree of oxydation, and which has not yet been tried in that refpect, has a decided advantage above all the other metallic oxyds; that it is capable of forming lakes valuable for painting, which ftand, without alteration, tefts by lime water, the acetic acid or radical vinegar, fulphurifed hydrogen gas, and even to a certain degree oxygenated muriatic acid gas, that enemy of colours, which fuddenly burns them, and which, according to the expreffion of Berthollet, performs in a few moments what is effected in a long time by the combined action of air and light. This affertion will excite lefs furprife, when it is known that this is the only one of all the metallic oxyds which withftands the folvent power of the three mineral acids.

The oxyd of tungften charges itfelf eafily with the colours of all vegetables. Hitherto I have found only one exception in the petals of the *nic ago*, from which I could not extract the beautiful purple red, though I was unable to difcover the caufe of my failure.

In general the lakes formed with this oxyd become darker inftead of lighter when diluted, and it is therefore neceffary to foften the fhade. I have remarked that they acquired alfo more intenfity, when I made the oxyd affume a blue colour, by boiling it in vinegar. C. von Mens, one of my colleagues,

colleagues, being informed of the object of my refearches, called my attention to the aloe. C. Desfontaines was fo kind as to procure me feveral fpecies, but I fhall fpeak only of that known under the name of the fuccotrine aloe. I accordingly tried experiments on this plant, one of the richeft in colour, though it has not the flighteft appearance of it while the equilibrium of its principles is maintained by vegetable life. The woody fibre which is on the outfide ferves as a covering to a very vifcous matter of a whitifh green colour, weakly acid; but fcarcely has this matter been expofed to the air when it affumes a very lively purple red colour, which becomes extremely abundant by the progrefs of fermentation. Of this matter I have formed lakes with alumine, the oxyd of tin, and the white oxyd of zinc: but none could bear a comparifon with that prepared by means of tungften. I have no doubt that the oxyd of this new metal may be employed in the compofition of colours for dyeing, at leaft for the dyeing of filks which are not intended to be fubjected to boiled leys. The oxyd of tin may be employed for that purpofe with advantage, as it is not eafily injured by acids: but our oxyd is abfolutely infoluble.

I fhall conclude with a reflection which may add fome intereft to thefe refearches:—Wolfram, from which this oxyd is obtained, is found in the territories of France*, feveral mines of it are already known, and the French chemifts have been employed for fome years in endeavouring to fimplify the proceffes for freeing it from foreign fubftances: we hope then, that the properties I have explained, will fupply artifts with new means to enfure duration to the productions of their genius, and open a new branch of national induftry.

* It is found in abundance in the tin mines in Cornwall. EDIT.

IV. *Experiments and Obſervations tending to ſhow the Compoſition and Properties of Urinary Concretions. By* George Pearson, *M.D. F.R.S. Read before the Royal Society, December* 14, 1797. *From the* Philoſophical Tranſactions.

[Concluded from the laſt Number, page 54.]

I SHALL next relate ſome experiments, made in order to obtain the acid ſublimate of Scheele, or lithic acid of the new ſyſtem of chemiſtry.

100 grains of an urinary concretion, which had been previouſly found to contain principally the above animal oxide, were introduced into a tube ¼ of an inch wide; which was ſealed at one end by fuſion, and which alſo was fitly bent for collecting ſublimate, and obtaining gaz. The ſealed end was coated and expoſed to fire, firſt to a low temperature, and gradually to a very elevated one.

1. Gaz was diſcharged, which had the ſmell of burning bone.

2. Water appeared boiling immediately over the charge, which ſeemed to be burning, and was turned black.

3. Gaz was diſcharged, of the ſmell of empyreumatic *liquor cornu cervi,* and about half a drachm of this liquor was in the upper part of the tube.

4. A brown ſublimate of carbonate of ammoniac appeared in the cold part of the tube; but in the hotter part, near the charge, was tar-like matter, and the gaz diſcharged had a very offenſive ſmell of empyreumatic animal oil, with which was mixed that of pruſſic acid.

The coated part of the tube was kept red hot, for ſome time after gaz ceaſed to come over.

The quantity of gaz amounted to 24 ounces, by meaſure: it conſiſted of nearly 16 ounces of carbonic acid gaz, and the reſt was air, with a larger proportion of nitrogen gaz than is contained in atmoſpheric air.

5. There

5. There was a residue of 30 grains, almost pure carbon; and 10 grains of heavy black and brown matter, a little above the coated part of the tube. In this last-mentioned matter were many small white *spicula*. At about half an inch above the carbonaceous residue, dark gray matter had been raised, which weighed 15 grains.

This sublimed gray matter did not contain any ammoniac, nor throw down any prussiate of iron, with sulphate of iron. It reddened turnsole paper and tincture. It dissolved in caustic soda; from which solution muriatic acid precipitated nothing; for, although on dropping it into the solution milkiness appeared, the liquid soon grew clear again.

Ten grains of this sublimate dissolved in four ounces of boiling water; which being evaporated to half an ounce, there was, on cooling, a copious deposit of white *spicula**. The sublimate had a sharp, but not sour taste. Being boiled in muriatic acid, and also in nitric, it did not dissolve at all; but remained, on evaporation to dryness, in the same state as before; and it must be particularly observed, that it left no red or pink matter, on evaporating the nitric acid from it. Sulphuric acid did not act upon it in the cold; but, when heated, it dissolved it, without effervescence, from which solution nothing was precipitated by caustic soda: on evaporating it to dryness, black fumes arose, leaving behind only a black stain. This sublimed matter did not render lime water turbid. Boiled in muriatic acid, so as to carry off all but a very little free acid, on the addition of lime water there was no turbid appearance, but milkiness ensued on adding oxalic acid.

The *spicula*, in the 10 grains of sublimate above mentioned, seemed to be of the same nature as the matter just described.

The whole of this sublimate amounted, by estimation, to 18 grains; and I apprehend it is the acid sublimate of Scheele.

* From the deposition of these *spicula* by cooling, and from many of the following properties, they appear to be analogous to benzoic acid.

The fublimate of carbonate of ammoniac amounted to 20 grains; and it was black empyreumatic animal oil which ftained the tube.

This experiment was repeated, on 120 grains of a nut-brown, very light, urinary concretion. The refult was not very different from that of the former experiment, except that the gaz contained a portion of hydrogen gaz. There were 30 grains of the above defcribed *fpicula*, principally mixed with carbonaceous matter: they were light, and had only a very flight fharp and bitter tafte.

The experiment repeated a third time, with 80 grains of urinary concretion, afforded 15 grains of the white *fpicula* above defcribed, mixed with carbonaceous matter. Thefe I found did diffolve in a large proportion of muriatic acid; which folution yielded them, on evaporation, in the fame ftate as before. Under the flame applied by the blowpipe, they firft melted, and then evaporated, without any fmell; leaving a flight black mark. Turnfole was reddened by thefe *fpicula*.

In a fourth experiment, I found the white *fpicula* contained in the carbonaceous matter united, on boiling, with carbonate of foda, as well as with cauftic foda; but, as before, muriatic acid precipitated nothing from the folution. Thefe *fpicula* could not be diffolved in nitric acid; nor did the folution of them in water become turbid with oxalic acid. Their tafte was, as before, rather bitter and fharp than four. A very fuffocating fmell iffued forth, on breaking the tube ufed in this experiment, but it was not from fulphur, nor from pruffic acid.

These experiments afford evidence of the wide difference between the animal oxide above defcribed and the acid fublimate of Scheele*.

* From thefe experiments, it now appears very doubtful whether the *lithic acid* of Scheele exifts as a conftituent of urinary concretions, or is compounded, in confequence of a new arrangement taking place, of the elementary matters of the concretion, by the agency of fire; but it is demonftrated, that the urinary animal oxide is really a conftituent part, and even a principal one, of almoft all human urinary calculi.

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If this conclusion be allowed to be juſt, it will be neceſſary to give a name to this urinary animal oxide. Agreeably to the principles of the new chemical nomenclature, the name ſhould be *lithic oxide*. But the term *lithic* is a groſs ſolecism; and I truſt that philological critics will find the name *ouric* or *uric oxide* perfectly appropriate; for, if it be thought objectionable, on account of the exiſtence of the matter in arthritic as well as urinary concretions, ſtill philology will allow its admiſſion, as in other ſimilar cauſes, κατ' εξοχην; it being found in greater abundance, by far, in the urinary paſſages than in other ſituations, and therefore falling under common obſervation, as an ingredient of the urine. If, however, the term lithic oxide, or any other denomination, ſhall obtain acceptance, I ſhall very willingly adopt it.

It requires no ſagacity, in a perſon acquainted with the facts of the preceding experiments, to perceive that they are applicable to a variety of uſes in chemical inveſtigation, and in the practice of phyſic. The latter I of courſe take no notice of in this place; but, relative to the former uſes, I ſhall particularly point out, that we are now able not only to detect, in the eaſieſt manner, the *preſence* of the minuteſt proportion of the above animal oxide in urinary concretions, and alſo in other ſubſtances, but even to determine its *proportion* to the other conſtituent parts, in the ſpace of a few minutes, in moſt caſes, and in all in a very little time, without any other apparatus than nitric acid, a round-bottomed matraſs or glaſs diſh, and a lamp. By this method, I have, in a general way, examined above 300 ſpecimens of concretions, of the human ſubject and other animals, principally urinary ones; and alſo many from other parts, particularly thoſe from the joints. For theſe opportunities, I am beholden to ſeveral profeſſional gentlemen; whoſe willingneſs to furniſh me with ſpecimens, I ſhall have much ſatisfaction in acknowledging on a future occaſion. At preſent, I muſt acknowledge my obligations to Mr. Heaviſide, in whoſe muſeum I found between 700 and 800 ſpecimens. The liberal poſſeſſor of this treasure offered me, what I could not have taken the liberty of requesting, namely, permission to break off pieces from any of the articles, for experiment. Mr. Edward Howard did me the honour to take upon himself the task of writing down the reports, and otherwise assisted me.

At this time I shall only mention,

1. That out of 200 specimens of urinary calculi, not more than six did not contain the animal oxide above described, *i. e.* about 32 out of 33 contained it.

2. That the proportion of this oxide was very different; varying from $\frac{1}{200}$ (exclusive of water,) to $\frac{190}{200}$; but, for the most part, varying between $\frac{80}{200}$ and $\frac{140}{200}$ *.

3. That the common animal mucilage of urine is frequently found in concretions, in very different proportions; but is perhaps never a principal constituent part of them.

4. That the above animal oxide was not found in the urinary concretions, or any other concretions, of any animal but the human kind.

5. That this animal oxide was found also in human arthritic calculi, but not in those of the teeth, stomach, intestines, lungs, brain, &c.

P. S. I think proper to subjoin a few experiments, made after the preceding paper was written, which afford evidence of the truth of some of my conclusions, and enable us to explain several properties of animal concretions.

I. *On an Urinary Concretion from a Dog.*

This calculus may be said to be a great curiosity, for it is probably the only specimen in London. I owe the opportunity of examining it to Mr. H. Leigh Thomas, who met with it in the course of his dissections; and therefore we have unquestionable authority, that the concretion was

* In some urinary concretions, the interior part contained this oxide, and the exterior part had none of it. On the contrary, in other urinary concretions, the exterior part contained it, and the interior part did not.

really

really from the urinary bladder of a dog. It is worthy to be noticed, that the animal appeared to be in perfect health.

This concretion is of an oval figure; is three inches and three quarters in length, and three inches in breadth; is white as chalk; its surface is rough and uneven. Being sawed through longitudinally, no nucleus was found, nor was it laminated, but near the centre it was radiated, and contained shining *spicula*. In other parts it was, for the most part, compact and uniform in its texture. It weighed nearly ten ounces and a half. Its specific gravity was found to be greater than that of human urinary concretions, in general; which I have learned by experiments is also the case with urinary and intestinal concretions of other brute animals, especially with those of the horse.

The specific gravity of the present calculus was 1,7.

That of one from the urinary bladder of the human subject, of the sort called mulberry calculus, and which consisted almost entirely of uric oxide, was 1,609.

That of another human urinary concretion, of the same composition as the former, but quite smooth, extracted by Mr. Ford, was 1,571.

1. The present calculus of the dog had no taste, nor smell, till exposed to fire.

2. Under the blowpipe it first became black, and emitted the smell of common animal matter; it next smelt strongly of empyreumatic *liquor cornu cervi*; and, after burning some time, became inodorous, and white, and readily melted, like superphosphate of lime.

3. On trituration with lye of caustic soda, there was a copious discharge of ammoniac.

4. It dissolved, on boiling in nitric acid: the solution was clear and colourless; and, on evaporation to dryness, left a residue of *white bitter matter*, which, under the blowpipe, emitted, weakly, the smell of animal matter.

5. Upon distilling a mixture of 150 grains of this concretion pulverized and two pints and a half of pure water, to

three ounces, the distilled liquid was found to contain nothing but a little ammoniac. The three ounces of residuary liquid, being filtrated and evaporated, yielded 20 grains of phosphate of ammoniac, with a little animal matter; and the residuary undissolved matter amounted to 67 grains.

6. These 67 grains, being triturated with four ounces of caustic soda lye, discharged very little ammoniac. On distilling this mixture to one ounce, a very small proportion only of ammoniac was found in the distilled liquid. The residuary ounce of alkaline liquid was filtrated, and mixed with the water of elutriation of the undissolved matter. One half of those liquids, on evaporation to dryness, afforded a dark brown matter, amounting to 20 grains, which consisted of phosphate of lime and animal matter. To the other half of the alkaline liquids was gradually added muriatic acid, which occasioned a deposit, in small proportion, of matter that dissolved in nitric acid, but which, on evaporation to dryness, left behind only a brownish matter, consisting of phosphate of lime and animal matter.

7. The residuary insoluble substance in caustic lye, (6.) under the blowpipe, first turned black, and then grew white, but could not be melted.

By diluted sulphuric acid it was decompounded. On the addition of nitrate of mercury, to the filtrated liquid, it yielded phosphate of mercury; and, with oxalic acid, it afforded oxalate of lime; but no sulphate of magnesia was found remaining after these precipitations were produced.

These experiments fully demonstrate, that the above concretion of a dog contained none of the uric or lithic oxide above described, but that it consisted, principally at least, of phosphate of lime, phosphate of ammoniac, and animal matter.

The present instance leads me to explain the reason of the fusibility of calculi. This is demonstrated by the above experiments, to depend upon the discharge and decomposition of the ammoniac of the phosphate of ammoniac, during the burning

burning away of the animal matter: hence the refiduary phofphoric acid readily fufes, and, uniting to the phofphate of lime, compofes fuperphofphate of lime, a very fufible fubftance.

The phofphate of ammoniac being diffolved out by water, or cauftic alkaline lye, the remaining matter is infufible, being phofphate of lime.

A very hard, brittle, and blackifh inteftinal calculus of a dog, from Mr. Wilfon, was found to be of greater fpecific gravity than human urinary calculi, and to have the fame compofition as that of the dog above defcribed.

This alfo was found to be the compofition of a white, fmooth, round, inteftinal calculus of a horfe, the fpecific gravity of which was 1,791.

The fame compofition was difcovered, on examining a very hard, gray, brittle, laminated, quadrilateral concretion, faid to be from the urinary bladder, but which, I think, was more probably from the inteftines, of a horfe.

II. *On a Calculus from the Urinary Bladder of a Rabbit.*

This is alfo a curiofity, being the only inftance I have feen. I am likewife indebted to Mr. Thomas for this fpecimen, which he very kindly fent me, fitted up as a preparation, included in the bladder itfelf. Mr. Thomas found this concretion, on diffecting a perfectly healthy and very fat rabbit.

This fpecimen is fpherical, and of the fize of a fmall nutmeg. It is of a dark brown colour, has a fmooth furface, is hard, brittle, and heavy. When broken, it appeared to confift of concentric laminæ. Its fpecific gravity was 2.

1. Under the blowpipe it grew black, and emitted the fmell of animal matter while burning; at laft it ceafed to emit any fmell; and, urged with the intenfeft fire, fhowed no figns of fufibility.

2. It readily diffolved, with effervefcence, like marble, in both muriatic and nitric acids, giving clear folutions.

3. The nitric solution (2.) being evaporated partly to dryness, and partly to the consistence of extract, the dry residuary matter was white; and the extract-like matter, which was bitter, could not be fused under the blowpipe; but, when brought to the state of a powder, the particles of it were made to cohere loosely together into one mass.

4. On dropping sulphuric acid into the muriatic solution, (2.) turbidness, and a copious white precipitation, immediately ensued, from the composition of sulphate of lime.

From these experiments it is warrantable to conclude, that the above urinary calculus of a rabbit consisted principally of carbonate of lime and common animal matter, with, perhaps, a very small proportion of phosphoric acid: it certainly contained no uric oxide.

I examined, in the same manner, a concretion which was said to be from the stomach of a monkey; but I have not evidence of its origin equally satisfactory as that of the two last calculi. Its composition was found to be similar to that of the calculus of the rabbit, *viz.* carbonate of lime and animal matter. Its obvious properties were also the same; it was of the size of the largest nutmeg.

III. *On Urinary Concretions of the Horse.*

I examined several specimens in cabinets, said to be vesical calculi of the horse, and found none of them to contain the uric oxide above described; but that they consisted (as well as the calculi from the stomach and intestines of the same animal) of phosphate of lime, phosphate of ammoniac, and common animal matter, which melted like superphosphate of lime, after burning away the animal matter and ammoniac. As these, and some other experiments, seemed to concur in establishing an important truth, I thought it necessary to examine an urinary concretion of a horse, which, from its figure and size, was unquestionably from the kidney of that animal; for I have found by experience, that one cannot depend entirely on the accounts in cabinets, nor indeed,

indeed, ſometimes, on the aſſertions of perſons who collect ſpecimens.

1. This concretion, which Dr. Baillie was ſo good as to give me, was of a blackiſh colour, was very brittle and hard, and had no ſmell or taſte. It felt heavier than human urinary calculi.

2. Under the blowpipe it became quite black, and emitted the ſmell, weakly, of common animal matter. It was reduced very little in quantity, and ſhowed no appearances of fuſibility, after being expoſed for a conſiderable time to the moſt intenſe fire of the blowpipe.

3. Muriatic acid diſſolved this concretion, with effervefcence, yielding a clear ſolution; which, on evaporation to dryneſs, left a black and bitter reſidue.

4. A little of the reſidue (3.) being boiled in pure water, to the filtrated liquor ſuperoxalate of potaſh was added; which occaſioned a very turbid appearance, and copious white precipitation.

5. Nitric acid alſo readily diſſolved this concretion, with effervefcence. The ſolution being evaporated, partly to dryneſs, and partly to the conſiſtence of an extract, the dry reſiduary matter was white and bitteriſh, and the extract-like part ſhowed no ſigns of fuſibility under the intenſeſt fire of the blowpipe.

6. A little of the concretion, being triturated with lye of cauſtic ſoda, emitted no ſmell of ammoniac.

From theſe experiments it appears, that this calculus, like the former one from a rabbit, conſiſts of carbonate of lime and common animal matter.

A renal calculus of a horſe, in Mr. Heaviſide's collection, appeared, on examination, to conſiſt of carbonate of lime and common animal matter.

Another ſpecimen, however, of renal calculus of a horſe, in the ſame collection, marked No. 3. was found to conſiſt of phoſphate of lime, phoſphate of ammoniac, and common animal matter. It was fuſed under the blowpipe.

The

The specimen marked No. 8. in the same collection, which was said to be a vesical calculus of a horse, appeared to consist of the three ingredients just mentioned.

I have met with two instances of a deposit of a prodigious quantity of matter in the urinary bladder of horses, which had not crystallized, or even concreted: it amounted, in one specimen, which was given to me by Dr. Marshall, to several pounds weight; and in the other, which is in the possession of Mr. Home, to about 45 pounds. Its composition was, principally, carbonate of lime and common animal matter *.

I have not found any instance of human urinary calculi of a similar composition to that of the rabbit, and those of horses above described, which consist of carbonate of lime and animal matter; and I believe that human urinary calculi very rarely occur of a similar composition to those of the dog and horses above mentioned, which were found to consist of phosphate of ammoniac, phosphate of lime, and animal matter, without containing *uric oxide*.

The difference in the constitution of urinary concretions may depend on the difference of the urinary organs of different animals, on the food and drink †, and on the various diseased and healthy states of the urinary organs.

I have not found the uric oxide in the urinary concretions of any phytivorous animal; but, whether it would be formed in the human animal when nourished merely by vegetable matter, must be determined by future observations. In the mean time, it is warrantable to conclude, from analogy, that it would not, and the application of this fact to practice is

* Since this paper was read, Mr. Blizard has been so attentive as to send me another specimen of the same kind of deposit as those here mentioned. It now appears probable, that such deposits frequently take place, although I believe they have not been noticed before.

† I found the stomach-concretion called *oriental bezoar*, to consist merely of vegetable matter; as did the intestinal concretion of a sheep.

is obvious: but I now purposely avoid making any practical inferences, until I can, at the same time, state a number of facts I have collected, relative both to concretions and to the urine itself.

V. *Short Account of the last Russian Expedition for making Discoveries in the North-east Sea. By Professor* BLUMENBACH *at Gottingen. From* Geographische Ephemeriden. *Published by Major von* ZACH, *May* 1798.

AS very little is yet publicly known of the great six-years expedition, undertaken by the Russians for making discoveries in the Northern Archipelago or Eastern Ocean, the following short account of it, taken from the most authentic sources, and particularly from the correspondence of Dr. C. H. Merck, who was employed in the expedition as naturalist and physician, with the Royal Academy of Sciences at Gottingen, may afford satisfaction to those fond of geographical researches.

This expedition was proposed by Catherine II. so early as the month of November 1784. A plan was also drawn up for it; and the command conferred upon Captain Billings an Englishman, then in the naval service of Russia, who had accompanied Mr. Bayly the astronomer in Cook's last voyage round the world in 1776–80. Three captains of the second rank were appointed under him, viz. Hall, Sarischef and Bering, not the son, as Lesseps says, but the grandson of the celebrated Capt. Vitus Bering, who, on the 14th of December 1741, was interred on an island in the sea of Kamtschatka, named after himself, and where he had been shipwrecked.

The principal objects of this great and very expensive expedition were, to supply all the deficiencies in regard to the important discoveries with which the geography of Asiatic Russia

Russia had been enriched, since the time of Peter the Great, by exploring that so little known north-east corner of Asia, the land of Tschukt; to pursue farther if possible the north-east passage, attempted by Cook; and, lastly, to search out more convenient posts for the Russian fur-trade on the north-west coast of America.

Captain Billings set out with his instructions from Petersburgh in the end of the year 1785, and in July 1786 arrived at Ochotzk. Having passed the winter at Werchne Ostrog, in the beginning of the summer 1787 he left the mouth of the Kolyma or Kovyma with two vessels, the larger of which, called the Pallas, was commanded by himself; and the other, the Jesaschna, named after an arm of the river Kovyma, in which it was built, was commanded by Captain Sarischef. This was only a preparatory expedition, the object of which, however, was nothing less than to double Cape Tschelazka, (Cook's Cape North) and to proceed by this unheard-of route from the Frozen Ocean through Bering's Straits to Anadyr. I call the route unheard-of, as the romantic voyage of the Starschina Cossac Semon Deschnew, in the year 1648, notwithstanding the account of it which the Russian historiographer Muller is said to have discovered in 1736, among the archives at Jakutzk, is still doubted by many sceptics, who consider a connection of the northern parts of both continents as possible.

These adventurous navigators, however, could not proceed farther than to a certain point between Baranikamen and the mouth of the river Tschaun; because the impenetrable fields of ice which they found there, rendered it impossible for them to continue their voyage to the North-east, and obliged them to return from Seredun-Kerymsky Ostrog to Jakutzk, in order to pass the winter.

In the mean time, Captains Hall and Bering were employed in preparations for the grand expedition. The former superintended at Ochotzk the building of the two vessels destined for that purpose, and the latter had the care of transporting

tranſporting from Jakutzk the materials and ſtores neceſſary for fitting them out.

In the ſummer of 1789, the two ſhips were ready at Ochotzk for putting to ſea; when, unfortunately, the ſecond of them, the Dobrowa Namerine (the Good Intent), which was to be commanded by Capt. Hall, got on ſhore juſt at the mouth of the Ochochta; and as her keel was broken, it was neceſſary to ſet her on fire. On account of this miſfortune, Capt. Billings, with his own veſſel the Slawa Roſſie (Ruſſian Glory), was not able to leave Ochotzk till towards the middle of September; at which time he proceeded to Awatſcha Bay, where he anchored in the month of October, having made in this paſſage a diſcovery of very great importance to nautical geography, as about 300 werſts from Ochotzk towards the Kurile iſlands, he fell in with a rock, an hundred fathoms high and a werſt in circumference, ſurrounded by leſſer rocks which were named Jonas Iſland, and on which many of the ſhips already loſt have, in all probability, been wrecked. Prodigious flocks of ſea-fowl come every morning from theſe rocks to the coaſt of Ochotzk, and return thither again in the evening to paſs the night.

After wintering at Kamtſchatka, theſe navigators explored, in the ſummer of the year 1790, the whole chain of the Aleutian iſlands, which ſeem to be of volcanic origin, and afterwards the large eaſtern iſlands explored by Cook; Onalaſchka and Kadjak; the bay of Cape St. Elias, &c. and returned to winter at Kamtſchatka. In the ſummer of 1791 they proceeded on their grand expedition, to ſearch for a northern paſſage through the Frozen Ocean; and having landed on Gore's and Clarke's Iſland, purſued their route from thence to the Continent of America.

As the fields of ice, which extend from the Eaſtern Cape of America, rendered it impoſſible for them to penetrate any farther, Captain Billings, in conjunction with Dr. Merck, accompanied by one of the pilots, the draftſman, two interpreters, and four ſeamen, undertook an expedition of diſcovery

through

through the country of Tschukt from the Bay of St. Lawrence to the river Kolyma, which they had left four years before. This wonderful journey, which they performed in sledges drawn by rein-deer and attended by some of the intrepid natives, continued from the middle of August till the end of February 1792, when they arrived at the river Angarka, which falls into the great river of Anuy, after having travelled through, and examined in regard to geography, natural history and statistics, an extensive tract of country very little known, the Bay of St. Laurence and the islands between Bering's Straits and the mouth of the Anadyr, inhabited by about four thousand Tschuktese, who are ichthyophagi or feeders on fish, and the whole almost level land, destitute of wood, of the rein-deer Tschuktese from the above-mentioned straits as far as the Kolyma.

In the beginning of May these enterprising travellers returned on horseback to Jakutzk. Their vessel, which they had left in the Bay of St. Laurence, had in the mean time proceeded to Onalaschka, under the command of Capt. Sarischef, and had wintered there, together with a small cutter called the Tschorne Orel (the Black Eagle), which had been built soon after their first arrival at Kamtschatka, to supply the loss of the vessel stranded at Ochotzk, and on board which were Captains Hall and Bering.

Next spring both vessels returned to Kamtschatka. The Slawa Rossie was left there in the harbour of St. Peter and St. Paul; but Captains Hall and Sarischef, in the course of the summer, paid a visit in the Black Eagle to the chain of the volcanic Kurile islands. They then proceeded to Ochotzk, from which they were followed, in the summer of 1793, by the rest of the crew of the Slawa Rossie in a transport commanded by Capt. Billings; and in the winter of 1794 the whole of the persons employed in the expedition returned to Petersburgh.

A full account of this remarkable and interesting expedition is now preparing for publication, under the inspection of of the Academy of Sciences at Petersburgh. In the mean time, the Academical Museum at this place*, through the liberality of its worthy benefactor Baron von Asch, counsellor of state, has received a present highly interesting to natural history and geography, consisting of works of art and natural curiosities from these remote regions of the northern part of Asia, as well as of the north-west coast of America and the chain of islands lying between the two continents.

The specimens of art of these polar inhabitants, and above all the needle-work of the women, (who, however, for the most part are troglodytes, and in their subterranean dwellings (*jurten*), must consequently strain their eyes by working at lamps filled with train oil,) exceed in elegance every thing I ever saw of such kind of manufacture, not only among savages, but even among the civilised Europeans. As a proof of this assertion, I shall here remark, that they stood examination by a magnifying glass, under which the finest embroidery of Europe lost much by being compared with them.

The assertion that, except food and drink, there is no object which engages more the attention of mankind than that of ornament, and that a turn for coquettery is one of the most general as well as most beneficent principles in human nature—an assertion strengthened by this striking observation, that though there are numerous tribes on the earth who go perfectly naked, even without so much as the covering of a fig-leaf, there are none, as far as we yet know from the information of travellers, who, notwithstanding their nudity, do not ornament themselves in some manner or other, I have found fully confirmed by various articles, the fruits of this voyage of discovery, which form part of the present transmitted to our museum by Baron von Asch.

The variety and singularity of the appendages of the toilette of these polar inhabitants, condemned as it were to the

* Gottingen.

coldest climate in the world, and who have to struggle incessantly with frost and hunger, exceed all description. By way of example, I shall mention only one article, a first-rate ornament of the ladies of the Alieutian Islands, consisting of a pair of the long tusks of a wild boar, cut down to a smaller size, which are stuck into two holes, one on each side of the under lip, from which they project, and give the wearer an appearance similar to that of the wallrus, which is considered as a beauty almost irresistible.

VI. *New Process for obtaining Lemon Juice of a stronger Quality. By M.* Brugnatelli. *From* Annali di Chimia, *Vol. II. p.* 31.

HAVING observed in the course of several experiments that the slimy substance in lemon juice separates itself spontaneously from that acid, I endeavoured to find out some method of preventing it from spoiling during the time necessary for its separation, in order that the acid should not acquire any bad properties which might render it unpleasant to the taste, or uncertain in its chemical effects.

I expressed in the common manner the juice of perfectly ripe lemons, and strained it through a piece of linen. In half an hour I strained it again, to free it from a little slimy matter which had settled at the bottom of the vessel. I then added to the juice a certain quantity of the strongest spirit of wine, and preserved the mixture for some days in a well-corked bottle. During that time there was a considerable deposit, which to all appearance was of a slimy nature, and which I separated by filtering paper. If the fluid was too thick to pass through the filter, I diluted it again with spirit of wine. After this operation, the deposit remained on the paper, which was entirely covered with it, and I obtained in the vessel placed below, the purest acid of lemons combined with spirit of wine.

If

If it be required to obtain the acid perfectly pure, nothing is neceffary but to feparate from it the fpirit of wine, which can be beft effected by evaporation. The acid of the lemons affumes, after it has been freed from the fpirit of wine and the moifture combined with it, a yellowifh colour, and becomes fo ftrong that, by its tafte, it might be confidered as a mineral acid.

It is not neceffary to evaporate the fpirit of wine in a clofe veffel, if the experiment is made only on a fmall fcale; nor is there any danger that in open veffels any of the acid will be loft, as it is too fixed to be volatilifed by the fame degree of heat at which fpirit of wine evaporates. This acid has peculiar properties, which deferve farther examination.

VII. *An Experiment to prove the Permeability of Glafs to the Electric Fluid. By Mr.* W. WOOD, *F.L.S. Communicated by the Author.*

WHETHER glafs is or is not permeable to the electric fluid has been long difputed among philofophers, and various have been the experiments made both to prove and to refute the Franklinean hypothefis.

A paper by Mr. Wilfon was read at the Royal Society, December 6, 1759, in favour of the permeability of glafs, in which the following experiments were related: He took a very large pane of glafs, a little warmed; and holding it upright by one edge, while the oppofite edge refted upon wax, he rubbed the middle part of the furface with his finger, and found both fides electrified plus.

He then held the fame pane of glafs within two feet of the prime conductor, which was electrified plus; that part of the glafs which was oppofite to the conductor became electrified minus on both fides; but, in a few minutes, the minus electricity difappeared, and the plus continuing, diffufed

 itfelf

itſelf into the place of the other; ſo that now the whole was electrified plus.

Many other experiments of a ſimilar nature were made by Mr. Wilſon, none of which, however, appear ſufficiently concluſive: I ſhall therefore ſubmit the following experiment to electricians; and if it does not prove the permeability of glaſs to the electric fluid, they will oblige me by explaining the way by which the balls in the electrometer are made to diverge without paſſing the electricity through the glaſs.

EXPERIMENT.

Cavallo's atmoſpherical electrometer was placed upon a glaſs pedeſtal, and covered by a thick glaſs receiver, ſo large as to admit of a ſpace of above two inches between its ſides and the electrometer. A charged jar was then brought within a little of the apparatus, and the balls immediately diverged conſiderably, as repreſented in Fig. 2. Plate IV. Upon touching the receiver with the knob of the jar, the diſtance between the balls was doubled; but, on the removal of the jar, they directly came together. This experiment was repeated upon the air pump, and the effects were exactly the ſame.

VIII. *Deſcription of the Apparatus employed by the Society for Philoſophical Experiments and Converſations, for producing Water by the Combuſtion of Hydrogen Gas in Oxygen Gas: with an Account of the Proceſs. Extracted from the* Minutes of the Society. 1795.

AB (Fig. 1, Plate IV.) is a light globular veſſel of flint glaſs about twelve inches in diameter, in the manner of an adopter, having the narrow necks A and B oppoſite to each other. The lower part of this veſſel is drawn out at C to form the tube CD, which is provided with a ſtop cock at its

its lower extremity D. The ſquare mahogany frame F G ſtands parallel with the horizon.

Near the end K of a mahogany board the braſs rod M N is ſcrewed ſo as to ſtand upright; it is provided with a ſhoulder, in order that it may be firmly fixed into the plate M O, faſtened at each angle to the board with ſcrews.

In the ſame manner the rod P Q is faſtened at the other end of the board K, which faſtening cannot be ſeen in this view of the apparatus. Theſe rods paſs through the ſquare frame F G at H and I, ſo that it may be ſlidden upwards or downwards on the rods.

At each hole in this frame through which the rod paſſes, a braſs ſocket (H a) is ſcrewed to the lower ſide of the frame, ſo that the rod may paſs freely through it; and that it may be fixed at any elevation, the ſocket is provided with a ſcrew H, by which the rod may be preſſed againſt the oppoſite ſide of the ſocket, and thus kept in the poſition required.

The oppoſite ſide of the frame near I is in the ſame manner provided with a ſocket and ſcrew.

The veſſel Q containing water has a tube fixed in the centre of its bottom, which receives the rod and ſlides on it, ſo that the veſſel may be ſuſtained at any required height. By means of a ſtop cock b the water may be made to trickle more or leſs quickly from the veſſel Q upon a piece of muſlin c, by which it is diſtributed over the whole ſurface of the adopter A B, and deſcends by C D into the ſquare trough D, after having ſerved to cool the adopter. d is a glaſs funnel cemented into a braſs cap at m, from which the tranſverſe tube B e, provided with a ſtop cock, may deliver the hydrogen gas of the funnel d into the adopter through the ſlender extremity e, made of iron leſt it ſhould be melted by the flame of the hydrogen gas.

Under the other neck of the adopter ſtands the funnel g furniſhed with a ſtop cock (at f) intended to receive and deliver oxygen gas by the courſe g *g* A into the adopter, in order to maintain the combuſtion of the hydrogen gas.

 Through

Through a collar of leather, fixed in the tube between i and A, an iron wire paſſes, bent in the direction A e: the end of this wire at e is at the diſtance of one-eighth of an inch from the end of the tube which ſupplies the hydrogen gas, when the wire ſtands in this poſition to deliver the electrical ſpark, and inflame the hydrogen gas as it iſſues. The end of the wire at i is ſcrewed into a ſmall braſs ball, by which it receives ſparks from the larger ball k of the electrical conductor.

The funnel containing oxygen gas enters water to the depth of three or four inches in the veſſel R S, the ſize of which admits a pint bottle of gas to be introduced under the funnel and delivered into it. The veſſel T U ſerves in like manner for the ſupply of hydrogen gas to the funnel d.

When it is intended to accelerate the combuſtion of the gaſſes, the hydrogen funnel muſt be kept conſtantly full, ſo that it may be preſſed upwards by a column of three or four inches of water: at the ſame time the oxygen funnel muſt be ſupplied ſo ſlowly that the water may riſe in it five or ſix inches above the common level. In the contrary circumſtances the combuſtion may be retarded at pleaſure; but care muſt be taken that the hydrogen gas iſſue in a continued ſtream, and the flame be maintained.

As it is neceſſary that the adopter ſhould be firmly ſcrewed to the ſquare frame, and yet eaſily ſeparable from it, the following proviſion is made:

a b is the neck of the adopter through which the gas is to be introduced. The lip at *b* ſtrengthens the mouth of the adopter. *d* is the external projecting part of the glaſs ſtopper, which is accurately ground to fit. This ſtopper being ground to a ſmaller diameter between *d* and *g* is there cemented into a braſs cap *g f*. The ſlender wire which is to deliver the electric ſpark is continued through the glaſs ſtopper *d* to i. The oxygen funnel g communicates by a narrow paſſage with the cavity of the adopter round the wire i e. The neck of the adopter is imbedded in the mahogany

frame;

frame; the brass clip *h* shuts upon this neck, and presses it to the frame by the screws *i i*. To keep the stopper *d* firm in the neck of the adopter, a semicircular clip embraces the brass cap *g f*, and meets the shoulder of the stopper *d*. From this clip two brass pins enter the piece *k*, which being drawn to the frame by the screws *l l*, forces the clip against the glass stopper *d*, and thus fastens it firmly in the neck of the adopter. By the like mechanism the other neck of the adopter is made fast to the frame.

The wire i e being moveable in a well-greased collar of leather, the brass ball i is turned round, when the hydrogen gas has been inflamed; and the wire A e turning with this ball, the end e is removed to one side from the flame of the hydrogen gas; the screw *m* serves to keep the wire in the position required.

Previous to the use of this instrument the funnels are to be screwed off: the oxygen funnel at f; the hydrogen funnel at the neck B of the adopter. The hydrogen stopper being removed, the adopter is to be rinsed with distilled water, and, being again put in its position on the frame F G, is to be left to drain, the tube C D being left open. After this the adopter with its stoppers and included air is to be weighed: the hydrogen stopper being then removed, the adopter is to be filled with distilled water of a known temperature, and the stopper to be again replaced. By the weight of the water in the adopter its capacity in cubic inches is ascertained.

The same stopper is now to be taken out and dried, and oxygen gas, under a pressure of a two-inch column of water, to be introduced till all the water is excluded from the adopter: its orifice, being still under the water, is then covered with the finger, and another person stands ready to introduce the stopper, which has to expel its bulk of gas, so that no air can enter against this current of the gas. The adopter is now fastened to its frame, and the funnels are screwed on. To

 prevent

prevent the hydrogen tube from introducing the atmofpheric air which it otherwife would hold, oxygen gas is fucked through it from the fmall extremity.

The funnels, the capacities of which are determined by meafurement, and marked at the different heights, now contain atmofpheric air confined by water, which is to be fucked out by means of a flender fyphon: when the oxygen funnel is thus emptied of its air, in order that none may remain in the neck, oxygen gas is to be introduced and fucked out repeatedly. Then it is to be charged with the fame gas, and the ftop cock to be opened to allow a free communication between the gas in the funnel and that in the adopter, which is now left to drain for 24 hours, at the end of which time the water which has gathered in the tube C D is to be paffed off by opening the cock D, which muft juft touch the furface of the water in D, that the oxygen gas in the adopter and funnel may accommodate itfelf to the prefent temperature and preffure of the external air, which is to be noted, and then the cock to be ftopped. The water on the outfide of this funnel is to be kept two or three inches lower than in the infide.

The hydrogen funnel d is to be freed of its contained atmofpheric air by the fame means employed for freeing the other funnel, and hydrogen gas is to be repeatedly introduced and fucked out. At laft it is to be filled with meafured quantities of this gas to the lip, which is to be compreffed by a column of about four inches of water.

The apparatus is now ready. The ball k of the electrical conductor, charged by a good machine, is to be brought near to the ball i; and while the fparks pafs in quick fucceffion from the wire A e to the point of the tube B e, the cock at f is to be opened quickly, fo that the firft portion of hydrogen gas iffuing at e may be inftantly inflamed; the wire is then to be turned away from the flame. The combuftion may be accelerated by increafing the column of water which preffes the hydrogen gas, and leffening the preffure on the oxygen

gen gas. The adopter is now to be kept cool by water, allowed to trickle down over it from the veſſel Q.

During the combuſtion meaſured quantities of the gaſes are to be introduced into the proper funnels; and when it is wiſhed to interrupt the proceſs, the cock which admits the hydrogen gas is to be quickly ſtopped. As the veſſels cool, the oxygen gas and aqueous vapour in the adopter will contract in bulk, and the water in the oxygen funnel will riſe towards the braſs cap f. At this moment the cock muſt be ſhut to prevent the water from riſing higher.

When the proceſs is to be renewed, the oxygen funnel is to be charged with gas, and the cock to be opened. The hydrogen funnel is next to be charged; the wire A e to be turned to its firſt poſition, and the electric ſpark to be applied as before. Thus the combuſtion may be carried on from day to day. That the electric ſparks may ſtrike quickly and vigorouſly, a communication ſhould be made with a wire between the cuſhion of the machine and the braſs cap m.

As the gaſes employed are not to be conſidered as free from azotic gas, its preſence will at laſt reduce the gas in the adopter to the ſtandard of atmoſpheric air. The flame will then become weaker, and muſt be watched, that the cock of the hydrogen funnel may be ſtopped before the flame is extinguiſhed; otherwiſe ſome of the hydrogen gas will paſs unaltered into the adopter, and be confounded with the azotic gas, from which it is not eaſily ſeparable.

When the proceſs is terminated, the quantity of hydrogen gas remaining in its funnel is to be noted from the gradations marked on the veſſel, and to be deducted from the ſum of the meaſures of hydrogen gas employed. This funnel is then to be ſcrewed off. The oxygen funnel is to be treated in the ſame manner, proper attention being paid to the level of the water, and to the temperature and preſſure of the air at the time. The adopter and ſtoppers, being now in the ſtate in which they were firſt weighed, are now to be weighed, with the contained water, to determine its weight.

To

To weigh the water thus formed ſtill more accurately, and to examine its quality, it muſt be drawn off from the adopter. For this purpoſe the adopter, after it has ſtood to drain for 24 hours, is to be warmed by wrapping the upper part of it in a hot cloth: a bottle of proper ſize is to receive the extremity of the tube C D, and, the ſtop cock being opened, the expanded gas in the adopter will preſs all the water into the bottle. During the paſſage of the water, the bottle is to be held at ſuch a height that the orifice of the ſtop cock may dip only $\frac{1}{8}$th of an inch in the water; and when a ſingle bubble of gas from the adopter has iſſued through the water, the ſtop cock is to be inſtantly cloſed.

The gas remaining in the adopter is now to be transferred into another veſſel, in which it may be expoſed firſt to lime water, that any carbonic acid gas contained in it may be meaſured; and afterwards to ſulphuret of lime, which will imbibe all the oxygen gas, and leave the azotic gas in a ſtate fit for menſuration.

The quantity of heterogeneous matter introduced with the gaſes during the combuſtion being thus diſcovered, a proportionate deduction is to be made from the calculated weight of the hydrogen and oxygen gas employed. The difference of weight of the azotic gas remaining, and the common air at firſt weighed with the inſtrument, may thus be eaſily determined.

The Society from whoſe intereſting minutes we make the preſent extract, carried on the combuſtion in the manner already deſcribed, for about two hours at a time on different days, till the column of water in the tube C D was 8$\frac{1}{2}$ inches in length. At each of theſe times the temperature of the gaſes and the height of the barometer were carefully noted. In the manner deſcribed by Lavoiſier, the volume of each gas at 29·85 inches of the barometer, and 54·5° of the thermometer, was aſcertained; and the weight of the oxygen gas conſumed was found to be 416·5 grains, and that of the hydrogen gas 72·5 grains; the weight of both being 489 gr. = 1 oz. 11 dwt. 9 gr.

The

The water produced weighed 1 oz. 11 dwt. 7 gr.; and, contrary to all expectation, had no ſenſible acidity.

IX. *On the Principles of Iron and Steel. By Mr.* DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

THE general diffuſion of coal and ironſtone, in rich and extenſive tracts throughout the iſland of Great Britain, while it has ſtamped an additional value on land, has rendered the manufacture of iron of ſuch national importance and advantage, as to weigh conſiderably in the ſcale of our commercial intereſts. Of late years it has gained in a great meaſure that juſt preponderance to which its magnitude and general utility have fully entitled it. At preſent, however, it muſt not be concluded, that the buſineſs has attained thoſe bounds which ſet limits to its improvement; or that it has attained its utmoſt conſequence as a ſource of national and individual wealth. Its future progreſs will greatly depend upon the liberal exertions of individuals, and the ſelf-denial of the legiſlature, by abſtaining from cramping in its enlightened march the genius of this native manufacture.

Impreſſed with theſe truths, the following details will be found more allied to the practice of the manufacture of iron than attached to any ſyſtematic arrangement of ſcience; where oftentimes the practical ſtudent is obliged to ſmile, bewildered at the lengthened aſſemblage of phraſes expreſſive of a ſimple ſubſtance or meaning.

It is much to be lamented that the ſcientific arrangement of the mineralogiſt was not more conſonant to the ideas of the manufacturer; and that the labours of the former were not more directed to aſſimilate to the juſt reſults of practice his pre-conceived theories.

With heartfelt pleaſure we ſhould then peruſe the hiſtory and analyſis of the many ſtrata of argillaceous ores of iron with

with which both England and Scotland ſo plentifully abound; their richneſs in iron, and capability of being manufactured; their contiguity to coal, and the local advantages which nature may have beſtowed, by the addition of waters ſufficient for turning machinery: theſe would form intereſting and inſtructing branches of information, and ultimately would tend to the advancement of our real intereſt.

It is alſo much to be wiſhed, for the improvement of all, that the method and order of the new nomenclature of the French ſchool would pervade every branch of chemical and mineralogical ſcience; and that the celebrated Kirwan would ſo far bend as to new model his excellent ſyſtem of mineralogy on theſe principles.

The metallic ſubſtance called iron is ſuſceptible of a greater variety of modifications, and poſſeſſed of more properties ſingular and uſeful, than any other metal. Iron, properly ſo called, is malleable. All the other ſtates of the metal contain certain ſubſtances in combination with the iron, which render it fuſible, brittle, more or leſs elaſtic, &c. Pure iron is deſtitute of foreign admixture, and is therefore perfectly malleable. A variety of methods have been eſtabliſhed to produce the metal approaching to that pure and ductile ſtate: in the purſuit of this laudable attainment the following diſtinct modifications of iron have manifeſted themſelves:

1ſt, Crude, caſt, or pig iron; 2d, Steel; and, 3d, Malleable iron. Crude iron is an eager brittle metal, obtained by the ſimple fuſion of ores in contact with pitcoal charred, or the charcoal of wood, united with a certain proportion of calcareous earth as a ſolvent or flux: its component parts are iron, carbon, and oxygen. Carbon is imparted to the iron from the fuel which is uſed in ſmelting the ore; oxygen is conveyed to the iron in a twofold manner: it exiſts in the ore in a concrete ſtate, and unites to the iron previous to ſeparation; a portion is alſo communicated by the

the great compreſſion of air uſed to excite the degree of heat neceſſary for reduction.

Theſe are the foreign ſubſtances which alter and contaminate the quality of the iron; but, as they exiſt in different proportions in various irons, it is obvious that theſe alterations of proportion will form varieties of crude iron: the following are diſtinguiſhable:

1ſt. Oxygenated crude iron, where a ſmall portion of carbone is united to the iron, and where a ſuperabundance of oxygen exiſts. The fracture of ſuch iron preſents a white ſurface deſtitute of grain, frequently diverging in ſtreaks, reſembling an early variety of cryſtallization; ſometimes it is mottled with ſpecks of a black colour, which plainly exhibit the ſcanty portion of carbonic concretions. The external ſurface of ſuch iron always cools concave, rough, and covered with oxyd. In commerce this variety of iron is known by the names of white iron, forge pigs, ballaſt iron, &c. and its preſent value is from 5l. 5s. to 5l. 15s. per ton.

2d. Carbo-oxygenated crude iron*, or iron united with equal portions of carbon and oxygen. The fracture of this iron is light grey, preſenting a ſmall diſtinct grain; the ſurface of the pig partially punctured, leſs concave, and more free from oxydation in cooling than the former ſtate. In commerce it is known by the names of grey iron, No. 3,

* I am fully aware of the novelty of this term, and that by ſome I may be liable to be cenſured. I have, however, the great Lavoiſier for my precedent, who, in naming the compound radicals of the vegetable kingdom, uſed hydro-carbonous and hydro-carbonic, to expreſs the ternary combination of hydrogen and carbon with oxygen; in the former, into that of an oxyd—in the latter, into that of an acid. It may however be remarked, that in this way the prevailing ſubſtance was marked by a precedency given to its ſign, which implied that there exiſted a larger proportion of this than the following ſubſtance. Let the preſent, however, expreſs the combination of iron with carbon and oxygen in equal portions: the precedency given to carbon in beginning the compound, is meant to denote its ſuperior agency, and its preſence being eſſential in the manufacture of crude iron.

&c.

&c. and its present value is reckoned from 5l. 15s. to 6l. 5s. per ton.

3d. Carbonated crude iron, wherein carbon fully predominates, and where an extra privation of oxygen has taken place. The fracture of this iron is dark grey inclining to blue, presenting large brilliant concretions of a metallic lustre in the centre of the pig, but diminishing in point of size as they approach the surface. In this quality of iron the upper surface, which is left to cool in contact with the open air, after being run from the blast furnace, is partially convex and full of punctures: it is then called by the workmen honey-combed, and its quality is often inferred from the size and depth of the puncture: its tendency to oxydation in cooling is still less than that of the second variety of crude iron. This quality is well known to the manufacturer and founder, under the names of No. 2, good melting pig iron, &c. Its present value is from 6l. 15s. to 7l. 10s. per ton.

4th. Super-carbonated crude iron, or iron saturated to excess with carbon, and having united to it but a scanty portion of oxygen. The fracture of this iron presents an astonishing group of large, regular, metallic grains, each presenting a prominent edge outwards; in this state the saturation of carbon has been so complete, that it exists united to the iron in the state of plumbago; lustre rich and brilliant, inclining to dark blue; the upper surface smooth and convex, frequently covered with a beautiful coating of shining plumbago, and completely free from oxyd. This is the No. 1, and smooth-faced iron of the manufacturers: its present value is 8l. to 8l. 10s. per ton.

These are the principal varieties of crude iron. A number of intermediate qualities are produced, exactly dependent upon the quantity of mixtures, and their relative proportions to each other. The greater the quantity of charcoal used in smelting the ore, the more saturated with carbon and the more

more valuable will be the pig iron. A ſparing proportion of charcoal in the blaſt furnace is productive of effects completely contrary to theſe.

It moſt naturally occurs to enquire, to what extreme degree of combination theſe alterative principles are capable of with iron, and in what ſtate the metal is when this exceſſive ſaturation is completed.

If crude iron is expoſed in fuſion, for a length of time, to abſorb carbon, and at the ſame time is protected from oxydation, it will receive this principle to ſuch exceſs as to form a true plumbago. In this ſtate it either reſembles ſteel, grained lead ore, or aſſumes an imperfect cubical cryſtalliſation, wonderfully brittle, and poſſeſſed of a real metallic appearance and weight: in this ſtate it is powerfully attracted by the magnet.

Specimens of this ſingular combination are extremely rare; ſeveral that I am in poſſeſſion of, have regular faces approaching to a cubical ſtructure, with ſurfaces chequered with numerous diagonal lines interſecting each other, and forming rhombuſes: theſe are eaſily diſplaced with a knife, and exhibit them compoſed of the thinneſt laminæ imaginable: in this ſtate they are not obedient to the magnet, unleſs a conſiderable number of them are attached together. The ſpecific gravity of this mixture of iron and carbon is to water as 6·9694 to 1·000; a cubic foot weighs 435·58750 pounds avoirdupoiſe.

In manufacturing crude iron, the higheſt poſſible pitch to which it can be united with oxygen is productive of a coarſe metallic ſubſtance, whoſe fracture is dark and porous, and whoſe ſurface on cooling becomes covered with a deep earthy oxyd; incapable of being fuſed but by withſtanding a violent heat; capable of receiving ſome impreſſions of malleability, though ſtill poſſeſſing exceſſive brittleneſs when cold. The ſpecific gravity of iron thus united with oxygen is 6·5325.

Theſe ſtates of extreme ſaturation of carbon and oxygen only

only relate to these principles as they become united to the iron in fusion: they may also be presented to crude iron in the process of cementation; in which case carbon unites to iron in an aëriform state, distending the particles and softening the mass: oxygen, on the contrary, attacks the metal, and reduces it to a dark blue oxyd destitute of metallic brilliancy and weight; but of this more hereafter.

Steel, from its great affinity to crude iron, ought next to be mentioned; but as manufacturers hitherto have placed it as the third existing state of the metal, it will be mentioned in that order.

To produce malleable iron in its pure state, many and various have been the processes adopted: these however have all in some measure fallen short. Malleable iron ought to possess no foreign mixture whatever, to be in a state of purity; but as the modes of operation have hitherto consisted in manufacturing this state of the metal from crude iron, and as crude iron is always found to contain principles inimical to malleability, it is obvious, that the quality of malleable iron will at all times depend upon the degree of expulsion of the alterative mixtures contained in the crude iron; the destruction of which, and the consequent malleabilization of the iron, constitute the universal acknowledged principles of bar-iron making.

From the imperfect dissipation of oxygen and carbon in the process of malleability, arise the various qualities of malleable iron; these may be arranged in the following order: 1. Hot short iron; 2. Cold short iron; and, 3. Iron partaking of none of these evils; and so far it may be denominated pure malleable iron.

1st. Hot short iron is possessed of an extreme degree of fusibility when in contact with a high degree of heat, and is incapable of receiving the weight of a small hammer without dissipating; it is, however, possessed of an extreme degree of softness and ductility when cold, and may then be bent or twisted in almost any direction. Various reasons have

have been aſſigned for this deſtructive property in hot ſhort iron. I am of opinion, that it ariſes from the iron containing a ſmall portion of concrete carbon, not extirpated during the operation of rendering the iron malleable; and that in proportion to the quantity of carbon united, ſo will be the ſhortneſs or fuſibility of the iron: this variety of iron is always of a dark-coloured unmetallic fracture.

2d. Cold ſhort iron is poſſeſſed of the property of withſtanding the moſt violent degree of heat, without exhibiting the leaſt indication to fuſion; it remains firm under the heavieſt hammer, and is capable, while hot, of being beat into any ſhape: when cold, however, it is brittle, and poſſeſſed of a ſmall degree of tenacity: its fracture is always clear and large-grained, of a light blueiſh colour. A ſmall portion of iron diſſolved in the phoſphoric acid is now believed to conſtitute the cold ſhort principle of iron. Beſides the difficulty of conceiving how an acid could exiſt in the violent and long-continued heats of the refinery, the puddling and balling furnaces, wherein the metal is ſubjected to motion, frequently agitated, and extremely divided, how does it happen, that that iron on which the cold ſhort principle is impreſſed, becomes more and more cold ſhort, by a continued expoſure to the combination of oxygen with caloric, either excited by blaſt or the attenuated heat of a wind furnace? This fact would imply a generation of the alterative principle—which is indeed the caſe—but which cannot be admitted, if the cold ſhort quality is attributed to the phoſphat of iron; unleſs recourſe is had to the ſuppoſition of a new combination of this metallic ſalt during the operation.

If highly oxygenated crude iron, of any manufacture, is expoſed to the action of a current of flame, after its ſmall portion of carbon is burnt out, and after the maſs has exhibited the proper ſigns of malleability, it will paſs into the ſtate of cold ſhort iron; and this principle will exiſt in proportion to the length of the expoſure; or, in other words, in

 proportion

proportion to the oxygen presented to the metal, and its tendency to quit the caloric to unite with the iron.

3. Pure malleable iron derives its strength, tenacity, malleability, and ductility, by being totally deprived of the principles which constitute the cold and hot short qualities of iron. This is effected in the course of rendering it malleable, either by the attention of the workmen, or from the proper quality of the crude iron used: its fracture is generally clear, consisting of small regular dark blue grains; by much hammering the iron commonly gains fibre, and is then of a light blue colour, uncommonly tenacious when cold. The excellence of pure malleable iron is also manifested by the astonishing degree of heat it withstands without exhibiting the least sign of fusion, or without losing much of its metallic parts by oxydation.

A line of distinction ought to be drawn betwixt the iron produced with wood-charcoal and pit-coal. As the present relation of the simple principles of the metal does not immediately interfere with that distinction, it will more properly arrange itself along with the observations on the various modes practised for rendering iron malleable.

However variously conducted the modes of operation are, at different works, and in different countries, to produce malleable iron, yet the principle of operation is the same, namely, that by dissipating the carbon and oxygen, contained in the crude iron, bar or malleable iron is the result.

Furnaces of a multiplicity of shapes have been erected for this purpose; but in the most perfect conducted processes hitherto, it has been found, that a heavy loss of metallic parts accompanied the manufacture: 40, 35, to 30 cwt. of crude iron have been used to fabricate 1 ton of finished bars; the quantity used always depending upon its aptness to become malleable, the skilfulness of the workmen, the operation adopted, and the quality of the malleable iron wished to be produced. These observations more immediately relate to the home manufactures of iron with pit-coal;

but

but in many inſtances they will alſo apply to thoſe of other countries, where the charcoal of wood is uſed for fuel.

Since crude iron exiſts of ſuch a variety of quantities, owing to the various proportions of mixture united with it; and ſince it is almoſt univerſally uſed to produce bar or malleable iron; it is natural to infer, that there muſt exiſt one particular variety of it, which could be appropriated to the manufacture in preference to any other. Theory ſays that that crude iron, carbo-oxygenated, which contains the alterative principles in equal portions, requires only to be expoſed in a fluid ſtate to the action of fire, either in a wind furnace or ſmall blaſt. By this expoſure the carbon becomes volatilized, and carries off the oxygen along with it*. Practice has however confined the operation chiefly to the forge pig (oxygenated crude iron). This variety of iron becomes ſooner malleable, but is likewiſe ſuſceptible of early oxydation, and conſequently liable to become cold ſhort. Neither can it unite to bar iron thoſe properties from whence are derived great ſtrength and ductility.

When carbonated crude iron is uſed, the waſte then is apt to be exceſſive: the metal retains for too long a period its fuſible principle, which muſt neceſſarily expoſe the maſs to a longer continued action of the flame, whereby oxydation on the metal in a fluid ſtate takes place, and a conſiderable portion of it is deſtroyed before the iron exhibit ſigns of infuſibility. Malleable iron made from this ſtate of the metal has a great tendency to be red ſhort, and loſes alſo conſiderably of its weight under the forge hammer.

It has at all times been aſſerted, that crude iron contains a conſiderable proportion of its parts, by weight, inimical to malleability; and that, in the operation of refining, it then

* A definition more conſonant to chemical language would be to ſay, that the oxygen unites to the carbon and forms carbonic acid, which is expellable even in a moderate heat. The eſcape of the laſt portion of the acid is indicated by the diſappearance of fuſion, and the coaleſcence of the clotted iron.

parts with this proportion of mixture, which renders the remainder malleable. A conclusive inference from this would be, that some crude irons contain one half, some three fourths, and others again an equal portion of mixture for iron; seeing these are the proportions lost by iron in the operation of rendering it malleable. The mischief with which this fallacious opinion is fraught is inconceivable; especially as it has been supported by men who have laid claim to scientific and practical abilities: the belief of it slackens the industry of individuals to attempt lessening the loss of real metal; on the contrary, workmen are taught to look upon a large proportion of it as incapable of being metallized, and as only fit for destruction.

If manufacturers of bar iron would more frequently deprive a given weight of the scoria of the refinery and puddling furnaces, of its iron, they would be more able to estimate the portion of unmetallic parts contained in their crude iron: upon finding the scoria to contain 30, 40, to 50 per cent of iron, equally fit for converting into malleable iron as any part of the original mass, their attention would be more frequently arrested, and employed to devise means, either to prevent the escape of such a considerable proportion of iron, or to fuse such scoria so as to deprive it of the last portion of metal.

The relative proportion by weight of carbon and oxygen united to crude iron is small indeed: the possible proportion in which they can exist will be more easily conceived by adducing the weight of a specific bulk of each and their analogy.

1 Cubic foot of oxygen gas	·0792859 lb. av.	S. gravity ·00105308̶80
1 ditto carbon	24·519	S. gravity ·39214
1 ditto carbonated crude iron	453·70325 lb do.	S. gravity 7·259368o

The vast disproportion betwixt the cube of iron and the aggregate of the mixtures renders further illustration on this head superfluous *, though at some future period I hope to be

* I wish not to be understood as if I meant to say that the quantity of oxygen in a concrete form in iron is to be considered as having no greater specific

be able to ftate the exact weight of mixtures united with a given quantity of crude iron.

Some, however, may contend for the exiftence of fome metallic fubftances along with crude iron, which may alfo form part of the unmetallic mafs: we are however unacquainted with any capable of enduring the violent heats ufed in manufacturing iron, excepting manganefe; and this femi-metallic fubftance is found in bar iron and fteel, nearly in the fame proportion as in crude iron: hence it can form no part of the *fuppofed* heterogeneous matter expelled during the procefs of malleability.

Steel is a mixture of iron with carbon in an aëriform ftate*. Carbon is given to iron by heating it violently, unexpofed to air, in contact with charcoal duft. The proportion in which carbon exifts in fteel is various, depending upon the degree of purity exifting in the malleable iron previous to cementation. In abforbing this principle it gains weight; and this augmentation of weight, by the addition of carbon, is dependent upon the reafon already mentioned. Some iron, in paffing to the ftate of fteel, gains $\frac{1}{140}$th part of its original weight, while others gain not more than $\frac{1}{175}$th part.

fpecific gravity than an equal bulk in a gafeous ftate, that is combined with caloric, inftead of being combined with the metal. The enormous wafte of real metal, in converting a given quantity of crude into malleable iron, is generally fo great, that, at prefent, I merely wifh to call the attention of artifts to the prevention of this wafte, inftead of fatisfying themfelves with faying they had only a given product, becaufe the crude iron employed was of fuch a nature as to be incapable of yielding more.

* In the works of thofe who have treated on iron, I have never yet feen carbon which exifts in crude iron, diftinguifhed from that abforbed by malleable iron, in the procefs of converting into fteel. I could adduce many facts, which to me appear conclufive, to prove that carbon exifts in crude iron in a concrete ftate, feparable by mechanical divifion; and that it is united to fteel in a gafeous ftate by the combuftion of its bafe, infeparable in any form by the moft minute mechanical reduction.

If malleable iron was entirely freed from carbon in the manufacturing, the inference would be juſt, to ſtate that the weight gained was the exact meaſure of carbon neceſſary to form ſteel; but as ſome malleable irons afford a conſiderable portion of carbon, it is evident that the total meaſure of carbon will depend upon the pre-exiſting quantity contained in the iron. The greater the quantity introduced the more brittle will the quality of the ſteel be found, and the leſs capable of preſerving its nature and a ſolid form, when expoſed to intenſe degrees of heat.

Steel, at certain degrees of heat, poſſeſſes all the ſoftneſs and malleability of iron; but, when cold, partakes of the eager brittleneſs of crude iron. When properly hammered, it gains fibre, and then becomes the moſt elaſtic ſtate of the metal. It is alſo capable of fuſion at a high degree of heat: it may then be run liquid into iron moulds, and afterwards beat out into the moſt ſolid ſhapes, poſſeſſing coheſion and cloſeneſs of grain, with an aſtoniſhing degree of flexibility and tenacity. In this ſtate it is called caſt ſteel, and is uſed for fine inſtruments, where durability, poliſh and edge are requiſite.

In ſo far therefore as ſteel is capable of fuſion, without deſtroying its nature; and as it contains iron and carbon alone, it muſt be conſidered as a variety of crude iron free of oxygen, and ſo far is partially malleable. The fuſion of ſteel deſtroys its property of being welded. This change of nature is occaſioned by the addition of oxygen in the caſt ſteel furnace: hence we find, that fuſion is incompatible with an extreme degree of malleability.

Since a ſmall portion of oxygen is added in the fabrication of caſt ſteel, the component parts of this modification of the metal will be, iron, carbon, and a ſmall portion of oxygen. Admitting then for a moment that the carbon is in the ſame ſtate as in crude iron, here then exiſts a ſimilarity of principles with carbonated iron. Yet there are few but know the

the very wide difference betwixt crude iron and caſt ſteel when applied to uſe.

This amongſt many other poſitions might be adduced to prove that carbon exiſts united in a gaſeous ſtate to iron, and conſtitutes ſteel; or, in other words, that iron to conſtitute ſteel muſt hold in ſolution a portion of carbon, not leſs than $\frac{1}{175}$th part of its own weight.

Some of the foreign writers account for the difference betwixt ſteel and crude iron, by affirming that the former is iron *perfectly reduced* to which carbon is given, and that the latter is only iron *imperfectly reduced*, and which alſo contains carbon. This is a feeble diſtinction. Iron knows of no ſtate of imperfect exiſtence as a metal; the particles of iron in a crude ſtate are equally diſpoſed to become malleable, ſo ſoon as the carbon which has interpoſed itſelf betwixt them is burnt out. The ſame operation muſt take place before ſteel is brought back to the ſtate of malleable iron; hence, according to the reaſoning of the French writers, they are both imperfect ſtates of the metal.

Crude iron is only ſo far imperfect, becauſe it contains carbon in a material ſtate. Steel may be ſaid to be more perfect, becauſe it is united to carbon in an elaſtic ſtate; and iron, properly ſo called, is perfect in proportion as it is void of theſe impurities.

Steel alſo poſſeſſes the ſole property of acquiring a degree of hardneſs, when immerſed at certain degrees of heat into cold water, which enables it to perforate and act upon all other metallic ſubſtances. This is occaſioned by the ſudden expulſion of the caloric from the interſtices of the metal, which brings on an inſtantaneous aggregation of the particles, and which renders the fracture uncommonly cloſe and regular. Expoſure to a ſimilar degree of heat, and cooling in the open air, brings it back to its uſual ſtate, capable of being again and again hardened, and not to the ſtate of malleable iron, as a late eſſayiſt on iron has erroneouſly ſtated.

Having thus ſimply ſtated the principles, and the various modifications of iron; thoſe operations which have been practiſed for obtaining the various ſtates of the metal come next to be related; prefaced by ſome account of the materials uſed; the manner in which they are obtained; their preparation and application to uſe; previous to which, I ſhall forward, for the next number of the Philoſophical Magazine, a few remarks relative to the hiſtory of the manufactures of iron and ſteel in Britain, which may not prove unacceptable to thoſe who feel themſelves intereſted in this important branch of national induſtry.

X. *Account of the* Canis Graius Hibernicus, *or Iriſh Wolf-dog, deſcribed in Pennant's Hiſtory of Quadrupeds, third edit. Vol. I. p.* 241. *By* A. B. LAMBERT, *Eſq. F.R. and F.L.S. From the* Tranſactions of the Linnean Society, *Vol. III.* 1797.

THIS drawing of the Iriſh wolf-dog was given me by lord Altamont; done exactly the natural ſize of one in his lordſhip's poſſeſſion, at Weſtport in the county of Mayo, Ireland. During my ſtay there in 1790, I had frequent opportunities of obſerving theſe dogs; lord Altamont having eight of them, the only ones now in the kingdom. There is a man employed on purpoſe to take care of them, as they are with difficulty bred up and kept healthy.

I took the meaſurement of one of the largeſt, which is as follows: From the point of the noſe to the tip of the tail ſixty-one inches, tail ſeventeen and a half long; from the tip of the noſe to the back part of the ſkull ten inches; from the back part of the ſkull to the beginning of the tail thirty-three inches; from the toe to the top of the fore-ſhoulder twenty-eight inches and a half; the length of the leg ſixteen inches; from the point of the hind toes to the top of the hind

hind ſhoulders thirteen inches; from the point of the noſe to the eye four inches and a half; the ears ſix inches long; round the wideſt part of the belly (about three inches from the fore-legs) thirty-ſive inches; twenty-ſix inches round the hind-part cloſe to the hind-legs; the hair ſhort and ſmooth; the colour of ſome brown and white; others black and white.

They ſeem good-tempered animals, but, from the accounts I received, are degenerated in ſize. They were formerly much larger, and in their make more like a greyhound.

The following extract of a letter from the Earl of Altamont to A. B. Lambert, Eſq. V. P. L. S. read to the Society Jan. 3, 1797, contains ſome farther particulars reſpecting theſe animals.

" There were formerly in Ireland two kinds of wolf-dogs, the greyhound and the maſtiff. Till within theſe two years I was poſſeſſed of both kinds, perfectly diſtinct and eaſily known from each other. The heads were not ſo ſharp in the latter as in the former; but there ſeemed a great ſimilarity of temper and diſpoſition, both being harmleſs and indolent. The painting in your poſſeſſion is of the maſtiff wolf-dog. (See Plate V.)

" I have at preſent five wolf-dogs remaining, three males and two females; in theſe the two ſorts appeared to be mixed. The dam was of the maſtiff, the ſire, if I am not miſtaken, was of the greyhound kind. The ſire and dam had not dwindled in ſize from any that I remember here. Thoſe which now remain are too young to judge of. We have an old man here named Bryan Scahil, now in his 119th year, whoſe memory ſeems accurate and all his faculties complete: he perfectly remembers the hunting of wolves in Ireland as a common matter of ſport; and informs me, that the uſage was, to collect all the dogs of every ſort in the neighbourhood, and to borrow wolf-dogs from the principal gentlemen, who alone had them, and who uſually aſſiſted in the chace. A tenth part of the dogs used were not wolf-dogs, which never were in any number in the hands of the common people. I conceive also, that these dogs having *no nose,* other kinds were necessary to find the game and follow the scent of it. Scahil described wolves with such perfect accuracy, that I have no doubt of his being well acquainted with the animal."

XI. *Observations on Platina, and its Utility in the Arts, together with some Remarks on the Advantages which reflecting have over achromatic Telescopes. By* ALEXIS ROCHON, *Director of the Marine Observatory at Brest. From the* Journal de Physique, 1798.

[Concluded from page 27.]

FORGED PLATINA.

THE reader must recollect that all metals are easily melted after they have been reduced into very thin plates. Thus gold leaf melts at the flame of a taper, though not excited by a blow-pipe. In this manner also philosophers are enabled to melt those small glass globules which serve them as simple microscopes. This observation is sufficient to indicate the process that must be pursued in the operations in regard to forged platina. The platina is first purified by means of nitre and sandifer (*sel de verre*); this mineral is then divided into very minute particles, either by trituration, or by solution in nitro-muriatic acid or diluted nitric acid, according to the method of my colleague Tillet.

Nitre, antimony, arsenic, and, in short, every substance which becomes volatilised, may be employed for this operation; but arsenic ought to be preferred, because it is more easily dissipated. The platina being thus divided into exceedingly small particles, must be exposed to a strong fire, which must be excited still more by the oxygen gas that disengages

disengages itself from nitre in combustion. In this violent fire the particles of the platina become agglutinated; and by forging them at a white heat repeated times, the workman is able to give them sufficient adhesion to stand being hammered into plates. The well-known labours of Sickengen on forged and laminated platina render it unnecessary to say any thing further on this subject. He allowed me to see his process; and to that favour I am indebted for the knowledge necessary to enable me to treat a difficult subject absolutely foreign to my studies.

CAST PLATINA.

Cast platina is infinitely more interesting to the arts; and it is on this labour that I have bestowed my chief attention. The process which perfectly succeeded with me, to cast crucibles and large pieces of platina of different forms, was, to melt the metal according to the method of Scheffer, by a mixture of arsenic and sandifer. The fire must be moderate; and for this reason there must be at least ten pounds of arsenic and four pounds of sandifer to melt one pound of platina. The mass then will be in a state of perfect fluidity when poured into the mould, though the fire be scarcely sufficient to fuse silver. Platina in this state is exceedingly fragile and brittle; were it exposed to a red heat, the operation would absolutely miscarry. The arsenic, by disengaging itself too rapidly, would reduce it to scales, which would no longer have any adhesion. It may readily be conceived, that this accident must have occurred to me more than once. I have, however, been able to avoid it by inclosing the pieces of platina which I had moulded in a box of plate-iron, filled with sand and pounded charcoal. I then exposed them for more than a month to a fire graduated from the heat of boiling water to that which fuses silver. Platina in this state no longer resembles a metal: it might rather be taken for a metallic calx. The particles which compose

compoſe it are very cloſe; but they have only a very feeble adheſion, like that of an earthen veſſel dried in the ſhade. It is then that the platina muſt be expoſed to the moſt violent fire; and when the metal has undergone that operation, it reſumes its natural ſtate, becomes ſonorous, malleable, and the ſtrongeſt heat gives it always new degrees of improvement.

A little time after I had read this memoir, the learned Dr. Ingenhouz begged me to unite into a maſs for him about two ounces of platina, which he had carefully purified by means of the nitro-muriatic acid. I was obliged to incloſe in a very thin leaf of platina all the fragments of this metal, which were too ſcattered and too minute to be ſubjected ſeparately to the action of the fire and of the ſtamper; but, when thus united, I gave them the higheſt degree of heat poſſible to be produced from charcoal excited by a pair of bellows; and I ſoon obtained, by ſtriking them with the ſtamper, a ductile and malleable maſs. After the ſucceſs of this experiment, I employed myſelf in purifying in the fire, and in a crucible, platina in grains, by means of nitre and ſandifer, which muſt be afterwards waſhed in the nitric acid; and by ſtriking at a white heat thoſe grains contained in the laminæ of platina, I procured at a ſmall expence conſiderable maſſes of malleable platina. This proceſs will render unneceſſary hereafter the uſe of the oxyd of arſenic, unleſs the workman wiſhes to obtain, by caſting, large crucibles or muffles of platina.

I was the firſt who treated platina in a large maſs in a manner truly uſeful to the arts: and though I have paid a great deal of attention to this labour, aſſiſted by the information of the learned Iſquierdo and the metallurgic talents of Daumy junior, I have employed my chief care in improving the mixture of platina with tin and the oxyd of arſenic, for the conſtruction of large ſpecula for teleſcopes, and, above all, for the ſpecula of ſextants and other inſtruments for de-

termining

termining the longitude at ſea. In the latter labour I have been well ſeconded by Carrochez and other artiſts who worked under my direction.

Being fully ſatisfied with the trials, of which I have given an account in the preceding memoir, I was deſirous of conſtructing a teleſcope like that of Herſchel. For this purpoſe, I engaged in the year 1790 a friend of the arts and ſciences, the unfortunate Trudaine junior, to procure from Herſchel a good ſeven-feet teleſcope. The ſuperiority of the teleſcopes made by that able aſtronomer depends much more than generally believed on the Newtonian conſtruction which he has adopted. The Gregorian teleſcopes are by no means to be compared to the former. An appearance of convenience made them however to be commonly adopted, though that conſtruction preſents great difficulties to be ſurmounted in the complete execution of it. But as it is always neceſſary in the uſe of teleſcopes, the magnifying powers of which are conſiderable, to adapt a magnifier that embraces a wide field, in order to find readily in the heavens the ſtar to be obſerved, it may eaſily be perceived that it is a matter of indifference whether the teleſcope employed for that purpoſe be of the Gregorian or Newtonian conſtruction; becauſe in that caſe a direct or lateral view of the object is abſolutely indifferent. The lateral ſight is indeed much more convenient when the Newtonian teleſcope is well diſpoſed on its ſtand. Herſchel has adopted for his teleſcopes a conſtruction ſtill more ancient and ſimple; and though it approaches near to the origin of the art, it is no leſs uſeful when uſed for large inſtruments. I have admired the effects of it in his teleſcope of twenty feet; and I ſhould have been enabled to form a better judgment of it in that of forty feet, but there then ſtill remained ſome improvement to be made in the latter, which is unique in the annals of aſtronomy. It is certain that a ſmall inclination given to a concave mirror of a long focus does not ſenſibly disfigure the image formed in its focus. This ſmall inclination is ſufficient to permit the obſerver to look through a ſtrong magnifier at the image of of the ſtar, without intercepting, by the head, the rays which proceed from it.

In the beginning of the year 1791, Trudaine entruſted to me the teleſcope which he had procured at London. Aſtronomy is indebted to Herſchel for the nobleſt diſcoveries of this century. The name of that obſerver will be tranſmitted to the moſt diſtant ages. He has augmented our planetary ſyſtem, and enriched it with a new planet, accompanied with ſeveral ſatellites. In 1671, Dominic Caſſini, obſerving the moon with an excellent teleſcope of Campani, remarked, in the obſcure part of her, ſome ſmall whitiſh nebulæ. This intereſting phenomenon did not eſcape the teleſcopes of Herſchel; and after the year 1784, that able aſtronomer announced, that he had ſeen a burning volcano in the middle of the ſpot called *Ariſtarchus*. We find in the Memoirs of the Academy of Sciences for the year 1706 the following remarkable paſſage of De la Hire: "The ſmall ſpot of Ariſtarchus is ſo brilliant, that ſome have believed it to be a volcano."

Are theſe ſmall whitiſh nebulæ bodies luminous of themſelves, or do they enjoy only a borrowed light? Such is the queſtion which I propoſed to reſolve, by aſſiduouſly obſerving theſe ſmall nebulæ, both with Herſchel's teleſcope, and that which I cauſed to be conſtructed of platina in the courſe of the year 1791, on the model of that of the above aſtronomer. Being deprived, ſince September 1792, of the uſe of that inſtrument*, the conſtruction of which had coſt me great

* Teleſcopes of ſtill greater magnifying powers might be ſo eaſily procured at Paris, that thoſe who are truly intereſted in the progreſs of the arts and ſciences are not a little aſtoniſhed that the great teleſcope of ſixty feet, announced in all our journals, is ſtill a project; and that no one even ſo much as thinks of realiſing it. Though the art of making large ſpecula is attended with ſome difficulties, it however requires neither the ſame talents nor the ſame patience as that of conſtructing large achromatic object glaſſes. The catoptric teleſcope requires only the regular labour of a ſingle ſurface, and it is the work of a few moments which forms or deforms the poliſh of the concave ſurface of a large ſpeculum.

labour

labour and much money, I was not able to continue this kind of obfervations.

This telefcope of feven feet, which I confider as fuperior to that of Herfchel of the fame length, enabled me, during the time I had the ufe of it, to be convinced that the fpot Ariftarchus, if not a volcano, is at leaft a body luminous of itfelf. The grounds on which I found my opinion are agreeable to the principles explained by Bouguer in his Treatife on the Gradation of Light; for thofe fpots of the moon which reflect moft ftrongly the direct light of the fun did not exhibit to me in the fhade the fame appearances as Ariftarchus, whatever efforts I made to augment the intenfity of that feeble light which arifes from the reflected rays of the earth. Befides, it is eafy to conceive that a very lively fire, concentrated in the hollow of a crater, cannot diffeminate the light which emanates from it: in that particular cafe, like a reverberator, it cannot be feen but under certain circumftances. It is remarked then, that it is in the months of Pluviofe, Ventofe and Germinal that this volcano is moft *apparent*.

When I undertook a journey to London, by order of Government, for the benefit of the fciences, I employed myfelf in a particular manner in the improvement of flint glafs; and I was convinced that the propereft and fimpleft means for rendering flint glafs fit for conftructing large achromatic telefcopes confift in removing the threads by means of a glafs-cutter's wheel. When thefe faults are removed, the glafs is to be kneaded in an oven and under a muffle, in fuch a manner as to give it almoft the form and fize of the object-glafs required to be made. This procefs is amply defcribed in a work which I publifhed in 1783, entitled *Recueil de Memoires fur la Mechanique et la Phyfique*.

It was in this collection that I faid that Euler had been the firft who thought of correcting the aberrations of refrangibility by ufing fubftances of different refractive powers. Maupertuis engaged to get conftructed at Paris Euler's ler's object-glafs, with water and glafs like that which Newton had imagined, to render the aberration of sphericity as little as poffible; but this object-glafs did not fucceed, on account of the proportion fince known between the refraction and difperfion of common glafs and water. This proportion is by the diafporameter as 155 to 133 in regard to refraction, and as 100 to 67 in regard to difperfion. But the ftrong curvatures which muft be given to deftroy the aberration of refrangibility would occafion a very ftrong aberration of fphericity. Thus, what might be gained on one hand would be infallibly loft on the other. This was fufficient to make Euler's project mifcarry, and to confirm the affertion of Newton, which tended to deftroy all hope of being able to obtain achromatifm in glafs. Since that epoch the firft knowledge of the ftrong difperfion of glafs in the compofition of which there is much lead, and which in England is known under the name of *flint glafs*, has been afcribed to John Dollond. This appellation however is not that beft fuited to this kind of glafs. But what is of moft importance to be known here is, that the more lead, or rather minium, is employed in making glafs, the more will its difperfive power be augmented. It was in the year 1759 that Dollond prefented achromatic glaffes, compofed of flint and crown glafs. He fays in his paper printed in the Philofophical Tranfactions, that he found means to deftroy with great eafe the aberrations of refrangibility; but he confeffes that he was ftopped by an object more difficult to be furmounted, that of annihilating at the fame time the aberration of fphericity. It was thought, and is ftill believed in France, that John Dollond was the inventor of achromatic telefcopes; but we know that, fome years after, Dollond's patent was attacked, on the ground that he was not really the inventor*.

XII. *A*

* The author here goes on to give what he confiders a correct account of the origin of the invention; but as he is incorrect in almoft every circumftance,

cumſtance, we ſuppreſs the reſt of his paper, and ſubjoin an article on the ſubject which appeared in the Gentleman's Magazine for October 1790, and which, we have been informed by Mr. Ramſden, contains a true ſtatement of the facts.

" The inventor was Cheſter More Hall, Eſq. of More Hall, in Eſſex, who about 1729, as appears by his papers, conſidering the different humours of the eye, imagined they were placed ſo as to correct the different refrangibility of light. He then conceived, that if he could find ſubſtances having ſuch properties as he ſuppoſed theſe humours might poſſeſs, he ſhould be enabled to conſtruct an object-glaſs that would ſhow objects colourleſs. After many experiments, he had the good fortune to find theſe properties in two different ſorts of glaſs; and by forming lenſes made with ſuch glaſs, and making them diſperſe the rays of light in contrary directions, he ſucceeded. About 1733 he completed ſeveral achromatic object glaſſes (though he did not give them that name) which bore an aperture of more than 2½ inches, though the focal length did not exceed 20 inches; one of which is now in the poſſeſſion of the Rev. Mr. Smith, of Charlotte-ſtreet, Rathbone-place. This glaſs has been examined by ſeveral gentlemen of eminence and ſcientific abilities, and found to poſſeſs the properties of the preſent achromatic glaſſes.

" Mr. Hall uſed to employ working opticians to grind his lenſes; at the ſame time he furniſhed them with the radii of the ſurfaces, not only to correct the different refrangibility of rays, but alſo the aberration ariſing from the ſpherical figures of lenſes. Old Mr. Baſs, who at that time lived in Bridewell Precinct, was one of theſe working opticians, from whom Mr. Hall's invention ſeems to have been obtained.

" In the trial at Weſtminſter-hall about the patent for making achromatic teleſcopes, Mr. Hall was allowed to be the inventor; but Lord Mansfield obſerved, that " it was not the perſon who locked up his invention in his ſcrutoire that ought to profit by a patent for ſuch invention, but he who brought it forth for the benefit of the public." This, perhaps, might be ſaid with ſome degree of juſtice, as Mr. Hall was a gentleman of property, and did not look to any pecuniary advantage from his diſcovery; and, conſequently, it is very probable that he might not have an intention to make it generally known at that time.

" That Mr. Ayſcough, optician on Ludgate-hill, was in poſſeſſion of one of Mr. Hall's achromatic teleſcopes in 1754, is a fact which at this time will not be diſputed."

XII. *A Postscript to Mr.* VARLEY'S *Paper on the Methods of hardening and tempering Steel.*

ON looking over the paper I sent for the last Number of the Philosophical Magazine (see p. 92), I see that I omitted mentioning an experiment or two connected with the subject, which I meant to have introduced into it.

As steel is always found more compact and strong bodied when hardened with a low heat, and as that effect is best obtained the colder the water is which is employed in hardening it, provided the water is clean, a circumstance which should always be attended to, it appeared probable, that if water was cooled down to the freezing point, or even lower, which it may be, and retain its fluidity, by being kept in a state of perfect rest, the effect might be heightened. I caused a large heap of snow to be collected together at a time when the thermometer stood at 22° of Fahrenheit, and making a deep hollow in the middle, I set a glass of clean water in the bottom of the hollow, and covered the whole with a board to prevent the air from disturbing or causing any motion in the water. I heated some pieces of steel in the breech end of a gun barrel to a low red heat; and by means of an assistant to take off the board at the instant I arrived with the heated barrel and its contents, I quickly dropped the pieces into the water; which having stood all the preceding night in the situation above described, must, though still fluid, have been cooled down to the temperature of the surrounding snow, which was still found to be 22°. Upon taking them out, I found the pieces hard but brittle, having the appearance of steel that had been overheated.

Being disappointed in what I had expected, I intended to repeat the experiment with a still lower heat; but an alteration in the state of the air prevented me from prosecuting the experiment at that time, and having since succeeded in making

making ufe of quickfilver inftead of water, I have never refumed the experiment. As methods are now well known by which water may be cooled below the freezing point, even by the fire-fide, and at an eafy expence, fome one who has time may perhaps think the experiment worth repeating: it might caft fome light upon the fubject of hardening fteel, and lead to fome ufeful refults.

The difh I employ for tempering is very fimple (A fig. 3, Plate IV.) and may be of any fize, with a proportioned handle. It is made of plate-iron, with an edge turned up on every fide a fufficient height to hold tallow or oil enough to cover the pieces to be tempered. The corners are nipped together, and then folded up againft the fides, as reprefented in the figure; by which means they are prevented from letting out the oil.

The other pan or difh B, turned up on three fides only, is ufed to lay pieces intended to be hardened: a cover is of advantage where the pieces are intended to come out clean and bright, as it more perfectly defends them from the air, and of courfe prevents oxidation from taking place. By this inftrument the work, though ever fo fmall or flender, may be brought out of the fire and dropped into the water with very little lofs of heat. It ought to be made of ftronger plate-iron than is neceffary for the other pan, and the corners cut out fo that the fides may bend up more fquare. They need not be folded as in the other, not being intended to hold any liquid fubftance. Such articles as fmall drills, pendulum and other fmall fprings need not be dropped into water, but only made to pafs through the air by toffing them out and letting them fall to the ground, which will make them hard enough for moft purpofes.

Small drills may be hardened by holding their points in the flame of a candle, and, when fufficiently hot, fuddenly plucking them out: the air will harden them; and they may then be tempered, by taking a little of the tallow upon their point, and then paffing them through the flame at about

 half

half an inch above the point, and holding them there till the tallow begins to ſmoke. This method, known to all watchmakers, may be of uſe to other artiſts, and therefore not unworthy of the notice I have taken of it.

XIII. *Account of M.* Fabbroni's *Diſcovery of a Method to imitate the Floating Bricks of the Ancients* *.

PLINY mentions two cities in Spain, Maſſiluta and Calento, in which a kind of bricks were made that would float in water. It is certain that Pliny does not here ſpeak of hollow bricks; for theſe would have had too little ſtrength for building. He muſt then mean ſolid bricks, but compoſed of a ſubſtance ſufficiently porous and light to float in water. Theſe bricks, according to Poſidonius, were made of a kind of argillaceous earth, which was employed to clean ſilver plate. As this earth could not be our tripoli, which is much too heavy to float in water, M. Fabbroni thought that it might be that earth called commonly *lac lunæ*, foſſil meal, mineral agaric, and guhr: this earth is abundant in Tuſcany, and is there actually employed for cleaning plate.

Guhr is liquid, and the *lac lunæ* approaches near to the mineral and calcareous agaric. The foſſil meal, according to M. Fabbroni, is a mixt earth which exhales an argillaceous odour, and throws out a light whitiſh ſmoke when ſprinkled with water. It does not effervеſce with acids; is infuſible in the fire, in which it loſes an eighth part of its weight, though it becomes ſcarcely diminiſhed in bulk; and according to the analyſis made by M. Fabbroni, conſiſts of the following component parts: ſiliceous earth 55, mag-

* Extracted from a ſmall work of 24 pages octavo, publiſhed at Venice, laſt year, under the following title: *Di una ſingolariſſima ſpecie di mattoni oſſia ritrovamento degli antichi mattoni gallegianti, diſſertazione letta nella publica adunanza dei Georgofili di Firenze, l'anno* 1791, *dal Signor* Fabbroni.

nesia

nesia 15, water 14, argil 12, lime 3, iron 1. With this earth, which is found near Casteldelpiano in the territories of Sienna, M. Fabbroni composed bricks which, either baked or unbaked, floated in water. The baked were in nothing different from the unbaked, but in the sonorous quality which they acquired. These bricks resist water exceedingly well, and unite perfectly with lime: they are subject to no alteration either by heat or cold; and about a twentieth part of argil may be added with advantage to their composition, without depriving them of the property of floating. M. Fabbroni tried their resistance, and found it very little inferior to that of common bricks; but it is much greater in proportion to their lightness. One of these bricks, seven inches in length, four and a half in breadth, and one inch eight lines in thickness, weighed only 14¼ ounces; whereas a common brick weighed five pounds 6¾ ounces.

Fossil meal is abundant in Tuscany. The method of making these bricks differs little from that of common bricks: one man may make about a hundred of them in a day. They may be of very important benefit in the construction of reverberating furnaces; as they are such bad conductors of heat, that a person may bring one half of them to a red heat, while the other is held in the hand. They may be employed also for buildings that require to be light; for constructing cooking places on board ships; and also floating batteries, the parapets of which, if made of these bricks, would be proof against red hot bullets; and lastly, for constructing powder magazines. The turrets which were raised on the ships of the ancients, adds M. Fabbroni, were perhaps formed of such bricks; and perhaps they were employed in the celebrated ship sent by Hiero to Ptolemy, and which carried so many buildings, consisting of porticoes, baths, halls, &c. ornamented with jasper and agates arranged in mosaic.

XIV. *Experiments to determine how far Charcoal is a Non-Conductor of Heat. By Cit.* GUYTON. *Read in the Nat. Inst. Germinal 6, An. 6. From the* Annales de Chimie, *Vol. XXVI.*

FROM the refearches of chemifts refpecting the matter of heat, the different ftates in which it is found, and the various ways in which it affects bodies, it is well known that charcoal is one of the weakeft conductors of it. This obfervation has given rife to the idea of forming furnaces with a double wall, in order that the intermediate fpace may be filled with charcoal; and lately a very happy application has been made of this property to veffels deftined for forming and preferving warm infufions *.

I, however, do not know that any one has endeavoured to fix, at leaft by comparative experiments, the limits of this kind of infulation †. They have remained fo vague that the ableft chemifts have not thought proper to pay any attention to them in judging of the refult of their operations; and thus the celebrated Klaproth, in a feries of experiments on the alteration which ftones experience in the ftrongeft fire, feems to think that the heat was almoft equal for thofe contained in crucibles of porcelain and thofe enclofed on all fides by charcoal. It is in a crucible of charcoal that chemifts attempt the reduction of the oxyds of tungften, titanium and uranium, though it is well known that what is fought is a degree of heat fufficient for their fufion, and that every means poffible are fought for, in other refpects, to expofe them to a greater heat.

Thefe reflections induced me to think that it might be of fome importance to give a more exact ftandard of this in-

* It has been alfo propofed, and certainly would be found to anfwer in practice, to furround bodies, intended to be kept cool, with charcoal—ice-houfes above ground for inftance. EDIT.

† Some of the ingenious experiments of Count Rumford have been directed to this very object. See Effay viii. EDIT.

fulating

fulating effect of charcoal. The experiments which I made on this subject are as follows:—Having taken from the same box, two of Wedgewood's pyrometrical pieces perfectly similar, I put one, which I shall call A, into a crucible filled with pure siliceous sand, well dried. The crucible was eight decimetres in height, and six decimetres in diameter at the top. The piece of clay was placed in the middle, and the cover was luted on. The other piece B was placed in a covered crucible of the like size, but filled with charcoal dust which had been previously exposed to a red heat. The two crucibles were placed close to each other on the grate of a large fusing furnace, and exposed to the action of the heat for about three quarters of an hour. When the crucibles had cooled, the piece A was taken from the sand, and applied to Wedgewood's pyrometrical scale: it had experienced a contraction of 89 degrees. The piece B, when taken from the charcoal, stood at 60·25 degrees. It had assumed a greyish tint, but without any appearance of incrustation. It thence results that the transmission of heat through sand is to that of heat through charcoal as 3 to 2 *.

The more the difference was striking, the more it was necessary for me to employ precautions, that I might not be deceived by foreign circumstances. It was possible that the

* This is not stated with that accuracy usually displayed by GUYTON It leads to a conclusion, that the result would have been the same had the pieces been continued in the furnace for three hours, three days, or three weeks, instead of *about* three quarters of an hour, which is an unwarrantable inference. This experiment only proves, and that is a matter of some consequence, what might have been fairly inferred from the known properties of charcoal, that to bring bodies surrounded with that substance to the same degree of heat with others surrounded with better conductors, *a longer time must be employed.* The not attending to this circumstance is the cause why chemists, able ones too, often fail in difficult reductions where charcoal is necessarily put round the ore to take up the oxygen. EDIT.

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pyrometrical piece might have ſome fault either in its compoſition or fabrication, which might change its diſpoſition to contract equally and proportionably to the heat. To obviate theſe doubts, the two pieces A and B were ſhut up in one crucible filled with ſand; ſo that they were diſtant from each other only about ſeven or eight millimetres, and the crucible was expoſed for half an hour to the moſt violent heat of a three-blaſt wind furnace. When the crucible cooled, it was found ſo much vitrified that there was a fiſſure in one of its ſides; but the ſand had not been deranged within it.

The piece A applied to the pyrometrical ſcale gave 163·5 degrees; it weighed no more than 1·491 grammes; and its ſpecific gravity was 2·232.

The piece B gave by the pyrometer 160 degrees; it weighed 1·53 grammes; and its ſpecific gravity was 2·346. It had loſt almoſt entirely the grey tint it had aſſumed in the charcoal, and diſtinguiſhed itſelf only by a black vitreous point, produced viſibly by the acceſſion of ſome foreign matter.

I did not expect, I confeſs, ſo complete a ſucceſs in this proceſs. The ſmall difference of $3\frac{1}{2}$ degrees is nothing when we conſider that the piece firſt ſhut up in the charcoal, and which ſtood at 60, was ſtill ſuſceptible of being contracted a hundred degrees more. It is known, beſides, that it is phyſically impoſſible that two bodies placed in the ſame crucible, in contact with the ſame matter, ſhould be exactly in the ſame condition to receive the heat, eſpecially when the wind is conducted in three directions neceſſarily unequal. A proof of this is furniſhed us by the vitrified fuſion being more advanced on one of the ſides of the crucible*.

* This way of accounting for the difference of $3\frac{1}{2}$ degrees might perhaps be admitted, if it could be ſhown that a longer expoſure to the heat would not have removed it. Edit.

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We may therefore conclude from these experiments*, that at the same heat a body enclosed in charcoal does not receive but about two-thirds of the heat of a body surrounded by quartzeous sand; that the reduction of metals, which do not melt but at a heat of 130 degrees, cannot be effected in charcoal; that pyrometrical pieces do not enable us to judge with correctness of the heat communicated, but in so far as they are in contact with substances similar to those which surround the bodies subjected to it, or with bodies equally conductors; lastly, that with these alterations we may make an advantageous use of this instrument.

NEW PUBLICATIONS.

Atti della Real Societa Economica di Firenze ossia de' Georgofili. Transactions of the Royal Economical Society of Florence, &c. Vol. II. 1795. Vol. III. 1796. 8vo.

IN the second volume of this work, after a continuation of the history of the Society, the following account is given of the life and services of Professor John Targioni Tozetti and of Saverio Manetti. The former was born at Florence, where his father was a physician, on the 12th of September 1712. In the year 1734 he received the degree of doctor, and soon after was appointed professor. He purchased the library and manuscripts of Micheli, his tutor, who died in 1737, with an intention of publishing a complete collection of the latter. He was afterwards named inspector of the public library, from 110 manuscripts, in which he published the letters of different learned men to Magliabechi; but, for want of encouragement, only five volumes were printed. Besides his well-known Travels, he intended to

* For the reason given in a former note, the author's conclusions cannot be admitted. Nay, they are quite erroneous. He has not at all attended to the only fact proved by his experiments—that a given quantity of heat will not pass in the *same time* through bodies possessing *different conducting powers*. EDIT.

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have undertaken a work entitled, *Corographia e topographia fiscia della Toscana*, the plan of which was printed in 1754; but this great work was never completed. He died on the 3d of January 1783, leaving behind him a daughter and a son, Ottaviano Benedetto, present professor of medicine.—Manetti was born on the 12th of November 1723; obtained the degree of doctor in 1747; and practised as a physician. He published that elegant work *Storia Nat. degli Uccelli*, and in 1770 began *Magazzino Toscano*, which, after it had increased to 31 volumes octavo, was in the year 1777 continued to nine volumes more, under the title of *Nuovo Magazzino*. He died of an apoplexy on his birth-day, in the year 1784.—Of the papers in this work the following are the most worthy of notice: A short account of the preparation of those raisins without stones, known under the name of Corinthian (currants), a production of the islands of Zante and Cephalonia, the greater part of which are purchased by the English and the Dutch. Experiments made by a Greek, in the neighbourhood of Pisa, seem to show that the vines which produce these grapes may be cultivated with advantage in Tuscany.

Gherardi, a Camaldule monk, has made some experiments to improve the culture, &c. of Spanish broom *(Spartium junceum)*, which must not be cut, as is commonly done, in January, but in October. Dr. Menaubone recommends the use of the common germander *(Teucrium chamædrys)* instead of cinchona, and the fruit of the privet *(Ligustrum vulgare)* for dyeing. On the danger of employing the blue chickling vetches *(Lathyrus sativa)*, which, as well as the dwarf chickling vetches, *Lathyrus cicera*, and the officinal tares, or true bitter vetches *(Ervum ervilia)*, are prejudicial when eaten, for a long time, in large quantities. Cautions against the use of a mushroom, *Fungus alloides annulatus* of Vaillant, *Fung. raphanum redolens* Micheli, of which an engraving is given. Some experiments of Fabbroni seem particularly interesting. As the farmers are accustomed

accuſtomed ſometimes to divide the ſeeds of pulſe, and particularly beans, each half of which they place in the earth and obtain rich crops; he pounded coarſely ſome grains of corn, threw them into water, and ſaw that the particles which contained germs fell to the bottom. He ſowed theſe particles, and obtained as good plants as from the whole grains: many of them even produced a greater number of ſtalks. According to Fabbroni's experiments, the germ conſiſts entirely of the gelatinous or animal part, called by ſome the *gluten* or *colla*. In his opinion, the fermentation neceſſary in the manufacturing of ſtarch, is for the purpoſe of bringing the animal part to a ſtate of corruption, that it may be then ſeparated with the greater eaſe. Hence ariſes the unſupportable and certainly unhealthful ſtench which proceeds from a ſtarch manufactory. He aſks, therefore, if it be not poſſible to ſeparate the gelatinous part of the ſeeds by mechanical means, without uſing water as he did, by which the labour would be accelerated and the ſtench in part prevented. The ſeparated part might then be ground, and employed with other meal for baking bread. The germ, in regard to weight, forms only the ſixth part of the grain. Dr. Molinelli ſhews, by experiments, that it is better to warm olives in the ſun, than to ſuffer them, according to the old method, to ferment. Olives which in 1789 had been froſt-bitten, yielded, however, by the above method, good oil.

The third volume contains an account of the cultivation of cotton in the Iſland of Malta; a natural hiſtory of the neighbourhood of Piſa; a paper by Dr. G. Leſſi on the pernicious tendency of prohibiting foreign manufactures; Seſtini on the uſe of ſeſamum oil in the Levant. The two ſpecies of Linnæus, and the *Seſamum trifoliatum* of Miller, are, according to his aſſertion, only varieties. Targioni Tozetti junior has obſerved, that duck-weed *(Lemna)* in places where it totally covers the water, retires, or contracts itſelf, as ſoon as a branch of the *Rhus radicans* is dipped

dipped into the water near it. If a bit of the leaf-ſtalk of the latter be thrown into the water, it moves itſelf for ſome time in all directions, while an oily matter iſſues ſometimes from one end and ſometimes from the other; which, without doubt, is the cauſe of its movement. A like motion is obſerved in other plants which emit a milky juice: the *Schinus molle* exhibits this phenomenon ſtrongeſt next to the *Rhus.*—Experiments on obtaining ſugar from grapes. Propoſals for preſerving lemons from froſt. A Diſſertation by Dr. Palloni on the influence of plants to improve the atmoſphere: Collections by the ſame author, to prove the variation of climate in the ſouthern part of Europe. Inſtances of the great age of vines: one is mentioned of 112 years, and ſeveral of two hundred. Gum elaſtic diſſolved in rock oil or naptha produces an excellent varniſh for leather wine-bags, and other things; but it does not readily dry. Experiments on raiſing rhubarb in Tuſcany.

Von dem Perkiniſmus, oder den Metallnadeln des Dr. PERKINS *in Nordamerika, nebſt Amerikaniſchen Zeugniſſen, und Verſuchen Kopenhagener, &c.*—On Perkiniſm, or the Metallic Tractors of Dr. PERKINS of North America, with American Teſtimonies, and Experiments of the Phyſicians at Copenhagen. Publiſhed by M. HERHOLDT Surgeon, and Aſſeſſor KAFN. Tranſlated from the Daniſh; with the Obſervations of Dr. J. C. TODE, Profeſſor and Phyſician to the Court. Copenhagen, 1798. 8vo. 108 pages.

Profeſſor Schumacher at Copenhagen made experiments with tractors of braſs and iron on ten patients in Frederick's hoſpital at Copenhagen. He tried alſo tractors of ebony and ivory, which are ſaid to have cured a pain in the knee; with others of ſilver and zinc; and ſome of copper and lead. By the two laſt, pains in the knee, arm, and face are ſaid to have been mitigated. According to M. Klingberg's experiments, this remedy was of uſe in *malum iſchiaticum*; and

according

according to thofe of M. Steffens, in *malum ifchiaticum* and megrim. According to M. Bang, the pains in fome cafes were increafed, and in others allayed. According to M. Blech, the tractors were of ufe in *hemicrania* and gouty pains in the head; and, according to M. Hahn, in rheumatic pains in both fhoulders. The principal document in this collection appears to be a letter of Profeffor Abilgaard, in whofe opinion Perkins's tractors will never acquire much value in medicine, and fcarcely even have the merit of being a palliative; but, in a phyfical point of view, he thinks they deferve the attention of phyficians, and particularly of phyfiologifts. Mankind, he fays, hitherto have paid too little attention to the influence which electricity has on the human body; otherwife they would know that the effects produced on it by our beds is no matter of indifference. If the feather beds and hair mattreffes, &c. are perfectly dry, the perfon who fleeps on them is in an infulated ftate; but the contrary is the cafe if they are moift. He three times removed a pain in the knee, by fticking the tractors, one on each fide of the knee, fo deep through the ftockings that the points touched the fkin. He removed a rheumatic pain in the head from a lady by the fame means. M. Kafn, by the tractors, relieved, in others, gouty pains of the head, and megrim; and in himfelf, a rheumatic pain of the back, which, according to his fenfations, was like a conftriction in the cellular tiffue. M. Herholdt, from his experiments, confiders the effect of the tractors as indefinite and relative as that of other remedies. He, however, faw relief given by them in the ftrangury in a cafe of fyphilis. M. Bang alfo, at Soroe, freed a man from a violent gouty pain in the thigh by drawing the tractors 200 times over the affected part. M. Jacobfen likewife found benefit derived from thefe tractors feveral times in the common hofpital at Copenhagen. M. Tode tried them alfo in rheumatic pains, tooth-ache, inflammation of the eyes, and obferved that they neither did good nor harm.

According to the editor, the tractors act as a mechanical ftimulus, ſtimulus, as conductors of electricity, as galvaniſm, and alſo by the effects of the imagination.

Philoſophical Tranſactions of the Royal Society of London, for the Year 1798. Part II.

This part, which was delivered to the members a few days ago, contains the following papers:

A Diſquiſition on the Stability of Ships. By George Atwood, Eſq. F. R. S.—Quelques Remarques d'Optique, principalement relatives à la Reflexibilité des Rayons de la Lumiere. Par P. Provoſt, Profeſſeur de Philoſophie à Geneve, &c. &c. &c. Communicated by Sir Charles Blagden, Knt. F. R. S.—An Account of the Orifice in the Retina of the Human Eye, diſcovered by Profeſſor Sœmmering. To which are added, Proofs of this Appearance being extended to the Eyes of other Animals. By Everard Home, Eſq. F. R. S.—A Deſcription of a very unuſual Formation of the Human Heart. By Mr. James Wilſon, Surgeon. Communicated by Matthew Baillie, M. D. F. R. S.—Account of a ſingular inſtance of Atmoſpheric Refraction. In a Letter from William Latham, Eſq. F. R. S. and A. S. to the Rev. Henry Whitfield, D. D. F. R. S. and A. S.—Account of a Tumour found in the Subſtance of the Human Placenta. By John Clarke, M. D. Communicated by the Right Hon. Sir Joſeph Banks, Bart. K. B. P. R. S.—On the Roots of Equations. By James Wood, B. D. Fellow of St. John's College, Cambridge. Communicated by the Rev. Nevil Maſkelyne, D. D. F. R. S. and Aſtronomer Royal.—General Theorems, chiefly Poriſms, in the Higher Geometry. By Henry Brougham, jun. Eſq. Communicated by Sir Charles Blagden, Kt. F. R. S.—Obſervations of the Diurnal Variation of the Magnetic Needle in the Iſland of St. Helena; with a Continuation of the Obſervations at Fort Marlborough, in the Iſland of Sumatra. By John Macdonald, Eſq. In a Letter to the Right Hon. Sir Joſeph Banks, Bart. K. B. P. R. S.—On the Corundum Stone from Aſia. By

By the Hon. Charles Greville, F.R.S.—An Inquiry concerning the Chemical Properties that have been attributed to Light. By Benj. Count of Rumford, F.R.S. M.R.I.A. —Experiments to determine the Denſity of the Earth. By Henry Cavendiſh, Eſq. F.R.S. and S.A.—An improved Solution of a Problem in Phyſical Aſtronomy; by which ſwiftly-converging Series are obtained, which are uſeful in computing the Perturbations of the Motions of the Earth, Mars, and Venus, by their mutual Attraction. To which is added an Appendix, containing an eaſy Method of obtaining the Sums of many ſlowly-converging Series which ariſe in taking the Fluents of binomial Surds, &c. By the Rev. John Hellins, F.R.S. &c.—Account of a Subſtance found in a Clay-pit; and of the Effect of the Mere of Diſs upon various Subſtances immerſed in it. By Benjamin Wiſeman, of Diſs in Norfolk. Communicated by John Frere, Eſq. F.R.S. With an Analyſis of the Water of the ſaid Mere. By Charles Hatchett, Eſq. F.R.S. In a Letter to the Right Hon. Sir Joſeph Banks, Bart. K.B. P.R.S.—A Catalogue of Sanſcrita Manuſcripts, preſented to the Royal Society by Sir William and Lady Jones. By Charles Wilkins, Eſq. F.R.S.—A Liſt of Preſents to the Society, and an Index.

Caſes of the Diabetes Mellitus, with the Reſults of the Trials of certain Acids and other Subſtances in the Cure of the Lues Venerea. By JOHN ROLLO, *M.D. Surgeon General, Royal Artillery. Second Edition, with large Additions. 1 Vol. 8vo.*

This edition, which has been anxiouſly looked for by the medical world for ſome time, made its appearance a few days ago. It contains many intereſting recent communications reſpecting the Diabetes, and the additional trials of the new remedies in the Lues. The obſervations introduced in the firſt edition on ſeveral diſeaſes apparently ariſing from ſtomach affection, and including the application of the new doctrines of chemiſtry, as well as the deſcription of a morbid poiſon

poison formed on sores, have been omitted in the present, to reduce the size, and consequently the price. They are still, however, as the Preface informs us, to be considered as equally interesting, and will continue to be prosecuted.

The experiments of Mr. Cruickshank, an accurate and ingenious chemist, on the difference between the sugar of milk and that of diabetic urine, and on urine and sugar, are highly interesting. While they in some measure unfold the peculiar nature of each, they also assist in the general explanation of diabetes, as well as what relates to the urine of patients labouring under other diseases.

The results of the trials with the new remedies in the lues venerea (which have been substituted for mercury, and are believed to operate by introducing oxygen into the system) completely establish their efficacy in the secondary as well as in the primary states of the disease. The oxygenated remedies have also been found efficacious in hepatic affections, (one of them attended with dropsy,) and in some cases of remittent fever, the character of which was such as would otherwise have demanded the exhibition of calomel.

It will not be easy for the opposers of the new medicines to get over the mass of evidence brought forward in this work in their favour. To us there does not appear any way of trying the power of these medicines so fairly as in a military hospital, where the patients cannot deceive those who prescribe for them, but are *forced*, if necessary, to comply with the directions given them. To *pick out* a patient here and there from among a number of out-door patients, who, let the faculty prescribe what they please, will only do what they themselves like; and to bring forward cases that have failed, under such circumstances, in being cured by the oxygenated medicines, is of all modes of proceeding the most uncandid, and must tend even to impress the public with an idea that a failure is *wished for*, merely to defend a system.

We cannot better close the present article than by quoting the concluding words of Mr. Cruickshank at the end of his remarks

remarks on the effects of the new medicines.—"One of the two following positions must be allowed: Either these remedies cure the lues venerea, or, in 99 cases out of 100 the disease cures itself. Our opponents may take which side they choose; for, on either supposition, mercury must be unnecessary:—and this is our principal object."

An Inquiry into the Causes and Effects of the Variolæ Vaccinæ, or the Cow-pox. By EDWARD JENNER, *M.D. F.R.S. &c.* 4*to.—An Inquiry concerning the History of the Cow-pox, principally with a View to supersede and extinguish the Small-pox. By* GEORGE PEARSON, *M.D. F.R.S. &c.* 8*vo.*

These two interesting publications having avowedly the same humane and beneficial object in view, namely, the rooting out of a disease which has swept away an immensely greater number of victims from the world than the amount of all that have been destroyed by the plague or pestilence, there can be no impropriety in joining them together in this short notice; for, short it must be, as all we can aim at, or hope for, is to excite the curiosity of such of our readers as have not seen them, that they may examine the facts brought forward, and by this means be led to yield their individual assistance in the prosecution of an object of so much importance.

Opinions are not agreed as to the origin of this disease in cows; some supposing that they get it by infection from men milking them, who have been previously applying dressings to the heels of horses affected with the *grease*; while others, with more probability, consider it as being in the first instance compounded in the animal economy of the cow; after which, it may be conveyed to any number (in an obvious way by the hands of the milkers, as the seat of the disease is in the breast and teats, which are covered with eruptions similar to the small-pox). But its origin is of no importance:—its application to the benefit of mankind is what demands the greatest attention.

 It

It is a singular fact, that it has been long known by country farmers and others, that this disease, which in several counties prevails at particular seasons among the cows, and is often communicated to the hands of the milkers, exempts such as have been so infected from being infected with the small-pox.—It is still more singular, that though they knew this fact, and also that no cow or human being had ever been known to die of the cow-pox, they never thought of having recourse to a voluntary infection of this kind, to free themselves and families from the possibility of being infected with the variolous poison, which so often proves mortal even when given by inoculation.

These publications contain a great body of evidence, all tending to prove that persons who have undergone the specific fever and local disease occasioned by the cow-pox, communicated either by accident to the hands when milking them, or by inoculation (for this has been already tried by the ingenious authors), are thereby rendered unsusceptible of the small-pox; and that matter from such patients may be employed with the like effects, no difference being observable in the effects of the matter generated successively in the first, second, third, fourth or fifth human creature.

Pits from the small-pox are a deformity that no one can certainly guard against even by inoculation. In the cow-pox no such consequences take place; for, though accompanied with fever, the pustules are local, and the place may be chosen.

According to some observations, (but this is not quite certain,) the same person may repeatedly have the cow-pox: If so, practitioners may avail themselves of this mean of exciting an innocent fever as a remedy of various disorders; it being a truth, that fevers are occasionally efficacious remedies for epilepsy, hysteria, insanity, St. Vitus's dance, tetanus, &c.

As the cow-pox poison acts upon the whole constitution in seven or eight days after its admission, and the small-pox most frequently not till fifteen or more; in cases where exposure

posure to the small-pox infection is unavoidable, and the consequence of infection at the time dangerous (as in pregnancy), inoculation with the former might, by its quicker action, produce that change in the system which would insure the least deadly of the two maladies.

To urge to such inquiries as may afford a sufficient number of facts, from which to draw all the uses that may be derived from a prosecution of this subject, seems to be the aim of the authors; and no sagacity is required to predict, says Dr. Pearson, that, should the practice of inoculating for the cow-pox ever become very general amongst young persons (which we hope will be the case), the variolous infection must be extinguished; and, of consequence, that loathsome and destructive disease, the small-pox, be known only by name. And this benefit will accrue, without even the allay of the introduction of a new disease; it being plain from the nature of the cow-pox poison, that (the other being once rooted out) it will be easy to avoid and prevent its dissemination—as there must be at least a real contact with it to cause infection.

Philosophy of Mineralogy. By ROBERT TOWNSON, *L.L.D. F.R.S. 8vo.*

This is a valuable performance, and will be highly useful to chemists and mineralogists. It gives an account of the elementary substances which enter into the composition of minerals, followed by an enumeration of compounds arranged according to Dr. Babington's system; interesting information respecting stratification; the irregularities of the earth's surface, veins and petrifactions; the value and use of the external characters of minerals; a good nomenclature in English, Latin, and German, with their corresponding definitions—colour, figure, surface, &c. &c.; instructions for collecting specimens; and a list of works on mineralogy.

This work is the outline of a larger formerly announced, but which did not meet with the necessary encouragement. We shall still hope, however, to see it made public.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

SWEDEN.

THE Royal Academy of Inſcriptions, the Fine Arts, Hiſtory, and Antiquities at Stockholm has propoſed the following as prize ſubjects for the preſent year:

HISTORY.

"Reſearches reſpecting the hiſtory of the herring-fiſhery, both on the coaſt of Scandinavia and all the coaſts of countries ſubject to the Swediſh government, from the reign of Guſtavus I. to the preſent time."—The prize is a gold medal of the value of 26 ducats.

FOREIGN LANGUAGES.

"A treatiſe, either in Latin or French, on the duty of an hiſtorian, when delineating the characters of great men, to examine carefully the character and genius of the century in which they lived, in order, on the one hand, that he may not give importance to and propagate principles prejudicial to ſociety; and on the other, that, by cenſuring the errors of great men, he may not weaken and leſſen that reſpect and admiration which are due to diſtinguiſhed talents, activity, reſolution, courage, and other heroic virtues, the exiſtence of which is ſo neceſſary for the independence and happineſs of nations."—The prize is a gold medal of the ſame value.

ANTIQUITIES.

"An inquiry into the origin, nature and object of the military expeditions and naval armaments of Sweden to the middle of the twelfth century."—The prize is a gold medal of the value of 15 ducats.

INSCRIP-

INSCRIPTIONS AND DEVICES.

"1. Hints respecting a Latin inscription for the Exchange at Stockholm.

"2. Hints respecting medals to commemorate the most remarkable events which have taken place in Sweden in the present century; to be chosen at the option of the author." The prize is a gold medal of the value of 12 ducats.—Those who wish to become candidates for this prize must send proposals respecting both the above subjects, otherwise their works cannot be laid before the Academy for examination.

The papers on all these subjects must be transmitted to the Academy with devices, and accompanied with the names of the authors, each in a sealed note, before the 20th of January 1799.

BERLIN.

The Society of the Searchers into Nature have proposed the following question, to be answered before the first of January 1800, as the subject of a prize:—"Allowing that electricity is requisite for the production and formation of hail in the atmosphere, can any hopes be entertained of rendering the clouds incapable of producing it, and of preventing its formation by means of conductors, such as those used for preventing the effects of lightning? what are the means to be employed for this purpose? and what observations and data, in general, have we on this head worthy of being taken into consideration?"—The prize is 20 ducats.

GOTTINGEN.

ASTRONOMY.

In the month of December of the last year, Dr. Schroter of Lilienthal transmitted to the Royal Society at Gottingen several astronomical observations, the most important of which were the following:

Dr. Schroter observed at different times, and with the greatest certainty, in Jupiter's four satellites, even in both the

 smallest,

ſmalleſt, the firſt and the ſecond, dark ſpots of an atmoſpheric nature, tranſitory and ſubjected to accidental changes. They however fully convinced him, that all theſe ſatellites each during the time of its ſynodical revolution revolves around its own axis: the caſe is the ſame with the ſatellites of Saturn. The ſpots of the latter cannot indeed be ſeen like thoſe of the ſatellites of Jupiter; but in all the five, particularly the firſt, ſecond, third and fifth, Dr. S. ſaw ſimilar and very diſtinct variations of light, at a conſiderable number of periods, which give him reaſon to ſuppoſe the exiſtence of ſpots of the like kind. They are not regular, as in the caſe of our moon, but accidental variable modifications; ſometimes ſubject to irregular changes, which, however, by their uſual, often very long, periodical duration, mark out certain regions expoſed to common atmoſpheric modifications, ſimilar, for example, to the tract of the monſoons on our earth. The moſt important reſult, however, is, that Saturn's ſatellites revolve round their axes during the time of a ſynodical revolution; a circumſtance which M. Lichtenberg conjectures in reſpect to all the ſecondary planets. Obſervations tending to confirm this ſuppoſition will be publiſhed by Dr. Schroter in the ſecond and third part of his Collections towards the neweſt aſtronomical diſcoveries.

PHYSIOLOGY.

Profeſſor Weideman at Brunſwick tranſmitted lately to the Royal Academy of Sciences a paper on the more exquiſite ſenſibility of certain parts of animals, from which the following is an extract in the author's own words:

"Many animals have a moſt exquiſite ſenſibility at the tip of the muzzle, and particularly thoſe which have theſe parts long. This delicate ſenſibility is principally produced by the end of the *nervus infraorbitalis*, in conjunction with ſome fibres of the optical nerves, eſpecially the middle branches, which run acroſs the *maſſeter* in an oblique direction. The *nervus infraorbitalis* is ſtrongeſt in thoſe animals which

which have long muzzles, or muzzles covered with long whiſkers. The muzzles of animals are moved in particular by three delicate muſcles; and, beſides theſe, ſeveral folds of the cutaneous muſcle lie at the ſide of the ſnout, and the branches of the optic nerves proceed in particular to theſe muſcles. I however found in a hedge-hog ſome fibres of the optic nerve proceed to the root *(bulbus)* of a briſtle. For the moſt part, however, theſe roots of the long whiſkers are connected with the numerous and proportionably ſtrong branches of the *nervus infraorbitalis,* which proceed to them in the form of a bundle, and in general tranſmit two fibres to the root of each briſtle, which they embrace on both ſides. This appearance I found exceedingly pretty in the head of a hare newly killed. In animals not provided with theſe whiſkers, the nerve proceeds only to the glandulous ſkin of the noſe, and which may be very diſtinctly obſerved in ſwine. The whiſkers ſerve as the vehicle of a finer ſenſation, in order to forewarn animals in certain circumſtances of the near approach of danger; for the ſlighteſt touching of the ſummits of theſe briſtles excites in them a very ſtrong ſenſation. Cats, and other animals which hunt for their prey in the night-time, extend the ſkin of the whiſkers, which enables them to aſcertain the nature, and even the hardneſs or ſoftneſs, of the bodies which they approach."

CHEMISTRY.

In the ſitting of Auguſt 4, M. Gmelin communicated to the Academy an account of ſome experiments which he made on the red lead of Siberia and the white gold ore of Fatzebay in Tranſylvania, and the new metals extracted from them. He found it eaſy to extract the metal of the former, which, on account of the beautiful colour it communicates to bodies combined with it, is by Vauquelin called chrome. He obtained it of an emerald green colour by means of the muriatic acid, and precipitated it from the latter by zinc, the Pruſſic acid, ſulphat of potaſh, carbonat of potaſh, and cauſtic

 potaſh.

potash. By potash it was precipitated of a mountain blue colour; and, when fused under this form with salts, communicated to them a green colour. The slag also acquired the same when the latter was fused with charcoal powder, pounded glass, borax, or its acid. As it dissolved, however, so easily in fluxing salts, he found it difficult to fuse it by this method to a metallic button, till it was first precipitated by zinc from the fluid slag; and it then gave a button of a leaden grey colour, which, when melted with borax, communicated to it a green colour. These characters sufficiently distinguish it from molybdena, which Bindheim supposed it to be, as well as from arsenic, which Lehman sought in it; though it agrees with both in this, that its calx readily assumes the properties of an acid, and with the last, that when burnt on charcoal by the blowpipe it emits a like smell.

The other series of experiments were made with the so-called aurum problematicum, from which, after it had been well mixed with finely-pounded grains of quartz, the metal was extracted by frequent boiling in nitro-muriatic acid, and then precipitated by potash. The deposit being boiled with caustic ley, what the latter dissolved was again precipitated by an acid. What was then obtained melted very easily by the blowpipe upon charcoal, without any remarkable smell, but surrounded with a beautiful blue and green flame, into an almost tin-white, hard, very brittle button, the whole surface of which had a granulated appearance; and when longer exposed to the heat it dissipated in flame and smoke. It did not dissolve entirely in pure nitric acid, but in the nitro-muriatic. What was precipitated from both exhibited the same phenomena by the blowpipe as the former metallic button. It is not precipitated by zinc and iron only, but also by copper. From these properties it appears to differ from all the metals hitherto known. Professor Klaproth has given it the name of *Tellurium*.

FRENCH

FRENCH NATIONAL INSTITUTE.

In the public fitting of Vendemiaire 15, An. 7, the following notice of the labours of the different claffes was read by the fecretaries of each clafs:

PHYSICAL SCIENCES.

The experiment of the reduction of lead by fulphur having been announced by Wiegleb, a German chemift, as favourable to Stahl's theory of phlogifton, Citizen Guyton fhewed that this experiment is not conclufive, if an apparatus be ufed that permits the operator to keep an account of all the aëriform fluids. The fame chemift made experiments on the nature of the fuccinic acid and the products from its decompofition. From his experiments he is inclined to affign to that foffil a vegetable origin, which agrees with the obfervations of mineralogifts. Citizen Guyton alfo laid before the clafs the products of his experiments on urinary concretions, which, as Scheele announced, manifeft the prefence of a peculiar acid formed in thefe concretions.

New obfervations on the yellow colour that may be extracted from vegetables for the art of dyeing, were communicated by Cit. Chaptal. (See *Phil. Mag.* Vol. I. p. 430.)

The fame chemift fhewed that the difference between the acetous and the acetic acid confifts in the proportions of carbon, which is the radical; and that the acetous acid contains much more than the acetic.

A heavy greyifh ftone of a clofe texture, found fome years ago in the quarries of Menil-Montant, near Paris, and which had been confidered for fome time as fulphat of barytes and afterwards as fulphat of lime, was analyfed by Citizen Vauquelin. It appears to be a compound of the fulphat of ftrontian and the carbonat of lime.

The fame chemift prefented two proceffes for the feparation of the component parts of brafs by the wet way. The firft confifts in diffolving in the nitric acid a determinate quantity

quantity of this mixt metal, and precipitating the ſolution by potaſh added to exceſs. The ſecond, which the author prefers, is by diſſolving the mixture in the ſulphuric acid, and afterwards plunging in the ſolution a plate of zinc, which precipitates the copper in a metallic ſtate.

Cit. Teiſſier has ſhewn, that by forming artificial meadows the advantages of natural meadows may be much increaſed.

Reſearches on the nature of the ſoil of the iſland of Malta, by C. Teiſſier; on that of Egypt, by C. Bruguiere aſſociate; and on the ſtructure of Mount Perdu, the higheſt of the Pyrenees, by C. Ramond aſſociate, have occupied, in ſucceſſion, the claſs of the Phyſical Sciences. It received alſo ſome intereſting details in regard to the medical art on an extra-uterine pregnancy, obſerved by C. Saucerote aſſociate; on urinary and arthritic concretions, by the ſame; and the caſe of a man, all whoſe bones, except the teeth, acquired in the ſpace of a few years an exceſſive ſize, without the muſcles being affected in this ſingular malady.

For a long time naturaliſts have been ſenſible of the neceſſity of having a new method of claſſing birds; and they wiſhed that this method, by being ſuited, on account of its preciſion, to the great quantity of known ſpecies, ſhould render the characters of them eaſy to be diſtinguiſhed; and be at the ſame time applicable to other ſpecies not yet diſcovered. This has been executed by Cit. Lacepede. His new table, in which he has included 124 genera, is preceded by new principles, according to which, in his opinion, naturaliſts ought to compoſe methodical tables of the different claſſes of animals.

MATHEMATICAL AND PHYSICAL SCIENCES.

Analyſts divide the problems which they wiſh to reſolve into two claſſes, one of which includes thoſe which can be reduced to an equation, in which there is one unknown quantity combined, throughout all the arithmetical operations,

tions, with itself, and with the known quantities: these are called determinate problems. The indeterminate are those, the solution of which depends on an equation where there are found two or more unknown quantities, susceptible of all the values which the analyst may assign to them, so that the unknown quantities remain indeterminate, at least in certain limits. The processes are very different in these two sorts of problems, and hence arise two kinds of analysis. Among those questions which cannot be solved but by the indeterminate analysis, are some respecting the nature of numbers; questions of a delicate nature and difficult to be treated, which require intense thought and exceedingly delicate and varied resources of mind, but which, at the same time, excite the curiosity more, and become more engaging. Cit. Legendre published, in the Transactions of the Academy of Sciences for 1785, a memoir upon this subject. In the last quarter he has made public new results respecting his further researches in this branch of the analytic art, under the title of *Essai sur la Théorie des Nombres*. This modest title promises much less than the work affords. It is a complete treatise of every thing known on the theory of numbers, or even of indeterminate analysis. But these theories would be much less useful if they wanted the demonstrations and new theorems discovered by Cit. Legendre.

A new work on determinate analysis engages, at this moment, also the attention of analysts. Cit. Lagrange has published a work on the resolution of numerical equations. He gives this name to equations where, with the unknown quantity, there are only numbers which retain their numerical value. In the last analysis every determined problem may be reduced to expressions of this kind. It is of great importance, therefore, to have methods given for resolving them; and we might even be inclined to believe that it would be sufficient for mathematicians to confine themselves to researches for discovering these methods. But geometricians

tricians are not ſatisfied unleſs their reſults are more general. They deſire, for each degree, a final equation, which may repreſent in what manner each of the given numbers concurs to the different values of the unknown quantity; ſo that with theſe expreſſions, or formulæ, nothing remains to be gone through but ſimple arithmetical operations to determine the unknown part of an equation, whatever may be the abſolute values of the known quantities which enter into its compoſition. Hitherto we had none of theſe formulæ beyond the fourth degree. It was neceſſary then to recur to means for reſolving individually numerical equations, and to bring out, one by one, the values of the unknown quantity. Newton gave a method for this purpoſe; but it is only approximative, even when there exiſt exact values of what is ſought for, and in certain caſes it gives nothing.

In 1767 Cit. Lagrange, whoſe name is here naturally coupled with that of the Engliſh geometer, gave a new method, exempt from the inconveniences of that of Newton. Analyſis was then in a more advanced ſtate, and the author took advantage of thoſe degrees of perfection which he had himſelf given to the analytic art. The queſtion then is to keep the number ſought between two determined fractions, which go on decreaſing, one of which is greater and the other leſs than that number, however ſmall the fractions may be; and thus, by exhauſting a fractional difference, we arrive at exact values of the unknown quantity, if there are any poſſible, or at leaſt we approach ſufficiently near it. Theſe firſt reſearches of Cit. Lagrange are but a ſmall part of the volume juſt publiſhed. Thoſe which form this laſt work will add a new degree to the eſteem and gratitude to which he has been long entitled by his numerous and learned labours.

Cit. Duc Lachapel, an aſſociated member, read a memoir on an obſervation which he made at Montauban on the appulſe of the Moon and Mars. Aſtronomers have given this name to phenomena where the moon paſſes ſo near to

a ſtar,

a ſtar, or a planet, as almoſt to eclipſe it. They obſerve theſe phenomena with great care, becauſe they can deduce from them, with ſufficient preciſion, the errors in the lunar tables. The *Connoiſſance des Temps*, An. VI. announced an occultation of Mars viſible at Paris. The diſtance between Montauban and Paris was ſufficiently great for the Moon to appear in the latter a little higher than Mars, and conſequently not to produce an occultation of the latter. This obſervation gave Cit. Duc an opportunity of examining with attention the diſk of Mars; and he obſerved, in the auſtral part, a ſpot of a very ſenſible diameter, round and white, a colour very apparent on a planet the appearance of which is reddiſh. According to ſome other obſervations which he made afterwards, Cit. Duc eſtimates that this ſpot is ſituated at the pole of the planet.

A paper was read in the ſitting of Meſſidor 15, in which Cit. Delambre gave an account of the operations for meaſuring the firſt baſe from Melun to Lieuſaint, extending in length 11808·5 metres. A ſecond baſe has juſt been meaſured on the high road from Perpignan to Narbonne. The length was found to be 11702·6 metres. Rarely have baſes of ſuch a length been meaſured, and ſtill more rarely has it been found poſſible to place them on ground ſo ſmooth and ſo level. But however regular the roads choſen for theſe operations may have been, there occurred in them a bending almoſt imperceptible to the ſight, and which rendered it neceſſary to break the two baſes. In this manner, inſtead of meaſuring a ſtraight line for each baſe, two were meaſured, forming an angle of 80° of the ancient diviſion. The exceſs of the broken line over the ſtraight line to Melun did not exceed 27 centimetres, and not more than 6 at Perpignan. The new baſe was meaſured with the ſame rules of platina which ſerved at Melun. The difficulty of tranſporting, without any accident, inſtruments ſo delicate, along ſo lengthened a route as that from Paris to Perpignan, and the neceſſary preparations and local difficulties,

culties, prevented the commencement of the real meaſurement till the 19th of Thermidor. It was however finiſhed on the firſt complementary day. The weather was, at times, ſo tempeſtuous, that it rendered the obſervations more tedious. One day, in particular, it blowed with ſuch violence that it diſplaced the rules and carried them away, together with their ſupporters, notwithſtanding their weight and a conſiderable friction. The obſervers continued to ſtruggle againſt this obſtacle, but at length were obliged to yield, and even to begin again during calmer weather the labours of that day, which amounted to 240 metres. At length the labour being repeated, with every poſſible care, and under the moſt favourable circumſtances, the firſt meaſurement was found to be correct within a millimetre of 240 metres. This aſtoniſhing conformity may ſerve to give an idea of the preciſion which may be hoped for from rules, when employed under favourable circumſtances. At the moment when C. Delambre wrote theſe reſults, he was preparing to return to Paris with Cit. Mechain. Nothing therefore remains but ſome calculations to be made for determining the length of a degree of the meridian, in the preſence of the learned men deputed by different powers of Europe to aſſiſt in this grand operation.

MORAL AND POLITICAL SCIENCES.

Cit. Buache has publiſhed a general map of Guiana; C. Mentelle, an analyſis of his leſſons of geography and coſmography, with an eſſay on the hiſtory of the Hebrews; C. Koch, aſſociate, a work entitled *Sanctio pragmatica Germanorum illuſtrata*; and C. Anquetil, an expoſition of the motives of the wars and treaties of France, from the year 1648 to 1783.

Cit. Bouchaud read hiſtorical and critical reſearches reſpecting the law *Julia miſcella*. This law, the object of which was to favour marriage, allowed widows to enter a ſecond time into that ſtate, without loſing certain advantages attached,

attached, either by contracts or teſtamentary diſpoſitions, to their perſevering in a ſtate of widowhood. Cit. Bouchaud communicated alſo to the claſs reſearches on the formation of the Roman and municipal colonies. The colonies founded by the Romans were called Roman, Italian, or Military: but they did not all enjoy the ſame rights; and a like political inequality was remarked between the *municipia*, which Feſtus likewiſe diſtributed into ſeveral claſſes. The moſt favoured of the *municipia* was Tuſculum, the inhabitants of which obtained all the rights of Roman citizens. Cit. Bouchaud has written, on the ſame ſubject, three other memoirs, to explain the different ſyſtems of magiſtracy by which the *municipia* and colonies were governed.

In a memoir on the ſtate of the French marine, at the beginning of the 14th century, Cit. Legrand deſcribed the naval battle of 1304 between the French and the Flemings, a very particular account of which he found in a hiſtory, in verſe, entitled, *La Branche aux royaux lignages*, written in 1306 by William Guiart. This ſmall work, conſiſting of fifteen or ſixteen verſes, one of the oldeſt now extant on the hiſtory of the French navy, gives a very accurate deſcription of the naval tactics and manœuvres of that period. Cit. Legrand has employed it to make known the different kinds of veſſels of which ſquadrons were then compoſed, and the manner of fitting them out either for attack or defence. From this memoir it reſults that, until Francis I, the kings of France had no regular navy; and that, in their naval wars, they were accuſtomed to purchaſe or hire privateers, ready equipped and manned, or merchant ſhips, which they manned themſelves and furniſhed with warlike machines. This memoir is an extract of a Hiſtory of the Arts and Sciences in France, on which Cit. Legrand has been employed for ſeveral years. He is employed alſo in a Hiſtory of the French Language and Literature: and in both theſe works

works he has made particular use of the manuscripts in the National Library, with the care of which he has been entrusted. As several of these manuscripts contain very curious paintings in miniature representing real instruments, furniture, games, dresses and combats, Cit. Legrand proposes to have accurate drawings made from them, in order that they may be engraved and added to his History of the Arts.

Cit. Anquetil read a historical fragment on Denmark, being an abridgement of the Danish history from the royal law in 1660 down to the present time. This royal law has been the particular subject of a memoir by Cit. Desales, who has chiefly applied himself to examine the part taken by the three orders of the state in that famous act.

Cit. Desales, in another memoir, gave an analysis of a book, printed in 1582, under the following title: *Le Mirouer des François, contenant l'état et maniement des affaires de France, &c. Le tout mis en dialogue par Nicolas de Mentand.* The real name of the author, according to Lammonaie, is Nicolas Barnaud. The choice of the speakers in this work, which consists of dialogues, is very singular: they are Cham, Sem and Japhet, Nimrod, Tubal-Cain, and other personages of the like kind, who discuss the affairs of France under Henry III; and who propose to convert the bells into money, to suppress the order of Malta, and to unite Belgium to France.

Cit. Papon read the preliminary discourse to a history he has undertaken of the French revolution.

Cit. Rœderer, in a work entitled *L'Art de savoir ce qu'on dit en Politique et en Morale*, &c. proposes to apply analysis to a great number of questions. He made the first trial of his method on that proposed by the class as the subject of a prize, viz. What are the institutions best calculated to lay the foundation of morals in a nation? By examining and distinguishing the different acceptations of each of the words which compose the above question, Cit. Rœderer found, by decomposition, that it is susceptible of 120 different meanings;

ings; and he afterwards determined, by recompofition, that in which it ought to be underftood*.

Cit. Dupont read two memoirs: one on the bafes of morals; and another on the philofophy of Haller and Bonnet.

Cit. Bernardin Saint-Pierre traced out, in a fragment entitled *Le Matin du Jour de la Mort de Socrate*, one of thofe immortal examples which may afford ufeful leffons of morality. The accufers of that philofopher, apprehenfive of the inconftancy of the Athenians, and fearing the regret, and, perhaps, the vengeance that would follow his death, but dreading above all his innocence, come and promife him his life, his liberty, and honours, if he will acknowledge himfelf guilty. When his ironical but folid anfwers deprive them of all hope of being able to perfuade him by their arguments, they introduce his family, and prefent to him his children, who wifh to die with him, and with whom he fheds tears. For a moment they fuppofe him overcome, becaufe they fee him affected; but he replies to his enemies, "I weep for joy that I am about to leave behind me children worthy of their father." Thefe dialogues, in which the character of the perfonages is fcrupuloufly preferved; where Lycon fpeaks as a fophift, Anytus as a fuperftitious man, and Melitus as a politician, form the firft act of a drama, which Saint-Pierre propofes to end with the death of Socrates.

LITERATURE AND THE FINE ARTS.

Cit. Dupuits read a fecond memoir on the Pelafgi, a nation of whom fcarcely any thing more is known than the name, and whofe antiquity goes beyond the fabulous ages. The author places the origin of thefe people in Egypt; from which he endeavours to fhow that the Pelafgi fpread into Lybia as far as the Atlantic ocean, and afterwards paffed into Peloponnefus, the Archipelago and Afia. Thefe conjectures of Dupuits refult from a comparative view of the

* Does this propofal fhow a progreffive improvement in literature? or, Are the French going back again to the jargon of the fchoolmen? EDIT.

religious worship of the Pelasgi, and that of the people in Upper Egypt and Ethiopia; as well as from the traditions and geographical names common to the Pelasgic nations, the Egyptians, and the Ethiopians.

Cit. Langles has already contested with the Europeans the invention of the compass, of paper, and of printing, in order to assign them to the Orientals. In a new memoir on gunpowder he deprives the German monk, Berthold Schwartz, of the fatal honour of that terrible invention, and asserts that it was conveyed to us from the Arabs. He assures us, that they made use of it, in 690, at the siege of Mecca; and he adds, that the Arabs derived it from the Indians, among whom it was known in the remotest antiquity, since their sacred books (the Vedam) forbid the use of it in war. Cit. Langles is of opinion, that a knowledge of these different inventions might have come to us from the East on the return of the crusaders. There is an interval, however, of two centuries between the last crusade and the first typographical attempts of Guttemberg in the city of Strasbourg about the year 1440. Gunpowder was known earlier in Europe than printing; but it does not appear that it was employed there in war before the battle of Creci, where the English had six pieces of cannon. If the conjectures of Citizen Langles are well founded, the Europeans, at present, only carry back to the East knowledge which we formerly borrowed from that quarter. Thus every thing changes on the face of the globe; the arts are lost in one nation to be revived in another; nations themselves are effaced and disappear; and vast accumulations of water covered formerly those countries which we inhabit at present. All this proves, that the small globe upon which we reside is very old; and that to live a century or two is nothing. We have scarcely time to commence our studies.

Cit. Langles read also a memoir on the Arabian literature.

Cit. Bitaubé read a memoir entitled *Des Jugemens de*

quelques

quelques Philosophes de l'Antiquité sur les Republiques anciennes. Second part. In this second part the author confines himself to an examination of the opinions of Xenophon and Isocrates respecting the republics of Sparta and Athens.

Cit. Ameilhon continues his researches on the art of dyeing among the ancients. His third memoir is particularly devoted to an examination of the substances from which the ancient dyers derived their red colours*. The scarlet red was procured from the *coccus,* which, as far as appears, was our *kermes*. This small insect is found on the thorny leaves and tender shoots of a kind of *Quercus ilex* or ever-green oak, which grows on the stony hills of Provence and Languedoc. The *purple* red, which was called simply *purple,* was the most valuable colour. It was reserved for the vestments of the first magistrates and of emperors. It was extracted from two small sea shell-fish, the *buccinum* and the *murex.* Reaumur found the former on the coasts of Poitou; and Duhamel the latter on those of Provence †.

Cit. Ameilhon read also a short notice respecting a Greek manuscript containing a work on the ancient chemistry, and erroneously ascribed to Democritus of Abdera.

C. Camus read a memoir on a book, which at bottom contains nothing very interesting, as it is only a bad romance, written in honour of the emperor Maximilian I. under the title of *Des hauts Faits d'Armes et des Avantures de l'illustre et célébre et belliqueux Heros et Chevalier du Tewerdank, ou du Grand Penser.* C. Camus, in this memoir, examines the question, which has been a subject of controversy among the learned, whether this book was printed with engraved blocks of wood, or with moveable

* For some curious information on this subject see Beckmann's Hist. of Inventions, vol. ii. p. 101. Edit.

† On this subject see Bancroft's excellent work upon the Theory of Permanent Colours. Edit.

 types.

types. There are ſtrong reaſons for adopting the latter opinion.

Cit. Cailhava, always occupied with the comic art, communicated extracts from ſome ancient Spaniſh pieces of Calderon de la Barca, entitled *Le Purgatoire de St. Patrice*, *Le Diable et le Saint*, &c.; and he obſerves, that the dramatic authors, who bring upon the ſtage in ſo agreeable a manner ghoſts, devils, and monks, have not the merit of the invention, and only carry us back to thoſe coarſe farces which diſgraced the infancy of the modern theatres. Cit. Cailhava calls the attention of government to that noble dramatic art, which might and ought to exerciſe a powerful influence over the opinions and manners of civilized nations. The ancients had particular magiſtrates appointed for the purpoſe of keeping a watchful eye over the theatres. The archons and the ædiles were, in all probability, more difficult in their choice of pieces than the directors of thoſe ſpectacles at preſent. Dramatic authors did not labour in haſte for pitiful wages. Sophocles and Menander were crowned in the aſſemblies of the people, at the Olympic games, and before the eyes of all Greece. Between good taſte and good morals there is more analogy than is generally believed. There is a certain exquiſite ſenſe of propriety which ariſes from a happy diſpoſition, cultivated by a liberal education; and it is of importance that this ſenſe ſhould never be ſuffered to become weak, and that all our inſtitutions, our uſages, and above all our theatres, ſhould tend to ſtrengthen it.

Cit. Langles has publiſhed the three firſt volumes of a collection of Voyages in Aſia, tranſlated from different Oriental and European languages, with a ſhort account of the revolution in Perſia, a memoir on Perſepolis, and hiſtorical notes.

Cit. Schweighauſen, aſſociate of the Inſtitute, who has already given editions of Appian and Polybius, has juſt publiſhed a new one of Epictetus and Cebes enriched with learned notes.

Cit.

Cit. Dupuis has publiſhed an abridgment, in one volume, of his large work on the origin of all the different forms of religious worſhip.

THE ROYAL SOCIETY OF LONDON.

This learned Society held its firſt meeting for the ſeaſon on Thurſday the 8th of November.

An abſtract of a paper (read at a former meeting) entitled "Experiments to determine the Denſity of the Earth, by Henry Cavendiſh, Eſq. F. R. S. and A. S." was read to the meeting. Theſe experiments, which are extremely ingenious and intereſting, are detailed at full length in Part II. of the Tranſactions for the preſent year. They were projected by the late Rev. John Michell, F. R. S. but he did not live to carry them into effect. After his death the apparatus came to the Rev. F. J. H. Wollaſton, Jackſonian Profeſſor at Cambridge, who transferred them to Mr. Cavendiſh. The apparatus contrived for making ſenſible the attraction of ſmall quantities of matter, and which has been improved by Mr. C. is very ſimple: it conſiſts of a wooden arm 6 feet long, ſuſpended by the middle in an horizontal poſition by a ſlender wire 40 inches long; to each extremity is hung a leaden ball about 2 inches in diameter; and the whole is incloſed in a wooden caſe to defend it from the wind.

As no more force is required to turn this balance on its centre, than is neceſſary to twiſt the ſlender ſuſpending wire, the ſmalleſt degree of attraction of a leaden weight or weights, a few (eight) inches in diameter, brought near to the ſmall ſuſpended ball or balls of the balance, will be ſufficient to move it ſenſibly aſide.

To determine from hence the denſity of the earth, all that is neceſſary is to aſcertain what force is required to draw the arm aſide through a given ſpace, and then to have recourſe to calculation.

To prevent any difturbance from currents that might be produced within the box that contained the balance, by even the difference of temperature that might be occafioned by heat being communicated by the bodies of the experimenters to one fide of it more than another, it was fupported in the middle of a clofe room; the operators, from adjoining apartments, viewed the operation through holes in the wall by means of telefcopes; and the apparatus had a ftrong light thrown upon its two ends (an opening being left at each end of the box for the purpofe) by means of two lamps, alfo in the adjoining apartments, the rays from which were likewife made to pafs through holes formed in the wall.

The two large balls were fufpended from a beam near the cieling, which could be moved in an horizontal direction, by means of a ftring and pulley, fo as to be brought near to the fmall balls of the balance, or made to recede again without requiring any perfon to be in the room.

From this defcription it will be eafily feen that, on the two large balls being brought near to the two fmall ones, but on oppofite fides of each that their forces may not counteract each other, the fmall fufpending wire of the balance muft be twifted by the movements of the arms, occafioned by attraction, which carries the fmall towards the large balls; and that the wire endeavouring to untwift itfelf will again in its turn carry the fmall balls away from the large ones. Vibrations are thus occafioned, which would continue a long time before the fmall balls would fettle between the firft point of reft and the large balls: but it is not neceffary to wait for this; an ivory fcale at each end of the balance enables the experimenters, by means of their telefcopes, to fee the two extreme divifions to which the fmall balls move in their vibrations, and thus to determine the middle point. The time neceffary for each vibration is alfo noticed.

It would be impoffible in a fhort notice to do juftice to Mr.

Mr. Cavendiſh's ingenious experiments, and the calculations founded on them. Thoſe who feel themſelves intereſted in them will have recourſe to the original account. We ſhall only mention the reſult. By a mean of the experiments the denſity of the earth comes out 5·48 times greater than that of water.

By the experiments made by Dr. Maſkelyne on the attraction of the hill Schehallien, the denſity of the earth was computed to be only $4\frac{1}{2}$ times that of water.

A paper * by Mr. Home was alſo read, containing an account of ſome experiments made in order to aſcertain the cauſe of the light ſeen in the eyes of cats and ſome other animals in the dark. After enumerating the opinions of other philoſophers, he proceeds to ſhew, that when the light was perfectly excluded from the room in which the cat was placed, the eyes were never obſerved to ſhine; whence he concludes that the eye merely collects the light diffuſed through the room. He then relates ſome obſervations on the ſtructure of the optic nerve. Having diſſected the eye of a cat juſt killed, he was ſurpriſed at finding the retina *tranſparent*. This induced him to repeat the experiment not only on cats, but alſo on horſes; and always with the ſame reſult, if the retina was examined immediately after death. But if this examination was delayed an hour or two, it was opake and whitiſh, as deſcribed by anatomiſts. The optic nerve, from the retina to the brain, ſeemed to be compoſed of bundles of fibres not parallel to each other, but alternately interwoven and ſeparated, the interſtices filled with a tranſparent fluid, ſo that a tranſverſe ſection taken near the brain was nearly a circle containing about 40 opake round ſpots; near the eye about 200 of theſe ſpots, and in the middle about a mean between theſe numbers. Theſe obſervations were made with a microſcope magnifying about 23 times.

* The Croonian Lecture.

At their second meeting, on the 15th, a paper by the Rev. Mr. Vince on an unusual atmospherical refraction was read.—One day last summer, directing his telescope to the sea, he observed part of the mast of a cutter (the hull being below the horizon), and above it an inverted image of the cutter, above which appeared a direct image of the same: these two images were joined at their hulls; but the point of the mast of the inverted image appeared to be as far above the top of the real mast as this last was above the horizon. These images appeared and disappeared very suddenly, something like the beams of the aurora borealis, beginning a little above the real object, and darting upwards.—The learned author, after supposing these appearances to be occasioned by atmospheric strata of different densities, recommends it to philosophers to investigate this subject; and suggests the utility of stationing men provided with telescopes at certain places on the coast; as by this means he thinks vessels and other objects might be sometimes discovered long before they would otherwise become visible.

On the 22d a paper, by the Abbé Mann, was read, the substance of which was to shew, that after having travelled several times over Germany he found very few remains of volcanos. There was very little interesting matter in this paper, which concluded with an account of some remarkable hail-storms, in which stones, or pieces of ice, from half an inch diameter to eight pounds weight had fallen.

MISCELLANEOUS.

ASTRONOMY AND GEOGRAPHY.

The astronomer Beauchamp, well known by his travels in the east, and formerly grand vicar of Babylon, has rendered a considerable service to geography by his new map of the Black Sea; the exact position of which he has determined from astronomical observations. In the year 1781 this active astronomer went to Bagdad, where he built an observatory. In 1787 he determined the position of the southern extremity of the Caſpian Sea, which before that period had been very uncertain, and alſo the geographical poſition of the cities of Caſbine, Iſpahan, Bagdad, Buſſora or Buſra, and Gella. In the year 1795 he was appointed conſul at Maſcate in Arabia, by the French republic; and ſet out from Paris on the 9th of June, with ſome excellent inſtruments and a chronometer by Berthoud, which he received from General Calon, director of the geographical depôt; but on account of the danger to which French veſſels were then expoſed, in the Mediterranean, he did not arrive at Corfu till the 25th of June 1796; and in the end of October reached Conſtantinople. In the courſe of his voyage through the Grecian Archipelago, he determined the poſition of Patras on the 22d of Auguſt; of Corinth on the 26th; of Naples in Romania on the 28th; of the iſland of Specia on the 1ſt of September; of the iſland of Andros on the 20th; of the iſland of Scio on the 21ſt; of Metelino on the 24th; and of the Cape of the Janiſſaries, in Natolia, on the 27th; &c. Between Corfu and Conſtantinople alone he determined the geographical poſition of twenty-ſix places; and by theſe means rectified the uncertain extent from weſt to eaſt of the Lepantine gulf. By the chronometer he found the longitude of Patras to be 39° 41′ 15″; and that of Corinth 40′ 48′ 15″, conſequently their difference of longitude 1° 7′. At Conſtantinople Citizen Aubert-Dubayet was obliged to negotiate a long time with the Porte before he could obtain permiſſion for Cit. Beauchamp to explore the coaſts of the Black Sea. For the greater ſecurity, he hoped to obtain a *kirlan-kiche,* that is, a ſmall veſſel belonging to the Captain Pacha; but after a great deal of trouble he could procure only a firman. In the year 1780 the Turks ventured to permit the then French ambaſſador, Count Choiſeul-Gouffier, to cauſe obſervations to be made on the coaſts of that ſea; but Achilles Tendu*, the aſtronomer ſent thither for that purpoſe,

* Achilles Tendu was the younger brother of the unfortunate Pierre Marie Tendu, guillotined at Paris on the 28th of December 1793, at the age

purpose, was obliged to return, without having accomplished the object of his mission. This circumstance was, in part, owing to the jealousy of the Russians and other European Powers; and besides, the French had then lost two friends, men of considerable intelligence, viz. the Vizier Halil Pacha, who established a school for artillery and engineering, and caused the best French works on these subjects to be translated into the Turkish language, but who was beheaded at Tenedos; and the Vice-Admiral Captain Bey, who possessed a great many astronomical and nautical instruments, and who caused Cit. de Lalande's abridgement of his astronomy to be translated into the Turkish language, but who was also decapitated in October 1787. Cit. Beauchamp, however, was more fortunate, as he arrived on the 26th of June 1797 at Trebisonde; and, without any impediment, was enabled to determine the exact position of a great many points of the Black Sea. He found the latitude of Sinope to be 42° 2′, instead of 41 as it is laid down even in the best maps; so that the very uncertain breadth of this sea, between Cape Karadzé and Cape Indgé, which was reckoned to be 62 French leagues, appears to be no more than thirty-seven leagues. The longitude of Trebisonde he found to be 57° 16′ 15″. According to a Turkish map of the Black Sea, printed at Constantinople in the year of the Hegira 1137, that is 1724 of the Christian æra, there is an error of half a degree of longitude in the position of this city; and in the map of the Russian empire, published in 1776 by Trescot and Schmid, this error extends to a degree and a half. The calculation of the Jesuit P. de Beze is totally false, and too great by 7½ degrees. We may, therefore, form some idea of the state of geography in Turkey, and of the important ser-

age of forty-eight. The latter is better known under the name of Lebrun, and who for some time held the office of minister for foreign affairs. His first occupation, however, was that of an astronomer; for he assisted Cassini III. and IV. in the Observatory at Paris till the year 1778, and instructed in astronomy his brother Achilles, who died at Constantinople in 1787, at the age of twenty-eight.

vices

vices rendered by Cit. Beauchamp to that ufeful fcience. He was accompanied by Charles Hyacinth Receveur, his pupil, who, though only feventeen years of age, was an accurate obferver and an able calculator*. On the 4th of September they returned to Conftantinople; and on the 20th of October fet out for Bagdad. M. Beauchamp, befides the fervices he rendered to geography and aftronomy, tranfmitted to the National Mufeum at Paris a great many plants, feeds and infects; and to the literary clafs of the National Inftitute a number of unknown ancient Greek infcriptions. He found the variation of the magnetic needle at Conftantinople to be 12° 33′; and at Trebifonde 8° 14′.

CONVERSION OF IRON INTO CAST STEEL.

A new method of preparing caft fteel has been lately announced in France by Cit. Clouet. His procefs is as follows: Take fmall pieces of iron, and place them in layers in a crucible with a mixture of the carbonate of lime. Six parts of the carbonate of lime, that is chalk, marble, limeftone, and in general all calcareous fubftances, and fix parts of the earth of pounded Heffian crucibles muft be employed for 20 parts of iron. This mixture muft be fo difpofed that, after fufion, the iron may be completely covered by it, fo as to be kept from coming into contact with the atmofphere. The mixture is then to be gradually heated, and at laft expofed to a heat capable of melting iron. If the fire be well kept up, an hour will generally be found fufficient to convert two pounds of iron into excellent and exceedingly hard fteel capable of being forged, an advantage not poffeffed by fteel procured in the common manner.

EXTIRPATION OF THE SMALL-POX.

M. Lenz, Profeffor at the Inftitute of Education of Schnepfenthal near Gotha, known by his Travels through Sweden,

* This young man died fince at Aleppo, on his way to Bagdad. Edit.

has

has been employed for twelve years in collecting every thing that the phyficians of different countries have written for or againft the total extirpation and annihilation of the fmall-pox by means of police regulations. He propofes to publifh a work, in which he will give the refult of his refearches on this fubject, and on the poffibility of the attempt, and will pay great attention to ftate with accuracy as many facts as poffible. In the German Journals he invites all thofe who have at heart the happinefs of mankind, to point out to him in a precife manner, either fuch facts as have come within their own knowledge, or paffages in books of travels which contain an account of meafures that have been taken by the order of governments, or only by individuals, among polifhed or favage nations, at any period, or in any country, by which this terrible contagion has been either removed or entirely checked.

A NEW PROCESS FOR FORMING THE UNGUENTUM HYDRARGYRI.

As the procefs of combining mercury with hog's lard is well known to be tedious, and to require a confiderable time, the following method of fhortening it has been announced by Göttling in his *Tafchen-Buch für Scheidkunftler* for the year 1798. This procefs, fays he, can be fpeedily performed by the addition of a very fmall quantity of the flowers of fulphur. For a mixture of two ounces of hog's lard and fix drachms of quickfilver, it will be neceffary to employ only fix grains of the flowers of fulphur, and the procefs will be completed in a few minutes. I do not fee, adds M. Göttling, that fo fmall a quantity of the flowers of fulphur can hurt the effect of the mixture, and am of opinion that this prefcription may be of confiderable ufe in pharmacy.

On

On Mr. CARTWRIGHT'*s Invention for rendering the Piſtons of Steam Engines tight by metallic Parts, without Packing or Leather.*

To Mr. TILLOCH.

SIR, Richmond, Nov. 10, 1798.

MY next door neighbour Mr. A. R. having requeſted Mr. Nicholſon* to give his opinion on Mr. Cartwright's new method of packing ſteam engines, and Mr. Nicholſon having, in conſequence, given a much leſs favourable judgment on the merits of the invention than that which appeared in the firſt number of your Magazine, I ſhall be much obliged if you will examine what he has advanced, and ſtate in your next number, whether you think his objections well founded, &c.

Your conſtant reader,

B. S.

No one will withhold from Mr. Nicholſon the tribute of praiſe, to which the numerous ſervices he has rendered and ſtill continues to render to ſcience ſo juſtly entitle him; nor will it any way diminiſh his acknowledged merit, ſhould it be ſhown that the opinion he has delivered on Mr. Cartwright's invention is founded on erroneous principles. Mr. N. has miſtaken the conſtruction of the piſton, deſcribed another, and then endeavoured to ſhow *that triangles will not fit a cylinder*, nor a wafer occupy the diameter of a millſtone. Theſe are not his words; but they are the fair inference from his mode of expreſſion, as we ſhall ſee immediately. But firſt we ſhall briefly ſtate how the piſton is *really* conſtructed. Two metal rings are ground, by means well known to good mechanics, into the cylinder, ſo as *to fit it* as perfectly as art and induſtry can make them—that is, ſo well that no ſteam can paſs between them and the cylinder: their upper and under ſides are alſo ground perfectly flat, and, though

* See Mr. Nicholſon's Phil. Journ. vol. ii. p. 264.

though not absolutely necessary, for the greater security two other rings are fitted to the inside of these. On the upper rings is placed a plate of metal, also ground perfectly flat, and of such a diameter as almost to fit the cylinder: a similar flat plate is placed below the under ones; and the two plates with the rings between are attached to each other by means of the piston rod that passes through them. It is plain then, that supposing neither the outside rings nor the cylinder to be able to wear one another, such a piston would remain steam-tight: but as constant friction must inevitably tend to widen the cylinder and diminish the diameter of the rings, the piston after some time would cease to fit, if a contrivance had not been fallen upon to remedy the evil. The rings are each of them cut into three pieces; and, in cutting them, such a portion of the metal is taken away as to leave room to introduce, between two of the pieces, a spring in the form of the letter V, the open end of which is placed outwards, almost close to the circumference; by which means the two pieces against which the two sides of the spring act, are pressed, *in the direction of the circumference*, against the ends of the third piece; so that the three pieces are thus kept so uniformly in contact with the cylinder, that *the longer the machine is worked the better the rings must fit.* To prevent steam from passing through the cuts in the rings, the solid parts of the upper rings are made to fall upon the divisions and springs of the under ones. This is the method contrived by Mr. Cartwright for making his piston fit; which will be clearly understood by looking at Plate I. Vol. I. of this Magazine. If he had left it to "a very moderate portion of mechanical knowledge to suggest the manner in which the pieces might be made to recede outwards, by means of springs," it might perhaps have been proposed to make such springs act from the centre on the circumference: in that case, the pressure of the different parts of each ring could never have been made uniform, and the machine would soon have worked itself into inequalities, instead of working itself more true.

If

If the piston was made of a *larger* or *less* diameter than the cylinder, and this difference was endeavoured to be accommodated by means of springs, then Mr. N.'s objections to this part would be well founded: in the former case the pieces of the rings would only touch the cylinder at their extremities, and in the latter only in their middle—6 points only would be in contact. But if we suppose the piston rings of a larger diameter [how came Mr. N. to think of such an absurdity?]—let us at once suppose their diameter equal to that of the earth—each portion then would not differ sensibly from a straight line. This however is only saying, that if Mr. Cartwright attempt to make a triangle fit a cylinder by means of springs, he will fail: so he would also if he should with half an inch endeavour to fill a mile. Mr. C. does not propose making any other figure or dimension fit his cylinder but its own; and has devised a mean by which it must, when once fitted, continue so.

Mr. Nicholson is still more unfortunate in his second objection. "When," says he, "a great pressure, such, for example, as the re-action of a column of 100 feet of water, comes to be exerted upon the face of this apparatus, the plates or pieces of these rings may be imagined to be confined in a vice. The pressure of such a column will amount to more than 40 pounds upon every square inch. Whence we may conclude, either that they would not move at all [outward, he means, against the cylinder], or that the force of the springs must be such as greatly to load the work with friction."——If such a re-action could possibly take place in Mr. Cartwright's steam engine as would *at one and the same time* lay a force equal to 40 pounds per square inch *upon both sides of the piston*, it would be indeed in a vice; but not such a one as would cause friction from the action of the springs; for *this vice* would keep the piston at rest—it would neither ascend nor descend. But every one acquainted with mechanics must know, that, to make a well-constructed steam engine

gine work, *the pressure must act only on one side of the piston at a time!*

In Mr. C.'s engine, the piston is not intended to adapt itself to *inequalities in the cylinder*; all inequalities are first removed. In the working, the piston ascends in *vacuo*, by the momentum communicated to the fly-wheel; therefore at that time *there is no pressure on either the upper or under side of the piston*, and the springs are in full action, pressing, lightly and uniformly, the whole circumference of the rings against the cylinder. When the piston reaches the top of the cylinder it raises the steam valve; and the steam then entering acts *only on the upper surface of the piston*, and forces it to descend; but, condensation having taken place below the piston, the whole under space is a vacuum, more or less perfect, and therefore there can be no re-acting power to perform the office of the vice!

Whether this contrivance will answer for pumps and other hydraulic apparatus, is not the present enquiry. It will be time enough to give an opinion on that point when we see what mode of construction may be used in such an application of the invention. A. T.

ERRATUM.

In our last Number, page 111, in the Recipe for preparing oxygenated Ointment, for Nitric Acid ʒij read ℥ij.

THE

PHILOSOPHICAL MAGAZINE.

DECEMBER 1798.

I. *Account of a remarkable fiery Meteor seen in Gascony on the 24th of July* 1790; *by* M. BAUDIN, *Professor of Philosophy at Pau. With some Observations on Fire-Balls and Shooting-Stars, by Professor* CHLADNI *at Wittenberg. From* Magazin für das Neueste aus der Physik, *by Professor* VOIGT. *Vol. XI.*

ABOUT half an hour after ten o'clock on Sunday evening, July 24, 1790, as I was walking in the court of the castle of Mormes, along with M. de Carrits Barbotan, the atmosphere being perfectly calm and serene, and not a cloud to be seen, we found ourselves surrounded, all of a sudden, by a whitish clear light, which obscured that of the moon, though the latter shone with great lustre, as it wanted only thirty hours of being at the full. On looking upwards we observed, almost in our zenith, a fire-ball of a larger diameter than the moon. It had behind it a tail, the length of which seemed to be equal to about five or six times the diameter of the body: at the place where it was connected with the body it had about the same breadth, and decreased gradually till it ended in a point. The ball and the tail were of a pale white colour; but the point of the latter was almoſt as red as blood. The direction of this meteor, which proceeded with great velocity, was from ſouth to north.

Scarcely had we looked at it for two ſeconds when it divided itſelf into ſeveral portions of conſiderable ſize, which we ſaw fall in different directions, and almoſt with the ſame appearance as the burſting of a bomb. All theſe different fragments became extinguiſhed in the air, and ſome of them, in falling, aſſumed that blood-red colour which I had obſerved in the point of the tail. It is not improbable that all the reſt may have aſſumed the ſame colour; but I remarked only thoſe which proceeded in a direction towards Mormes, and which were particularly expoſed to my view.

About three, or perhaps two minutes and a half after, I am not certain which, as I was not reflecting upon what might be the conſequences, and therefore did not look at my watch, we heard a dreadful clap of thunder, or rather exploſion as if ſeveral large pieces of ordnance had been fired off together. The concuſſion of the atmoſphere by this ſhock was ſo great that we all thought an earthquake had taken place. The windows ſhook in their frames, and ſome of them, which probably were laid-to and not cloſely ſhut, were thrown open. We were informed next day, that in ſome of the houſes at Houga, a ſmall town about half a mile diſtant from Mormes, the kitchen utenſils were thrown from the ſhelves, ſo that the people concluded there had been an earthquake. But as no movement was obſerved in the ground below our feet, I am inclined to think that all theſe effects were produced merely by the violent concuſſion of the atmoſphere.

We proceeded into the garden, while the noiſe ſtill continued, and appeared to be in a perpendicular direction above us. Some time after, when it had ceaſed, we heard a hollow noiſe, which ſeemed to roll along the chain of the Pyrenees, in echoes, for the diſtance of fifteen miles. It continued about four minutes, becoming gradually more remote, and always weaker; and at the ſame time we perceived a ſtrong ſmell of ſulphur.

While

While we were endeavouring to point out to ſome perſons preſent the place where the meteor had divided itſelf, we obſerved a ſmall whitiſh cloud, which aroſe perhaps from the vapour of it, and which concealed from us the three ſtars of the great bear lying in the middle of thoſe forming the ſemicircle. With ſome difficulty, however, we could at laſt diſtinguiſh theſe ſtars again behind the thin cloud. There aroſe, at the ſame time, a freſh gentle breeze.

From the time that elapſed between the burſting of the ball and the exploſion which followed, I was inclined to think that the meteor was at the height of, at leaſt, ſeven or eight miles, and that it fell four miles to the north of Mormes. The latter part of my conjecture was ſoon confirmed, by an account which we received, that a great many ſtones had fallen from the atmoſphere at Juliac, and in the neighbourhood of Barbotan. One of theſe places lies at the diſtance of about four miles to the north of Mormes, and the other at about the diſtance of five to the north-north-weſt.

M. de Carrits Barbotan, who was at Juliac two days after, confirmed to us the truth of this circumſtance; and it appeared from the accounts of ſeveral intelligent perſons, highly worthy of credit, that the meteor burſt at a little diſtance from Juliac, and that the ſtones which fell were found lying in an almoſt circular ſpace, about two miles in diameter. They were of various ſizes. I have not heard of any houſes being damaged, though ſome of the ſtones fell in courts and gardens. In the neighbouring woods ſome branches were found broken and torn by the falling of the ſtones, which as they deſcended made a ſtrong whiſtling noiſe that many perſons heard. I was told alſo by people of reſpectability, that as the meteor proceeded in its courſe they heard a ruſhing noiſe and ſnapping, like that of electrical ſparks; which appears to me very natural, though theſe were heard neither by myſelf nor M. de C. Barbotan.

Some ſtones were ſeen to fall, which, when found, weighed 18 or 20 pounds, and which had ſunk into the earth from two to three feet. I was told alſo that ſome were found which weighed 50 pounds. M. de C. Barbotan procured one weighing 18 pounds, which he tranſmitted to the Academy of Sciences at Paris. I examined a ſmall ſtone which was brought to me, and found it very heavy in proportion to its ſize: it was black on the outſide; of a greyiſh colour in the inſide, and interſperſed with a number of ſmall ſhining metallic particles. On ſtriking it with a piece of ſteel, it produced a few ſmall dark red ſparks, not very lively. A mineralogiſt, to whom a like piece of ſtone from the ſame meteor was ſhown at Paris, deſcribed it as a kind of grey ſlag mixed with calcareous ſpar, the ſurface of which exhibited vitrified, blackiſh calx of iron. I was told alſo that ſome ſtones were found totally vitrified.

This meteor was ſeen at Bayonne, Auch, Pau, Tarbes, and even at Bourdeaux and Thouloufe. I learned that in the laſt-mentioned place it excited no great attention; which is not ſurpriſing, when we conſider the great diſtance. It appeared there only ſomewhat brighter than thoſe ſhooting ſtars which are ſeen from time to time; and after it burſt, there was heard a hollow report almoſt like a diſtant clap of thunder.

Had it been accurately obſerved at Auch and Pau what ſtars were obſcured by the vapour that aroſe from the burſting of the meteor, the real height of it might have been thence determined with preciſion.

Such, ſays Profeſſor Chladni, is the account given by Baudin of this meteor; the phenomena of which he endeavours to explain from accumulations in the upper parts of the atmoſphere.

According to all the obſervations hitherto made with any accuracy on fire-balls, the height at which they were firſt perceived was always very conſiderable; and by comparing

the

the angles under which they were ſeen from different points, often 19 German miles, and even more; their velocity, for the moſt part, ſeveral miles in a ſecond; and their ſize always very great, often a quarter of a mile and even more in diameter. They were all ſeen to fall moſtly in an oblique direction: not one of them ever proceeded upwards. All of them have appeared under the form of a globular maſs, ſometimes a little extended in length and highly luminous; having behind it a tail, which, according to every appearance, was compoſed of flames and ſmoke. All of them burſt after they were ſeen to move through a large ſpace, ſometimes over ſeveral diſtricts, with an exploſion which ſhook every thing around. In every inſtance where there has been an opportunity of obſerving the fragments that fell after they burſt, and which ſometimes have ſunk to the depth of ſeveral feet into the earth, they were found to conſiſt of ſcorious maſſes which contained iron in a metallic or calcined ſtate, pure, or elſe mixed with different kinds of earth and ſulphur. All the ancient and modern accounts, written partly by naturaliſts and partly by others, are ſo eſſentially ſimilar, that the one ſeems to be only a repetition of the other. This conformity in accounts, the authors of which knew nothing of thoſe given by others, and who could have no intereſt in fabricating ſimilar tales, can ſcarcely have ariſen from accident or fiction, and gives to the related facts, however inexplicable many of them may ſeem, every degree of credibility. In my eſſay on the maſs of iron found by Profeſſor Pallas in Siberia, and others of the like kind, and ſeveral natural phenomena therewith connected *, I have collected the principal obſervations made on fire-balls and the falling of ferruginous ſcorious maſſes obſerved at the ſame time, and have given a kind of explanation, which, however romantic it may ſeem, yet agrees better, in my opinion, with the facts hitherto obſerved than any other, and is contrary to no law of nature hitherto known. Some critics, as

* See the Philoſophical Magazine, Vol. II. p. 1.

well as others, have ridiculed my ſingular hypotheſis, or condemned it altogether; but no one has yet confuted my principles, or given any other explanation that correſponds ſo well with facts. On the other hand, I could mention ſeveral naturaliſts, who, as I know from their own mouths, agree with me in the eſſential parts of my explanation, did I not conſider it improper to bring them thus forward to public notice without their expreſs permiſſion. The ſtrongeſt objection made to my aſſertions is, that ſuch a maſs, from ſuch a prodigious height, would not ſink to the depth of a few feet, but to the centre of the earth. This aſſertion, however, contradicts itſelf; becauſe ſuch a maſs is not ſolid, as may be concluded from the variation of its form ſo often remarked, and the increaſe of its ſize till it at length burſts; but conſiſts of ſoft and elaſtic fluids, which, probably being expanded by the heat, extend to a monſtrous globular form; is then ſupported by the atmoſphere, and loſes the greater part of its gravity. To this may be added, that a ſoft tough maſs, which beſides falls in a very oblique direction, would not in general ſink ſo far into the earth as a ſolid maſs that falls in a perpendicular direction.

The above-deſcribed meteor ſeems, in every point of view, to confirm my method of explanation as much as if it had abſolutely taken place for that purpoſe. This much, at any rate, is proved, that all the phenomena which accompany fire-balls, as well as the falling of maſſes of ferruginous earth and ſulphureous maſſes, obſerved at the ſame time, cannot be explained from accumulations in the upper regions of the atmoſphere, as it can hardly be ſuppoſed that ſuch groſs ſubſtances could float or be diſſolved in ſo rarefied air at a height of 20 German miles, ſo as to be collected and to unite into monſtrous maſſes. As we are acquainted with no power which is able to force ſuch large bodies to ſo conſiderable a height, and then to give them an oblique movement downwards, and ſometimes almoſt horizontal, with a velocity which is equal to that of the planets in their orbits; and

and as no ſuch maſs has ever been ſeen to aſcend; they appear not to be terreſtrial, but coſmical bodies. Should this not be admitted, it is much to be wiſhed that ſome other perſon might give an explanation conſiſtent with the obſerved facts; and that more attention than has hitherto been beſtowed, were paid to the obſervation of fire-balls and ſhooting ſtars; as for example, that obſerved on the 8th of March 1796 in Luſatia, and in ſome parts of Saxony and Brandenburg.

Shooting ſtars are perhaps meteors of the ſame nature as thoſe teleſcopic ſparks of light obſerved by Mr. Schröter, and may be different from fire-balls only in this, that they move at a much greater diſtance from our earth, and that they do not fall, but only occaſion a tranſient luminous appearance in their paſſage through the upper regions of the atmoſphere.

I ſhall here mention an idea which does not proceed from myſelf, but from a very intelligent aſtronomer, that ſhooting ſtars might be employed to determine the difference of two meridians. Two or more aſtronomers, reſiding at ſome diſtance from each other, might agree to make obſervations on ſhooting ſtars, which appear almoſt at all times, when the weather is clear, in ſome part of the heavens, not with inſtruments, but merely with the naked eye; and to remark, not only the time of their appearance, but alſo their apparent courſe; and from the difference of the times of ſeeing theſe ſhooting ſtars, the difference of the meridians of the places might be determined; and from the difference of their apparent courſes, their real height and real courſe might be diſcovered.

II. *Account of a singular Instance of Atmospheric Refraction. In a Letter from* WILLIAM LATHAM, *Esq. F.R.S. and A.S. to the Rev.* HENRY WHITFIELD, *D.D. F.R.S. and A.S. From the* Philosophical Transactions of the Royal Society of London, 1798.

DEAR SIR, Hastings, August 1, 1797.

ON Wednesday July 26, about five o'clock in the afternoon, while I was sitting in my dining-room at this place, which is situated upon the Parade, close to the sea-shore, nearly fronting the south, my attention was excited by a number of people running down to the sea-side. Upon enquiring the reason, I was informed that the coast of France was plainly to be distinguished by the naked eye. I immediately went down to the shore, and was surprised to find that, even without the assistance of a telescope, I could very plainly see the cliffs on the opposite coast; which, at the nearest part, are between 40 and 50 miles distant, and are not to be discerned, from that low situation, by the aid of the best glasses. They appeared to be only a few miles off, and seemed to extend for some leagues along the coast. I pursued my walk along the shore eastward, close to the water's edge, conversing with the sailors and fishermen upon the subject. They, at first, could not be persuaded of the reality of the appearance; but they soon became so thoroughly convinced, by the cliffs gradually appearing more elevated, and approaching nearer, as it were, that they pointed out and named to me the different places they had been accustomed to visit; such as the Bay, the Old Head or Man, the Windmill, &c. at Boulogne; St. Vallery, and other places on the coast of Picardy; which they afterwards confirmed when they viewed them through their telescopes. Their observations were, that the places appeared as near as if they were sailing, at a small distance, into the harbours.

Having

Having indulged my curioſity upon the ſhore for near an hour, during which the cliffs appeared to be at ſome times more bright and near, at others more faint and at a greater diſtance, but never out of ſight, I went upon the eaſtern cliff or hill, which is of a very conſiderable height, when a moſt beautiful ſcene preſented itſelf to my view; for I could at once ſee Dengeneſs *, Dover cliffs, and the French coaſt, all along from Calais, Boulogne, &c. to St. Vallery; and, as ſome of the fiſhermen affirmed, as far to the weſtward even as Dieppe. By the teleſcope, the French fiſhing-boats were plainly to be ſeen at anchor; and the different colours of the land upon the heights, together with the buildings, were perfectly diſcernible. This curious phenomenon continued in the higheſt ſplendour till paſt 8 o'clock, (although a black cloud totally obſcured the face of the ſun for ſome time,) when it gradually vaniſhed.

Now, Sir, as I was aſſured, from every inquiry I could poſſibly make, that ſo remarkable an inſtance of atmoſpherical refraction had never been witneſſed by the oldeſt inhabitant of Haſtings, nor by any of the numerous viſitors (it happened to be the day of the great annual fair, called Rock-fair, which always attracts multitudes from the neighbouring places), I thought an account of it, however trifling, would be gratifying to you.

The day was extremely hot (68° at 10 A.M. 76° at 5 P.M.). I had no barometer with me, but ſuppoſe the mercury muſt have been high, as that and the three preceding days were remarkably fine and clear. To the beſt of my recollection it was high water at Haſtings about two o'clock P.M. Not a breath of wind was ſtirring the whole

* The cape of land called Dengeneſs, which extends nearly two miles into the ſea, and is about ſixteen miles diſtant from Haſtings, in a right line, appeared as if quite cloſe to it; as did the fiſhing-boats and other veſſels which were ſailing between the two places: they were likewiſe magnified to a great degree. L.

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of the day; but the ſmall pennons at the maſt-heads of the fiſhing-boats in the harbour were in the morning at all points of the compaſs.

I was a few days afterwards at Winchelſea, and at ſeveral places along the coaſt; where I was informed the above phenomenon had been equally viſible.

III. *Deſcription of the* Equus Hemionus *or* Dſhiggetai *of the Eaſtern Deſerts of Middle Aſia. By Profeſſor* PALLAS. *From* Neue Nordiſche Beytrage, *Vol. II.*

[Concluded from page 121.]

THE covering ſeaſon of the dſhiggetai falls towards the middle or end of Auguſt; and about this period Meſſerſchmidt obſerved in a female, which he diſſected, a fœtus not larger than a mouſe. They caſt their young in the ſpring, and generally have one foal at a time. When the young attain to the age of three, they are equal in ſize to the old ones, and are fit for procreation, as I was aſſured by the inhabitants of thoſe countries, who often had an opportunity of killing and examining theſe animals.

The males when they fight bite each other, like the common wild horſes. The dſhiggetai fights alſo with its heels, as was obſerved in a foal which had been caught, and which, a few years before my arrival in Dauuria, was kept there by one of the Coſſacks; but it continued alive only a ſhort time. The hair of the dſhiggetai in winter is almoſt of a pale iſabella yellow colour, about an inch and a half long; a little rough on the back, as was the caſe in the foal of a wild horſe, which I have already deſcribed *, and equally ſoft and tender. Skins covered with winter hair of this kind I have found among the Tunguſians. The female, however, which I procured in Dauuria, at the end of the month

* See *Pallas Reiſe*, vol. iii. p. 509, Plate VIII.

of

of May, had at that period loſt almoſt all its winter hair, though the Tunguſian horſes ſtill retained theirs. The ſummer hair of this female was uncommonly ſmooth and pretty; and I never found it much longer on the ſkins of animals ſhot far later in the ſeaſon. The colour eaſily becomes paler; and on the ſtuffed hide of the female, which I have deſcribed, and which is preſerved in the cabinet of natural hiſtory at Peterſburgh, the ſummer hair, partly by the preparation the hide has gone through, and partly by the effects of the ſun, has been totally bleached to a dull iſabella colour, which appears lighter than the common winter hair.

The above female was about three years old, and was ſhot on the 26th of May O. S. 1772, in the neighbourhood of Tareinoor, in the country of the Tunguſians. As the ſpring heats had then commenced with great violence in thoſe diſtricts, the animal, at Kuluſſutai, where it was kept for me, had already begun to putrefy on the 28th, and expoſed me to a very diſagreeable piece of labour, eſpecially in a barren region, where I was obliged to diſſect it without any aſſiſtance. The figure (Plate V.) done from a drawing made before the diſſection, is ſo accurate, that I was never better ſatisfied with any repreſentation of an animal. The dſhiggetai cannot, therefore, be any longer conſidered among the doubtful animals, and its deſcription is as follows:

In ſize and figure it has a great reſemblance to a middle-ſized mule; but it excels the mule in the beauty and delicacy of its make. The head is larger than that of a horſe, and more compreſſed at the ſides; the forehead is perfectly flat, and runs downwards with a ſmall angle towards the muzzle. The ſides of the head are alſo flat, eſpecially where the broad part of the jaw-bones lie, and where the head has the greateſt thickneſs. On the other hand, the throat, between the broad parts of the jaw-bones, is hollow.

The lips, particularly the upper one, are thick and flabby; thinly covered with hair, and black on the edges, which are

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beset with stiff grey bristles, crooked and bent downwards. The corners of the mouth are covered with soft hair on the inside; and the inner side of the cheeks is covered with fine blackish glands. The number of the teeth amounts to thirty-four; so that this animal has two less than the horse. The fore-teeth are six; the four middlemost of which, in the above-mentioned female, had not yet been changed; they were of a conical form marked with a small furrow; and the side ones were obliquely blunted, and pressed towards those in the middle. The situation of the fore-teeth is the same as those of the horse, standing perpendicular in the upper, and obliquely in the under jaw. I found the eye-teeth neither in this female, nor in the skull of a stallion, which had been shot a little before, and brought to me by the Tungusians; but I observed in the upper jaw of the former, at a mean distance between the fore and jaw teeth, a trace as of a socket for a tooth. The jaw-teeth were like those of the horse; but on each side above, as well as below, there were only three fully grown, beyond which the fourth was just beginning to appear. I found a fifth in the before-mentioned skull concealed within the socket. Of the latter, Messerschmidt, speaking of the skull of a stallion, makes no mention. In the palate I counted seventeen broad wrinkles, of which, those before were flatter, and those behind higher and broader.

The nostrils, as in the horse, are wide, blackish on the inside and edges; but under the nostril, on each side of the cartilage, there is an excrescence like a large round wart, which is to be found neither in the horse nor the ass. The muzzle is interspersed with long blackish bristles, the longest of which, about two inches in length, are found on the under lip, and on the outside of the nostrils.

The eyes are of a moderate size, and, with their longest diameter, stand in the head obliquely. The edges of the eyelids and a triangular spot at the corner of the eye are bald and blackish; and the upper eyelid only is furnished

with

with a row of black eyelaſhes, ſeven lines in length, which are at a little diſtance from the edge of the eyelid, and do not reach entirely to the corners. Below the foremoſt corner, however, of the eye, in the neighbourhood of the *os jugalis*, there are ſeveral ſcattered black hairs, two of which, more than two inches in length, lie entirely flat. In the corner of the eye lies a thick white fold of ſkin, which is capable of being extended, ſeven lines in breadth, as far as the iris, and in the middle of its edge has a blackiſh moon-formed ſpot. The white of the eye, next to the tranſparent cornea, is browniſh; the iris is darkiſh grey, and, as it were, radiated with folds; the pupil is elongated, ſo that its longeſt diameter runs through the corner of the eye, and, like the eye itſelf, ſtands obliquely.

The ears are much larger than thoſe of the horſe, though much more in proportion to the ſize than thoſe of the aſs; ſharp-pointed, erect, internally of the colour of the body; but the inſide, at the top, and a ſtripe on the edges downwards, are browniſh black. On the inſide they are covered with curled whitiſh hair, which riſes up from the circumference. Three raiſed ſtripes run along the inſide of the ear lengthwiſe, which are thinly covered with hair of the like kind projecting from each other.

The neck is ſmaller and rounder than that of the horſe, and even than that of thoſe called ſtag-necked. The mane proceeds from the back part of the ſkull to the ſhoulders, of an equal height, and is as ſoft and as upright as in young foals. It is of a blackiſh colour with yellowiſh grey points, and about three quarters of an inch in length. Inſtead of the tuft before, the whole ſpace between the ears and the orbits of the eyes is thick ſet with ſoft hair, of the ſame colour as the mane, and at moſt one inch three lines in length.

The body is pretty long, more compreſſed on the ſides than in the horſe, contracted towards the lower part of the breaſt, particularly before, into a conical form, and ſtrongly built.

built. The rump is pretty ſtraight and ſomewhat ſharp, as in the aſs. As the body was ſwelled up, the ſpine was become bent into the form of a bow.

The animal ſtands high on its limbs, which are delicate, though its muſcles are ſtrong; but the ſhoulders, thighs and legs are ſomewhat meagre, like thoſe of ſlight-formed mules. The fore legs, on the inſide, have a longiſh, round, bald, blackiſh ſcar, covered with a tender, ſomewhat hard and brittle ſkin, which, at ſome times of the year, may perhaps be covered by a corneous ſubſtance. In the common aſs this ſcar is more of a round form. It was in length two inches ſeven lines, and in breadth one inch ſix lines. On the hind legs no traces of ſuch a ſcar were to be ſeen. The lower part of the leg is perfectly ſmooth, ornamented behind with a conſiderable tuft of ſhort hair: on the fore-ſide inwards there is a black ſpot, and outwards a faint mark near the before-mentioned tuft. On the hind feet there are two ſmall faint ſpots above it. The hoofs are very hard, dry, of a black colour, ſmall, and almoſt like a half cone; roundiſh above, and very hollow on the ſole. The edges of all the hoofs exhibited traces of cracks which had grown up again.

The tail was almoſt like that of a cow; the trunk is thin, moderately long, perfectly round, quite bald from the rump to the middle; but the other part is covered with ſhort briſtles of the ſame colour as the ſides of the body. It is buſhy at the end, where it forms a black tuft, about nine inches in length.

I found the winter hair on the ſkin already mentioned to be two inches long, tolerably thick, as ſoft as camel hair, and of an iſabella grey colour outwardly, but of a pale iron-grey towards the roots. The ſummer hair on the female, which I have deſcribed, was ſcarcely three quarters of a line in length, here and there diſpoſed into circular arrangements (*vortices*) and ſhadings, and on the back never turned forwards as in the zebra. A ſhading of the hair runs length-

wiſe

wiſe along the face, and two others above the eyes. The vortices I obſerved firſt on each ſide of the mane immediately behind the ears. There were two alſo above each other under the neck; two on the ſides of the neck oppoſite the ſhoulders; a larger one on each joint of the ſhoulder; another large one on each ſide of the breaſt behind the ſhoulders, and alſo a cruciform ſhading of the hair. Several more of theſe hair vortices could be obſerved on different parts of the body.

The colour of the muzzle is whitiſh; the reſt of the body inclines a little more to yellow; the neck is of a fallow colour; the rump from the back to the ſides of an ochre yellow; the ſides fallow, and the limbs paler. The hind part of the fore legs, and the inner part of the hind legs, together with the lower part of the rump and the hinder edge of the thigh, are whitiſh. Where the mane ceaſes, there begins a blackiſh brown ſtripe, which runs along the ridge of the back to the buſhy part of the tail. The udder is blackiſh and perfectly bald, with two ſtrong ſhort teats. The meaſurement of the principal parts of this animal is as follows: The length from the ſkull between the ears to the root of the tail 5 feet 1 inch 3 lines; length of the head 1 foot 8 inches 6 lines; height of the animal at the ſhoulders before 3 feet 9 inches 9 lines: height behind 4 feet 3 inches 6 lines; length of the ears 7 inches 2 lines; length of the tail without the bruſh at the end 1 foot 4 inches 1 line; length of the bruſh 8 inches 2 lines. The weight of the whole animal amounted to 560 pounds apothecary's weight.

Every thing conſidered, the dſhiggetai is diſtinguiſhed particularly by the head, which has a mean proportion between that of the horſe and the aſs; and, in that reſpect, as well as by the ears and the tail, it approaches very near to the zebra. In the reſt of the body and the thighs it is more like the aſs; and in the limbs it has a greater ſimilarity to the mule and the horſe. The tail is more naked than that of the aſs, and nearly like that of the cow. Its colour

colour and hair vortices are peculiar to itſelf. The ſtripe on the back, however, is like that of the female onager, and of many horſes, without any croſs ſtripes. The tail excepted, it has, in general, the greateſt likeneſs to the mule. But, from the above circumſtances, it clearly appears that the dſhiggetai is an animal of a diſtinct genus, and as much peculiar to Aſia as the zebra and quagga are to Africa; whereas the aſs, and perhaps the horſe, in a wild ſtate, belong to both theſe quarters of the world in common.

IV. *Experiments on, and the Manner of diſtinguiſhing, ſeveral Diſeaſes by the Urine. By Mr.* CRUICKSHANK. *From* Caſes of the Diabetes, &c. *Second Edition.*

THE urine is a fluid ſeparated from the blood by the kidneys, containing ſeveral neutral ſalts, with more or leſs animal extractive matter. The relative proportions of theſe ſubſtances are found to vary ſo much in the ſame perſon, both in health and diſeaſe, that it is extremely difficult to fix on what may be conſidered as a ſtandard for healthy urine. The ſpecific gravity of this fluid reaches from 1005 to 1033, that of diſtilled water being 1000: by expoſure to the air it ſoon runs into the putrefactive ſtate, accompanied with the production of much ammonia, although when firſt voided it always contains an exceſs of phoſphoric acid, and reddens litmus: in conſequence of this exceſs, it holds in ſolution more or leſs phoſphat of lime, which may be readily thrown down by a fixed alkali, or even pure ammonia. By evaporation, 36 oz. yield a reſiduum varying from 1 oz. to 1½: this conſiſts of the muriats of potaſh and ſoda, the phoſphats of ſoda, lime, and ammonia, the phoſphoric and lithic acids, with animal extractive matter. Their relative proportions in a healthy ſtate may be nearly as follows:

Oz.

	oz.	dr.	gr.
Muriatic ſalts - - - -	0	1	0
Phoſphoric ſalts - - -	0	3	50
Lithic acid and phoſphat of lime, with exceſs of acid - - - -	0	0	25
Animal extractive matter - -	0	3	40

The neutral ſalts, when purified by cryſtalliſation, are generally very fuſible; but this circumſtance varies much, according to the greater or leſs proportion of phoſphoric ſalts, more particularly the phoſphat of ammonia, on which their fuſibility in a great meaſure depends: inſtead of melting, this ſaline matter ſometimes decrepitates when ſuddenly heated, owing to an exceſs of the muriatic ſalts: of theſe laſt it may be obſerved, that the muriat of potaſh is in general the moſt prevalent, and is eaſily diſtinguiſhed from the muriat of ſoda, by its cryſtalliſing in ſome degree by cooling, and by its affording cream of tartar on the addition of acid of tartar.

In recent urine the ammonial ſalts bear a very ſmall proportion; but when it has become ſtale or putrid, they are much more abundant. The phoſphat of ammonia is the principal, although we have likewiſe met with the muriat of ammonia.

(A.) The lithic acid and phoſphat of lime are generally depoſited, at leaſt in a great meaſure, after the urine has become cold and ſtood for ſome time: the quantity of the firſt varies exceedingly, but that of the laſt we have found, for the moſt part, nearly the ſame, the proportion being about 1 grain to 2 ounces. Theſe ſubſtances may be eaſily diſtinguiſhed, by diſſolving them in twice their weight of nitrous acid, diluted with a little water, and evaporating to dryneſs; the dry maſs when hot will aſſume a beautiful deep roſe or crimſon colour, when the lithic acid is preſent, but will continue white if heated even to redneſs, or have only a ſlight greeniſh tinge when there is nothing but phoſphat of lime. Their relative proportions may be aſcertained by expoſing the mixed maſs for ſome time to a red heat in a crucible; in which caſe, the lithic acid will either burn out or evaporate, leaving the phoſphat in a pure ſtate.

The quantity of extractive matter is more variable than that of any other ſubſtance—hyſterical or crude urine (as it has been called) containing hardly any, while that of concoction abounds with it. This matter yields, by diſtillation, water containing the carbonat of ammonia; this carbonat in a concrete ſtate; a fœtid empyreumatic oil; a little phoſphorus; and laſtly, a reſiduum of animal coal difficult to incinerate: in ſhort, nothing more than the uſual products from animal ſubſtances. If to 1 oz. of this extract be added 1 oz. of the concentrated nitrous acid, diluted with an equal quantity of water, a violent efferveſcence, accompanied with heat and the diſengagement of nitrous gas, will take place: when the action has ceaſed, and the liquor become cold, a number of ſhining ſcales, or cryſtals, reſembling the acid of borax, will be depoſited, which, when well dried on blotting-paper, will be found to weigh from 5 to 7 dr. or ſometimes more, the proportion varying according to the quality of the extract and the method of conducting the proceſs. The figure of theſe ſcales appears to be that of flat rhomboids; they have a ſmooth greaſy feel when preſſed between the fingers; are ſoluble in much greater quantity in hot than cold water, and alſo in ſome degree in alcohol: although repeatedly waſhed with this fluid, and dried on blotting-paper, they ſtill retain acid properties, and ſtrongly redden the ſyrup of violets; they are readily taken up by the ſulphuric and muriatic acids without commotion; but with the nitrous acid they produce a kind of efferveſcence, and form very ſoluble neutral ſalts, whoſe properties have not been ſufficiently examined. Their ſolution in water does not precipitate lime-water, nor the muriats of lime or barytes, nor the nitrats of ſilver or mercury, in any ſenſible degree, nor has it any effect upon the ſulphat of iron or acetite of lead; they do not, therefore, contain phoſphoric or oxalic acid: when thrown upon a red hot iron, they melt and evaporate in white ſmoke,

ſmoke, leaving a very ſmall quantity of a charry reſiduum, by no means difficult to incinerate; but, when expoſed to an intenſe heat, they burn with a reddiſh flame and a kind of detonation ſomewhat ſimilar to nitrat of ammonia.

From theſe experiments it would appear that this ſubſtance is an animal acid hitherto unknown, and whoſe baſis exiſts in this extractive matter.

We ſhall now briefly mention the effects produced by certain re-agents on the urine, when in a healthy ſtate, and likewiſe when altered by ſome morbid diſpoſitions of the body.

Pure ammonia and the fixed alkalies, dropped into healthy recent urine, produce a ſlight cloud, which, on examination, will be found to conſiſt principally of phoſphat of lime; about 2 gr. may be obtained in this way from 4 oz. of urine. Lime-water likewiſe throws down a precipitate which is much more copious, for reaſons that muſt be obvious.

Nitrous acid, added to healthy urine, produces a ſlight effervеſcence, and gives it more or leſs of a reddiſh colour, but produces no precipitation. In ſome diſeaſes, however, particularly general dropſy or anaſarca, this re-agent, when dropped into the urine, produces a milkineſs, and in ſome inſtances a coagulation, ſimilar to what would take place if added to the ſerum of the blood. When bile is mixed with this fluid, as in jaundice, the acid renders it green: a ſimilar effect is produced by the muriatic, and alſo in ſome degree by the ſulphuric acid; for this purpoſe, however, the muriatic is to be preferred.

The principle of tan, or infuſion of oak-bark, detects animal mucilage or jelly, and the quantity of coagulum thrown down will in general bear a certain proportion to the extractive matter. Four oz. of healthy urine afforded in this way a precipitate of about 4 gr.*

* *Seguin* remarks, that in every caſe where the action of the ſtomach and organs of digeſtion is much impaired, this infuſion produces a copious precipitate. C.

The corrosive muriat of mercury is a very useful re-agent, as it has no immediate effect upon recent healthy urine; but in every case of increased action of vessels, more particularly of the inflammable kind, a greater or less milkiness, and a whitish precipitate, is instantly produced; it likewise in some degree coagulates dropsical urine.—Effects somewhat similar, although not so striking, are produced by alum.

The muriat of barytes detects the phosphoric salts. Four oz. of healthy urine yield with this re-agent a precipitate of 13 gr. equivalent to about 24 or 25 gr. of microcosmic salt, consisting of such a mixture of the phosphats of soda and ammonia as are usually met with in the urine. This substance will therefore shew when these salts are deficient, or in too great a quantity. The sulphat of iron has a similar effect, but is not so certain, as any little excess of acid might prevent the separation of the phosphat of iron.

The nitrats of mercury and silver are decomposed by the phosphoric and muriatic salts, and likewise, in some degree, by the extractive matter; they can, therefore, be but of little use as re-agents.

The acetite of lead is decomposed by the muriatic and phosphoric salts: with the last it forms an insoluble precipitate; but the muriat of lead may be dissolved by 18 or 20 times its weight of hot water. This circumstance affords a ready method of determining their relative proportions; for, if we precipitate a given quantity of urine by this substance, dry the precipitate, and then digest it in 20 times its weight of distilled water, what remains must be phosphat of lead, and the quantity taken up will indicate the proportion of muriat of lead. Four oz. of healthy urine treated in this way yield a precipitate of 31 gr.; this being digested in distilled water, 7 gr. were taken up, the remaining 24 gr. were found to be phosphat of lead, equivalent to 23 or 24 gr. of microcosmic salt, as was determined directly by experiment.

It

It muſt be obſerved, that the urine employed in theſe trials ſhould be recent, and not kept for any length of time, as it is well known that ammonia is ſoon produced, which would render the reſults extremely uncertain. It was thought proper to give the quantity of precipitate thrown down by the principal re-agents, when added to healthy urine; for by this means we ſhall be better enabled to deteċt any remarkable deviation from the healthy ſtandard. The quantity of four ounces was conceived to be the moſt convenient, as in many caſes we might not be able to procure more, and a leſs quantity could only afford uncertain reſults.

Upon the whole, therefore, we would obſerve, that the proportion of extraċtive matter may, in ſome meaſure, be determined by an infuſion of oak bark, or rather galls; the quantity of phoſphoric ſalts by the muriat of barytes, or acetite of lead; that of the muriatic ſalts by the latter ſubſtance; the proportion of phoſphat of lime by pure ammonia, or any of the alkalies, and the lithic acid by the proceſs already deſcribed. (See A.)

In morbid ſtates of the urine, the coagulable part of the ſerum is deteċted by the nitrous acid, and even by heat; bile by the nitrous or muriatic acids; and the condition of urine accompanying rheumatiſm and other inflammatory complaints by the corroſive muriat of mercury, and ſometimes by alum. With regard to ſugar which is met with in diabetes, the different methods of deteċting it have been already fully explained*: we would only further propoſe, when

* In confirmed diabetes the urine is ſweet to the taſte. In one caſe "Mr. Cruickſhank took 36 oz. troy weight of urine, and it yielded by evaporation 3 oz. 1 dr. of ſaccharine extraċt, of the appearance of molaſſes, but thicker, having nearly the conſiſtence of wax, and ſomewhat tenacious. If the whole of the day's urine had been evaporated, it would (at the ſame rate) have yielded about 29 oz. an aſtoniſhing quantity to be formed and ſeparated daily from the ſyſtem. By ſtanding in the air it became moiſt, and

when the quantity of ſaccharine matter is but ſmall, that the extract obtained by careful evaporation ſhould be treated with twice its weight of nitrous acid, and the whole reduced by evaporation to a very ſmall compaſs: when this has become cold, the cryſtals formed ſhould be carefully examined. If we perceive nothing but ſmall cubes or rhomboids, we may be certain that no oxalic acid has been produced; but if, along with theſe, we ſhould obſerve ſlender needles or priſms, theſe ſhould be carefully ſeparated, dried on blotting-paper, and thrown into lime water: if a precipitate is formed, it muſt either be from phoſphoric or oxalic

and of nearly the conſiſtence, ſmell, and appearance of treacle. Treating ſome of this extract with the nitrous acid, he procured the ſaccharine or oxalic acid; and with a ſmaller portion of the acid it produced a ſubſtance, which, in reſemblance and ſmell, could not be diſtinguiſhed from honey." In another caſe 36 oz. of diabetic urine yielded 3 oz. 1 dr. 10 gr. of reſiduum, apparently more ſaccharine than the above, but having the other reſemblances. Treating it with the nitrous acid it gave the ſame reſult. A quantity of the ſame reſiduum was expoſed to heat in a retort: the firſt product was evidently acid, but on the addition of potaſh the ſmell of ammonia could be perceived—the laſt matter was manifeſtly alkaline, and mixed with a little empyreumatic oil. The ammonia did not come over in a diſengaged form until the bottom of the retort became red hot, and the quantity on the whole was very ſmall.

"In order to aſcertain how far the ſaccharine matter produced in diabetes reſembled that ſecreted in the breaſts of animals, the following experiments were made by Mr. Cruickſhank:

"Two drachms of cryſtalliſed ſugar of milk were treated with 12 dr. of the concentrated nitrous acid, diluted with one oz. of water: after proper evaporation the liquor was ſuffered to cool, when a maſs of cryſtals, mixed with a white powder, was depoſited: theſe being ſeparated and dried on blotting paper, amounted to 58 gr.; about 6 dr. of hot diſtilled water were then added, upon which the cryſtals, conſiſting of oxalic acid, were diſſolved, and the white powder fell to the bottom. The clear liquor being decanted, the remainder was thrown into a filter, and by this means the powder obtained in a ſeparate ſtate, which when dried on blotting-paper amounted to 10 grains. This was found to have all the properties of ſaccholactic acid, as deſcribed by Scheele.

"Two

oxalic acid, and from which, may in a great meafure be determined by the appearance of the precipitate: if this has the refemblance of flocks, and fubfides flowly, the phofphoric acid is the precipitant; but if it has a powdery form, and fubfides quickly, it muft be produced by oxalic acid. To this mode we know it may be objected, that all animal fubftances yield more or lefs oxalic acid: but this is by no means true to the extent generally fuppofed; for there are feveral animal fubftances, and the extractive matter of healthy urine is one, from which we have never been able to procure any fenfible quantity of this acid. Of the different parts of the blood, the coagulating lymph is the only one which yields it in any remarkable proportion; and we

"Two drachms of very fweet extract from diabetic urine were taken, and treated at the fame time with an equal quantity of nitrous acid, and under exactly fimilar circumftances. The liquor in this cafe, when properly evaporated, depofited a quantity of very tranfparent cryftals, but no white powder: thefe, when properly dried on blotting-paper, weighed 40 gr. and, on the addition of 6 dr. of hot diftilled water, were entirely diffolved.—The fame experiment was repeated with the fweet extractive matter from the urine of two other patients; the oxalic acid was procured, but not the leaft trace of faccholactic acid.

"Half an ounce of honey was treated with 3 oz. of nitrous acid in the ufual manner, and it yielded about 2 dr. of pure oxalic acid, but no faccholactic. Honey therefore differs effentially from the fugar of milk; and, indeed, from moft of its obvious properties, would appear to be merely a modification of common fugar.

"In the courfe of thefe experiments I found that 2 dr. of pretty dry and fweet diabetic extract yielded, with 12 dr. of the nitrous acid, from 40 to 50 grains of cryftallifed oxalic acid, being nearly the proportion which may be procured from an equal quantity of common fugar, if we make allowance for the water and faline fubftances. Upon the whole, therefore, it would appear that this extractive matter does not contain the bafis of the faccholactic acid—a circumftance which fufficiently diftinguifhes it from the faccharine part of the milk of animals; and feems to fhew that it is nothing more than vegetable fugar, if we may be allowed the expreffion, mixed with a greater or lefs proportion of animal mucilage." C.

believe that the coagulable part of the ferum, when perfectly pure, does not afford it at all. We fhall only further remark, that the method by fermentation, fo much relied upon by fome, is by no means correct.

From what has been delivered it muft be evident, that an attentive examination of the urine may lead to ufeful conclufions in feveral difeafes.

In dropfy, the general difeafe may readily be diftinguifhed from that depending on morbid vifcera, by attending to the effects produced on this fluid by nitrous acid and the corrofive muriat of mercury. In three cafes which we have lately met with, the urine coagulated not only on the addition of nitrous acid, but likewife by heat; and, in one of them, which proved fatal in fix weeks, the urine appeared to differ but little from the ferum of the blood, fo remarkable was the coagulation produced by heat and acids. This coagulable ftate, however, muft not be confounded with that produced by cantharides; for we have feen fome cafes of violent ftrangury from this caufe, where the urine had the appearance of hydatids*.

In the dropfy proceeding from difeafed liver and other morbid vifcera, the urine does not coagulate either by nitrous acid or heat: it is ufually fmall in quantity, high coloured, and depofits, after ftanding, a confiderable quantity of pink-coloured fediment. This peculiar fediment we confider as, in fome meafure, characteriftic of difeafed or rather fcirrhous liver. On examination we found that it confifted of a phofphat of lime, fome animal matter, to which its red colour was probably owing, and a little lithic acid; this laft, however, was in very fmall quantity.

In inflammatory affections, particularly thofe of the cheft and acute rheumatifm, the urine, during the active ftate of the difeafe, always affords an immediate precipitate with the corrofive muriat of mercury or alum, and fome-

* The infufion of galls likewife coagulates this fpecies of urine.

times

times with the nitrous acid: when the diſeaſe takes a favourable turn, this effect will in a great meaſure ceaſe, and the lateritious ſediment make its appearance.

In fevers, particularly ſuch as are accompanied with a ſtrong action of veſſels, ſimilar phenomena may be obſerved; but in this caſe the lateritious ſediment, which never fails to make its appearance at the criſis or abatement of the diſeaſe, is much more remarkable and conſtant; and the nitrous acid, when added to the urine before the depoſition takes place, gives it a pretty deep red tinge.

In gout, too, the termination of the paroxyſms is moſt perfectly indicated by a copious lateritious ſediment; and when this ſuddenly diſappears, and the urine at the ſame time affords a precipitate with the muriat of mercury, a freſh attack or relapſe may be expected. We have generally found this ſediment to be compoſed of lithic acid, phoſphat of lime, and ſome peculiar animal matter but little ſoluble in water: it has by ſome been ſuppoſed to conſiſt entirely of lithic acid; but this for the moſt part conſtitutes the ſmalleſt part.

In jaundice, a very ſmall quantity of bile may be detected in the urine by the nitrous or muriatic acids, but more particularly the latter. When, therefore, the urine ceaſes to become green on the addition of theſe acids, we may infer that the obſtruction to its paſſage into the duodenum is removed, and that, conſequently, the yellowneſs of the ſkin, &c. will ſoon diſappear.

The ſpaſmodic affections that take place in many nervous complaints are immediately indicated by the urine, which upon the approach of theſe will moſt generally be found tranſparent, large in quantity, and abounding in ſaline, but containing hardly any extractive, matter. Similar appearances have been obſerved to precede delirium in fevers. This ſtate may be diſcovered by infuſion of oak bark, with which it will hardly give any precipitate, and by the acetite of lead, which will produce a very copious one.

In

In ſcurvy, and ſome other putrid diſeaſes, as they have been called, we make no doubt the appearances and properties of this fluid are ſufficiently remarkable, and we would recommend it to be examined by thoſe who may have opportunities.

Can internal ulceration and ſuppuration be detected in this way? In ſome diſeaſes of the abdomen, accompanied with tumefaction, the urine has been met with of a white colour, as if mixed with pus; and in a few inſtances, when this change has taken place, the enlargement has ſuddenly ſubſided.—Was this colour owing to pus? and, if ſo, was the pus taken up by the abſorbents, or was it carried off by the kidneys, in conſequence of ſome direct morbid communication? In children ſubject to worms, the urine has likewiſe been obſerved to have at times a white colour; and this has been ſuppoſed to proceed ſomehow from the chyle. This peculiar appearance is not to be confounded with what takes place in local affections of the kidneys and bladder, where it alſo occurs, but is ſufficiently underſtood. We have had no opportunity of examining this kind of urine, and cannot, therefore, give any ſatisfactory account of it.

We have thrown out theſe imperfect hints, merely with a view to induce others to pay ſome attention to a ſubject which has of late been much neglected, but which, in our opinion, is capable of affording great aſſiſtance in the inveſtigation and cure of many diſeaſes.

V. *On*

V. *On the fascinating Power of the Rattle-Snake, with some Remarks on Dr.* Barton's *Memoir on that Subject* *. *By Professor* Blumenbach. *From Professor* Voigt's Magazin für den neuesten zustand der Naturkunde. *Part II.* 1798.

IT has been asserted of many animals, both warm and cold-blooded, and particularly of different snakes, poisonous as well as harmless, in the old † and new world ‡, that even when at some distance from other animals, especially those which serve them as food, they have such a fascinating power over them, that they are forced to approach them just in the same manner as if attracted by them.

The rattle-snake has been particularly celebrated on account of this property, which has been denominated its fascinating power; and naturalists have endeavoured to explain it on the following principles. Many suppose that the small birds, squirrels, &c. which have been seen to fall from the branches of trees, as it were spontaneously, into the mouth of the rattle-snake, must have been previously bitten by the snake; and that, weakened by the activity of the poison, they were incapable either of flying away or of remaining longer on the tree. Some suppose that the rattle-snake, under cer-

* A Memoir concerning the fascinating Faculty which has been ascribed to the Rattle-Snake and other American Serpents. By Benjamin Smith Barton, M.D. and Professor of Natural History and Botany in the University of Pensylvania. Philadelphia, 1796. 70 pages 8vo.

† M. le Vaillant says, in his New Travels into the interior Parts of Africa, that the fascinating power of many serpents is generally believed by the Hottentots, as well as by many of the Negroes and Moors. B.

‡ Dr. Barton says, page 19, that he never found any traces of this assertion among the Indians of South America. I however remember to have read of a like idea in the account of many voyages to that quarter of the world. Thus Dobrishoffer, for instance, asserts in his History of the Abipons, that all the Spaniards and Indians in that part of Paraguay unanimously ascribe a like property to the snake called *ampalabas*. B.

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tain circumstances, emits from its body a stupefying vapour; and that it is this which produces the effect. Others are said to have remarked that this terrible animal, on such occasions, makes a noise with the rattle in its tail, a singularity which exclusively belongs to it, and that there is reason to suppose that the whole charm is to be ascribed to the terror produced by the sound of that organ. Against these three ways of accounting for this phenomenon Dr. Barton makes the following objections: In regard to the first, the common symptoms after the bite of the rattle-snake are very different from those which have been remarked in small animals supposed to have been fascinated. Besides, this pretended fascination can be destroyed, and the animal saved, if the snake be immediately killed near it; and in the last place, this so called fascinating power is ascribed to many serpents that are not poisonous, as for example the *coluber constrictor*.

He endeavours to weaken the second mode of explanation by remarking, that many observers have seen nothing of that mephitic evaporation of the rattle-snake; that small birds, when enclosed in a box with the animal, have remained lively and well; and that the rattle-snake often lies whole days under bushes and trees, while thrushes and fly-catchers nestle in them without any danger*.

As Dr. Barton's argument against the third manner of accounting for this property is particularly and solely directed against a passage in my Manual of Natural History, I shall first quote the passage itself, before I offer any remarks on his objections.

"That squirrels, small birds, &c. fall down spontaneously from trees into the mouth of the rattle-snake, lying below them, is an undisputed fact, and is the less surprising, as the like phenomena have been remarked in regard to other snakes, and also toads, hawks, and cats; all of which, in

* It is a pity that Dr. Barton did not compare with his observations Kalm's account in the Swedish Transactions for 1752, and the valuable essay of Michaëlis on this subject in the Göttingen Magazin for January [illegible].

certain

certain circumſtances, as appears, have the power of drawing towards them ſmall animals, merely by fixing their eyes ſtedfaſtly on them. In regard to the rattle-ſnake, this effect is produced by the rattle in its tail, the hiſſing noiſe of which makes ſquirrels, &c. whether through curioſity, miſtake, or terror, ſeem to approach the animal as it were ſpontaneouſly. At any rate, I know from the information of intelligent eye-witneſſes, that it is a common ſtratagem of the young ſavages in America to conceal themſelves in the buſhes, where they imitate the hiſſing noiſe of the rattle-ſnake, and by theſe means attract ſquirrels, which they are then enabled to catch."

Dr. Barton's objections to this paſſage are as follows: "1. This faſcinating power is by no means peculiar to the rattle-ſnake." This is literally what I ſaid myſelf, with the addition, that the effect is produced by the rattle. This lazy animal, when lying on the ground, might certainly employ that ſingular organ for enticing animals, as well as the ceraſtes employs its horns for the ſame purpoſe, at leaſt according to common report.

2. The author ſays he has been aſſured by ſome perſons that "the rattle-ſnake, during the time of its ſuppoſed faſcination, does not employ its rattle." It is very probable that the caſe here may be altered by circumſtances. Dr. Barton, however, was told the contrary by other perſons. A Mohigan Indian informed him that the rattle-ſnake faſcinates ſquirrels and birds by means of its rattle; and by its noiſe can bring down animals from trees. An interpreter, who enabled him to carry on a converſation with a Choktaw Indian, told him the ſame thing; and the experiments of M. Voſmaer are well known.

3. In regard to the ſtratagem of the ſavages, Dr. Barton knows nothing of it; and others, of whom he made enquiry, were equally ignorant on the ſubject. He is therefore inclined to believe that I have been impoſed on, or that this ſtory perhaps has taken its riſe from the following circumſtance:

cumstance:—The young Indians place a reed cross-wise in their mouth, and by a tremulous motion of the lips imitate the cry of young birds, by which means they entice the old ones, so that they can then easily shoot them. In this manner the butcher bird (*lanius excubitor*), concealed in the thickest bushes, imitates the cries of young birds, and thus often catches the old ones, who approach deceived by the similarity of the sound."[a]

As far as I know, Dr. Mead, about fifty years ago, when controverting the idea that providence had furnished the rattle-snake with its rattle to give warning to travellers, was the first who asserted that it serves the animal to terrify squirrels and small birds, which are then so stupefied by the sight of an enemy so terrible to them, that they at length drop down and become its prey, and that this is what the Indians call fascination. He himself observed, that when a hawk was perched on a tree in a garden, the small birds in the neighbourhood were so stupefied that they fluttered about within a small circle, but were not in a condition to escape from the claws of the ravenous animal. This accords perfectly with what Dr. Barton says himself, in general, that nature has taught different animals what kind of animals their enemies are, and that if small animals are attracted by the rattle-snake it may be owing to fear. In regard to the pretended effect of the noise occasioned by the rattle, nothing can agree better than what Dr. Barton says himself in regard to the stratagem of the young Indians with a reed in their mouth.

I shall here observe, that I obtained my information from Major Gardner, who, with his family, resided many years in East Florida. He is a very intelligent naturalist, an accurate observer, and certainly would be very far from imposing upon me.

Dr. Barton, after endeavouring by the above objections to refute the before-mentioned three methods of accounting for the fascinating power of the rattle-snake, gives himself a fourth

fourth method; the ſum of which is, that thoſe birds which under certain circumſtances, as has been aſſerted, flutter into the mouth of the animal, are in general thoſe which neſtle on the ground, in buſhes, or on low trees, and which having eggs or young in their neſts, expoſe their lives through love for their brood on the approach of this dangerous enemy.

With this method of explaining the phenomenon I have been acquainted ſince 1785, from the before-mentioned Eſſay of Michaëlis, who, among many ways of ſolving the problem, gives the following:

"Others believe that it is owing merely to the care of the old ones for their young, which throw themſelves between the latter and their enemies, and by theſe means become a prey to them. One of my friends, Mr. David Colden, at Fluſhing, an amateur of natural hiſtory, and ſon of Governor Colden, whoſe ſervice to ſcience is ſo well known, aſſured me that he had ſeveral times ſeen birds faſcinated by ſnakes, but always found the neſt of the bird either with eggs or young ones in the neighbourhood, which made the ſpectators give up the idea of faſcination. But, Mr. Michaëlis adds, I know ſome inſtances where no neſt could be in the neighbourhood, and where, though the ſnake was at firſt at a great diſtance from the bird, it nevertheleſs fell towards it."

I would however add another mode of explanation from Dr. Barton's work itſelf, where he aſſures us that the reſult of his enquiries, whether the rattle-ſnake creeps up trees or not, induces him to believe the latter to be the caſe. He had an opportunity of ſeeing many of them, but he always obſerved them on the ground. They never move, like the moſt part of the other ſerpents, in a ſpiral manner, but ſtraight on; and this is the reaſon why they cannot aſcend trees. The rattle-ſnake is alſo one of the laziest of all the ſerpent tribe; under theſe circumſtances it ſeems very natural that ſuch a lazy animal ſhould be endowed with the faſcinating power of bringing down from trees ſmall animals, which otherwiſe would have nothing to fear from a ſnake that cannot creep upwards.

VI. *Account of a new Method to cure and prevent the Plague, as practiſed at Smyrna. Publiſhed by Count* VON BERCHTOLD. *From the* Verkundiger, *Nov.* 8, 1798.

COUNT LEOPOLD VON BERCHTOLD, well known by his zeal for promoting every thing that can tend to public utility, when at Hamburgh, in the month of July laſt, preſented, among other works, to the ſociety for improving the arts, a ſmall treatiſe, written by himſelf, on the cure and prevention of the plague*. The ſociety, in compliance with the benevolent wiſh of the author, have publiſhed the following extract from it, which on account of its general importance to mankind, and particularly to Britain, as a commercial nation, we hope our readers will thank us for laying before them.

In the preface, Count von Berchtold pays a handſome compliment to the humanity of Mr. Baldwin, the Engliſh conſul, who during a long reſidence in the Turkiſh empire made very accurate obſervations on the nature of the plague, and endeavoured to diſcover ſome efficacious means of guarding againſt that dreadful and deſtructive ſcourge. After long labour he at length found that this effect may be produced by olive oil. Perſons infected by the plague, and given over by the phyſicians, were perfectly cured by

* The title is as follows: Deſcription of a new Method to cure and prevent the Plague, which was employed with the beſt Succeſs in the Hoſpital of St. Anthony at Smyrna. Collected in that City, and publiſhed by Leopold von Berchtold, Knight of the Military Order of St. Stephen in Tuſcany. To be diſtributed Gratis, for the Benefit of thoſe Nations which trade in the Levant. Vienna, 1797. 28 pages octavo.

 rubbing

rubbing their bodies over with warm oil; and others not yet infected were preſerved from it by the ſame means. Experiments were made, by Mr. Baldwin's deſire, in the hoſpital of St. Anthony at Smyrna; and P. Luigi di Pavia*, chaplain to the hoſpital, who for twenty-ſeven years has been of ſo much ſervice during periods when this diſeaſe prevailed, aſſerts that of all the remedies he ever employed, olive oil has been the moſt effectual. The following information, in regard to the manner of employing this remedy and preventive, was communicated to Count von Berchtold by the above P. Luigi.

This excellent cure for the plague conſiſts in rubbing olive oil, with the ſtrongeſt friction, into the whole body of the infected perſon. When the body is thus rubbed, the pores being opened imbibe the oil, and a profuſe perſpiration takes place, by which the poiſonous infection is again thrown out. This operation muſt be performed the firſt day of the infection; and if only a weak perſpiration enſues, it muſt be repeated till it is obſerved that every particle of infection is removed, and that the whole body of the patient is covered with a profuſe ſweat. Neither the patient's ſhirt nor bed-clothes muſt be changed till the perſpiration has

* Mr. Howard, in his work on Lazarettos, page 32, ſays: " Fra. Luigi de Pavia, prior of the hoſpital of San Antonio of Smyrna, is a native of Padua, of the order of Recolets. He built and eſtabliſhed an hoſpital about twenty-ſeven years ſince, and has applied the whole of the penſion he receives from his family to its benevolent purpoſes. Patients of all ranks are admitted without a fee; and what is contributed by thoſe of the better ſort is added to the common ſtock. *He does not pretend to any ſkill in medicine, but tries every plauſible experiment with unremitted attention,* and frequently performs the moſt menial offices himſelf. Having been infected himſelf with the plague, he made a vow to attend one perſon at leaſt, if he recovered. His ſucceſs has induced him to dedicate the remainder of his life to that ſervice. He has lately adopted the *oiled ſhirt with friction, and found it a remedy of more frequent avail than many others.* He computes, with the ſtricteſt veracity, that of his patients nearly two thirds have eſcaped death." Edit.

entirely ceased. The operation must be performed in a very close apartment; and at every season of the year there must be kept in it a fire-pan, over which sugar and juniper must be thrown, from time to time, that the vapour which thence arises may promote the perspiration. The whole body of the patient, the eyes alone excepted, must in this manner be anointed, or rather rubbed over with the greatest care.

In the space of a year I remarked that this operation, if not employed too late, was attended with the most wonderful effect. If it be delayed till the nervous system of the patient is attacked by the disease and the blood corrupted, after which a decomposition of it follows, the remedy is of no avail, and the patient must fall a victim. The operation, therefore, must be performed as soon as the smallest symptom of infection is remarked. In cases where perspiration was slow, I have endeavoured to promote it by making the patient drink tea of elder flowers without sugar, from which I have seen the happiest effects.

To the above rules Count von Berchtold adds the following remarks by way of illustration: 1. The operation of rubbing in the oil must be performed by means of a sponge, and so speedily as not to last more than about three minutes. 2. The interval between the first and the second rubbing, if a second be necessary, must be determined by circumstances, as the second must not be performed till the first perspiration is over, and this will depend on the constitution of the patient. If any sweat remains upon the skin, it must be wiped off with a warm cloth before the second rubbing takes place. This strong friction with oil may be continued, for several days successively, until a favourable change is remarked in the disease; after which the rubbing may be performed in a more gentle manner. The quantity of oil requisite each time cannot be determined with accuracy; but, in general, a pound may be sufficient. The purest and freshest oil is the best for this operation: it must not be hot, but only lukewarm. The breaſt and privities muſt be rubbed ſoftly. In a cold climate ſuch as ours, thoſe parts only into which the oil is rubbed muſt be expoſed naked. The other parts muſt be covered with warm clothing. In this manner each part of the body muſt be rubbed with oil in ſucceſſion, as quickly as poſſible, and be then inſtantly covered. If the patient has boils or buboes, they muſt be rubbed over gently with the oil till they can be brought to ſuppurate by means of emollient plaſters. The perſons who attend the patients to rub in the oil muſt take the precaution to rub themſelves over in the like manner, before they engage in the operation. They muſt, if poſſible, avoid the breath of the patient, and not be under any apprehenſions of catching the infection.

P. Luigi then ſays: In order to prevent the patients from loſing their ſtrength, I preſcribed for them, during four or five days, ſoup made of vermicelli boiled in vinegar without ſalt. I gave them ſix or ſeven times a day a ſmall ſpoonful of preſerved ſour cherries; preſerved not with honey, but with ſugar, as the former might have occaſioned a diarrhœa. When convinced that the patients were getting better, I uſually gave them the fifth morning a cup of good Mocha coffee, with a piece of toaſted biſcuit (*biſcotto*) prepared with ſugar, and I doubled the latter according to the ſtrength and improvement of my patients.

At dinner and ſupper I allowed them for 15 or 20 days nothing but rice or vermicelli boiled in water. After that period, I increaſed the quantity of bread in proportion to their appetite. In ſummer they had ſoup made of ſmall pompions, and of herbs in winter, without any other addition than a little oil of almonds. I gave them alſo, according to their condition, either ſome oranges or a very ripe pear, boiled if in winter, and as much toaſted bread as might enable them to digeſt their food eaſily and leave them ſome appetite remaining. After the thirtieth or thirty-fifth day I allowed them morning and evening ſoup made from a fowl or neck of lamb; but I did not allow them fleſh till after the fortieth day, left it might occasion indigestion, which is very danger-ous and often mortal in this disorder, and give rise to a new breaking-out of pestilential boils. After the fortieth day I allowed them to eat boiled as well as roasted veal, and to drink moderately of wine; but I recommended to them to abstain from fish, salted provisions, pork, sour fruits, and, in general, every thing that either by quantity or quality might occasion indigestion.

This regimen has been the result of observations made in the course of twenty-seven years, during which I have attended patients attacked by the plague. It has been approved by the ablest physicians; and long experience has shewn that it is the best calculated to guard against the dangerous consequences of this horrid disease.

According to the accounts of Mr. Baldwin, among the thousands who died of the plague in Upper and Lower Egypt, there was not one person who had been employed in carrying oil; from which I concluded that oil must also be a preservative against it. I therefore put in practice this idea in regard to all those persons who were infected without knowing it, and I always found it infallible in its effects, as will appear from the following striking proofs:—In the year 1793, twenty-one Venetian sailors resided, day and night, for five days, with three persons ill of the plague, who afterwards died, and preserved themselves from infection by often rubbing with oil in the manner above directed. The same year three Armenian families, one consisting of thirteen, the second of eleven, and the third of nine persons, remained with some of their relations ill of the plague; and though they lay in the same apartment with them, according to their custom, and even in the same bed, and held the sick in their arms, none of them were attacked by the disease, because, in consequence of my advice, they daily rubbed their bodies over with oil. In the year 1794, a healthy poor woman attended thirteen persons ill of the plague; remained with them day and night, and yet was preserved from this

horrid

horrid difeafe by anointing herfelf with oil. The fame year two perfons attacked by the plague remained feveral days in the fame houfe with the numerous family of M. Natale Pezer, a Ragufan; but the family employed oil, as above mentioned, and were perfectly free from infection.

In a word, this wonderful prefervative has fo much reputation at Smyrna, that almoft all the inhabitants, though perfectly found, when the unfortunate infection makes its appearance, immediately fecure themfelves againft it by repeated rubbing with oil.

When this operation is ufed as a preventive, it is not neceffary that it fhould be performed in the fame manner as on thofe infected. As it is not done for the purpofe of promoting perfpiration, but merely to prevent the infection from penetrating through the pores, it is not requifite that it fhould be performed with the fame fpeed as when for curing the diforder; nor is it neceffary to abftain from flefh and to ufe foups; but it will be proper to ufe only fowls or veal for ten or twelve days boiled or roafted, without any addition or feafoning *(condimento)*. In the laft place, it will be neceffary to guard againft fat and indigeftible food, and fuch liquors as might put in motion or inflame the mafs of the blood.

Careful and repeated rubbing of the whole body with oil prevents the breaking out of new boils, which often take place after the oil has been firft ufed. The oil muft be applied as foon as poffible after the infection has been communicated: if omitted for four or five days, it will be of no effect. Diarrhœa in this difeafe is a fymptom of death, and difficult to be cured; but the editor adds, in a note, that Father Luigi, by the ufe of oil, was enabled to recover four perfons who had been already attacked by it. The abundant perfpiration produced by the oil not only prevents new buboes from breaking out, but in a few days brings thofe which have appeared to fuppuration, or makes them vanifh entirely.

In the courſe of five years, during which friction with oil was employed in the hoſpital at Smyrna, of 250 perſons attacked by the plague the greater part were cured; and this would have been the caſe with the reſt had they not neglected the operation, or had it not been employed too late after their nervous ſyſtem had been weakened by the diſeaſe ſo as to render them incurable. Immenſe numbers of people have been preſerved from the effects of this malady by the above means; and of all thoſe who have anointed themſelves with oil and rubbed it well into their bodies, not one has been attacked by the plague, even though they approached perſons already infected, provided they abſtained from heavy and indigeſtible food.

The above account of P. Luigi is accompanied with ſeveral atteſtations of the efficacy of oil, both as a cure and a preventive, ſigned by B. Giraud the Imperial conſul, and F. Merry the Engliſh conſul, at Smyrna.

We are informed by Count von Berchtold, that this method of cure is at preſent employed with the beſt effects in Egypt, Conſtantinople, and Wallachia; and that great care has been taken to make it generally known both in the Eaſt and in thoſe countries that carry on trade in the Levant.

This important diſcovery, which does ſo much credit to our countryman Mr. Baldwin, deſerves the ſerious conſideration of all medical men; for, if olive oil has been found efficacious in curing or preſerving againſt one ſpecies of infection, it is not abſurd to ſuppoſe that the ſame, or other kinds of oil, might be productive of much benefit in other malignant infectious diſeaſes. We hope ſoon to hear of ſome trial being made with it in this country. Would it be of any ſervice in the yellow fever, ſo prevalent in the weſtern world?

VII. *Exa-*

VII. *Examination of the Experiments and new Obſervations of* G. PEARSON, *M.D. on Human Urinary Concretions* *; *and a Compariſon of the Reſults obtained by that Chemiſt with thoſe of* SCHEELE, BERGMAN, *and ſome of the French Chemiſts. By C.* FOURCROY. *From* Annales de Chimie, *Vol. XXVII.*

DR. George Pearſon, an Engliſh chemiſt, well known by his very uſeful labours, and particularly his ingenious experiments on the decompoſition of the carbonic acid, in his *Experiments and Obſervations tending to ſhew the Compoſition and Properties of Urinary Concretions,* inſerted in the Philoſophical Tranſactions for 1798, endeavours to prove that the calculi of the human bladder are compoſed of a particular matter hitherto not well known to chemiſts; which Scheele, according to his opinion, neglected to ſtudy, and which he calls the *uric* oxyd. As this concluſion tends to overturn completely the diſcovery of the illuſtrious Swede, confirmed by Bergman, reſpecting the acid of the human urinary calculus, and the reſult of very numerous experiments which I ſince made on that animal concretion, (a reſult which ſerved to confirm in many points the firſt data of Scheele, according to which the expreſſion of lithic acid had been adopted in the new nomenclature,) I thought it my duty to examine with particular care the long diſſertation of Dr. Pearſon. I was beſides induced to do ſo by the lively intereſt which it is pretty generally known I take in every thing that regards the analyſis of animal ſubſtances; and the more ſo at preſent, on account of the reſearches reſpecting urine on which I and Cit. Vauquelin have been for ſeveral years employed. Inſtead of finding ourſelves anticipated on this ſubject by this able Engliſh chemiſt, I was not a little aſtoniſhed to diſcover in his diſſertation a great number of aſſer-

* For Dr. Pearſon's paper on this ſubject, ſee Philoſoph. Mag. vol. ii. p. 38 and 130.

 tions

tions and facts which ſhew, that the author ſeems not to have accurately comprehended the labours of Scheele, and that he ſeems to have overlooked the reſearches which I publiſhed on the ſame ſubject, though he quotes me in regard to ſome facts, but only as one of thoſe who may be conſidered as almoſt a ſtranger to the object which he had in view. It alſo appears to me, that the experiments he made, inſtead of contradicting the facts obſerved by Scheele and myſelf, and the conſequences I have thence deduced in regard to the nature of urinary concretions, are rather calculated to confirm them.

What I mean to eſtabliſh in this memoir requires, 1ſt, That I ſhould give an exact account of Dr. Pearſon's experiments: 2d, That I compare with his reſults the facts obſerved by Scheele and Bergman; and that I add to them thoſe which I obſerved myſelf: and, 3d, That I draw from this compariſon thoſe inductions which form the principal part of this memoir.

The firſt pages of this diſſertation contain a very conciſe account of the labours of Scheele, Bergman, Fourcroy, Link, and Black. But I muſt here obſerve, that this ſhort notice is far from being ſufficient to give an accurate idea of theſe labours; that it is very ſingular to hear Dr. Pearſon ſay, that the particular matter of which he intends to ſpeak, and which he ſays he obtained by diſſolving concretions in ley of fixed cauſtic alkali and precipitating it by means of acids, was conſidered as of little importance by Scheele, who, he ſays, of courſe never made any reſearches in regard to its properties; whereas, if we read with attention the maſterly diſſertation of the Swediſh chemiſt, we ſhall find that it was this matter which he conſidered as his real acid of calculus, and which we have ſince called the *lithic acid*. I myſelf have ſeveral times announced in my works, particularly under the article of calculus in the *Dictionnaire de Chimie Encyclopedique*, inſerted in the *Annales de Chimie*, 1793, tom. xvi. that it was thus that I prepared the lithic

acid

acid for my lectures. Nor is it accurate to say, that the acid sublimate obtained by Scheele by treating the urinary calculi by fire, was taken for the same as the precipitate of their solution in fixed alkali by an acid, since the French chemists, in announcing that a portion of the lithic acid was sublimated without decomposition, proposed the process of sublimation to obtain the lithic acid; and since I have particularly described the decomposition of the greater part of this acid by fire, when I announced its property of being convertible into the Prussic acid. But I shall now proceed to detail the experiments, as I shall have occasion several times to shew that Dr. Pearson has been singularly misled in regard to our lithic acid.

[Cit. Fourcroy then gives a pretty full account of Dr. Pearson's experiments, which it would be useless to repeat here, as we have already in the last two numbers of the present work laid the paper at full length before our readers. On Dr. Pearson's expression (Phil. Mag. vol. ii. p. 130), "I "shall next relate some experiments made in order to ob-"tain the acid sublimate of Scheele, or lithic acid of the "new system of chemistry," the French chemist makes the following remark: "I must observe that these words prove that Dr. Pearson did not understand very clearly the results of Scheele and of the French chemists; for neither the one nor the other have ever considered as real lithic acid the product sublimated by fire from the urinary calculus, but only the matter of the whole calculus precipitated in crystals from the boiling water with which it has been treated, or from its solution in fixed caustic alkali by an acid. I must remark here also, that Scheele in his dissertation has accurately distinguished this sublimated portion from the real acid of the urinary calculus not treated by fire; that he has compared it to the volatile acid salt of amber; and that Cit. Vauquelin, in an article which he furnished for Deschamp's *Traité de la Lithotomie*, vol. i. p. 132, &c. took great care to point out that the sublimated produce of the calculus of the bladder was nothing but the matter of the calculus altered and changed in its nature."—Citizen Fourcroy concludes his abridgement of Dr. Pearſon's paper as follows: "I thought it my duty to give an account of all his [Dr. Pearſon's] experiments and reſults, in order that it might be more eaſy to compare what he has done with the reſearches of Scheele and thoſe made by myſelf. By giving a ſimilar abridgement of the latter alſo, it may be then ſeen whether Dr. Pearſon has made uſeful additions to the diſcoveries which preceded his labour, and whether the concluſions which he thinks himſelf authoriſed to deduce from his experiments can be found in them." Cit. Fourcroy then proceeds as follows:]

A ſhort Account of the Reſearches of Scheele and Bergman, and of thoſe made by myſelf.

When the illuſtrious Scheele read in 1776, to the Academy of Stockholm, his examination of the bezoar, or ſtone of the human bladder, no one then had an accurate idea of the nature of this concretion, though Margraf had already obſerved, that it was not formed of an abſorbing earth, as was pretty generally believed before him, and as has been repeated ſo often ſince in many works on medicine. Scheele obſerves in the beginning of his diſſertation, that he examined ſeveral calculi, ſmooth, rough, or angular; that he found them poſſeſs the ſame nature and properties: it is therefore the hiſtory of the genus that he meant to give. His memoir is divided into ten ſections. To aſcertain properly the value of his labour, I muſt here make the reader follow him through theſe ſections.

I. The ſulphuric acid diluted produces no effect on the calculus; but concentrated by diſtillation it diſſolves it: the ſolution diſtilled to dryneſs leaves a black coal, giving off ſulphureous acid fumes.

II. The muriatic acid, diluted or concentrated, has no effect even by ebullition on the urinary calculus.

III. Weak

III. Weak nitric acid attacks it cold: with the aſſiſtance of heat there is produced an effervefcence and red vapour; the calculus is entirely diſſolved, and carbonic acid is diſengaged. This ſolution is acid, even when ſaturated with the calculus: it gives a beautiful red colour to the ſkin in half an hour; when evaporated it becomes of a blood red; a drop of acid then added deſtroys the colour; it does not precipitate the muriat of barytes nor metallic ſolutions, even with the addition of an alkali; the latter makes it turn yellow; a ſuperabundance of alkali gives it, by digeſtion, a roſe colour, as well as the property of precipitating ſulphat of iron black, ſulphat of copper green, nitrat of ſilver grey, the ſuperoxygenated nitrat of mercury and ſolutions of zinc and lead white. The ſame nitric ſolution of the calculus of the bladder gives, with lime water, a white precipitate, which diſſolves without effervefcence in the nitric and muriatic acids without deſtroying their acidity. The oxalic acid added to the nitric ſolution gives no precipitation.

IV. Potaſh united to the carbonic acid does not diſſolve the urinary calculus, either hot or cold; but a perfectly cauſtic ley of the ſame alkali, without any trace of the carbonic acid, diſſolves it even cold. This ſolution is yellow, of a ſweetiſh taſte; it is precipitated by all the acids, even the carbonic; it does not render lime water turbid; it decompoſes and precipitates metallic ſolutions, thoſe of iron brown, of copper grey, of ſilver black, of zinc, mercury and lead white: it exhales an odour of ammonia.

V. Lime water diſſolves the calculus by digeſtion; 200 parts almoſt are neceſſary to take up one; it then loſes its ſharp taſte; this ſolution is precipitated in part by acids.

VI. Pure water diſſolves entirely the ſtone of the human bladder; but it is neceſſary to boil, for ſome time, 360 parts with one part of the calculus reduced to powder to effect a ſolution. This ſolution, being then complete, reddens a tincture of turnſole; does not render lime water turbid; and

and on cooling deposits almost every thing it contains in small crystals.

VII. Seventy-two parts (grains) of this calculus, distilled in a small glass retort over an open fire urged so as to bring the vessel to a red heat, produced water of ammonia like hartshorn, and a brown sublimate without oil: there remained twelve parts or $\frac{1}{6}$ of a black charry substance, which preserved its colour on red hot iron in the open air. The brown sublimate, weighing 28 parts, grew white by a second sublimation; it was destitute of smell, even when moistened by an alkali; its taste was acid; it dissolved in water by ebullition; alcohol dissolved it also, but in less quantity than water: it did not precipitate lime water, and resembled the succinic acid.

From the facts in these seven sections, Scheele concludes that the urinary calculus does not contain either sulphuric acid or lime; but that it is composed of a concrete acid, oily, volatile, mixed with a little gelatinous matter, which acquires new properties and changes its nature by the nitric acid.

VIII. He says he found a little of this acid in all urine, even in that of children. This liquor evaporated to $\frac{1}{112}$ of its weight (14 pounds reduced to 2 ounces) deposits a subtle powder similar to the calculus, which adheres to the vessel, and which the caustic alkali dissolves very easily. The deposit from the urine of patients labouring under fevers exhibited the same nature; it is formed in close vessels as well as in those that are open; it is re-dissolved by means of heat, and its precipitation is owing only to the cooling of the urine.

IX. All urines thus contain phosphat of lime, kept in solution by an excess of the phosphoric acid; which is the reason that it reddens blue paper, and deposits a white powder by means of ammonia. Urine gives of it $\frac{1}{576}$ of its weight. This precipitate dissolved in the nitric acid is rendered

rendered turbid by the addition of the ſulphuric acid, which forms with it a ſulphat of lime; the ſupernatant liquor, when evaporated, leaves the phoſphoric acid after ſeparating the nitric acid by evaporation. The urine of diſeaſed perſons is more acid, and contains more phoſphat of lime, than that of healthy perſons.

X. It reſults from all theſe facts, ſays Scheele in concluding his diſſertation, that urine, independently of the ſubſtances already known, viz. the muriats of potaſh, ſoda, and ammonia, the phoſphat of ſoda and ammonia, and an oily extractive matter, contains a concrete acid, hitherto unknown, (which forms the urinary calculus,) and phoſphat of lime.

I have mentioned with accuracy, and without omitting a ſingle experiment, the labour of Scheele, becauſe it appeared to me neceſſary to do ſo, in order to eſtabliſh an eaſy and preciſe compariſon between his experiments and thoſe of Dr. Pearſon.

The diſcovery of Scheele, communicated to the Academy of Stockholm, was confirmed by Bergman, who gave, under the title of an addition, a memoir containing his own experiments on the ſtone of the human bladder, with which he was occupied at the ſame time as his pupil and friend; and it may be readily perceived what muſt be the weight of the aſſent of that celebrated man, who firſt introduced into the deſcription of chemical phenomena, and the reaſoning on them, the purity, preciſion, and method of the geometricians. In announcing that his experiments conducted him to the ſame concluſion, viz. that the urinary concretion was compoſed chiefly of a particular acid; he ſays he found ſome differences, which, though he aſcribes them to thoſe of ſubſtances which they had both examined, were, however, found in all thoſe which he treated. It is of importance that I ſhould relate here the differences obſerved by Bergman, becauſe they may ſerve to explain thoſe which were obſerved by Dr. Pearſon himſelf, and which led him to draw

draw a conclusion contrary to that of the illustrious Swedish chemists whom he combats in his memoir.

1. Bergman never succeeded so far as to dissolve completely urinary concretions in distilled water, or in the nitric acid; but at the same time the greater part was dissolved in the latter, especially when precautions were taken to employ an excess of the solvent, fragments of calculus instead of powder, a vessel sufficiently small to permit the insoluble matter to be collected; and by keeping the matters at a heat near that of boiling water, there was separated a white spongy matter, on which water, alcohol, acids, and ammonia had no action; dividing itself into very minute particles by ebullition, though still insoluble; giving by fire a coal difficult to be incinerated, and of which the ashes were insoluble in the nitric acid. He never had enough of this substance to enable him to become better acquainted with its nature.

2. Though the nitric solution of the calculus is not precipitated by the oxalic acid, Bergman thinks that lime may be found in it in union with some matter that prevents it from being precipitated; and he finds a proof of this in the ashes of burnt urinary calculus, which exhibited the same phenomena as lime in his experiments. The nitric solution of calculus evaporated to dryness, and burnt or calcined to whiteness, gave him also traces of lime. The concentrated sulphuric acid thrown into this solution when evaporated, exhibited likewise small crystals of the sulphat of lime. This earth rarely exceeds $\frac{1}{200}$ in the urinary calculus.

3. The concentrated sulphuric acid dissolves the calculus with effervescence by the means of heat; it becomes of a blackish brown colour: a little water added to this solution makes it immediately coagulate; a great deal of this liquid re-dissolves the whole coagulum, and forms a solution of a yellowish brown colour. The muriatic acid has no action on the urinary calculus, and deprives it of no part of its lime.

4. Berg-

4. Bergman frequently mentions the red colour assumed by the nitric solution of the urinary calculus when spontaneously evaporated in the air, or by the action of fire; even when it does not contain an excess of free nitric acid: he observes that this colour disappears by the addition of acids and alkalies; that it becomes black by the action of a strong fire; that the calculus thus dissolved and evaporated is afterwards soluble in all acids; that by employing the nitric acid too much concentrated, the calculus is wholly reduced into froth; that the sudden swelling-up of the solution when rapidly heated is considerable, and the foam of a bright red; that alkalies do not separate the calculus from the nitric acid, but unite with it as they do when two acids are presented to them; that the red mass obtained by evaporation of the nitric solution is very different from the concrete acid of the calculus in its colour, its deliquescence, the rose-coloured tint which the smallest quantity of it communicates to water, its solubility, and its loss of colour by the muriatic acid, the spots which it leaves on the skin, on bones, glass, paper, especially by the aid of time and heat. He ascribes these remarkable effects to the alteration produced in the native acid of the urinary calculus by the nitric acid, rather than to a precipitation with the latter.

5. Bergman, in mentioning that he made many other experiments on the stone of the bladder, takes care to point out that they prove nothing more or any way different from what Scheele has said in his excellent memoir. All researches, says he at the end of his addition, for the purpose of discovering a remedy for this disease, ought to be founded on a perfect knowledge of the properties of the calculus. He observes that alkalies are the only truly active remedies, the efficacy of which has been acknowledged by medical experience, in concert with chemical researches. He concludes his note by announcing that he hoped to be able to determine more accurately whether all calculi of the bladder were really of the same nature. But during the eight years which

which were added to his life after this epoch 1776 (he died in 1784) his occupations and deranged ſtate of health prevented him from completing this labour, as he wrote nothing more than what I have here made known.

[To be concluded in the next Number.]

VIII. *Obſervations on the Garden Spider, and the Method it employs to conſtruct its Web. By an anonymous Author. From the* Journal de Phyſique, *Vendemiaire, An. VII.*

THOUGH the natural hiſtory of inſects be not the particular object of my ſtudies, I never neglect any facts, relating to that ſcience, with which accident may make me acquainted. In the month of Germinal laſt I had before my windows ſome ſhrubs in pots; and one day, when it was very warm, I removed them from the ſun, and placed them on the floor of my chamber. Caſting my eyes on them about an hour after, I was not a little ſurpriſed to ſee a pretty, ſmall, vertical ſpider's web, which extended from one ſhrub to another. It was not above two inches in diameter; but the concentric circles and radii were exceedingly numerous. Nothing could be more elegant; and the centre of it was quietly occupied by a ſmall ſpider, not larger than the head of a pin. I was certain that this web had not exiſted an hour before, as I had removed my pots one after the other; and I could not conceive how ſo much work, that muſt have required ſo many journeys, could have been completed ſo ſoon; but what increaſed my aſtoniſhment not a little was, that each pot was placed in a ſmall veſſel filled with water. Suppoſing then that the ſpider had gone from the one ſhrub to the other to fix its threads, it muſt have been obliged to croſs the water, which appeared to me improbable, as the animal was not of the aquatic kind.

I then recollected a ſimilar fact, which I had obſerved the year

year before in company with ſome of my friends, and which had appeared to us equally wonderful. We were walking in the gardens of a country-ſeat, much neglected for ſeveral years, where we ſaw an alley of horſe-beeches, the branches of which left a paſſage of ſcarcely five or ſix feet, barred up, as it were, by a multitude of ſpiders' webs in a vertical poſition. As we began to enquire how the ſpiders had been able to convey their threads from one ſide of the alley to the other through ſo many leaves and branches, one of the company ſaid that the threads, in all probability, had been floated to the other ſide by the wind, and that they had been caught and retained by the oppoſite branches. The problem ſeemed thus reſolved, and the converſation turned upon ſome other ſubject. The fact, however, which had taken place in my chamber, where the air was in a ſtate of perfect tranquillity, clearly convinced me that the threads of theſe inſects had not been tranſported by the wind; and that they muſt have ſome direct method of conveying them from one place to another.

I was then induced to ſuppoſe that theſe ſpiders were themſelves acquainted with ſome method of projecting their threads, from the point where they are ſtationed, to another at which they wiſh to arrive. In conſequence of this idea, I reſolved to make ſome experiments. I removed, by means of a feather, the ſmall ſpider from the middle of its web; and to be ſure that no floating thread adhered to it, I moved another feather ſeveral times around that on which the ſpider was placed. I then gave it a gentle ſhake, which made the inſect deſcend ſeven or eight inches, extending its legs and ſpinning. It then remained ſtationary in a horizontal ſituation, having all its legs folded up on its belly, where it had applied its thread; ſo that it ſeemed to be ſuſpended by the middle of its body. I ſaw it from time to time make half a turn, very ſpeedily, ſometimes to the right and ſometimes to the left, and this movement was perfectly ſpontaneous; for there was no agitation in the air or the feather, which I had fixed to the back of a chair. After being ſuſpended in this manner half an hour, the ſmall ſpider made a ſudden ſpring towards my breaſt, raiſing itſelf rapidly by an oblique line, which made an angle of 40° or 50° with the perpendicular. I repeated this experiment ſeveral times; and I always obſerved that the ſpider, after having remained a few moments ſuſpended, conſtantly roſe in an oblique direction, in order to reach ſome neighbouring object.

My attention being diverted by ſomething elſe, I did not then carry my obſervations any farther; but in the month of Thermidor laſt, having found under my ſhrubs one of theſe ſpiders, about the ſize of a grain of hemp-ſeed, I reſumed my former experiments; and, being furniſhed with a magnifying glaſs, I attentively examined every thing that paſſed at the moment when the ſpider was in ſuſpenſion. It was not long before I ſaw, very diſtinctly, a pretty large thread iſſue in a jet from its anus, and riſe diagonally, making with the thread of ſuſpenſion an angle of about 45°. This thread was lengthened about ſeven or eight inches, at leaſt, per ſecond. When the thread reached a neighbouring body it remained there attached; and the inſect then making half a turn, darted out another on the oppoſite ſide, and proceeded thus alternately five or ſix times. The ſpider then mounted with rapidity, and traverſed theſe different threads, which became ſtretched horizontally, by I know not what operation, though at firſt they would have formed an angle of 90°, the ſummit of which was occupied by the ſuſpended animal. Soon after I ſaw a multitude of other threads eſtabliſhed between theſe principal ones; and the work was carried on with ſo much rapidity, that it was impoſſible for me to follow it minutely. The net work ſeemed as if formed by magic; but no doubt remained to me reſpecting the principal fact, which is the emiſſion of the large tranſverſal threads, an operation not performed by chance, but deſign, and which might be compared perhaps to the extenſion of the long tentacula of certain marine animals.

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As the threads, when they iſſue from the body of the animal, aſcend always obliquely, it appears to me that this is produced by the effect of a double impulſe. On the one part the inſect forces them out horizontally, and on the other their own ſpecific lightneſs makes them mount vertically, from which there reſults an oblique direction. This ſpecific lightneſs is owing, in my opinion, to a kind of veſicle, ſhaped like a very elongated Prince Rupert's drop, which is at the end of the thread at the moment of its emiſſion. This veſicle, the ſubſtance of which ſeems to be exceedingly thin, is perhaps filled with ſome fluid, light, and at the ſame time viſcous, which poſſeſſes the double property of making the thread aſcend, and of cementing it to the bodies which it touches.

In a word, I have no doubt that the garden ſpider directs at pleaſure, and towards a determined point, thoſe threads which it throws out; for I remarked, in the alley abovementioned, that all the webs were vertical and at right angles to it, which could not be conſidered as the effect of chance. I hope, therefore, that entomologiſts will purſue theſe obſervations, in order to diſcover, if poſſible, by what ſenſe the ſpider judges either of the diſtance or the poſition of the bodies to which it directs its threads. I obſerved that the ſituation in which it was when it emitted them did not allow it to ſee the place to which they were directed. Beſides, I have ſome reaſon to doubt that the eyes of ſpiders are actually the organs of viſion. I have often preſented to theſe inſects different bodies, by which they were in no manner frightened, though exceedingly near to them, and they muſt certainly have ſeen them, had they been endowed with the faculty of ſight. I have even cut off ſome of their claws without their perceiving the ſciſſars; and yet it is well known that the miſtruſt of ſpiders is ſo great, that, as ſoon as they have the leaſt perception of a ſtrange object, they betake themſelves to flight. On the other hand, if their web be agitated in the ſlighteſt manner, as it would be by a fly, they are ſeen to run out that moment, and never retire back until they have aſſured themſelves, by feeling, that they have been deceived. An animal endowed with ſight would not commit ſuch errors. Beſides, the curious hiſtory of their amours; the different manœuvres they practiſe before they touch each other; their fear and miſtruſt when they firſt approach, and their precipitate flight, all announce that they are very uncertain in regard to the object preſented to them: it is only by means of feeling that they are able to diſcover that they have not to do with an enemy.

My doubt on this head is not confined merely to ſpiders, but extends to all white-blooded animals, the cruſtaceous excepted. It is probable that the antennæ and other tentacula perform, in inſects and worms, the office of the organs of ſight. That multitude of eyes aſſigned to flies, butterflies, &c. in my opinion, is by no means agreeable to the progreſs of nature, which never forms any thing ſuperfluous. But what could be more uſeleſs than that profuſion of organs of the ſame ſenſe, eſpecially in beings which, by the ſhortneſs of their life, are the leaſt expoſed to the loſs of theſe organs; while the largeſt animals, deſtined to exiſt for a century, have received only a double organ of ſight, which is ſo neceſſary to them? This would be an abſurdity which we cannot ſuppoſe to exiſt.

I ſhall here add, in regard to the garden ſpider, that as Nature is infinitely wiſe, ſhe could not intruſt to chance their moſt eſſential means of exiſtence. Had ſhe made the fabrication of their web to depend on a breath of wind, that may not take place, ſhe would have expoſed them to the danger of periſhing. It was neceſſary, therefore, that ſhe ſhould put under their diſpoſition direct means; and this ſeems to be actually the caſe. But we muſt generaliſe this conſequence, and conclude, that when any mean is indiſpenſibly neceſſary for the preſervation of a ſpecies of living beings, Nature always places this mean in their own power. She has rendered it precarious at no time; and it never depends

upon

upon any fortuitous circumstances. As I have since learned from two well-informed naturalists, that it was commonly believed that the garden spider merely suffered its threads to float in the wind by chance, I thought it might be of some utility to publish the result of my observations.

IX. *On the System of Forces.* *By* J. C. Delametherie. *From* Journal de Physique, *Brumaire, An. VII.*

GEOMETRICIANS, accustomed to precise mathematical demonstration, cannot reconcile themselves to the difficulties which occur in the explanations given by physics to the different phenomena of nature. They prefer the method of the great Newton, which is, to calculate the effects whatever may be the causes; and hence has been introduced the system of forces, which seems to gain ground in a singular manner. Kant is one of the first who announced it in Germany. He distinguishes two kinds of physics, the *dynamic* and *atomist*. He calls atomist physics that which teaches that the primitive parts of matter are composed of atoms or indivisible parts, and which endeavours to explain all the phenomena of nature by the action or impulse of different fluids. The second, which he calls dynamic physics, appears to him preferable. It supposes matter to be composed of moleculæ always divisible. This matter is actuated by two forces: 1st. the attractive; and, 2d. the repulsive. The atomists consider fluids as composed of small solid moleculæ. Kant does not admit these solid moleculæ. Fluids, according to him, are such originally, so that we cannot conceive a part of a fluid which is not fluid. These two forces, according to Kant, produce several other forces, viz. 3d. the caloric force, which is the principle of heat and of all the phenomena ascribed to fire; 4th, the luminous force, which is the principle of light and all the phenomena depending on it; 5th, the electric force, which is the cause of all the phe-

 nomena

nomena ascribed to electricity; 6th, the magnetic force, which produces all the phenomena ascribed to magnetism. Consequently all the phenomena of heat, light, electricity, magnetism, according to him, are modifications of the attractive and repulsive force of the first parts of matter, and there exists neither caloric fluid, luminous fluid, electric fluid, nor magnetic fluid. This system has numerous partisans in Germany, and it has even been extended still farther. 7th. The galvanic force. Humboldt supposes that the phenomena of galvanism may be explained by a particular force, which he calls the galvanic. Humboldt however always speaks of a galvanic fluid, as several of Kant's pupils speak of the caloric fluid, the luminous fluid, the electric fluid, and the magnetic fluid. But these are mere denominations, which express the unknown causes of the phenomena of heat, light, electricity, magnetism and galvanism. 8th. The vital force, *vita propria*. Blumenbach, to express the phenomena of vitality, supposes a particular force, which he calls *vita propria*. 9th. *Nisus formativus*. The same learned man, to express the formation of organised bodies, supposes a particular force, which he calls *nisus formativus*. This amounts to the same as that called by other philosophers the plastic force.

Barthez believes also, that we ought to consider all the vital functions in man and animals, as produced by peculiar forces and directed according to the primordial laws of a vital principle. " I think I have found, adds he, that there exists in the living muscles a force of the fixed situation of the moleculæ and of their fibres (tending to rest) different from the forces of contraction and dilatation (tending to motion), the existence of which has not been before so much as suspected. The forces of the vital principle are inherent in each part of the body which they animate, and exercise there the movements peculiar to that part. The sound method of philosophising in each natural science admits in them general *occult causes* *.

* Nouvelle Mécanique des Mouvemens de l'Homme, par Barthez.

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As this expression, *occult causes*, which modern philosophy has had so much difficulty to banish, is inconsistent with the generally adopted ideas, I shall here offer some reflections on that subject, as well as on Kant's system of forces. In my opinion, the manner of cultivating natural philosophy ought to be considered under several points of view. 1st. Some confine themselves to a description of the objects and phenomena that occur. The zoologist describes animals, their manner of living, and of reproducing their species. The botanist does the same in regard to plants. The mineralogist in the like manner describes minerals and their external qualities. The physical geographer describes the surface of the earth; and the astronomer the celestial bodies, their movements, &c. 2d. Others go still farther. The anatomist explores the internal parts of animals and vegetables, and describes their structure; and the chemist analyses them, as well as minerals, to discover the principles of which they are formed. 3d. The geometrician calculates the movements and forces of all these beings, independently of the causes by which they may be produced; and he furnishes the mechanist with calculations for constructing and directing his machines. 4th. In the last place, others endeavour to discover the causes of all the phenomena exhibited by these bodies, as well as to explain the mechanism of their different movements. This is the science of physics. But it has so often led men into error, that true philosophers are exceedingly difficult in regard to the explanations it gives. This has induced them to have recourse to the system of forces, by which they express a fact, the effects of which they calculate without attempting to trace them to their causes: as they cannot, for example, yet explain the phenomena of vitality, they express them by the words *vital force*, whatever may be their cause. The vital force, then, is that which produces the phenomena of vitality; but we are ignorant of the manner in which it acts. This is what ought to be understood by the expression *occult causes*. The ancients, for example, not being acquainted with the weight of the atmoſphere, could not explain why water did not riſe in a pump but to a certain height. They ſaid it was the effect of an occult cauſe; that is to ſay, of a cauſe with which they were unacquainted, which was concealed from them, *occulta*.

In the like manner we ought only to underſtand by the word *force* the cauſe of a general fact, whether this cauſe be known or not. This is the acceptation in which the word was underſtood by Newton. He obſerved that all bodies had a tendency towards each other, and he called the cauſe of this general phenomenon attractive force, or attraction. He obſerved alſo, that in certain circumſtances they repelled each other; and he called the cauſe of this ſecond general phenomenon repulſive force, or repulſion. This mode of expreſſion may be applied to all the grand phenomena of nature, and we may uſe the word force in the following different ſenſes: *Luminous force*, the cauſe of the phenomena of light; the *caloric force*, the cauſe of the phenomena of heat; the *electric force*, the cauſe of the phenomena of electricity; the *magnetic force*, the cauſe of the phenomena of magnetiſm; the *galvanic force*, the cauſe of the phenomena of galvaniſm; the *ſonorous force*, the cauſe of the phenomena of ſound; the *capillary force*, the cauſe of the phenomena of capillary attraction; the *force of affinities*, the cauſe of the phenomena of affinity; the *diſſolving force*, the cauſe of the phenomena of ſolution; the *conſolidating (ſolidifiante) force*, the cauſe of the phenomena of ſolidity; the *cryſtallizing force*, the cauſe of the phenomena of cryſtallization; the *vital force*, the cauſe of the life of animals and vegetables; the *generative force*, the cauſe of the generation of animals and vegetables; the *nutritive force*, the cauſe of nutrition; the *muſcular force*, the cauſe of muſcular motion; the *ſympathetic force*, the cauſe of ſympathetic movements; the *concocting force*, the cauſe which aſſimilates morbific humours. The number of theſe forces might be greatly extended if we employ

employ that term to expreſs the cauſe of a general phenomenon [illegible]

The geometer calculates the effects of thoſe forces which he employs, as he does algebraic ſigns inſtead of numbers, to ſimplify his operations; but if he wiſhes afterwards to obtain reſults, he muſt give to theſe ſigns their real values. In the like manner, if he wiſhes to have a phyſical reſult, he muſt aſſign a value to the word *force* which he employs. The philoſopher endeavours to diſcover the cauſes of theſe forces; but he is ſo often deceived, and gives ſo many falſe explanations, that we are always inclined to conſider as bad thoſe which he aſſigns. We muſt not, however, fall into the oppoſite exceſs, and aſcribe to the word force an acceptation which it ought not to have. Let us imitate the wiſdom of Newton: "All bodies, ſays he, have a tendency towards each other; that tendency I call attraction, attractive force; but it may be the effect of an impulſion, or of ſome other cauſe which is unknown to us." He ſays the ſame thing of repulſive force. Let us apply this to all the forces before mentioned. The ſonorous force, for example, has certainly as its cauſe ſome agitation in the ſonorous body, and the atmoſpheric air by which it is ſurrounded. This is a certain fact, though we cannot yet explain all the phenomena exhibited by ſonorous bodies. The caſe is the ſame with the luminous, electric, magnetic, caloric, and galvanic forces. The phenomena of heat, light, electr city, magnetiſm, galvaniſm, have as cauſes the movements of particular fluids; and, though we are not yet able to determine the nature of all the movements of theſe fluids, we know that their action is in the inverſe ratio of the ſquares of the diſtances.

Reil has ſhewn that the *niſus formativus* of Blumenbach ought to be conſidered, as I have ſaid, as a real force of cryſtallization. In general the formation of organiſed bodies, their increment, their nutrition, is nothing but this force of cryſtallization. It has formed all minerals; the globe itſelf, and the whole univerſe. It is alſo the conſoli-

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dating power, or that which gives solidity to all bodies. The force of crystallisation is consequently a force which acts in the most general manner in nature; that is to say, among existing beings. Attraction itself is the effect of the action of the gravific fluid, and repulsion is the effect of the repulsive fluid or caloric. The philosopher acknowledges that he is yet ignorant of the manner in which all these fluids act: he is only acquainted with some of their laws.

This acceptation of the word force leaves every possible latitude to the calculations of geometry (which form the physico-mathematical sciences), and does not violate the principles of sound philosophy. The expression *occult causes*, explained in this manner, can give no offence. But if people should persist to consider force as a quality independent of the action of all matter, fluid or not fluid, this would be a mere metaphysical abstraction.

X. *Observations on the Satellites of the Georgium Planet, and the two innermost Satellites of Saturn. By Dr.* J. H. SCHROTER, *F.R.S. &c. From* Neuere Beytrage zur Erweiterung der Sternkunde. 1798.

I WAS prevented by various speculations, during the hours of observation, from directing the thirteen or twenty-seven feet reflectors to the Georgium Sidus till the 19th of February 1797, when about eight o'clock in the evening I looked at it through the thirteen feet reflector, with a magnifying power of almost 200. It appeared very plainly as a planet of mensurable diameter, having a pale white light; and in a little time, when the eye became accustomed to the instrument, several very small stars were perceptible around it. Two of these, being the nearest, in *a* and *b* (Plate VI, fig. 1), were a little clearer, though it was with some difficulty they could be distinguished. The largest, *a*, was to the north-

north-west, distant about seven or eight apparent diameters of the planet; but *b*, which was at a much less distance, was less perceptible. They were both too faint for measurement. M. Harding distinguished them plainly also; and both our delineations exactly corresponded. As the planet at an inconsiderable elevation had irradiation, and at the same time a large apparent diameter, it was possible, according to the distance assigned by Dr. Herschel, that they might be the satellites; and we considered them as such because they had a satellite-like appearance.

The weather being serene, we were able to observe the Georgium planet next evening, the 20th, at eight o'clock, through the same reflector with magnifying powers of 180 and 288. It was very evident that we both distinguished, with full certainty, the same two luminous points, which we had seen before, at nearly the same distance and in almost the same relative positions; so that, from their perfectly similar appearance, we had reason to conclude they must be the same stars. They had their situation in *c* and *d*, in such a manner that *c*, the most remote, preceded the planet in the direction of its equatorial motion without perceptible declination.

As uranus, being then retrograde, had within twenty-four hours moved 2′ 40″ towards the west, as was visible from the neighbouring stars, the two which we observed, had they not been satellites, must have been seen two minutes towards the east. This was not the case; but as on the evening before, they were again visible in *c* and *d*, with the like relative position; which fully convinced us that they were satellites.

At eight o'clock the following evening we found the same luminous points, with the thirteen feet reflector and a magnifying power of 288, at the like distance and in the former relative position, but more towards the south in *e* and *f*; and it appeared to our conviction, that the second larger satellite, which the evening before preceded the planet westwards, in

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the direction of its equatorial movement, now formed with it an evident angle, and at the ſame time had proceeded ſouthwards the like diſtance. Beſides the ſatellite three teleſcopic fixed ſtars were diſtinguiſhable in α, β, γ. (fig. 2.)

About ten o'clock we continued our obſervations with the twenty-ſeven feet reflector, and M. Harding, beſides the ſmall ſtars which had now moved a little from their place, obſerved two more in δ and ε (fig. 3.) In the ſtrong light of this teleſcope the ſecond larger ſatellite, now moved to *c*, which from its diſtance, colour, and degree of light, we perceived to be the ſame obſerved on the 19th and the 20th, diſtinguiſhed itſelf clearly from the other ſmall ſtars, and even from the firſt ſatellite, though its light was very weak. At the ſame time we obſerved the direction of its equatorial motion towards ζ, ſo that both the ſatellites, according to the proportion of the periods of their revolution, ſeemed to have moved ſouthwards. By this circumſtance, and as it was impoſſible that with a reflector having ſo much light we ſhould not, in ſerene weather, ſee both the ſatellites, we were more confirmed in our opinion.

As the weather was unfavourable I could not repeat my obſervations till the 26th of February, at 42 minutes paſt 10, when, with the thirteen feet reflector and a magnifier of 288, I diſtinguiſhed two faint luminous points in quite another poſition, viz. one in *g* (fig. 1.), which I took to be the ſecond or larger ſatellite, and another in *h*, which I conſidered as the firſt. Both theſe points correſponded with Herſchel's periods; ſo that we could form no other concluſion than that, with this excellent reflector, we had ſeen both the ſatellites.

How far the power of this reflector extends will particularly appear from the following obſervations on the ſatellites of Saturn. We had often obſerved, with this inſtrument, during clear moon-ſhine, the five old ſatellites, and the variation of their light; but I never believed that it would

would shew the two innermost; and yet I know, with the utmost certainty, that this was the case.

I. On the 17th of February 1797, after having surveyed with it every thing remarkable in regard to Saturn, M. Harding observed, about 7 h. 23m. true time, at *a*, (fig. 4.) a difficult to be distinguished faint luminous point, which he was inclined to consider as the sixth satellite. I distinguished it also; and both our delineations of its position coincided so far, that it was seen, according to its proportional distance from the ring, in the orbit of the sixth satellite. Its light, on account of its very small size, was so weak that it was not always distinguishable, but only now and then by intervals.

II. About eleven o'clock, the same evening, our observations were continued; and though it was difficult to find this point again, it was at length discovered by us both. About 11 h. 24 m. it appeared to have moved the considerable segment from *a* to *b*, in the orbit of the sixth satellite. This was sufficient to convince us that we had observed that satellite with the thirteen feet reflector and a magnifying power of 288; for in both points its distance from the ring, according to the proportion of the ellipse, amounted, like that of the sixth satellite, to only $\frac{1}{4}$ of the diameter of the ring. 2d. Saturn was retrograde, and, according to calculation, receded westwards 3·3 seconds, in four hours, from 7 h. 23 m. to 11 h. 24 m. Had it been a fixed star, it must have appeared about 11 h. 24 m. nearly 3·3 seconds farther from *a* towards the east, instead of having moved westwards to *b*. It could, therefore, be no fixed star, but a satellite. 3d. If the segment *a*, *b*, which it appeared to have passed over, be reduced to the orbit of the sixth satellite, the point in the course of four hours had not completely moved $\frac{1}{8}$ of that orbit; and therefore gives a period of somewhat more than 32 hours. The synodical period of the sixth satellite, according to the determination of Dr. Herschel,

Herſchel, amounts to 32 h. 53 m. 9 ſec. A more accurate coincidence could not be expected in ſo ſmall a circle.

III. On the 20th of February, in the evening, as the weather was favourable, we directed the twenty-ſeven feet reflector to Saturn, and M. Harding ſignified that he obſerved, very clearly, a ſmall luminous point, near the ring, which from its diſtance and appearance he thought might be one of the ſatellites. I ſaw it alſo myſelf very diſtinctly and with perfect certainty. Each delineated its poſition ſeparately; and both delineations correſponded exactly. About 10 h. 44 m. true time, he ſaw it, not as exhibited by the front view, but according to its true poſition at *c*, in the orbit of the ſixth ſatellite; and the calculation afterwards made, proved that it actually was the ſixth ſatellite, obſerved in *a* and *b* on the evening of the 17th with the thirteen feet reflector; for from the 17th, 11 h. 24 m., to the 20th, 10 h. 44 m. there had elapſed 71 hours 20 minutes, in which time this ſatellite muſt have performed 2·16, nearly 2 whole periods and not quite ¼, of its ſynodical revolution, and have appeared removed not fully one ſixth of its orbit towards the weſt from *b*. If the poſition of the planet at ſuch a weſtern diſtance from *b* be projected, it will be found to correſpond very accurately with the obſerved point *c*.

IV. On the 21ſt of February, when viewing Saturn and his ſatellites, for another purpoſe, with the thirteen feet reflector, I for ſome time found no appearance of the ſixth ſatellite; but I at length diſcovered it, and, as I believed, with perfect certainty. At about 7h. 30m. it ſtood in *b*.

V. About 11 o'clock, the ſame evening, our obſervations were continued with the twenty-ſeven feet reflector and a magnifier of almoſt 200. Deceived by the front view of the inſtrument, I imagined that the ſixth ſatellite, according to the before-made obſervations, muſt ſtand ſomewhat to the right of the ring. I believed alſo that I ſaw a point at *f*, or according to the poſition with the ſmall reflector of the thirteen feet telescope in *g*; and having desired M. Harding, who often distinguished delicate points better than myself, to direct his attention towards that part, he assured me that he saw very clearly, not only a point in *f*, but also a second pale luminous point in *e*, the position and distance of both which points he delineated very accurately, as they were seen with a front view, about 11 h. 34 m. true time; and that at *f* was found to be in the orbit of the first, and that at *e* in the orbit of the second inner satellite. It was not till the next day that I discovered my error occasioned by the front view; and I found, to our great satisfaction, that the luminous point, seen at *e* in the orbit of the second inner satellite, was actually the sixth or second inner satellite: for, as it was seen by a front view in *e*, it must have been seen by the common mode of observation towards the east at *d*. Through mistake, we by no means suspected the sixth satellite in *e*; and, therefore, the observation was proved to be so much the more correct when calculation shewed that the sixth satellite had actually been, according to the front view, in that position, or, according to the usual mode of observation, in *d*. From 10 h. 44 m. on the evening Feb. 20th, till 11 h. 34 m. on the evening of the 21st, there had elapsed 24 hours 50 minutes, in which time this satellite, according to its period of 32 h. 53 m. 9 sec. had passed over $\frac{3}{4}$ of its period + $\frac{1}{24}$, and, consequently, must have stood in *d*; which corresponds perfectly with the point seen in *e* by the front view.

I shall here take occasion to remark, that the pale luminous point which M. Harding saw, by the front view, at *f*, exactly in the orbit of the seventh satellite, and of which I myself had a transient glance, may really have been that satellite; for it had often happened before, that, besides seeing the five old satellites, I imagined that I saw in proportionally near, small, pale luminous points, the two inner, the sixth and seventh satellites, when the weather was not so favour-

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able as to enable me to examine them particularly for any time without intermiſſion.

VI. At 7 h. 34 m. February 27th, when we were again employed in obſerving with the thirteen feet reflector, M. Harding aſſured me that he ſaw, with perfect certainty, a very faint luminous point at *i*, where I had ſeen it alſo a little before, but not with ſo much certainty. According to his delineation, it ſtood in the orbit of the ſixth ſatellite; and it was found afterwards by compariſon that this luminous point was actually that ſatellite: for, from 11 h. 34 m. on the evening Feb. 21ſt, till 7 h. 34 m. on the evening of the 27th, five days 20 hours had elapſed, which divided by the period of its revolution gives 4·25 revolutions; ſo that the ſatellite muſt have ſtood in *i*, about $\frac{1}{4}$ of its orbit farther from *d* towards the weſt, where it actually was according to accurate obſervation.

Theſe ſix obſervations, made in the courſe of ten days, during which the ſatellite was always ſeen in thoſe points in which, according to Dr. Herſchel's determination, it ought to be found, clearly ſhew not only that we diſtinguiſhed the ſixth ſatellite with the thirteen feet reflector, but that the period aſſigned by Herſchel has been determined with great accuracy. Two obſervations, however, made later appear to me to be worthy of notice.

VII. On the evening of the 6th of March, when Saturn was diſtant only from 1$\frac{1}{4}$ to 1$\frac{1}{2}$ degree from the illuminated half of the moon, I diſcovered the four outer ſatellites with the thirteen feet reflector and a magnifying power of 288. On account of ſome meaſurement which I had long wiſhed to make under ſuch circumſtances, I applied to the reflector a magnifying power of 532; and it is certain that with this power, almoſt double to the former, at ſo ſmall a diſtance from the moon, I ſaw much better, though the light was conſiderably weakened; for, at the firſt view, I not only clearly diſcovered the firſt ſatellite in its weſtern digreſſion

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and periodical change of light towards faintneſs; but I ſaw alſo to the north-eaſt, at the diſtance from the ring of $\frac{1}{2}$ of its diameter, a very ſmall fixed ſtar, which was only half as perceptible as the pale firſt ſatellite was during its periodical increaſe of light.

M. Harding ſoon after found not only this fixed ſtar with all the five old ſatellites, but obſerved alſo, on the weſtern ſide nearer the ring, a ſtill paler, more delicate luminous point, the ſituation of which he ſhewed only in general. I ſucceeded in diſcovering it alſo; and both our delineations of its poſition being compared, proved that we had both ſeen it very accurately in the ſame point, and in the orbit of the ſixth ſatellite. Even if we had not immediately calculated the place of this ſatellite, we muſt, from the proportional decreaſe of its light and the foregoing obſervations, have conſidered it as the ſixth. About 8 h. 12 m. true time, it ſtood in *k*; and it afterwards appeared that we had not erred; for M. Harding, having continued the obſervation alone, found about 10 h. 30 m. that it had proceeded eaſtwards to *l*. As Saturn at that time moved daily about two minutes towards the eaſt, the luminous point *k*, had it been a fixed ſtar, muſt have been diſtant from Saturn about 10 ſeconds weſtward. This circumſtance, that it not only had accompanied Saturn eaſtwards, but had moved in its orbit, a perceptible portion of a circle, proved with full certainty that it was the fixth ſatellite, and this was afterwards confirmed by calculation; for from 7 h. 23 m. true time, in the evening, Feb. 17th, when it was firſt ſeen by M. Harding, to 8 h. 12 m. on the 6th of March, 17 days 0 hours 49 minutes had elapſed, during which the ſatellite had completed 12·43 ſynodical revolutions of 1 day 8 hours 53 minutes 9 ſeconds. It muſt therefore have moved about $\frac{43}{100}$, or almoſt the half of its orbit from *a* towards the weſt; and this exactly agrees with the poſition where we both ſaw it in *k*. The arc which it had moved over from *k* to *l* correſponds alſo, becauſe the ſatellite in 2 h. 18 m. from

 8 h.

8 h. 12 m. to 10 h. 30 m. must have moved towards the east about $\frac{1}{14}$th of its orbit, which corresponds with the arc *k l*.

It is also worthy of remark, that we distinguished this satellite with a thirteen feet reflector during serene weather, by moonlight, and only at the distance of 1½ degree from the moon; and the circumstance that, in the course of seventeen days, we found it eight times exactly in those positions where, according to Herschel's period, it ought to stand, confirms in the completest manner the accuracy of that period.

Observations which confirm what others have discovered with large telescopes contain indeed nothing new; but they are, however, still valuable not only to the observer, but to many amateurs, who often wish to try whether they have instruments that possess a sufficiently strong power; and under that view I have considered it as my duty to give the above at full length, selected from a great many which I made in regard to the satellites of Saturn.

I shall pass over several made on the sixth satellite of Saturn, which seem to betray irregularities in it; and only remark that, according to our observations, this sixth satellite, like the whole of Jupiter's four, and the five outermost of Saturn, are, in all probability, subject to a variation of their light.

XI. *Extract of Experiments and Observations on the Use of Phosphorus administered internally.* *By* ALPHONSUS LEROI, *Professor at the Medical School of Paris.* *From* Bulletin de la Societé Philomatique, 1798.

1. PHOSPHORUS administered internally in consumptive diseases appears to give a certain degree of activity to life, and to revive the patients, without raising their pulse in the same proportion. The author relates several instances that

that occurred to him in the course of his practice, one of which is as follows: Being called to attend a woman, at the point of death, who was quite worn out by a consumptive disorder, with which she had been afflicted for three years, in compliance with the earnest desire of her husband, who requested him to give her some medicine, he composed one of a portion of syrup diluted with water in which a few sticks of phosphorus had been kept. Next day the woman found herself much better. She was revived for a few days; and did not die till about a fortnight after.

2. He himself, as he acknowledges, was so *imprudent* as to take two or three grains of solid phosphorus combined only with treacle, and experienced the most dreadful symptoms. At first he felt a burning heat in the whole region of the stomach. That organ seemed to be filled with gas which escaped by the mouth. Being dreadfully tormented, he tried to vomit, but in vain, and found relief only by drinking cold water from time to time. His uneasy sensations were at length allayed; but next morning he seemed to be endowed with an astonishing muscular force, and to be urged with an almost irresistible impulse to try its energy. The effect of this medicine at length ceased, adds the author, *à la suite d'un priapisme violent.*

3. In many cases the author employed, and still employs, phosphorus internally, with great benefit, to restore and revive young persons exhausted by excesses. He divides the phosphorus into very small particles, by shaking it in a glass filled with boiling water. He continues to shake the bottle, plunging it into cold water, and thus obtains a kind of precipitate of phosphorus, exceedingly fine, which he bruises slowly with a little oil and sugar, or afterwards employs as liquid electuary, by diluting the whole in the yolk of an egg. By means of this medicine he has effected astonishing cures, and restored the strength of his patients in a very short time.

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4. In malignant fevers the uſe of phoſphorus internally, to check the progreſs of gangrene, has ſucceeded beyond expectation. The author relates ſeveral inſtances.

5. Pelletier told him, that having left, through negligence, ſome phoſphorus in a copper baſon, that metal was oxydated, and remained ſuſpended in the water. Having thoughtleſsly thrown out the water in a ſmall court in which ducks were kept, theſe animals drank of it, and all died. *Mais le male*, ſays the author, *couvrit toutes ſes femelles juſque au dernier inſtant de ſa vie.* An obſervation which accords with the effect experienced by the author.

6. The author relates a fact which proves the aſtoniſhing diviſibility of phoſphorus. Having adminiſtered to a patient ſome pills, in the compoſition of which there was not more than a quarter of a grain of phoſphorus, and having had occaſion afterwards to open the body, he found all the internal parts luminous; and even the hands of the perſon who had performed the operation, though waſhed and well dried, retained a phoſphoric ſplendor for a long time after.

7. The phoſphoric acid, employed as lemonade, has been ſerviceable to the author in the cure of a great number of diſeaſes.

8. Leroi aſſures us that he oxydated iron with phoſphorus, and obtained, by the common means, a white oxyd, almoſt irreducible, which he thinks may be employed with advantage in the arts, and particularly in painting with oil, and in enamel, inſtead of the white oxyd of lead. This white oxyd of iron occaſioned violent retchings to the author, who ventured to place a very ſmall particle of it on his tongue. He does not heſitate, therefore, to conſider this oxyd as a terrible poiſon. He was not able to reduce it, but by fixed alkali and the glaſs of phoſphorus.

9. The author aſſerts that by means of phoſphorus he decompoſed and ſeparated from their baſes the ſulphuric, muriatic and nitric acids; that by help of the phoſphoric acid he

he tranfmuted earths; and that with calcareous earth he can make, at pleafure, confiderable quantities of magnefia. He declares that to his labours on phofphorus he is indebted for proceffes by which he effects the diffipation (*op re la frite*) of rubies, the fufion of emeralds, and the vitrification of mercury.

[We need hardly add, that Englifh practitioners will ufe their wonted caution in the application of fo powerful a remedy.]

XII. *On the Procefs of Bleaching with the oxygenated muriatic Acid; and a Defcription of a new Apparatus for bleaching Cloths with that Acid diffolved in Water, without the Addition of Alkali. By* THEOPHILUS LEWIS RUPP, *Efq. From* Memoirs of the Literary and Philofophical Society of Manchefter, *Vol. V.* 1798.

FOR the difcovery of the oxygenated muriatic acid, its effects on colouring matter, and its ineftimable advantages, the arts are indebted to the juftly-celebrated Scheele. M. Berthollet loft no time in applying the properties of this curious and highly interefting fubftance to the moft important practical ufes. His experiments on bleaching with the oxygenated muriatic acid proved completely fuccefsful, and he did not delay to communicate his valuable labours to the public. The new method of bleaching was quickly and fuccefsfully introduced into the manufactures of Manchefter, Glafgow, Rouen, Valenciennes, and Courtray; and it has fince been generally adopted in Great Britain, Ireland, France, and Germany. The advantages which refult from this method, which accelerates the procefs of whitening cottons, linens, paper, &c. to a really furprifing degree, in every feafon of the year, can be juftly appreciated by commercial people only, who experience its beneficial effects in many ways, but particularly in the quick circulation of their capitals.

Great difficulties, for a time, impeded its progress, arising chiefly from prejudice and the ignorance of bleachers in chemical processes. These obstacles were, however, soon removed, by Mr. Watt at Glasgow, and by Mr. Henry and Mr. Cooper at Manchester. Another difficulty presented itself, which had nearly proved fatal to the success of the operation. This was the want of a proper apparatus, not for making the acid and combining it with water, for this had been supplied in a very ingenious manner by Mr. Watt and M. Berthollet*; but for the purpose of immersing and bleaching goods in the liquor. The volatility of this acid and its suffocating vapours prevented its application in the way commonly used in dye-houses. Large cisterns were therefore constructed, in which pieces of stuff were stratified; and the liquor being poured on them, the cisterns were closed with lids. But this method was soon found to be defective, as the liquor could not be equally diffused: the

* M. Berthollet's apparatus, however, is too complex for the use of a manufactory; Mr. Watt's is better; but a range of four, five, or six hogsheads, or rum-puncheons, connected with one another, in the manner of Woulfe's distilling apparatus, is preferable to either of them. Agitators, on M. Berthollet's principle, may be applied. The retort or matrass should be of lead, standing in a water-bath; its neck should be of sufficient length to condense the common muriatic acid, which always comes over, and it should form an inclination towards the body of the retort, so that the condensed acid may return into it. I beg leave to observe here, that I always found the liquor to be strongest when the distillation was carried on very slowly. I have also found, that the strength of the liquor is much increased by diluting the vitriolic acid more than is usually done. The following proportions afforded the strongest liquor:

Three parts manganese.
Eight parts common salt.
Six parts oil of vitriol.
Twelve parts water.

The proportion of manganese is subject to variation according to its quality.

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pieces were, therefore, only partially bleached, being white in ſome parts and more or leſs coloured in others. Various other contrivances were tried without ſucceſs, till it was diſcovered that an addition of alkali to the liquor deprived it of its ſuffocating effects, without deſtroying its bleaching powers. The proceſs began then to be carried on in open veſſels, and has been continued in this manner to the preſent period. The bleacher is now able to work his pieces in the liquor, and to expoſe every part of them to its action, without inconvenience. This advantage is unqueſtionably great; but it is diminiſhed by the heavy expence of the alkali, which is entirely loſt. It is moreover to be feared, that the alkali which is added to the liquor, though it does not deſtroy its power of bleaching, may diminiſh it; becauſe a ſolution of the oxygenated muriat of potaſh, which differs from the alkaline bleaching liquor in nothing but in the proportion of alkali, will not bleach at all. This is a well known fact, from which we might infer, that the oxygenated muriatic acid will loſe its power of deſtroying the colouring matter of vegetable ſubſtances, in proportion as it becomes neutralized by an alkali. But as we ſhould not content ourſelves with inferences however plauſible, when the truth may be eſtabliſhed by experiment; and as I thought the matter of ſufficient importance, I made the following experiments on the ſubject.

I beg leave to premiſe, that in all theſe experiments I made uſe of one and the ſame acid, which was kept in a bottle with a ground-glaſs ſtopper, and ſecured from the influence of light. The manner in which I made the experiments was ſimply this. I weighed, firſt of all, a bottle filled with the colouring ſubſtance which I meant to employ: I then weighed, in a large and perfectly colourleſs bottle, half an ounce of the acid, to which I immediately, but very gradually, added of the colouring ſubſtance contained in the former bottle, till the acid ceaſed to deſtroy any more of its colour. The bottle with the colouring ſubſtance was then weighed again, and the difference between its present and original weight was noted. The same method was observed in all the experiments.

Experiment I. To half an ounce of oxygenated muriatic acid, I added a solution of indigo in acetous acid*, drop by drop, till the oxygenated acid ceased to destroy any more colour. It destroyed the colour of 160 grains of the acetite of indigo.

Experiment II. A repetition of Experiment I. The colour of 165 grains of acetite of indigo was destroyed in this experiment.

Experiment III. A repetition of Experiments I. & II. The colour of 160 grains of the acetite was destroyed.

Experiment IV. To half an ounce of the oxygenated muriatic acid, were added 8 drops of pure potash in a liquid state. This quantity of alkali was about sufficient to deprive the acid of its noxious odour. This mixture destroyed the colour of 150 grains of the acetite of indigo.

Experiment V. A repetition of Experiment IV. The colour of 145 grains of the acetite was destroyed.

Experiment VI. To half an ounce of the oxygenated muriatic acid, 10 drops of the same alkali were added. It destroyed the colour of 125 grains of the acetite of indigo.

Experiment VII. A mixture of half an ounce of the oxygenated acid, and 15 drops of the alkali, destroyed the colour of 120 grains of the acetite of indigo.

Though I had taken the precaution of avoiding the sulphuric acid, for the reason stated in the foregoing note, I was not quite satisfied with these experiments, on account

* It has been usual to estimate the strength of the oxygenated muriatic acid by a solution of indigo in sulphuric acid. This method was inadmissible in these experiments on the comparative strength of the bleaching liquor, with and without alkali; because the sulphuric acid would have decomposed the muriat of potash, and thereby produced errors. I therefore added to a solution of indigo in sulphuric acid, after it had been diluted with water, acetite of lead, till the sulphuric acid was precipitated with the lead. The indigo remained dissolved in the acetous acid.

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of errors which might have taken place through a double affinity. I therefore made the following experiments, in which I employed a decoction of cochineal in water, instead of the acetite of indigo.

Experiment VIII. To half an ounce of the oxygenated muriatic acid, a decoction of cochineal was added till the acid ceased to act on its colour. It destroyed the colour of 390 grains of the decoction.

Experiment IX. A repetition of Experiment VIII. The colour of 385 grains of the decoction was destroyed in this experiment.

Experiment X. To half an ounce of the acid, 6 drops of the liquid alkali were added. This mixture destroyed the colour of 315 grains of the decoction.

Experiment XI. Eight drops of the alkali were mixed with half an ounce of the acid. This mixture destroyed the colour of 305 grains of the decoction.

On a comparative view of the results of these experiments, it will appear, that an addition of potash to the bleaching liquor impairs its strength considerably. This diminution of power, and the expence of potash, are a serious loss in an extensive manufacture. It would, therefore, be desirable to have an apparatus for the use of the pure oxygenated muriatic acid simply dissolved in water, which is at once the cheapest and best vehicle for it. This apparatus must be simple in its construction, and obtainable at a moderate expence; it must confine the liquor in such a manner as to prevent the escape of the oxygenated muriatic acid gas, which is not only a loss of power, but also an inconvenience to the workmen and dangerous to their health; and it must, at the same time, be so contrived, that every part of the stuff which is confined in it, shall certainly and necessarily be exposed to the action of the liquor in regular succession. Having invented an apparatus capable of fulfilling all these conditions, I have the pleasure of submitting a description of it to the Society, by means of the annexed drawing.

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DESCRIPTION OF THE APPARATUS.

Fig. 1, (Plate VII.) is a section of the apparatus. It consists of an oblong deal cistern A B C D, made water-tight. A rib, E E, of ash or beech wood, is firmly fixed to the middle of the bottom C D, being mortised into the ends of the cistern. This rib is provided with holes, at F F, in which two perpendicular axes are to turn. The lid, A B, has a rim, G G, which sinks and fits into the cistern. Two tubes, H H, are fixed into the lid, their centres being perpendicularly over the centres of the sockets, F F, when the lid is upon the cistern. At I, is a tube by which the liquor is introduced into the apparatus. As it is necessary that the space within the rim, G G, be air-tight, its joints to the lid, and the joints of the tubes, must be very close; and, if necessary, secured with pitch. Two perpendicular axes, K L, made of ash or beech wood, pass through the tubes, H H, and rest in the sockets, F F. A piece of strong canvas, M, is sewed very tight round the axis K, one end of it projecting from the axis. The other axis is provided with a similar piece of canvas. N, are pieces of cloth rolled upon the axis L. Two plain pulleys, O O, are fixed to the axes, in order to prevent the cloth from slipping down. The shafts are turned by a moveable handle, P. Q, a moveable pulley, round which passes the cord, R. This cord, which is fastened on the opposite side of the lid (see fig. 2), and passes over the small pulley S, produces friction by means of the weight T. By the spigot and fausset V, the liquor is let off, when exhausted.

Fig. 2. A plan of the apparatus, with the lid taken off.

THE MANNER OF USING THE APPARATUS.

The dimensions of this apparatus are calculated for the purpose of bleaching twelve or fifteen pieces of $\frac{7}{4}$ calicoes, or any other stuffs of equal breadth and substance. When the goods are ready for bleaching, the axis, L, is placed on a frame

frame in a horizontal poſition, and one of the pieces, N, being faſtened to the canvas, M, by means of wooden ſkewers, in the manner repreſented in fig. 1, it is rolled upon the axis by turning it with the handle, P. This operation muſt be performed by two perſons; the one turning the axis and the other directing the piece, which muſt be rolled on very tight and very even. When the firſt piece is on the axis, the next piece is faſtened to the end of it by ſkewers, and wound on in the ſame manner as the firſt. The ſame method is purſued till all the pieces are wound upon the axis. The end of the laſt piece is then faſtened to the canvas of the axis K. Both axes are afterwards placed into the ciſtern, with their ends in the ſockets F F, and the lid is put on the ciſtern by paſſing the axes through the tubes H H. The handle P is put upon the empty axis, and the pulley Q upon the axis on which the cloth is rolled, and the cord R, with the weight T, is put round it and over the pulley S. The uſe of the friction, produced by this weight, is to make the cloth wind tight upon the other axis. But as the effect of the weight will increaſe as one cylinder increaſes and the other leſſens, I recommend that three or four weights be ſuſpended on the cord, which may be taken off gradually, as the perſon who works the machine may find it convenient. As the weights hang in open hooks, which are faſtened to the cord, it will be little or no trouble to put them on and to remove them.

Things being thus diſpoſed, the bleaching liquor is to be transferred from the veſſels in which it has been prepared into the apparatus, by a moveable tube paſſing through the tube I, and deſcending to the bottom of the ciſtern. This tube being connected with the veſſels, by means of leaden or wooden pipes provided with cocks, hardly any vapours will eſcape in the transfer. When the apparatus is filled up to the line *a*, the moveable tube is to be withdrawn, and the tube I cloſed. As the liquor riſes above the edge of the rim G, and above the tubes H H, it is evident that no evaporation

tion can take place, except where the rim does not apply clofely to the fides of the box; which will, however, form a very trifling furface if the carpenter's work be decently done. The cloth is now to be wound from the axis L upon the axis K, by turning this; and when this is accomplifhed, the handle P and pulley Q are to be changed, and the cloth is to be wound back upon the axis L. This operation is, of courfe, to be repeated as often as neceffary. It is plain, that by this procefs of winding the cloth from one axis upon the other, every part of it is expofed, in the moft complete manner, to the action of the liquor in which it is immerfed. It will be neceffary to turn, at firft, very brifkly, not only becaufe the liquor is then the ftrongeft, but alfo becaufe it requires a number of revolutions, when the axis is bare, to move a certain length of cloth in a given time, though this may be performed by a fingle revolution when the axis is filled. Experience muft teach how long the goods are to be worked; nor can any rule be given refpecting the quantity and ftrength of the liquor, in order to bleach a certain number of pieces. An intelligent workman will foon attain a fufficient knowledge of thefe points. It is hardly neceffary to obferve, that, if the liquor fhould retain any ftrength after a fet of pieces are bleached with it, it may again be employed for another fet.

With a few alterations, this apparatus might be made applicable to the bleaching of yarn. If, for inftance, the pulley O were removed from the end of the axis K, and fixed immediately under the tube H;—if it were perforated in all directions, and tapes or ftrings paffed through the holes, fkains of yarn might be tied to thefe tapes underneath the pulley, fo as to hang down towards the bottom of the box. The apparatus being afterwards filled with bleaching liquor, and the axis turned, the motion would caufe every thread to be acted upon by the liquor. Several axes might thus be turned in the fame box, and being connected with each other by pulleys, they might all be worked by one perfon at the

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ſame time; and as all would turn the ſame way and with the ſame ſpeed, the ſkains could not poſſibly entangle each other.

In order to ſhew the uſefulneſs of this apparatus ſtill more clearly, I requeſt the Society to attend to the following ſtatement of the expence of a given quantity of bleaching liquor, with and without alkali, but of equal ſtrength.

WITH ALKALI *.

	£.	s.	d.
80 lb. of ſalt, at $1\frac{1}{2}$d. per lb. - - -		10	0
60 lb. of oil of vitriol, at $6\frac{1}{2}$d. per lb. - -	1	12	6
30 lb. of manganeſe - - -		2	6
20 lb. of pearl-aſhes, at 6 d. per pound - -		10	0
	£2	15	0
But it appears by the foregoing experiments, that the liquor loſes ſtrength by an addition of alkali. The value of this loſs, which on an average amounts to 15 per cent. muſt be added to the expence - - - - - -		8	3
	£3	3	3

WITHOUT ALKALI.

	£.	s.	d.
80 lb. of ſalt - - - -		10	0
60 lb. of oil of vitriol - - -	1	12	6
30 lb. of manganeſe - - -		2	6
	£2	5	0

It appears from this calculation, that a certain quantity of the liquor, for the uſe of my apparatus, coſts only 2l. 5s. but that the ſame quantity of the alkaline liquor coſts 3l. 3s. 3d. which is 40 per cent. more than the other. The aggregate of ſo conſiderable a ſaving muſt form a large ſum in the extenſive manufactures of this country.

* I make no mention of the expence attending the *preparation* of the liquor, it being the ſame in both caſes.

XIII. *A*

XIII. *A Differtation on Painting in Oil in a Manner fimilar to that practifed in the Ancient Venetian School. By Mr.* TIMOTHY SHELDRAKE*. *From* Tranfactions of the Society for the Encouragement of Arts, *Vol. XVI.* 1798.

THE method of painting practifed in the Venetian School, I conceive to have been as follows:

The cloth was primed with colours in diftemper, of a brownifh hue, fuch as would properly enter into the darkeft parts of the picture. The moft tranfparent colours are the propereft. I believe umber was moft generally ufed, broken with red, yellow, or blue, according to the tint intended to be produced, and diluted with chalk or whiting to the proper degree of ftrength. Upon the ground fo prepared the fubject was correctly drawn with umber, pure, or mixed with lake, blue, or black; and, with the fame colours, thofe fhadows that were darker than the ground were then painted in.

The artift then painted the lights with *pure white*, in a folid body, where the light was brighteft, or where the full effect of colour was to be produced; and, where the demitints were afterwards to be, fcumbling it thinner by degrees, till it united with the fhadows.

In this manner the chiaro-ofcuro was finifhed as much as poffible, and the local colour of every object in the picture glazed over it. All the colours ufed in this part of the work were ground in oil, which was abforbed into the ground, the picture remaining flat, fomething like a picture in water colours or crayons; it was then varnifhed, till faturated with varnifh, and the full of every colour brought out: the picture was then complete.

* The Great Silver Pallet was voted to Mr. Sheldrake for this ingenious performance.

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Upon the moſt ſuperficial view of this proceſs, it will be evident that a picture painted by it is, as to all viſible properties, a varniſh picture; for the ſmall quantity of oil that had been uſed, ſunk into the ground, and never could riſe again to be hurtful; while the varniſh, being laid on after the colours, gave them all the brilliancy and durability they could derive from that vehicle, without being liable to the objections that are made to painting in varniſh, ſuppoſing it to be uſed in the ſame manner as oil is in painting with oil. It is true that this mode of painting is itſelf liable to ſome objections: theſe I have endeavoured to obviate, and ſhall therefore mention hereafter. Here it may be obſerved that, as any varniſh may be uſed, it is to this circumſtance we muſt attribute the different degrees of durability in pictures of the Venetian School. I have ſeen ſome that would reſiſt the moſt powerful ſolvents, while others were deſtroyed by the weakeſt; though all poſſeſſed the apparent properties that diſtinguiſh the Venetian pictures from all others.

As I do not pretend to degrade painting to the rank of a mechanical art, that may be infallibly practiſed by a receipt, I ſhall be permitted to obſerve, that this was the general ſyſtem of the Venetian School, which I have ſeen variouſly modified in the works of different artiſts of that, as well as of the Flemiſh, which is derived from it. It is ſuſceptible of an almoſt infinite number of modifications, in proportion to the talents, the judgment of, and the objects to be painted by, the artiſts who may adopt it. This being the caſe, if it is proved by experiment that effects ſimilar to thoſe of the Venetian pictures may be produced by this method, and that the ſyſtem has a ſtrong tendency to produce that brilliancy, and harmony of colouring that is ſo much admired, with more certainty and facility than thoſe qualities can be obtained by any other mode of painting, I hope my caſe will be proved to the ſatisfaction of the Society.

I once aſked Sir Joſhua Reynolds, by what circumſtances in the management of a picture he thought the harmony of

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colouring was to be produced? He replied, An unity of light and an unity of ſhadow ſhould pervade the whole. He explained to me the difficulty of reducing the various colours of all the objects that may be included in a picture, and the various modifications of thoſe colours to the ſimple, harmonious ſtate he deſcribed, and illuſtrated what he had ſaid by this ſimile. "A picture, to poſſeſs harmony of colouring, ſhould look as if it was painted with one colour (ſuppoſe umber and white), and, when the chiaro-oſcuro was complete, the colour of each object ſhould be glazed over it."

This obſervation, from ſuch authority, was impreſſed with peculiar force on my mind; and if I can retrace its operations on a ſubject which has ſo long engaged my attention, I ſhould ſay Sir Joſhua's obſervation was the clue that guided me through all my experiments, and, I hope, will enable me to prove, that the beautiful and ſimple practice which he ſuggeſted as a ſimile, was literally the practice of that ſchool upon whoſe works his ideas of colouring were founded. At the ſame time I may obſerve, that the fact ſeems to have eluded his obſervation, or he would not have uſed it as a compariſon to ſimplify his deſcription of a practice which he thought both difficult and complex.

In the Newtonian doctrine of light and colours, it is believed that all colours are inherent in light, and are rendered viſible by the action of various bodies, which reflect particular rays, and abſorb the reſt. Without diſputing the truth of this doctrine, it is to be obſerved, that a painter muſt conſider the objects he repreſents as being analogous to the materials he uſes to repreſent them; and, in this view of the ſubject, colour is to be conſidered as a property inherent in bodies, which is rendered viſible by the contact of light, a colourleſs, or at leaſt a mono-coloured ſubſtance, and ſhadow the mere privation of light.

A picture may repreſent either a group o figures, or other objects, in a room, or any objects in the open air: whatever the ſituation may be, it repreſents certain objects in a given

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ſpace; poſſeſſing individually their peculiar colours; and generally expoſed to the operations of light. The quantity of light each can receive muſt depend upon its form, and its poſition reſpecting that part whence the light comes; for, in proportion as other parts recede from the light, the ſhadow becomes viſible: but ſhadow is nothing but privation of light, and privation of colour, in proportion as the light is diminiſhed. Some attention to theſe circumſtances will, perhaps, enable us to demonſtrate the truth of Sir Joſhua's poſition.

If a globe of one colour be expoſed in a painter's room, properly darkened, that part which is neareſt the light will partake of its colour; the next part will ſhew the true colour of the object: that which firſt recedes from the light will be a little obſcured, the next a little more, and ſo on progreſſively, till that part which is fartheſt from the light will loſe its colour, and appear equally dark with the ſhadieſt part of the room. Now we know this globe is of one uniform colour; the variations we ſee in different parts of it are only deceptions, occaſioned by the acceſſion of light in ſome parts, and the privation of it in others.

What is true of this one object and its parts, would be equally true of any number of objects, whatever their colours or relative ſituations might be: if they were placed together in the ſame room, each would poſſeſs its own individual colour, each would partake of the general light, in proportion to its ſituation, and of the general darkneſs in proportion as it recedes from the light. All this may be eaſily conceived; but the difficulty, and in the ordinary modes of painting a ſerious one it is, is to repreſent ſuch objects with the appearance of truth, and preſerve the harmony neceſſary to conſtitute a whole. The Venetian painters however, by whatever means they obtained their knowledge, diſcovered a method ſo ſimple, that perhaps no other can produce ſuch brilliant effects, and undoubtedly not with facility and certainty at all comparable with theirs.

The artiſt will remark that, in deſcribing the whole of the Venetian method of painting, I have ſaid nothing of the manner of producing thoſe demi-tints which conduce ſo much to the brilliancy of a picture, which are ſo difficult to execute, and in which he moſt frequently fails. Thoſe tints are, in the ordinary modes of painting, produced by the mixture of black, grey, blue, or brown (according to the judgment of the artiſt), with the local colours of the objects. It is theſe tints which, from their being made with ſuch colours, it is difficult to get clear, and which never are ſo clear in any other as in the Venetian, and in ſome of the Flemiſh pictures, which are painted upon analogous principles. The fact is, that thoſe painters produced all ſuch tints without the admixture of any colour to repreſent them, and by a method ſo like that by which they are produced in nature, that this circumſtance alone enſures a degree of brightneſs to their colours, and of harmony to their ſhadows, that it is perhaps impoſſible to produce, in an equal degree, by any other mode of painting.

It is a ſingular fact, which I have not ſkill in phyſics to be able to account for, though by numerous experiments I have aſcertained beyond contradiction, that if upon any degree of brown, between the deepeſt and the lighteſt brown yellow, we paint pure white, in gradations, from the ſolid body to the lighteſt tint that can be laid on, *all the tints between the ſolid white and the ground will appear to be* GREY, intenſe in proportion to the depth of the ground, and the thinneſs of the white laid upon it. But in every caſe all the tints laid upon one ground will harmonize with each other, and form one connected chain (if I may uſe the expreſſion), which will perfectly unite the higheſt light with the darkeſt ſhade.

If then we examine the component ſubſtances of a Venetian picture, we ſhall find the lighter parts conſiſt only of white, to repreſent the light; and of the local colours of the objects it repreſents, the demi-tints are imitated by an *ap-*

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pearance almoſt as deceptive as the ſimilar appearances in nature: but in every other method of painting, theſe demi-tints are produced by mixing ſome duſky colour with the local colours and the light. The compariſon of theſe methods will afford a demonſtrative reaſon why the Venetian muſt be brighter than any other mode of painting.

Having ſhewn, as near to a demonſtration as the nature of the ſubject will perhaps admit, why thoſe parts of a Venetian picture that are connected with light and colours are brighter than the correſponding parts of any other pictures, it remains to explain the cauſe of ſimilar ſuperiority in the darker parts of the ſame pictures.

It has been ſaid, with much confidence, that as white repreſents light, ſo black is the repreſentative of darkneſs. But though this may be true in phyſics, it certainly is not ſo in painting: for the painter's art is to repreſent objects as they *appear*, in point of colour, to be, not as they really are. Thus, if I know an object is perfectly black, and am to repreſent it as it appears to be at the diſtance of fifty feet, black from the pallet will not produce a good imitation of it, becauſe the interpoſition of fifty feet of the atmoſphere will cauſe it to appear of a colour different from what it really is; and *vice verſa*, if we go into a cavern, a cellar, or a room, ſo darkened that the colour of no object can be diſtinctly ſeen, and if we there hold any ſolid black ſubſtance near to the eye, the difference will be viſible at once; the black object will be immediately diſtinguiſhed, by its ſolidity and colour, from the ſurrounding ſpace, and ſuch remote objects as may be obſcurely viſible through it. Theſe objects actually poſſeſs their individual colours, and only appear indiſtinctly from the abſence of light. The black object may appear ſolid, and of that colour, from its proximity to the eye; but the circumjacent ones will appear of a colour perfectly diſtinct from it, more or leſs tranſparent, in proportion to their diſtance from the eye, and ſhewing a portion of their individual colours, according to the quantity of ill-defined light that may be admitted. Thus we fee (if I may venture to mention fo notorious a truifm), that fhadows are nothing real; they only feem to exift in the abfence of light, and give to objects an ill-defined appearance, diftinct from, though in fome inftances mixed with, light and colours in different degrees: but as the painter muft reprefent this *appearance* by fomething *real*, he chooses the colours moft analogous, viz. browns, and the moft tranfparent of their clafs, to reprefent this tranfparent, but imperfectly defined appearance in nature.

It has been fuppofed that the Venetian painters had fome peculiarly rich and tranfparent brown colour, which is feen to pervade all the works of that fchool; the effect of which no modern artift has been able to imitate, and which therefore is fuppofed to have been loft. It is not very probable that a colour fo common, as to pervade the works of the worft as well as of the beft artifts of that fchool, fhould be fo unaccountably loft; and, as the effect attributed to it may be eafily produced by the mode of painting I have defcribed, it is not unreafonable to conclude that this much-lamented colour has never exifted.

It is well known that chalk, and other earths of the fame kind, lofe, when wetted, much of their whitenefs, and become femi-tranfparent: it is equally certain, that if umber or other earths are mixed with chalk, and faturated with varnifh after they are laid in the cloth, they in like manner become diaphanous, and are infinitely more brilliant than the fame colours can be when mixed with white lead and oil. This feems, on good grounds, to have been the bafis of the Venetian method of painting, and all its peculiar effects; at leaft if I may draw any conclufion from the numerous experiments I have made. But if artifts, whofe talents will enable them to repeat thofe experiments to the beft advantage, fhould be induced to do fo, the fact will be determined in the moft fatisfactory manner.

I may now be permitted to ſay, it is difficult, if not impoſſible, to conceive a theory more ſimple, more beautiful, or more true, than that of Sir Joſhua Reynolds. It is certainly impoſſible to form a practice more ſimple, or more conformable to that theory, than the one I have deſcribed, as will be evident on recapitulating the particulars.

The artiſt, having determined what hue ſhould pervade his picture, formed his ground with that colour prepared in diſtemper: upon this the ſubject was drawn, and the darker ſhades painted in with tranſparent colours, which ſunk into the ground: with pure white he then painted in all the lights and demi-tints, and, laſtly, glazed in the colours, each in its place. Upon applying the varniſh, the darker ſhades were, as to body, incorporated with the ground; and thus, though different in colour, appeared thinner and more tranſparent than any colours could be when laid upon any ground: the full effect of every colour was brought out, and the picture was complete.

Whoever has been accuſtomed to paint, or to mark the progreſs of painting in the common way, and will reflect on the practice of the method I have deſcribed, by artiſts who had been brought up to it, muſt ſee that ſuch artiſts would paint with a degree of facility, expedition, and certainty, as to effect, that could never be equalled in the ordinary way of painting in oil: beſides, it will be evident that an artiſt would not only paint a picture himſelf with more facility, but, if he had occaſion, could employ a number of ſubordinate artiſts upon large works, and put thoſe works out of hand with more uniformity, as to merit and effect, than if he were to employ ſuch aſſiſtants in ſimilar works if they were to be painted in the common way.

I am ſenſible how little attention will, and perhaps ought to be paid to obſervations on painting, if made by thoſe who are not profeſſionally artiſts: for practical men acquire a kind of knowledge that can never be obtained in any other way; but at the ſame time they contract prejudices that often prevent them from fully inveſtigating any novelty in practice that may be offered to their notice. The ſpeculative man, on the contrary, who inveſtigates the properties of matter, unſhackled by practical prejudices, and with ideas purely chemical or philoſophical, will be more likely to aſcertain all the facts relative to any theory that may become the object of enquiry. In this way I hope I have proceeded in this inveſtigation. I have endeavoured to conſider pictures as maſſes of matter, poſſeſſing the properties, but differing from each other in degree of brilliancy, tranſparency, and duration. I have endeavoured to aſcertain the cauſes of this difference, with what ſucceſs the Society will determine, and with what utility muſt be hereafter aſcertained by the practice of thoſe for whoſe uſe the inveſtigation was intended.

I ought, perhaps, here to take leave of the ſubject; but as I have been induced to ſubmit to the Society's notice an attempt at painting, it may be expected that I ſhould give an account of the manner in which the pictures I have ſent were painted.

I have already mentioned, that there are ſome difficulties in the method of painting I have deſcribed, as being that of the old artiſts, and which would form objections of conſiderable force to the practice of it by artiſts who are well acquainted with the uſual modes of painting: theſe difficulties are, firſt, the ground abſorbs the oil from the colours ſo faſt, that they are not ſo manageable as in oil-painting; ſecondly, the effect of the picture is not ſeen till the finiſhing varniſh is laid on; and thirdly, as the effect is not ſeen till the picture is finiſhed, it will ſometimes diſappoint the artiſt, and in that caſe it will be difficult, if at all practicable, to alter it.

As I believe the proceſs I have deſcribed in the beginning of this paper is ſimilar to that of Miſs Provis, the artiſts who are acquainted with her receipe can aſcertain whether my conjectures on this ſubject are right or not. I am certain at at leaſt that theſe difficulties occurred in my attempts to paint, and to obviate them I adopted the following proceſs.

I prepared the ground in diſtemper, and painted the dark parts in the way I have deſcribed; I then varniſhed the ground with the copal oil-varniſh, till it was fully ſaturated, and by this means the full effect of that part of the picture was ſeen: upon this I painted the lighter parts with white, uſing much of the vehicle where the colour was thin, and little in the ſolid parts, leaving the white in them dead: by this means I underſtood the effect of my chiaro-oſcuro, as I ſaw the effect of the demi-tints nearly as well as when the picture was finiſhed.

Upon this I glazed the colours, in the way I have deſcribed in the beginning of this paper, and finiſhed the picture. I often found (probably from want of practice) that the effect was different from what I intended, as the effect of the colours, added to that of the chiaro-oſcuro, produced an eſſential alteration in the whole: as I took care in general that the defect did not ariſe from too much white, I added more where it was deficient, and glazed freſh colours over it, which united perfectly with what had been done before, and did not give the appearance of a mended picture. If the defect was from too much white, I glazed on it a colour ſimilar to that of the ground, painted with freſh white upon that, and glazed the proper colours over it. In this way I found I could alter the picture, but not ſo well as in the former caſe.

I found I could, when neceſſary, increaſe the effect of the picture, by painting on the principal maſs or maſſes of light with the local colours, only mixed with white; as this practice brought thoſe parts more forward, by making them appear ſolid, and thus contraſting them with the tranſparency of the reſt of the picture. In this way I found I could uſe the colours tempered with copal varniſh without difficulty; and I believe, that if I had been accuſtomed to paint large pictures, I could have painted one as large as life, as easily as either of those I have submitted to the Society's inspection.

XIV. *Some Account of the Travels of the two French Naturalists* BRUGUIERE *and* OLIVIER. *From* La Decade Philosophique, *No. VII.* 1798.

IN the year 1793, during the ministry of Roland, Citizens Bruguiere and Olivier, the first known by a work upon shells and researches respecting microscopic animals, and the second by a history of insects, were sent at the expence of government to the eastern parts of Asia. They were to traverse the Archipelago, Greece, Turkey, Persia, &c. for the purpose of making discoveries in natural history, and of collecting facts and observations respecting that science. Their mission extended to the arts and the sciences in general; and they were instructed to procure every information they could in regard to the agriculture and political economy of the countries through which they might travel. Soon after their departure, however, by the unsettled state of the French government, they were left destitute of its assistance; but their love for natural history supported them under this misfortune. They continued their journey, made valuable collections while traversing deserts and mountains, studied the manners of the people, and endeavoured as far as lay in their power to gratify the wishes of naturalists, and of those fond of the arts and sciences. After five years labour they were at length on their return home, and had happily arrived at Ancona, when C. Bruguiere was snatched by death from his friends and the rewards which awaited him in France. This loss is announced by C. Olivier to C. Thouin, professor at the museum of natural history, in the following letter, which contains also some details respecting the success of a tour which must be interesting to the public.

Genoa,

Genoa, Brumaire 8th, Year VII.

Citizen,

Cit. Bruguiere, after having escaped the dangers of the sea, and being almost recovered from his fatigue, fell ill at Ancona on the very day of our arrival; and I had the misfortue to lose a friend, the companion of my travels, on the eleventh day of his illness.

I can hardly find words to express with what painful sensations I was affected by this unexpected death.

Cit. Bruguiere had kept his health during the course of our travels through the islands of the Archipelago, and even in Egypt, because the principal part of them had been performed at sea, and because I alone undertook all that part which required a greater degree of fatigue; but when we quitted the coasts of Syria to penetrate farther into the country, and when we joined a caravan, which rendered it necessary for us to travel thirty or forty days successively without resting, C. Bruguiere's health became so deranged, that several months repose at the court of Persia was not sufficient to re-establish it. After staying, however, six months at Bagdad, Bruguiere found himself in a condition to traverse the desert; and though the season was already very hot, our journey was exceedingly pleasant, on account of the precaution which he took to travel in a kind of carriage. As for me, I continued to ride on horseback, because I could readily dismount in order to collect plants, seeds, and other objects, and could again soon rejoin the caravan; to lose sight of which was often attended with danger.

Fatigue, however, was not the only cause of the continual illness of Bruguiere while in Persia. The want of wine contributed greatly towards it on many occasions, especially as the water in general is brackish, and of a purgative quality. The chemists will easily give an explanation of this circumstance, when I have communicated to them the curious observations I have made on that subject. I held out better than

than Bruguiere, becauſe I was younger, more habituated to bodily exerciſe, and accuſtomed to drink water.

We ſpent ſome time on the unhealthful coaſt of Syria, waiting for a veſſel to convey us to Europe. We even traverſed the iſland of Cyprus without any accident, during the moſt dangerous ſeaſon of the year, and arrived at the coaſt of Caramania, with an intention of traverſing Aſia Minor. As the Engliſh and Algerines infeſted the Levant ſeas, we had with us effects too valuable to be expoſed to danger. This voyage was leſs fatal to Bruguiere, and will be highly valuable to botaniſts; for, beſides various kinds of ſeeds, they will ſee the fruit of the wild plum, which we found very common in Iconium, as far as the environs of Mount Olympus. This tree does not differ from the cultivated. Its fruit, a little larger than the Damaſcus plum, is yellowiſh, with a greater or leſs tinge of red. It is tartiſh, ſomewhat ſour when not fully ripe, but in other reſpects perfectly ſimilar to our ſmall white plums.

During the forced ſtay, which we were in ſome meaſure obliged to make at Conſtantinople, to arrange our ſcattered collection, and to wait for a ſafe conveyance, Bruguiere recovered, if not his former looks, at leaſt a pretty good ſtate of health. Our voyage to Athens, and afterwards to Corfu acroſs the iſthmus of Corinth, and as far as Ancona, was very agreeable, becauſe we had for fellow-travellers men of intelligence.

I accompanied the collection as far as Milan, from which I diſpatched it to Paris. It will no doubt be ſuperfluous to enumerate to you the very valuable objects which I have procured, conſiſting of ſeeds, fruits, drugs, plants, quadrupeds, reptiles, inſects, &c.

XV. *On a New Musical Instrument invented by Dr.* Chladni; *with some Experiments on the Vibrations of Sonorous Bodies.*

IN the month of February last, Dr. Chladni of Wittenberg, well known by his various publications on philosophical subjects, and particularly his experiments on sound, performed before a numerous assembly at Vienna, on a new instrument he has invented, and to which he gives the name of *Euphon*. This instrument has nothing in common with the *Harmonica* but the glass. It consists of forty-one immoveable parallel cylinders of glass, of equal length and thickness. Its construction, tone, and the method of playing it, are totally different from those of the Harmonica. At the same time Dr. Chladni made several curious experiments on the vibrations of sonorous bodies, by which he shewed that sand or saw-dust, strewed over these bodies while vibrating, forms different regular figures, according to circumstances. As it may afford satisfaction to our philosophical readers to know the manner in which these experiments may be partly repeated, we shall subjoin the following short account: Take a square piece of glass, pretty thin, such as that used for windows, about four or five inches over, or even more. Smooth it at the edges on a grinding-stone; strew a little saw-dust over its surface, and lay hold of it gently with the thumb and fore-finger of the left-hand, supposing that you lay hold of it by the middle. With the right-hand rub a violin bow softly against one of the edges of the glass, drawing it either up or down, in a direction almost perpendicular to its surface, and you will then see a tremulous movement and the whole dust leap about. If the bow is exactly in the middle of one of the sides, the dust will arrange itself almost in the direction of the two diagonals, dividing the square into four isosceles triangles. If the bow be applied at a quarter only of the

distance

diftance of the one corner from the other, the duft will arrange itfelf in fuch a manner as to be found in the two diameters of the fquare, dividing it into four equal fquares. At other times, if the bow deviates a little, it forms a figure like a double C, when the two letters are joined back to back. If the fquare be held by the two extremities of the diameter, oppofite to that againft which the bow is applied, the duft will form a kind of oval, one of the axes of which will be the fame diameter. If the glafs be of a circular figure and be held by the middle, the duft will arrange itfelf in fuch a manner as to form the fix radii of a regular hexagon. In our next number we fhall prefent our readers with fome farther particulars on this interefting fubject.

XVI. *Account of an extraordinary large Oriental Pearly Excrefcence, which was offered for Sale fome Years ago at Peterfburgh. From* Neue Nordifche Beytrage, *by Profeffor* Pallas, *Vol. II.*

THIS remarkable production, which was brought from Holland to Peterfburg in the year 1779 in order to be fold, is reprefented fig. 3, Plate VIII. The poffeffor of it at that time was Mr. Daniel Gildemeefter Janz, of Amfterdam, into whofe hands it came by bequeft from one Mr. Sander, an agent of Deux-Ponts, and had been purchafed in India for 50,000 florins (4,500l. fterling). It was offered for fale, under the name of the *Sleeping Lion*, at double the above fum. It weighed 578 carats, and was quite perfect in its fhape, as feen in the figure; fo that its name feems to have been given it not improperly. The other fide was fomewhat flatter, and beautifully marked with zig-zag ftripes *(guillofchirt)*: the colour and fplendour were alfo remarkably fine; fo that this production feems entitled to a place in the firft clafs of pearly excrefcences; and on account of its fize deferves to be made known as a curiofity in

natural

natural hiſtory; though inferior in ſome reſpects to many much ſmaller but regular pearls, ſuch as that in the poſſeſſion of the late Empreſs of Ruſſia, which was worn by Charles XII. in his hat, and afterwards given to his ſiſter as a preſent on her marriage, and which is accompanied with two other pearls not much ſmaller; and the celebrated pearl of the King of Spain, called *La Peregrina* *, purchaſed by Philip II. from a traveller, which weighs 25 carats; is valued at 150,000 dollars, and, in all probability, is the firſt in the world. The above pearly excreſcence ſeemed to have been attached by the ſmall end to a hole in the mother ſhell. On the reſt of the ſurface there was not the leaſt appearance of art having been uſed to give it its ſingular form.

XVII. *Deſcription of the Apparatus invented by Mr.* John Cuthbertson *for producing Water by the Combuſtion of Hydrogen Gas in Oxygen Gas.*

A B C D (Fig. 1, Plate VIII.) repreſents the inſtrument and the veſſel *a b c d* in which it ſtands. The glaſs bottle A D, which can contain about 1000 cubic inches of water, has a braſs cap which ſcrews off at A, and is perforated at the bottom, in which the piece *e f* (fig. 2.) is ſcrewed. B and C, two glaſs receivers, with proper mountings, the tops of which paſs through E F, a ſtraight bar of braſs, are made faſt to the bar by female ſcrews put on theſe tops, which are perforated perpendicularly, and have alſo a ſide-hole correſponding with a hole in the braſs bar and with two holes in *e f* communicating with the large bottle. *m* and *n* are two ſtop-cocks in the braſs bar, to ſhut or open the communication between the receivers and the bottle. F R and E N are two flat pieces of braſs made faſt to the veſſel containing the receivers, and which is

* It was a production of the pearl-fiſhery, near the ſmall iſland Margarita, on the coaſt of Comana.

nearly

nearly filled with water, by means of ſcrews at *a* and *b*. O, a metallic wire, is made faſt to the braſs cap A: the lower part of this wire is made of platina, and is brought as near as poſſible to the piece *e f*, but not to touch it. When the inſtrument is to be uſed, the ſtop-cocks being kept ſhut, the large veſſel muſt be detached from the receivers, by unſcrewing the female ſcrews Q Q, filled with oxygen gas by any of the common methods, and again put in its place. The receiver B, which has a hole in its ſide at *o*, muſt then be filled with oxygen gas, and C with hydrogen; and, while electric ſparks are made to paſs from the wire O to the aperture *e*, the cock *n* muſt be opened, by degrees, till the gas takes fire. Stop the electric ſparks and regulate the flame by turning the cock one way or the other. The cock *m*, which ſupplies the oxygen gas, muſt be kept quite open, and the receivers be kept ſupplied, C to its lip and B to the hole *o*, by known meaſures of the gaſes, from time to time, while the proceſs is continued. The paſſage that leads from the hydrogen gas to the large veſſel is made ſmaller than that from the oxygen, that the gas may enter in a very ſmall ſtream. The hole in the ſide of the receiver B is for the purpoſe of preventing more oxygen gas being introduced than will fill it to that point, that the column of water may always be heavier upon the hydrogen gas, which has to force its way through a ſmaller aperture than the oxygen gas. The ſame end would be gained by making B only about half the depth of C. Both theſe receivers are open below, to receive the gas introduced under them.

NEW

NEW PUBLICATIONS.

Kong. Vetenskaps Academiens Nya Handlingar, &c. New Tranſactions of the Royal Academy of Sciences at Stockholm, for the Year 1797. Vol. XVII. Part Second, with two Plates. Part Third, with three Plates.

THE ſecond part of this work contains the following papers: I. Melanderhjelm's continuation of the Hiſtory of Phyſical Aſtronomy. The author here mentions the attempts of the Academy of Paris, in 1730, to revive the ſyſtem of Deſcartes in oppoſition to Newton's ſyſtem of gravitation, and particularly what John Bernouilli ſays in his New Thoughts on the Syſtem of Deſcartes, and the manner of deducing from it the orbits and aphelia of the planets, together with the objections which he makes to Newton. D'Alembert ſhewed, in his Treatiſe on the Equilibrium and Movement of Fluids, the faults committed by Bernouilli, and proved that, according to Bernouilli's ſyſtem, all the parts of ſuch a vortex muſt complete the revolution of their orbits at the ſame time; and that the planets, if they moved round the ſun in ſuch vortices, muſt deſcribe their orbits in the ſame period; which, however, is contrary to nature. As Bernouilli himſelf found that the velocity of ſuch vortices did not agree with Kepler's rules, founded on obſervation, he endeavoured to explain this difference, but fell into the ſame errors as before. His new hypotheſis alſo, for explaining the motion of the aphelia, was not agreeable to nature; and Bouguer as well as D'Alembert ſhewed that the elliptic orbits of the planets could not agree with Deſcartes's ſyſtem of vortices, and that this ſyſtem could not ſerve to explain their motion.—II. Experiments with *Pietra Fongaia (lapis fungifer)*, and Obſervations on its Nature, by F. A. Gadd.—This ſpecies of earth, found near Rome, Naples and Florence, was firſt diſcovered by Ferber. Near Naples it is found in the chalk-hills, like a white ſtalactites intermixed with a great many ſine roots of ſhrubs; and near Florence there is a ſpecies of it conſiſting of hardened turf, which is dug up near volcanoes. The author made experiments with a piece procured from Italy, and found that 100 parts contain from 45 to 46 ſiliceous earth, 23 argillaceous earth, 7 calcareous earth, and 20 calx of iron, with ſome white magneſia and vegetable alkali. It is well known, that when this friable ſpecies of ſtone is preſerved in cellars and moiſtened with water, it produces abundance of eatable muſhrooms, which, in Italy, are highly eſteemed and brought to the firſt tables. The author conſiders it more beneficial to cultivate morels inſtead of theſe in Sweden, and gives an account of the method.—III. On the Art of hardening Copper, by P. J. Hjelm. Copper, without doubt, was earlier known and employed than iron; and ſome ancient weapons of great hardneſs have given riſe to reſearches in regard to the art of hardening it. The attempts, however, to harden it in the ſame manner as ſteel, all miſcarried, and the art was conſidered as loſt. It was then tried whether this object could not be accompliſhed by mixing it with other metals. Monnet believed that arſenic had been uſed by the ancients for this purpoſe; Geoffroy, iron; Mongez and Dize, tin. The laſt opinion is ſtrengthened by the experiments of M. Hjelm, who having accurately examined the blade of a dagger diſcovered in the earth, found that it conſiſted of 83 copper and 16 tin. Of a like mixture of both metals he made blades for knives, which in hardneſs approached very near to the former.—IV. New and little-known Species of Lichens, Fifth Continuation, by E. Acharius. The author here treats of the *Phyſcia foliis membranaceis, tubuloſis, vel longitudinaliter lacunoſe canaliculatis*, to which belong, 1. *Lichen Iſlandicus*; *membranaceus, adſcendens, multifido-laciniatus, ciliatus, canaliculatus, viridi-caſtaneus, ſcutellis ſeſſilibus planis concoloribus*. This ſpecies, beſt known of all on account of its medicinal and nouriſhing qualities, grows abundantly in Sweden. In foreſts covered with moſs it grows to the greateſt ſize on the

cytiſus

cytisus laburnum, and on stones it acquires fine leaves. On the edges it is furnished with small stiff bristles, and on the sides has small excrescences like the head of a pin besprinkled with white meal. 2. *Lichen cucullatus*; *membranaceus erectus, glaber, incisus, tubuloso-canaliculatus, albus, basi purpurascens, scutellis posticis cucullatis fuscis.* It is often confounded with the *Lichen nivalis.* 3. *Lichen nivalis*; *membranaceus, adscendens, laciniatus, crispus, lacunosus, albus basi flavescens.* Most botanists have considered this as the *Lichen cucullatus.* It grows farther towards the north. The organs of fructification are little known. 4. *Lichen tenellus*; *membranaceus, decumbens laciniatus, laciniis apice ciliatis obtusis, tubuloso-fornicatis, adscendentibus, cinerascens*; *scutellis sessilibus, lateralibus, nigrocæsiis.* It has long been considered as a variety of the *L. ciliaris*; from which, however, it is very different. 5. *Lichen ciliaris*; *membranaceus, adscendens, linearis, laciniatus, ciliatus viridi-glaucus, subtus albus, canaliculatus, scutellis terminalibus nigrocæsiis.* It grows particularly on the ash. 6. *Lichen furfuraceus*; *membranaceus, decumbens laciniatus, pulverulentus cinereus, subtus canaliculatus violaceo-niger, scutellis sparsis ampullaceis rubris.* It grows on the fir, birch, and stones; contains abundance of inflammable particles, and resin.—V. Description of the *Picus Javanensis*, a new Bird from Java, by S. J. Liungh; with a Figure. It is a kind of woodpecker with three toes, the characters of which are as follow: *Picus Javanensis, vertice cristato nigro albo maculato, collo subtus albo, lineis sex nigris, dorso superius flavo, inferius cinnabarito, pedibus tri-digitatis.*—VI. Description of an Apparatus for planing Ship Pins, invented and employed at Carlscrona, in 1784, by C. F. Bouke, with a figure. This machine is so constructed that it will make these pins either round or square. Two workmen in a day can make with it four or five times as many as by the usual apparatus with a hand-plane. At Carlscrona, where 35000 such nails of oak or fir are used every year, this machine causes a saving of $666\frac{2}{7}$ rix-

dollars

dollars in point of labour.—VII. Obſervations on the Strength of the Walls of Fortifications, by A. Sjöberg. The author prefers the theory of Stahlſverd, in regard to fortification, to thoſe of Lorgna, Delanges, and Woltmann: a more accurate account of this theory has been given in Bohm's Magazine for Engineers; but Stahlſverd is too ſhort, and in ſome parts he has not ſufficiently explained his calculations. He has alſo employed fluxions ſometimes with long converging ſeries, though it might have been poſſible by other methods to approach nearer to the object. M. Sjöberg, therefore, has begun here to improve and explain this theory.—VIII. Farther Examination of the Black Stone of Ytterby, and the peculiar Earth found in it, by A. G. Ekeberg. The author continued the experiments made by Gadolin on this ſubject, and found in 100 parts $47\frac{1}{2}$ of a peculiar earth, different from all the other kinds of earth hitherto known, and to which he gives the name of Ytter earth, *Yttrica.* The ſtone itſelf he calls Ytter ſtone.

In the third part we find the following papers: I. Some new Moths of the Genus of the *Tortrices*, by C. P. Thunberg, ſuch as, 1. *Tortrix Fahlbergiana: alis baſi cinereis apice purpureis; ſtrigis albidis*; from the iſland of St. Bartholomew in the Weſt Indies. 2. *T. Stickmanniana, alis externe fuſcis interne albis, linea media ferruginea abbreviata.* 3. *T. Liungbiana: alis albis punctis fuſcis irroratis; faſciis tribus fuſcis.* 4. *T. Achariana: alis plumbeis, faſciis duabus nigris, inferioribus margine albis.* 5. *T. Blomiana: alis plumbeis ſuperioribus, arcu faſciaque abbreviata obliqua atra.* 6. *T. Naezeniana, alis purpureo-aureis; maculis octo flavis, antennis annulatis.* All theſe are found in Sweden, and have been named after the Swediſh naturaliſts by whom they were diſcovered. II. *Weſtringia*, a new Genus of Plants deſcribed by J. E. Smith, M.D. Preſident of the Linnæan Society of London. It was firſt diſcovered in New Holland by Dr. Solander, who called it *Cunila fruticoſa*, though it is totally different, and has rather a ſimilarity to roſemary, from which,

which, however, it is different alſo. Its peculiar character is: *Calyx ſemiquinquefidus, pentagonus; corolla reſupinata, limbo quadrifido, lobo longiore erecto, bipartito: Stamina diſtantia, duo breviora (inferiora) abortiva.* The author aſſigns it rather to the *didynamia-angioſpermia*, immediately after the *teucrium*, than to the *diandria*. III. Experiments on the method of preparing, from moſt of the lichens, dyes for giving beautiful high colours to ſilk and wool. By D. Weſtring, M.D. Sixth continuation. Of theſe lichens, fit for the purpoſes of dyeing, there are eleven or twelve kinds, a great many of which grow in Sweden, ſo that large quantities of them might be collected every year. They afford excellent nouriſhment to goats. In ſome places they are employed as ſtuffing for chairs and ſophas, in the room of horſe hair, &c. ſuch, for example, as the *Lich. chalybeiformis, barbatus* and *plicatus*. Some kinds, ſuch as the *L. barbatus* and *plicatus*, are uſed by the common people as medicine in the hooping-cough, hemorrhages, jaundice, &c. for which the *L. hirtus* is alſo uſed. The author was at great pains to examine theſe different ſpecies, and made upwards of two hundred experiments with them in dyeing, but particularly with *L. jubatus; filamentoſus pendulus axillis compreſſis: L. chalybeiformis; filamentoſus ſubramoſus decumbens, implicato-flexuoſus; and L. lanatus, filamentoſus, ramoſiſſimus, decumbens, implicatus, opacus.* The firſt gives a kind of orange-red dye (*color aurantiacus*), and particularly to yarn; the ſecond does not yield ſo good a dye; and the third is of no uſe for dyeing. IV. Deſcription of new and little known ſpecies of lichens, by E. Acharius. Sixth continuation. The author here treats of the *phyſcia foliis ſubcartilagineis, planis aut convexiuſculis*, of which figures are given, and among which, beſides thoſe mentioned in the preceding part, the author enumerates, 7. *Lichen prunaſtri: ſubcoriaceus mollis erectiuſculus lineari laciniatus planus rugoſo-lacunoſus, ſubtus albiſſimus; ſcutellis lateralibus concavis fuſcis.* 8. *Lich. fraxineus; cartilagineo-membranaceus erectus planus, lanceolatus*

latus rugoso-lacunosus cinereus; scutellis sparsis lateralibus, marginalibusque pallidis. 9. *Lich. fastigiatus: subcartilagineus erectus caespitosus ramosus; ramis fastigiatis teretiusculis lacunosis sursum incrassatis subinermibus; scutellis sessilibus terminalibus.* 10. *Lich. calicaris: subcartilagineus erectus linearis ramoso-pinnatifidus, compressus lacunulosus pallidus; scutellis pedunculatis convexis sparsis.* V. Farther examination of Stählsverd's theory respecting the strength of the walls of fortifications, by A. Sjöberg, with figures. VI. Geometrical essay on the motion of bodies drawn from or towards a given point in the inverse double ratio of the distance from that point, by J. Svanberg. Neither of these papers, which are to be continued, will admit of abridgement.

Afhandling om. Telegrapher och försök til en ny inrättning däras, &c. A Treatise on Telegraphs, and a new Construction of one, by A. N. Edelcrantz, Counsellor of the Chancery, one of the Eighteen of the Swedish Academy, &c. Stockholm, 1796. 95. p. 8. with five copper-plates and three tables.

When people wish to transmit intelligence to others, at a distance, in a quicker manner than by letters or messengers, it can be done only by signals, but two different ways: either by single signals, which, according to previous agreement, convey whole ideas; or by several successive signals, which, by representing letters and words, answer the same purpose. The first kind of signals were employed in the earliest periods, and some of them were suited to the ear as well as to the eye. For the eye the ancients employed fires and smoke, torches, flags, and, in modern times, sky-rockets have been used. For the ear they employed drums and trumpets; and, since the invention of gun-powder, the firing of cannon has been applied to the like use. But even all these are incapable of expressing what could be communicated by speech and writing; and to accomplish that object, by signs capable

of

of expreffing all the poffible variations and combinations of the letters of the alphabet, forms, in a proper fenfe, the true telegraphic art. Even the fignals at fea, as they extend only to particular circumftances, are, when compared to fignals by letters, only a kind of hieroglyphics.

The proper telegraphic art, however, was not unknown to the ancients. The Greeks and the Romans, for fignals, made ufe of pots filled with lighted twigs and ftraw, over which they poured oil; and thefe being placed in certain rows, expreffed certain letters, according to the order in which each row was lighted. Polybius mentions a method in which the letters of the alphabet were divided into five rows; and by means of a certain number of torches, raifed on the right and left, the number of the row, and the letter in the row, could be expreffed. The *fteganographia tritheomiana* of a benedictine monk, in the 15th century, feems to have been fomething of the fame kind; but the firft experiment, after the manner of the Greeks, is defcribed by Kircher in his *Ars magna lucis et umbræ*, under the title of *Cryptogamia catoptrica*. It was, however, imperfect, and could be employed only at a certain diftance. Schott in his *Technica curiofa* propofes, from an anonymous author, to erect pofts upon an eminence, fo as to be diftinguifhed through a telefcope, and on which proper fignals could be elevated as might be neceffary. Kefsler, in his Concealed Arts, advifes characters to be cut out on the bottom of a cafk, fo as to appear luminous; and Hook propofes certain figures, the form of which could be eafily changed, to be fufpended on a wooden frame. Gautkey recommends tubes fome thoufand fathoms in length; Guyat, tables with the letters cut out in them; and Paulian, in his *Dictionnaire de Phyfique*, a tranfparent figure confifting of one perpendicular and three horizontal ftripes forming ten compartments, each of which, by removing boards from behind, can be rendered vifible or invifible. The inventions of Linguet, Bergftraffer, Chappe, Burja, Bockman, and Achard, were all much on the fame

plan.

plan. After this historical introduction, the author describes the properties of a good telegraph. These are: 1st, perfection in regard to the combination of the characters and the property of the signs; 2d, perfection in regard to easiness of movement and use. These properties, the author says, are united in that of Chappe. His telegraph consists of three arms, the inclination of which towards each other, towards the perpendicular post, and towards the horizon, give certain positions that represent the old Runic letters, or the oldest alphabets, and by their combinations 256 positions or particular signs are possible. In September 1794, the author began to make experiments in Sweden, before he was acquainted with a complete description of the French telegraph; and he contrived various forms, some like the French and some entirely different, till he at length fell upon that which he here describes, the combination and use of which are attended with great advantages. A description of it without the figures would require too much time. It is properly a sort of lattice with ten apertures in three vertical rows, which can be opened and shut by means of boards*, and which are capable of forming 1024 combinations or distinct signals. These, in order to be easily distinguished and repeated, are expressed by figures arranged in tables subjoined to the work; so that, with these 1024 signs, it is possible to represent 2097152 variations of the figures. For signals in the night-time a lamp is applied behind each hole, and covered or uncovered as may be necessary.

* This seems to be on the same principles with those adopted in England. EDIT.

INTEL-

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

ROYAL SOCIETY OF LONDON.

THE meetings which took place on the 6th and 13th instant were occupied by the reading of a paper on Vision, by Dr. Wilson, of which we find it impossible to give any abstract. At the latter meeting the Annual Register of Meteorological Observations was read to the Society.

At the meeting on the 20th, a paper was read containing experiments on vegetation in pure water, by Dr. Crell. He planted the seeds of sunflowers in some ferruginous sand which he had several years employed for sand heats, and which, he therefore says, could contain no carbon. The *pure* water was that with which his place of residence is supplied by pipes. The pot in which the seeds were planted was put into his library, which, being but seldom opened, *he* concludes, could therefore contain no carbonic acid gas (fixed air). Four of the seeds grew and flowered: the seeds of one of which were again reared in the same manner in the following year. The question put by Dr. Crell is: Whence do vegetables derive their nourishment? and particularly, whence comes the carbonaceous matter which constitutes so large a portion of their bulk? After some reasoning on the subject, the author concludes, that carbon is either deposited in plants by the light which falls upon them, and is therefore a constituent part of light, or that it is generated in them by its action.

The reader will naturally ask, How water coming from a common reservoir can be considered as pure? How sand which has been employed for the purposes of a sand heat for years, and consequently exposed to receive dust and small fragments of coals, can be free from carbon? And what sort of a room it must have been which could contain no carbonic acid gas in the atmospheric air with which it was filled, places but seldom opened being generally found to contain more of that gas than those which are better ventilated?

FRANCE.

The Society of Natural History at Bourdeaux has formed itself into a Society of the Sciences, Belles-Lettres and Arts; and, like the National Institute, is divided into three classes: 1st, Mathematical and physical sciences; 2d, Moral and political sciences; 3d, Literature and the fine arts.

The Society of Natural History at Paris, has given itself a new organization. In future it will assemble only once a month; but it has chosen an administration who will meet once every fortnight. This administration consists of six commissioners, Jussieu, Lamarck, Hauy, Fourcroy, Desfontaine and Lacepede, who have chosen six assistants: Ventinat, Brogniard, Leliere, Vauquelin, Celse and Millin. Cit. Sylvestre has been appointed treasurer, and Cit. Cuvier secretary. The rest of the Society is divided into two sections: one of members, each of whom engages to read a memoir annually; and the other of free associates, who are not obliged to perform any labour. The Society have published a volume of Memoirs in folio, under the title of *Acte de la société d'histoire naturelle*, and has erected a statue of Linnæus in the national garden of plants.

MISCELLANEOUS.

PRESENT STATE OF CHEMISTRY IN GERMANY.

As we have frequent occasion, in the course of this Magazine, to mention or make extracts from the works of different chemists on the Continent, and as they have not yet all entirely abandoned the old system, our chemical readers, we hope,

hope, will not be displeased with the following short account of the present state of chemistry in Germany, being an extract of a letter from Dr. Girtanner to Van Mons, dated Gottingen, Sept. 5, 1796, published this year, in one of the German Journals, with some observations by Van Mons.

"The system of chemistry in Germany has undergone a revolution. The existence of phlogiston is no longer defended, but by Gren (a man of distinguished talents, though obstinate), Westrumb, Gmelin and Crell. The three last have declared eternal war against the anti-phlogistic doctrine. Their enthusiasm even proceeds so far that, if we still lived in the age of martyrdom, they would not hesitate to suffer themselves to be burnt, in order to prove the existence of phlogiston in their bodies. Trommsdorf, who has embraced the new doctrine, still adheres, however, in some small points to the old. Göttling defends his new hypothesis. Among our young chemists, Scherer of Jena promises great things. He is a zealous follower of the French chemistry, a good experimenter, and possessed of great knowledge: there is nothing but the *res angusta domi* which prevents him from labouring and making new discoveries. Professor Mayer at Erlangen is a man of great talents, who to natural philosophy and chemistry unites a profound knowledge of the mathematics like Monge at Paris. Hermbstädt does every thing he can for the advancement of the new doctrine. The above is a faint sketch of the present state of chemistry in Germany.

"As my occupations have not permitted me to continue my experiments on phosphorus and alkalies, I am unwilling to communicate to you those I have made, until I repeat them: I will, however, venture to assure you, that phosphorus is a compound of azot and hydrogen. All phosphorus contains more or less carbon; but, in my opinion, that principle does not enter into its composition.

"I have proved that phosphorus may shine in azotic gas and carbonic acid gas by means of the water which these gases

gases contains, and which the phosphorus decomposes; as is proved by the phosphorated hydrogen gas obtained in these experiments. I explain by this the experiments of Göttling. I wait with impatience for the memoir you have announced, and in which you have proved that I was deceived in regard to the muriatic radical. I shall repeat the experiments; and whatever be the result, shall render homage to truth."

The following observations on the above letter have been published by Van Mons: "This letter might induce people to believe that the four chemists, of whom Girtanner speaks, still profess the principles of the theory of Stahl. On this subject I ought to undeceive those who have been prevented by the war from being fully acquainted with the progress of the new chemistry in Germany. That country has ceased to have among its chemical writers any partizan of the unqualified system of phlogiston, since I convinced them of the presence of oxygen in the oxyd of red mercury. They have all adopted the new doctrine without restriction, or with restrictions of very little consequence. Crell, Westrumb, Wiegleb, Trommsdorf, Gmelin, Richter, Leonardi, &c. in endeavouring to unite the new theory with the existence of phlogiston in combustible bodies, all admit it in general and all its consequences. They wish only to save themselves from the appearance of a complete defeat. Those who still adhere to the preservation of that agent, consider it as the basis of light, or as dormant light. This basis, abundantly contained in inflammable substances, when it meets and combines itself with caloric, constitutes luminous fire; which explains why combustible substances require a certain degree of heat before they are inflamed. This system, and the applications of it which follow, are the only points in which they differ from us: in all the other explanations they agree perfectly with our principles. We shall see how little influence these theories modified will have over the future progress of sound chemistry in Germany.

"Gren,

"Gren, as profound a philosopher as a chemist, a great mathematician and geometrician, no longer attaches any importance to the admission of a particular inflammable matter. His Foundations of the New Chemistry, the first volume of which he has just published, are entirely written according to the principles of the French system. In his Manual of Chemistry, printed two years ago, he gave the theory of oxygen along with that of phlogiston. He did almost the same thing, the preceding year, in the second edition of The Grounds of Natural Philosophy. A third edition of that work is now printing, in which he will give an account of the phenomena of that science according to the pure system of Lavoisier. His Journal of Natural Philosophy, of which eleven volumes have appeared, has always admitted indiscriminately articles for and against both theories. That Gren should so long doubt, can astonish those only who are ignorant, that to think for oneself gives birth to scepticism and diversity of opinions.

"Gmelin is exclusively employed, as we may say, with historical and technical chemistry. In the second edition of his Manual of Chemistry, as applied to the Arts, which he has just finished, he gives the little theory required in such a work according to the old principles; but in addressing himself to beginners, ought he not to speak in language that is known and suited to their comprehension? His Introduction to General Chemistry gives an account of the state and progress of the science in both theories.

"Westrumb gives also many articles of technical chemistry, which he treats of with a knowledge and discernment which denote a chemist well versed in the practical part of his art. His writings on pharmacy evidently shew that they are the work of a man who has seen much and reflected well on an art where a great deal still remains to be done. In both these kinds of labour he prefers facts to reasoning.

"Crell is still the editor of the Chemical Annals; a valuable collection, which has tended much to promote the cultivation

vation of chemiſtry in Germany; and in which he gives, with fidelity, not only the opinions, but even the language of the authors. He ſtill finds it difficult to adopt our principles; but at the age of that reſpectable literary veteran it is not eaſy to abandon old ideas. Beſides, Crell has among his ſubſcribers and correſpondents ſome diſciples of Stahl, whoſe ſupport he muſt endeavour to retain."

EARTHQUAKE IN SOUTH AMERICA.

A letter, dated Quito, February 20, 1797, contains the following particulars reſpecting this dreadful cataſtrophe, ſome account of which has already appeared in different gazettes:

"Hiſtory affords no example of a devaſtation like that which lately took place in the provinces of Taninga, Ambato, Riobamba, Alaoſi, part of Chimbo and Quito. Not a houſe has been left ſtanding: every thing is levelled with the ground. We are aſſured, that the volcano of Maas made a moſt dreadful eruption, and ſplit in two parts, which ſeparated from each other. An earthquake, which took place at the ſame time, ſhook the mountains with ſuch violence that they were daſhed againſt each other, and threw up ſometimes ſtones with clouds of duſt, and ſometimes ſtreams of burning lava, or water. The mountain Ygualata in falling threw out a ſtream of lava which rolled along with fiery waves, and which in its courſe totally deſtroyed Capalpi, San Andreas, Ouaono, Emlyies, Guanando, and ſeveral other places. The mountain Moya almoſt diſſolved into water, and ſwept away Pelile and the celebrated plantation of St. Ildephonſo, where a thouſand perſons periſhed. The mountain Euero fell on the village of the ſame name, without leaving a ſingle witneſs of this melancholy cataſtrophe. The mountain Yatagui fell upon Maſoro, and opened ſuch a dreadful gulph, that every thing, houſes, churches, and inhabitants, all but two perſons, were ſwallowed up by it. This place was converted into a bituminous lake, which emitted

emitted a ſulphureous vapour. The ruins are every where ſo great, that all the gold and ſilver of America will hardly be ſufficient to repair the devaſtation. The number of thoſe who have loſt their lives cannot be aſcertained; but it muſt be very conſiderable. The provinces of Riobamba, &c. have ſuffered moſt: in the laſt many died of hunger, and even of thirſt, as all the water was corrupted. In other diſtricts the ſhocks ſtill continue; and the lakes throw up flames. At Sambagna and Timba new rivers have burſt forth at different places."

SINGULAR MAGNETIC PHENOMENON.

In the *Reichſanzeiger*, a German periodical work, No. CCXXII. for 1797, it is ſaid, that a certain perſon having an artificial magnet ſuſpended from the wall of his ſtudy with a piece of iron adhering to it, remarked, for ſeveral years, that the flies in the room, though they frequently placed themſelves on other iron articles, never ſettled on the artificial magnet; and even that if any of theſe inſects approached it, they in a moment again removed from it to ſome diſtance. "It is worth the trouble," ſays Profeſſor Voigt, who repeats the ſame circumſtance in his Journal, "to make farther obſervations on this phenomenon; and, were it confirmed, to magnetiſe iron might be employed to preſerve it from being dirtied by flies. Perhaps it might be employed alſo for other purpoſes."

VENTILATION.

Dr. Van Marum has diſcovered a very ſimple method, proved by repeated experiments, of preſerving the air pure in large halls, theatres, hoſpitals, &c. The apparatus for this purpoſe is nothing but a common lamp, made according to Argand's conſtruction, ſuſpended from the roof of the hall and kept burning under a funnel, the tube of which riſes above the roof without, and is furniſhed with a ventilator. For his firſt experiment he filled his large laboratory with the ſmoke of oak ſhavings. In a few minutes after he lighted his lamp the whole ſmoke diſappeared, and the air was perfectly purified.

MEDICINE.

A letter from Dr. B. Lynde Oliver, of the ſtate of Maſſachuſetts in North America, to a medical gentleman in this country, who has favoured us with a peruſal of it, contains the following information, which may prove acceptable to practitioners:

"I have this ſeaſon," ſays he, "had great ſucceſs in exhibiting Dr. Wright's medicine, viz. Vinegar ſaturated with common marine ſalt, and diluted with thrice its quantity of hot water, in dyſentery. Dr. Perkins had the merit of introducing this compoſition in that particular diſeaſe. From the trials I have made of the efficacy of this medicine, I am almoſt inclined to believe that it will ſuperſede the uſe of all other remedies. I have ſeen patients apparently ſnatched by it from the jaws of death. I generally join a little laudanum with it, but firſt abate the violence of the diſeaſe by a few doſes of the mixture. Oftentimes the firſt doſe has given a favourable turn to the diſeaſe."

The following is a copy of Dr. Perkins's notice publiſhed on this ſubject:

A uſeful Treatment for the Dyſentery, and Scarlatina Anginoſa or Canker Raſh.

IN the courſe of an extenſive practice for about five years paſt, I have met with the moſt pleaſing ſucceſs in treating the dyſentery and ſcarlatina anginoſa; and as theſe complaints frequently extend their baneful ravages, I take pleaſure in communicating to the public a ſimple remedy, which, when judiciouſly uſed, has ſeldom failed of removing thoſe diſeaſes.

Saturate any quantity of the beſt vinegar with common marine ſalt; to one large table-ſpoonful of this ſolution, add four times the quantity of boiling water; let the patient take of this preparation, as hot as it can be ſwallowed, one ſpoon-

ful

ful once in half a minute until the whole is drank: this for an adult. The quantity may be varied according to the age, size, and constitution of the patient. If necessary, repeat the dose once in six or eight hours. Considerable evacuations I conceive to be not only unnecessary, but injurious, as they serve to debilitate and prolong the disease.

A tea of plantain, or some other cooling, simple drink, may be useful; and if a thirst for cyder be discovered, it may be gratified.

Carefully avoid keeping this preparation in vessels partaking of the qualities of lead *, as the poison produced by that means may prove dangerous.

The success of the remedy depends much on preparing and giving the dose, as above directed.—The simplicity of this treatment renders it the more valuable, as all persons have it in their power to avail themselves of its use.—I have found it useful in agues, diarrhœas, and the yellow fever.

DISTANCE OF COMETS FROM THE EARTH.

Mr. Proserpin, who in the years 1775 and 1785 published in the Transactions of the Swedish Academy of Sciences, papers on the least distance of comets from the earth, has published, in the XVIIth Vol. Part I. of the same work, a continuation of that subject, in which he gives a calculation of all those that have appeared since 1785. He enumerates the different comets observed by Saron, Mechain, Von Zach, Maskelyn and Bode, and marks their least distance from the earth in an annexed table. It appears from this paper, that none of these eleven comets can approach very near to the earth. That, even, which passes at the least distance, cannot approach nearer to it than about thirteen times the distance of the moon from the earth; and the two next, when nearest to us, are twenty or twenty-six times as far from the earth. Besides these, three only can

* This caution ought to be extended to some other metals also. EDIT.

approach nearer the earth than Venus; and two cannot approach so near as Saturn when at his greatest distance.

REMARKABLE INSTANCE OF LONGEVITY.

In a small village not far from Bergen in Norway, died in October 1797, Joseph Surrington, in the 160th year of his age. He retained the perfect use of his senses till the last hour of his life. The day before he died he assembled his family and divided his property amongst them. He had been several times married; and left behind him a young widow and several children. His eldest son is 103, and his youngest nine years of age. *Bayreuth Gazette*, No. 216. 1797.

Our readers are requested to make the following corrections in our last Number. Page 188, 5th line from the bottom, for *cured a pain*, read *diminished a pain*. Page 189, l. 9, after *merit of being*, insert *more than*.

THE

PHILOSOPHICAL MAGAZINE

JANUARY 1799.

I. *Observations on Fire-Balls and Hard Bodies which have fallen from the Atmosphere. By Dr.* CHLADNI *of Wittemberg. From Professor* VOIGT'S Magazin für der Neuesten Zustand der Naturkunde, 1797.

SINCE I wrote my last essay on this subject*, several new circumstances have been made known, which seem still farther to confirm my theory. One of the most interesting phenomena of this kind was the shower of stones near Sienna, on the 16th of June 1794, of which an account has been given in the works of several Italian and other philosophers; and in a paper, by Mr. Zolner, in the Berlin *Monatschrift* for September 1796. About seven o'clock in the evening of that day there appeared, at the above place, a longish, round, dark cloud, totally insulated, which by its singular appearance excited fear as well as attention, and was observed, at the same time, at various places lying at a considerable distance from each other. All of a sudden there fell, amidst the most dreadful explosions, accompanied with lightning and a kind of vapour or smoke which burst from the

* See Philosophical Magazine, vol. ii. p. 225.

the clouds, a multitude of red hot ſtones of the vitrified kind, moſt of them quite ſmall, but ſome of them a pound in weight, many of which ſunk to the depth of more than an ell in the earth. One of them pierced the brim of a boy's hat and ſinged the felt: others, which fell upon trees, left traces of their ignition on the leaves. Some of conſiderable ſize, which fell in a pond, ſplaſhed the water out to a conſiderable diſtance, and made it even begin to boil. The government found means to drain the pond in order to get at the ſtones, which were purchaſed at a dear rate by ſome Engliſh travellers then in that part of the country; and on this account many attempted to make ſuch ſtones artificially, ſo that people in purchaſing theſe curioſities were frequently in danger of being cheated.

It was at firſt believed that this phenomenon might have had ſome connection with the eruption of Veſuvius, which took place the day before; but the Italian naturaliſts all now agree that this opinion is entirely void of foundation, as the ſtones which fell from the atmoſphere had no ſimilarity to the volcanic ſubſtances thrown up by Veſuvius, and as the place where they fell was above 200 miles diſtant from that mountain. A ſtone of this kind, which was ſubjected to examination, was inwardly of an aſh grey colour; and had a dull earthy fracture mixed with ſhining metallic particles which reſembled pyrites. In other ſpecimens there were found octoedral cryſtals, which were found to be magnetic iron. The colour on the outſide was a greyiſh black, and the wrinkled ſurface betrayed marks of fuſion.

This ſubſtance, in all probability, was of the ſame nature as that which fell, with a dreadful exploſion, from a fire-ball (*bolis*) in Gaſcony on the 24th of July 1790, as mentioned in the *Decade Philoſophique* of February the 29th, 1796, and as many others of the like kind quoted in my treatiſe on the iron maſs found by Profeſſor Pallas, and on ſimilar bodies. Since that period two new circumſtances of this nature have been made known. In the Engliſh journals there is an account

count of a ſtone weighing fifty-ſix pounds, which fell from the atmoſphere with a loud report at Wold Newton in Yorkſhire, on the 13th day of December 1795. As it ſunk only eighteen, or according to others twenty-one inches into the earth, it is to be conjectured that the ground was extremely hard, or that the ſtone did not fall in a ſolid body, but in a ſoft liquid maſs. It was ſtill warm to the touch when found; ſeemed externally of a black colour, and in the inſide exhibited ſhining particles and traces of ſulphureous vapours. In the Gentleman's Magazine, for September 1796, there is an account of ſome ſtones which fell near Petreſwood, in the county of Weſtmeath in Ireland, in the year 1779, accompanied by a violent clap of thunder. Theſe ſtones, which had no likeneſs to any of the known foſſils in that neighbourhood, weighed only 3½ ounces; they were almoſt like free ſtone, of a whitiſh brown colour, and in the inſide were interſperſed with ſilvery white, ſhining ſpecks. They were ſtill warm when taken up, and after they fell the whole neighbourhood was filled with ſulphureous vapour. In a work publiſhed at London in 1796, entitled, Remarks concerning Stones aid to have fallen from the Clouds, by Edward King, with which I am acquainted only by the Engliſh Reviews, an account is given of the above phenomenon, and of ſeveral others of the like kind. Intereſting obſervations by Mr. Böttiger of the accounts given in ancient authors of ſtones ſaid to have fallen from the heavens, may be found in the German *Monatſchrift* for Auguſt 1796, where the author ſhews that Anaxagoras explained this phenomenon in the ſame manner as I have done. The caſe with this conjectural theory of mine is the ſame as with the theory of comets, which by Seneca were conſidered as regular planetary bodies*; but by others afterwards as terreſtrial meteors, till more accurate obſervation ſhewed that Seneca was right.

* Quæſt. Nat. lib. vii.

The only instance of a soft, frothy mass being found in the place where a fire-ball fell is that which occurred in Lusatia, and the neighbouring districts, on the 8th of March 1796; and of which an account was given, in particular by Mr. Von Gersdorf and Mr. Bauer, in the Lusatian *Monatschrift* for April and May 1796. The fallen mass appeared to be only a part which had been broke off, or which had, in some measure, dropped from one of these fire-balls. It is much to be lamented that the apparent course of this body, as far as could be done by the eye, was not observed with some accuracy, as has been the case with others mentioned in my Treatise upon Iron Masses, &c. that by calculating their parallax their real path might be discovered. Its velocity must have been as great as that of many other fire-balls, which have moved at the rate of several German miles per second, and equal to the velocity of the planets in their courses. This fire-ball, as was the case with that observed on the 22d of July 1762, and with others, was first visible at a considerable height above the horizon in the form of a shining point; moved along in a somewhat serpentine direction, and increased suddenly to a considerable size: the duration of the whole phenomenon was about two seconds.

It is much to be wished that some one could give a more accurate account of the fire-ball which, as I have been informed, fell a few years ago in the sea near Genoa, and occasioned a strong ebullition in the water.

I consider it as not superfluous to give here a short account of some more instances of stones and masses of iron which have fallen from the atmosphere, as mentioned in my Essay, because some, on account of my apparent paradoxical method of explaining these phenomena, may have been prevented from reading that work; and to take some notice of the circumstances attending them, which, on account of their great conformity, cannot be denied. A very remarkable

able inſtance, which is related by Mr. Stütz, took place at ſix o'clock in the evening on the 26th of May 1751, in the diſtrict of Agram in Sclavonia. This fire-ball, which burſt aſunder into two parts, that had the form of chains of fire twiſted together (and, according to all appearance, were liquid maſſes), ſeemed accompanied with ſmoke, and fell with a dreadful exploſion and ſuch force that it ſhook the earth, into which it ſunk to the depth of three fathoms. One part weighed 71 and the other 16 pounds. The larger, which conſiſts entirely of iron, and exhibits on its ſurface the moſt evident marks of fire, is now to be ſeen in the Imperial collection of natural curioſities at Vienna, together with an atteſtation reſpecting it from the Conſiſtory of the Biſhopric of Agram, who examined ſeveral eye-witneſſes that had ſeen it, and which Mr. Stütz has inſerted in his paper. The ſame naturaliſt quotes alſo two other inſtances. One is of a ſtone, which, according to the account given, fell with a violent exploſion in the diſtrict of Eichſtadt, and was ſo hot that it could not be touched till it had been cooled in ſnow: this ſtone conſiſts of ſiliceous earth and ferruginous particles, and is covered with a cruſt of native iron. The other is a ſhining iron ore deſcribed by Born *, interſperſed in a green matrix having a ſcoriaceous ſurface, and which, as we are aſſured, fell from the heavens during a thunder-ſtorm on the 3d of July 1753.

In the Hiſtory of the Academy of Sciences for 1769, we find very remarkable accounts of three maſſes which fell from the clouds during a thunder-ſtorm. Theſe accounts were tranſmitted to the Academy by their correſpondents from Maine, Artois, and Cotantin, three places lying at a very great diſtance from each other. The ſame circumſtances were remarked to have taken place in regard to theſe three maſſes. They were all hot when firſt found; they were of the ſame compoſition, as they contained ſulphur and iron, and were covered with a hard cruſt of that metal. They

* Index Foſſilium, vol. i.

proceeded, in all probability, from the same meteor which in the course of its somewhat serpentine course, as is usual, may have made several explosions. Ancient authors, such as Pliny, Plutarch and Livy relate various instances of stones that fell from the heavens, which are commonly considered as fabulous; but which, on account of the number of new observations of the like kind, may be considered as real phenomena of nature. Avicenna mentions a sulphureous kind of stone which fell from the atmosphere at Cordova in Spain *. It is related in Spangenberg's *Chronicon Saxonicum*, that two large stones fell at Magdeburg, in the year 998, with loud explosions like thunder. Cardan relates †, that in the year 1510 several large stones fell from the heavens, which were mostly of a ferruginous colour, exceedingly hard, and, when found, still exhaled a sulphureous vapour. We are assured by Julius Scaliger ‡, that he himself had in his possession a piece of iron which fell from the atmosphere in Savoy. Muschenbroek § and various other writers mention a blackish stone of 300 pounds weight exhibiting traces of fire, which fell at Ensisheim in Alsace in 1492 or 1493, and which was said to be preserved in the church of that place. In the summer of the year 1766 a stone fell from the clouds at Alboreto, in the duchy of Modena, which is briefly mentioned by Vassalli in his Physico-meteorological Letters ‖, and on which Troili has written a treatise. In the Breslau collection respecting natural history four instances are quoted of stones having dropped from the heavens. Five stones, as large as a man's head, exceedingly heavy, of a rusty iron colour, and having a strong smell of sulphur, fell from the heavens with explosions and a dreadful concussion of the air at Miscoz in Transylvania, in the

* In Averrhoes Meteor. lib. ii. cap. 2.

† De Rerum Varietate, lib. xiv. c. 72.

‡ De Subtilitate Exercit. 323.

§ Essai de Physique, tom. ii. sect. 1557.

‖ Lettere fisico-meteorologiche, p. 120.

year 1559, and are preſerved in the treaſury at Vienna. On the 26th of July 1581, between the hours of one and two in the afternoon, a ſtone 39 pounds in weight, of a blue and browniſh colour, and which ſtruck fire with ſteel, fell from the clouds in Thuringia, with an exploſion which ſhook the earth, and accompanied by the appearance of a ſmall light cloud, that could have been nothing but a fire-ball, the heavens at that time being in other reſpects ſerene. This ſtone, which ſunk to a conſiderable depth in the ground, made the earth fly up to twice the height of a man, and was ſo hot that no perſon could touch it. We are told that it was carried to Dreſden. On the 6th of March 1636, while the heavens were perfectly ſerene, a large ſtone fell with a loud craſh between Sagan and the village of Dubrow in Sileſia. It had internally the appearance of a mineral, could be eaſily rubbed to powder, was covered on the outſide with a cruſt, and ſeemed as if burnt by fire. On the 16th of March 1698, a black ſtone fell from the atmoſphere with various exploſions, and was tranſmitted with an account of the circumſtance to the library at Berne. This ſtone is mentioned by Scheuchzer in his Natural Hiſtory of Swiſſerland *. D. Roſt relates, in the Breſlaw Collection reſpecting Natural Hiſtory †, that at two o'clock in the afternoon on the 22d of July 1723, the weather being then ſerene, there was ſeen a ſmall cloud (probably a fire-ball), and at the ſame time ſeveral large and ſmall ſtones fell from the heavens, accompanied by loud exploſions, but without any lightning. Theſe ſtones, which were black on the outſide, had internally the appearance of metal, and exhaled a ſtrong ſmell of ſulphur. It is worthy of remark, that the iron maſs mentioned by Pallas, which has no affinity with any of the known foſſils, but which correſponds in many reſpects with ſome of the before-mentioned maſſes, and particularly that which fell at Agram, was conſidered by the inhabitants of Siberia, where it was found, as a ſacred relic dropped from heaven.

* P. II. ad ann. 1726, p. 75. † Page 44.

heaven. It is a pity that the place was not dug up where the fire-ball, mentioned in the Philoſophical Tranſactions *, fell in Jamaica, in the year 1700. In that ſpot there were found ſeveral holes in the earth, which were ſo deep, that the poles with which they were examined did not reach to the bottom of them. A ſulphureous vapor was perceived in the neighbourhood, and the graſs around the holes appeared ſcorched.

When all theſe data, which correſpond ſo well with each other, are compared with the obſervations made on other fire-balls, where no opportunity occurred of getting poſſeſſion of the fallen maſſes, the following concluſions may be drawn:

I. That the accounts given of ſcoriaceous maſſes, which contained iron, earth, ſulphur, &c. having fallen from the heavens with violent exploſions, are not fictions, but true relations of real natural phenomena actually obſerved at various times.

II. That fire-balls and the falling of ſuch maſſes are the ſame meteor.

Reſpecting the queſtion, whence fire-balls and ſuch fallen maſſes proceed, opinions are very different. Moſt people believe that they are owing to accumulations in the atmoſphere. But even when it is allowed that a great many foreign ſubſtances are diſſolved in the atmoſphere, the quantity of them, eſpecially in regions at the diſtance of eighty miles or more, from which ſuch fire-balls are ſeen to fall in the form of a luminous point, is too ſmall to admit of our ſuppoſing ſuch large maſſes to be formed of it. Should the ſolid particles, which may perhaps be diſſolved in the atmoſphere, precipitate themſelves, it would be rather in the form of a fine powder. I conſider it, therefore, with Anaxagoras, Maſkelyne, Halley, &c. as more probable that theſe maſſes come to our regions from the common expanſe of the univerſe, and that, beſides planetary bodies, there are ſmaller

* N° ccclvii. p. 148.

2 accu-

accumulations of matter, which when they approach too near our earth muſt fall down. That material bodies actually exiſt in the remoteſt regions is ſhewn both by the ſingle and accumulated luminous ſparks which Dr. Schröter ſaw paſs over the field of his teleſcope, as alſo by the ſhooting ſtars which paſs by our earth, probably at a greater diſtance and with greater velocity than to allow their being attracted by it, and made to fall to its ſurface, and to which, fire-balls on their firſt appearance, when they ſeem to approach like a luminous point, have a perfect reſemblance. There are many reaſons for inducing us to believe that ſhooting ſtars cannot be mere electric phenomena without the preſence of ſome coarſer ſubſtances.

The paradoxicalneſs of this mode of explanation, which is contrary to no known obſervations of nature, is rather apparent than real, and conſiſts only in this, that people have not been accuſtomed to it, or that, on account of the rarity of theſe phenomena, many facts of this kind have been denied, or have eſcaped notice. For this reaſon, after I had written the Treatiſe on the Maſs of Iron diſcovered by Profeſſor Pallas, I heſitated whether I ſhould publiſh it, becauſe I expected that it would meet with conſiderable oppoſition. The more I endeavoured however to compare, without partiality for any ſyſtem, the obſervations already made, which correſpond ſo much with each other, the more I found that theſe phenomena could not properly be explained in any other manner, without either contradicting obſervations already made, or well-known laws of nature; ſo that I ſee no grounds for retracting any thing I have advanced on this ſubject.

II. *Hiſ-*

II. *Historical Remarks relative to the Manufactures of Iron and Steel in Great Britain. By Mr.* DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

IT is uncertain at what period the manufacture of iron commenced in Britain. It is probable that the working of the iron mines of Cornwall by the Phœnicians, would introduce into the country a class of men skilled in all the then known metallic ores; capable of appreciating their true value, by converting the riches of an unexplored country, either to their own immediate wants, or to the conveniencies of the unskilful inhabitants. The invasion of England by the Danes, and their consequent establishment, would, most likely, add to the former stock of knowledge in the art of mining and fusing ores. Large heaps of scoria are to this day met with in many places in England, with so great an accumulation of soil as to grow trees of a large size *; these heaps are called Danes cinders, and are in our times smelted to advantage for the production of crude iron. From whatever period the iron trade may date its origin; certain it is, that towards the end of the 16th and early in the 17th centuries we find it had attained a pitch of magnitude almost incredible, at a time so hostile to the peaceable views and industry of the manufacturer. Hence we find that cannon and mortars, of various calibres and constructions, were fabricated from cast-iron at some of the English works; and that this species of manufacture was in considerable request on the continent. The calibre of the gun was in those days, and within these forty years, formed by a loam core of the exact diameter placed vertically in the middle of the mould. The boring and turning mills were quite unknown, together with all that scrupulous exactitude which

* Dudley mentions that as early as 1620, oaks were found of a large size decayed on the tops of large hills of cinder.

distinguishes

distinguishes the artillerist, and the manufacture of the present times.

Hitherto cast and malleable iron were obtained from ores with the charcoal of wood, and the manufacture of these articles had acquired certainty and extent.

If credit could be given to the *metallum marks* of Dudley, in the 12th year of James, anno 1615, there were at that period not less than 300 blast furnaces for smelting iron ore with charcoal; each of which had fuel, upon an average, for 40 weeks per annum. The average produce in crude iron at each furnace, 13 tons per week, makes the total annual quantity 180,000 tons*; for the production of this astonishing quantity, calculating at the rate of two loads of charcoal for each ton of iron, and reckoning 8 cwt. charcoal to each load, we find the amazing quantity of 144,000 tons of charcoal necessary. As wood in charring nearly affords bulk for bulk, and as a cubic foot will be found to weigh on an average nearly 18·75 pounds avoirdupoise, we find that 17,310,000 cubical feet of timber was necessary to produce this quantity of charcoal. Again, let this quantity of charcoal be valued at the present price (in Scotland), viz. 4*l.* per ton, its value will amount to 576,000 *l.* a sum little short of the annual value of all the pig iron manufactured at this time in England, Scotland and Wales.

Mr. Dudley also informs us, that at the same period there were reckoned 500 forges and iron mills for refining the crude iron, and making it into malleable bars. These on an average made 3 tons each per week, for 50 weeks annually = 150 × 500, annual produce in bar iron 75,000 tons; a produce little short of the whole annual export of the Russian and Swedish markets. Three loads of charcoal were requisite to refine metal for 1 ton of bar iron; so that, if the above calculation of 8 cwt. to each load is adopted, a further

* Upwards of 80,000 tons more than is at present manufactured in Britain with pit-coal.

quantity

quantity of 90,000 tons of charcoal would be requisite for a year's supply at that period = 10,732,000 cubical feet *.

Let the waste of the refining furnace in those days be reckoned equal to 50 per cent. 112,500 tons of pig iron must have then been used to fabricate 75,000 tons of bars, and a reversion of 67,500 tons cast into cannon, mortars, wares, &c. or exported in a raw state as pig iron or ship ballast.

However much the above quantities may be exaggerated, as I am inclined to think they are, yet they seem to prove that, at the commencement of the last century, the iron business had obtained an eminent rank among the manufactures of the country. The progress of agriculture and the increase of population under the reign of the peaceable James had at length taught the husbandman and the proprietor the value of cultivated fields. The great consumption of wood for the navy and iron works had greatly exhausted the principal forests of supply: tracts of country became cleared, and in proportion as the spirit of cultivation increased, the annual quantity of fuel for the manufacturing of iron diminished.

Pit-coal had been long known before this period, and wrought at Newcastle prior to the year 1272. Annually vast quantities of it were exported to Holland, and the Low

† The aggregate quantity of timber necessary for the manufacture of iron alone amounts to 28,062,000 cubical feet. Let an acre of ground be supposed to afford 2000 cubical feet of timber, then it will be found that 14,031 acres of land were annually swept to supply the iron manufacturers. Admitting that wood fully replaces its cubical contents in 18 years, then 252,558 acres of land would have been required to furnish the necessary consumption of timber, without in the end diminishing the supply. Besides iron works, smiths' and nailors' fires, manufactories of every sort were carried on by means of wood; even at a time when pit coal was exporting to other countries. The data on which I have made this calculation are moderate. I have supposed the cube of charcoal produced from the same cube of timber; which is not strictly the case, as some woods shrink considerably. I have likewise reckoned an acre to produce 2000 cubical feet, which I suppose wood in a natural state seldom does, taking it upon an average of the whole country.

Countries,

Countries, for the ufe of the fmithy, and other manufacturers requiring an intenfe and continued heat. Yet in England prejudices ran fo ftrong againft its application to the manufacturing of caft or malleable iron, that the projectors of this ufeful undertaking met with every obftacle which the narrow, unenlightened minds of the eftablifhed manufacturers could devife.

James granted feveral patents for the exclufive right of manufacturing iron with pit-coal. None of the projectors, however, were fuccefsful, till 1619, when Dudley fucceeded in making coak pig iron, though only at the fparing rate of 3 tons per week. By this time many of the iron works were at a ftand for want of wood; the confequence was, an advance on the price of iron: this therefore rendered it a lucrative bufinefs to thofe manufacturers whofe fupply of wood was ftill undiminifhed, and, of courfe, made them hoftile to any innovation whereby the prefent price of iron was likely to meet with a reduction.

This period of prejudice fo unfavourable to innovation in the iron bufinefs, was followed by one more general, and more calamitous for the nation. Amidft the diftraction occafioned by civil war, neither innovation nor improvement could be expected. Patents however were granted to fome during the commonwealth for the exclufive manufacture of iron in the new way; in one of which it was believed Cromwell was a partner: thefe partly fhared the fame fate as did their predeceffors, and none fucceeded in eftablifhing a manufactory either of extent or of certainty. In 1663 we find Dudley applying for his laft patent, and fetting forth, that at one time he was capable of producing 7 tons coak pig iron weekly, with an improved furnace 27 feet fquare, and bellows which *one man could work for an hour without being much tired.*

It was not till impelled by neceffity, by the rapid decline of the annual growth of timber, that pit-coal became an object of univerfal eftimation. When the improvements on machinery

machinery had attained a pitch of certainty, and experience had taught the mechanic the manifold advantages to be derived from the ſteam-engine, men of induſtry and enterpriſe began to think of extending the manufactures of the country in iron with pit-coal. Small furnaces ſupplied with air from leathern bellows, blown by oxen, horſe, or human labour, became exploded, and an increaſe of ſize took place, together with an increaſe of the column of blaſt neceſſary to excite combuſtion. But as it ſeldom happened, that to the advantage of having pit-coal, ores, and limeſtone concentrated in one ſpot, water alſo was added, it became neceſſary to form a ſubſtitute. For this purpoſe, the ſteam-engine, that ſuperhuman invention, was applied. Rude and unpoliſhed no doubt were its early deſigns and execution—rapid however have been its improvements; and at the preſent time, by many it is believed to have arrived at the higheſt poſſible pitch of human perfection.

With the improvements in machinery the advancement in the practice of manufacturing coak pig iron kept pace; and it is now a certain truth, that with pit-coal in our time we produce a quality of pig iron ſuperior for every purpoſe of the arts (bar iron making excepted) to that at any time made with charcoal of wood, and in the following increaſed proportion:

	Tons.
Average annual produce of a charcoal furnace 180 years ago - - - -	600
Some furnaces in England on an average now produce 40 tons per week - -	2080
Value of the former when manufactured £.6 per ton - - - - -	£.3600
Value of the latter on an average of the qualities 6*l.* 10*s.* - - - - -	£.13520

By comparing the value of pig and bar iron at preſent with what it ſold for 180 years ago, an accurate notion may be formed of the increaſed price of labour and materials attached to iron works.

About

	£.	s.
About the year 1620 charcoal pig iron sold for per ton	6	0
In the year 1792, carbonated pig iron -	8	10
In the year 1798 ditto, ditto - -	10	0
Coak pig iron when invented sold at - -	4	0
In the year 1792 melting pig iron sold for -	5	10
In the year 1798 ditto - - - -	7	10
Malleable iron made with charcoal sold for - -	15	0
The same in 1792, to be drawn into wire, for -	23	0
Ditto in 1798 - - - £.27 or	28	0
The first bar iron made (1620) with pit-coal sold for	12	0
The same iron in 1792 sold for - -	18	0
Ditto in 1798 for - - -	22	0

By these statements it may be seen that all along there has been preserved an analogy between the value of the respective states of the metal. We cannot, however, be but astonished at the mighty advance on iron within the last six years, nearly and in some cases more than equal to the advance of a period of 170 years before.

Let it be taken for granted, that the manufacture of England, Scotland and Ireland at the beginning of the 17th century amounted in crude iron to 180,000 tons.

112500	tons of which, suppose, produced 75000 tons bars at 15*l*. Amount -	£.1,125,000
67500	tons cast into guns, mortars, ships' ballast, &c. &c. at 10*l*. - -	675,000
180000	tons, amount of the manufactures of iron at that early period - -	£.1,800,000

In Britain at present the total produce in pig iron does not exceed 100,000 tons; and reckoning on an average that 33 cwt. of crude iron produces 1 ton of bars, and that the manufacture of malleable iron amounts to 35,000 tons per annum,

57750

57750	tons of crude iron will then be neceſſary to form 35000 tons of bars at 20*l*.	£.700,000
42250	tons caſt into cannon, cylinders, machinery wares, &c. at 14*l*. - -	591,500
100000	tons amount of the native manufacture of iron at this period - -	£.1,291,500

The extenſive manufacturers of this country have for many years paſt demanded an additional ſupply of foreign bar iron. This has been chiefly received from Ruſſia and Sweden, and the annual quantity may be averaged for the laſt 20 years at 70000 tons, at 18*l*. per ton, - £.1,260,000

£.2,551,500

This may be taken as the annual amount of one raw material, the chief part of which becomes more valuable in an uncommon ratio, by ſubſequent labour.

Amount of the native manufacture at the beginning of laſt century, when the raw material was exported in quantity - - 1,800,000

Balance in favour of this period - - £.751,500

excluſive of the additional value ſtamped upon iron in the now extenſive operations of ſlitting it into rod iron for nails, rolling it into hoops, and converting it into ſteel. In theſe manipulations value is gained as follows: Rod iron 3*l*. 10*s*. per ton. Hoops 7*l*. Bliſtered ſteel 7*l*. to 9*l*. Tilted ſteel 10*l*. to 12*l*. and German ſteel 25*l*. to 28*l*. per ton. Caſt-ſteel according to the ſize of the bars 30*l*. to 45*l*. per ton. Some of theſe operations are attended with a waſte of metal, though not nearly in the proportion of making bar iron from pig iron. The manufacturer of ſteel alſo buys his iron at the

the rate of 20 cwt. to a ton; but in ſelling ſteel he gives at the rate of 21 cwt. 1 qr. 20 lb. to each ton, or 120 lb. inſtead of 112 lb. for each hundred weight.

It is uncertain whether the quality of ſteel, fabricated from Engliſh iron at the above early period, was in any way comparable with what we now make from foreign iron; or whether the artiſts were ſupplied with this ſtate of the metal from Spain and the Low Countries. The latter is moſt probable.

In whatever point of view the iron trade may be conſidered with regard to this country, the advantages derived from its progreſs have been great: whether we conſider it as having cleared the country of vaſt tracts of wood—affording at the ſame time an ample indemnification for the labour beſtowed—the conſequent improvement of climate, and the ſpread of agriculture; as having placed us at the head of the manufacturing countries of Europe; as affording us at all times a plentiful ſupply for the conſtruction of every ſpecies of machinery; as being an arſenal for the rearing and protecting an extenſive navy; or, as having been a ſource of wealth to many individuals, and at the ſame time affording a competent recompenſe for the labour of a number of our fellow creatures.

III. *Account of Count* RUMFORD's *Experiments on the conducting Power of Liquids with Regard to Heat, and a Deſcription of the Apparatus employed in the Experiments. Extracted from his* Eſſays, Political, Economical and Philoſophical, *Vol. II.*

OUR limits will not allow us to make long extracts from the intereſting experiments of this ingenious philoſopher, who has done more in what regards the ſcience of heat than all who have ever written upon it beſides. We only hope to be able to convey ſome intelligible ideas on the ſubject to

 ſuch

ſuch of our readers as have not ſeen the Count's Eſſays, or who, from their numerous avocations, cannot ſpare time to read a more voluminous account.

In the courſe of a ſet of experiments, in which the Count had occaſion to uſe thermometers of an uncommon ſize, (their bulbs being above 4 inches in diameter) having expoſed one, filled with ſpirit of wine, in a window, to cool after being heated, he obſerved the whole maſs of liquid in a moſt rapid motion, running ſwiftly in two oppoſite directions *up* and *down* at the ſame time. This motion was rendered viſible by ſome particles of duſt which had got by accident among the ſpirit of wine, the ſun happening to ſhine upon the window, as duſt in the air of a darkened room is viſible by the ſun-beams coming through a hole in the window-ſhutter. The aſcending current occupied the *axis of the tube*, the deſcending *the ſides*. On inclining the tube a little, the former moved out of the axis and occupied that ſide which was uppermoſt, the latter the whole of the lower ſide. Quick cooling, by applying ice cold water to the tube, increaſed the velocities of the currents, which, however, ceaſed entirely when the thermometer had acquired the temperature of the room.

Being perſuaded that this motion in fluids (for the ſame experiment was tried with the ſame reſult with a ſimilar thermometer filled with linſeed-oil *) was occaſioned by their particles *going individually* and *in ſucceſſion* to give off their heat to the cold ſides of the tube, the Count was led to conclude, that fluids are in fact *non-conductors* of heat; and that, if heat be propagated in them *only* in conſequence of the internal motion of the particles, whatever could ob-

* The ſame motions were rendered viſible in water by mixing powdered amber with it, which is nearly of the ſame ſpecific gravity, being 1·078, while that of the former is 1·000. Potaſh was added to the water till it became of the ſame gravity with the amber, the particles of which then remained ſtationary in any part of the liquid, unleſs when the particles of the latter were put in motion by any ſudden change of temperature.

ſtruct

ſtruct thoſe motions would retard that effect. To determine this point, a certain quantity of heat was made to paſs through a given quantity of pure water; and, noting the time employed, the experiment was repeated with water mixed with ſome fine ſubſtance, as eider-down, which, without altering its chemical properties, or impairing its fluidity, could only ſerve to obſtruct and embarraſs the motions of the particles of the water in tranſporting the heat, ſhould heat be *tranſported* and *carried* in this manner, and not paſs freely through it.

The body which received the heat, and which ſerved at the ſame time to meaſure the quantity of it communicated, was a very large thermometer *c f* (Plate IX. *fig.* 1.), with a cylindrical bulb *c* made of thin copper, ſpherical at the ends, 1·84 inches in diameter, 4·99 long, of 13·2099 cubic inches capacity, and meaſuring externally 28·834 ſquare inches: it weighed 1846 gr. and could contain 3344 gr. of water at the temperature of 55°. To this bulb was affixed a glaſs tube *e f* (repreſented in the plate as broken off at *f*) 24 inches long and $\frac{4}{10}$ of an inch in diameter, by means of a cork fitted into a neck of copper 1 inch long, belonging to the bulb. This thermometer, filled with linſeed oil and graduated, was fixed in the axis of a hollow cylinder (*a b* is a ſection of it) made of thin ſheet-copper $11\frac{1}{2}$ inches long, and 2·3435 inches diameter within, with a ſpherical bottom, weighing 2261 gr. The bulb of the thermometer was made to occupy the lower part of this cylinder by means of 4 pins of wood $\frac{1}{10}$ of an inch in diameter and $\frac{1}{4}$ of an inch long, one of them faſtened to the bottom, the other three round the inſide of the cylinder at equal diſtances, in very ſmall ſockets made to receive them. (Theſe pins may be ſeen at the lower part of *fig.* 1. and alſo in *fig.* 2. which repreſents a horizontal ſection of the cylinder and a bird's-eye view of the thermometer in its place.) The diſtance between the external ſurface of the bulb of the thermometer and the internal of the containing cylinder was 0·25175 of an an inch, and could contain, at the height of $\frac{1}{4}$ of an inch above the bulb, 2468 grains of water.

The bulb of the thermometer being ſurrounded by water, or by any other liquid, or mixture, the conducting power of which was to be aſcertained, a cylinder of cork *b* ſomething leſs* in diameter than the braſs cylinder, about half an inch long, having a hole in its centre in which the tube of the thermometer paſſed freely, was thruſt down into the braſs cylinder nearly to the ſurface of the ſubſtance it contained, and made to reſt on three projecting braſs points fixed to the neck of the copper bulb. The upper part of the tube was then filled with eider-down and cloſed with a cork ſtopper *g*, the tube of the thermometer, which paſſes through a fit hole in the middle of this ſtopper, projecting upwards. The ſcale from the point of freezing to that of boiling water is on that part of the tube which riſes above the ſtopper, and is divided according to that of Fahrenheit.

The thermometer being fixed in the tube as above deſcribed, ſurrounded by the ſubſtance the conducting power of which was to be aſcertained, the inſtrument was placed in thawing ice, and kept there till the thermometer fell to 32°. It was then taken out and inſtantly plunged into boiling water, and the conducting power of the ſubſtance under experiment was eſtimated by the time required to make the heat paſs through it into the thermometer; the time being carefully noted when the liquid in the thermometer arrived at 40°, and alſo when it came to every 20th degree above it.

A number of experiments were made with this inſtrument, all of which tended to prove that the paſſage of heat through water is much impeded, by mixing other ſubſtances with it, whether they be ſuch (eider-down for inſtance) as merely

* If this cork had been made to fit cloſe, yet ſo as to move in the braſs cylinder, and its centre hole been well fitted to the glaſs tube, the trouble of contriving and fixing pins to keep the bulb in its place might have been avoided. EDIT.

embarraſs

embarrafs the water in its motions, or thofe (mucilages, &c.) which leffen its fluidity.

The time required to heat the inftrument from 32° to 200, when the bulb of the thermometer was furrounded with

1.	2276 gr. of water and 192 gr. of ftarch, was	1109″
2.	2276 gr. of water and 192 gr. of eider-down,	949
3.	With water and 48 gr. or $\frac{1}{30}$th of its bulk of eider-down - - - -	763
4.	With ftewed apples - - -	1096½
5.	With pure water - - -	597

The ftarch was boiled with the water with which it was mixed, as was alfo the eider-down—the latter to free it from air, which adheres to it with great obftinacy.

As Count Rumford fuppofes, and juftly, that there is a poffibility of error when the refults are determined by the extreme points *freezing* and *boiling*, owing to the flownefs of the procefs when the inftrument approaches the medium of the temperature in which it is placed, he thinks they may be got more accurately by taking the times occupied in heating from 80° to 160. They were as follows;

with the 1ft	341″
with the 2d	269
with the 3d	215
with the 4th	335
with pure water	172.

The time the heat took to pafs out of the thermometer through the fame fubftances

	from 200° to 40°.	from 160° to 80°.
through the 1ft . . .	1548″ . .	468″
the 2d . . .	1541 . .	460
the 3d . . .	1395 . .	373
the 4th . . .	1749½ . .	520
Water . . .	1032 . .	277

As the refults of thefe experiments prove that the propagation of heat in water is retarded, not only by thofe things which diminifh its fluidity, but alfo by thofe which, by me-

 chanical

chanical means, and without forming any combination with it whatever, merely obstruct its internal motions, it appears to the ingenious author, and we believe it will not be denied, that this proves, that heat is propagated in water *in consequence* of its internal motions;—or, that it is transported or *carried* by the particles of that liquid, and that it does not spread and expand in it, as in metals and other conductors of heat, as has generally been imagined.

The success of these experiments encouraged the author to plan and execute others still more decisive and extremely interesting. It has been generally believed that water cannot be heated in contact with ice: reflecting on the subject, he perceived that either this must be a mistake, or his ideas respecting the manner in which heat is propagated in that fluid, erroneous. On the supposition that water is not a conductor of heat, according to the common acceptation of that term, or that heat cannot pass in that fluid, except when *carried* by its particles, which, being put in motion by the change it occasions in their specific gravity, transports it from place to place, it did not appear how ice, if, instead of being permitted to swim on water, it were confined at the bottom of it, or any where below the surface, could affect the temperature of the superincumbent water, or prevent its receiving heat from other bodies:——but, on the other hand, the ice-cold water which results from the melting of ice when on the surface of that fluid, cannot but descend by its gravity to the bottom of the containing vessel in an uninterrupted stream; so that as long as this operation is going on the mass of water cannot be much heated.

A cylindrical glass jar 4·7 inches diameter and 14 inches high was nearly filled with boiling hot water. A circular cake of ice of nearly the same diameter, 3½ inches thick, and weighing 10¼ oz. was then gently put on the surface of the water. In 2′ 58″ it was entirely melted.

A cake of ice of the same form and dimensions with the above was afterwards fastened down on the bottom of the same

ſame jar, by means of two ſlender laths, a trifle longer than the diameter of the jar, forced down into it, and laid acroſs each other over the ice. Cold water to cover the ice to the height of $\frac{1}{4}$ of an inch was then poured into the jar to prevent its breaking by the ſudden application of boiling water with which it was next filled. To protect the ice while the hot water was pouring in, a circular piece of paper was previouſly laid on its ſurface, which was afterwards gently removed by means of a ſtring faſtened to one ſide of it. The reſult of the experiment proved, that the Count was not miſtaken in his ideas. When 20′ had elapſed, the heat in the water at different depths was found to be—immediately above the ſurface of the ice 40°; at $\frac{1}{2}$ inch above it 46°; at 1 inch 130°; at 3 inches 159°; at 7 inches 160°; at the end of 35′ it was, at the ſurface of the ice 40°; at $\frac{1}{2}$ inch 76°; at 1 inch 110°; at 2 inches 144°; at 3 — 148°; at 5 — 148$\frac{1}{2}$°; at 7 — 149°. After an hour and 15′ it was at the ice 40°; 1 inch above it 82°; 2 inches 106°; 3 — 123°.—Theſe were taken near the ſide of the jar, the following at the axis; at the end of 1 h. 30 m. at the ſurface of the ice 40°; at 1 inch above it 84°; at 2 inches 115°; at 3 — 116°; at 7 — 117°. At the end of 2 hours ſtill 40° at the ſurface of the ice; 76° at 1 inch above it; 94° at 2 inches; 106° at 3; 108 at 4; 108$\frac{1}{4}$° at 6; 108$\frac{1}{2}$ at 7 inches.—An end was now put to the experiment, the water was poured off; and the remaining ice being weighed, it was found that 5 oz. 6 gr. Troy had been melted. Taking the mean temperature of the water at the end of the experiment at 106°, it appeared that 73$\frac{1}{4}$ oz. of hot water employed was cooled 78°. As 1 oz. of ice abſorbs juſt as much heat in being melted as 1 oz. of water loſes in being cooled 140°, *each* of theſe 73$\frac{1}{4}$ oz. would give off as much heat as would melt $\frac{78}{140}$ths of 1 oz. of ice; that is, all of them together as much as would melt 40$\frac{8}{10}$ ounces of ice; but the quantity melted was only about 5 oz. and hence it appears that *leſs than* $\frac{1}{80}$th *part of the heat loſt by the water was communicated to the air.* Or, *ice melts* *eighty times slower at the bottom of a mass of boiling-hot water than when swimming on its surface.*

But the ice was melted, though slowly, at the bottom of the hot water, which the author accounts for in a satisfactory manner without needing to abandon his hypothesis. Fresh water presents an exception to the general law of condensation by cold: it condenses in cooling till it comes to 40°, but on cooling it lower *it expands*, and continues to expand till it freezes and after it has become ice*. Water in contact with melting ice is always at the temperature of 32°, and therefore specifically lighter than that which is 8 degrees warmer, or at 140°: the latter will therefore *descend*, being heavier, and by its greater heat melt a portion of the ice, be cooled, and then give place to the descending currents of warmer water which succeed it. It appears too from the experiments which followed, that a considerable portion of the ice that was melted, was melted in consequence of the motions into which the water was thrown on being poured into the jar.

The experiments on which the author builds his results were conducted in the following manner: 43·87 cubic inches, or 1 lb. 11½ oz. Troy of water was put into the jar *e f c d*, *fig*. 3, which was placed in an earthen bowl and surrounded with a freezing mixture composed of ice and common sea salt, by which means the water in the jar was frozen into one compact mass adhering to its bottom and sides. The jar was then removed from the freezing mixture, and placed in a mixture of pounded ice and water for 4 h. that the cake of ice might be brought to the temperature of 32°, when the surface of the ice, *c d*, was covered to the height of 0·478 of an inch with ice cold water before pouring in the boiling water. Instead of a piece of paper as before, a wooden dish perforated with many hundreds of

* Salt water on the contrary continues to be condensed the more, the more it is cooled.

holes

holes was put on the ſurface of the ice to defend it while the hot water was pouring in, which was done through a long wooden tube, ſtopt with a cork at the lower end, but perforated with a number of ſmall holes in the ſides, immediately above the cork, to make the water iſſue horizontally, and not impinge with force againſt the bottom of the wooden diſh, which of courſe floated as the water roſe; which tended to leſſen the motions in the liquid. The diſh was then carefully removed from the ſurface of the water *e f*.

The experiments were varied by ſometimes leaving the upper part of the jar ſurrounded by the atmoſphere, at other times by covering the part occupied by the hot water with cotton, and, at others, by keeping the jar plunged to its brim in melting ice and water.

The mean quantity of ice melted by hot water in 30′, when the jar was kept plunged to its brim in melting ice and water, was $399\frac{2}{5}$ grains; when ſurrounded by air at the temperature of 41°, 456 gr.; when ſurrounded by air at the temperature of 61°, $558\frac{1}{2}$ gr.; when covered up by a thick and warm covering of cotton, $690\frac{1}{2}$ gr.

When the experiments were ſimilar, the mean reſults of thoſe which were made with water at different temperatures were as follows:

In the experiments in which the part of the jar occupied by the water was expoſed uncovered to the air at the temperature of 61°, with boiling water the quantity of ice melted in 30 minutes was $558\frac{1}{2}$ gr.; with water at the temperature of 61°, 646 gr.; with water at the temperature of 41°, 574 gr.

In the experiments in which the jar was wholly ſurrounded by pounded ice and water, and conſequently was at 32°, the quantity melted in 30′ with boiling-hot water was $399\frac{2}{5}$ gr.; with water at the temperature of 61°, 661 gr.; with water at the temperature of 41°, 541 gr.

From

From these results the ingenious author concludes, and certainly his experiments justify the conclusion, that boiling-hot water is not capable of melting more ice, *when standing on its surface*, than an equal quantity of water at the temperature of 41°, or when only 9 degrees above freezing—a fact which proves that water is a perfect non-conductor of heat, and that heat is propagated in it *only* in consequence of the motions which the heat occasions in the insulated and solitary particles of that fluid, by altering their specific gravities. He here observes, in a note, that the insight which this discovery gives us in regard to the nature of the mechanical process which takes place in chemical solutions, is too evident to require illustration.

The author having frequently observed, when freezing water in one of his jars into a cake of ice, by placing the jar in a freezing mixture, that the water in the axis of the jar, which was latest in freezing, being compressed by the expansion of the ice round it, was always forced upwards, and formed a pointed projection of ice in the form of a nipple, which was sometimes above $\frac{1}{2}$ inch high, was led by the circumstance to make another experiment, which proved oil to be also a non-conductor of heat.

Into a jar (see *fig*. 4) containing a cake of ice *a* of the form above described, some fine olive oil, previously cooled to 32°, was poured till it stood (at *b*) 3 inches above the surface of the ice. A solid cylinder of iron *c* 1$\frac{1}{2}$ inch in diameter, and 12 inches high, and a paper sheath over it, the lower end of which projected $\frac{1}{10}$ of an inch past the cylinder, so contrived as to be suspended over the centre of the ice by means of the hook *d* and the wire *e*, fastened to the ceiling of the room, being heated to 210° in boiling water, was immersed in the oil so deep that the middle of the flat surface of the lower end of the hot iron was only distant from the conical projection of the ice $\frac{2}{10}$ of an inch. Had any heat *descended*, a portion of the ice would have been

been melted, but it was no way affected by the vicinity of the hot iron. The intention in making the sheath project $\frac{1}{10}$ below the cylinder was to prevent internal motions in the oil, the particles of which, by becoming specifically lighter by being in contact with the iron cylinder, would otherwise have slid from under it and ascended.

A similar experiment was tried with mercury poured to the height of 1 inch over the ice, instead of the 3 inches of oil, and the result was exactly the same; though the ice at the time could not bear a finger to touch it (by putting it down through the mercury), however expeditiously removed, without a portion being dissolved, and which instantly became visible on the bright surface of the mercury.

From his experiments the author seems inclined to doubt the existence of that peculiar kind of attraction of predilection which has been called chemical affinity, and to attribute the equal distribution of the particles of any body in its menstruum to the internal motions among the particles of the fluid occasioned by accidental changes of temperature, produced by the union of the two; or to a great difference in the specific gravity of the menstruum in its natural state, and that of the same fluid after it has been changed to a saturated solution. The following experiment serves to support the author's opinion:

A cylindrical glass jar was placed within a larger one which stood in a shallow earthen dish, nearly filled with pounded ice and water. Ice cold fresh water, lightly tinged of a red colour with turnsol, was poured into the small jar to the height of 2 inches; and then, by means of a funnel, which ended in a long and narrow tube, put down through that water and resting on the bottom of the jar, an equal quantity of the strongest brine that could be made with sea-salt was poured in, so gently that, without disturbing the fresh water, the brine took the lower station, the coloured water reposing above it without the smallest appearance of blending.

blending. The fpace between the jars was now filled, almoft to the top, with ice cold water mixed with pieces of ice (pounded ice would have obftructed the view), and then ice cold olive oil was gently poured on the furface of the tinged water to the height of an inch above it. In a temperature of about 36° the brine and water fhewed not the leaft difpofition to mix during 4 days. At the end of that time it was removed, without agitating its contents, into a warmer room; in lefs than an hour the brine and water began to mix: they were completely mixed in 24 hours, as was then evident by the uniform colour of the aqueous fluid on which the oil repofed.

Fig. 5 is a reprefentation of the apparatus employed in the procefs, and fhews the different liquids repofing one above another; with the fpace between the cylindrical veffels filled with water and pieces of ice, fo high as to overtop the furface of the contents of the inner jar.

IV. *Experiments and Obfervations on the Nature of Sugar, by Mr.* CRUICKSHANK. *Extracted from* Cafes of the Diabetes Mellitus. *Second Edition.* 1798.

SUGAR has been fuppofed to be a fubftance intermediate between the vegetable mucilages and acids, containing more oxygen than the former, but lefs than the latter. With a view to afcertain this and fome other facts relative to thefe fubftances, Mr. Cruickfhank made the following experiments:

Two ounces of refined fugar were expofed in a retort to a heat gradually increafed till the bottom became red hot, 8½ dr. of pyromucous acid came over, which required 150 gr. of a folution of potafh to faturate it: this liquor contained mixed with it a little empyreumatic oil: the charry refiduum in the retort weighed 5 dr. Therefore the gas which efcaped muft muſt have weighed $2\frac{1}{2}$ dr.: ſome of it being examined, was found to conſiſt of carbonic acid gas and hydro-carbonat.

Two ounces of gum arabic treated in the ſame manner yielded 7 dr. 40 gr. pyromucous acid containing a little more empyreumatic oil, and required only 118 gr. of the ſame ſolution of potaſh to ſaturate it; 3 dr. 45 gr. reſiduum; 5 dr. of gas conſiſting like the former of hydro-carbonat and carbonic acid gas.

As ſugar yields more acid than gum in the proportion of 150 to 118—as oxygen is the univerſal acidifying principle —and as the acid from both is the ſame, viz. the pyromucous, ſugar muſt, therefore, contain the greateſt proportion of oxygen; for the carbonic acid and hydro-carbonat were not produced in any quantity till near the end of the operation, and therefore were probably formed by the decompoſition of the water.

To obſerve the changes and decompoſitions that take place during the proceſs of malting, which ſomehow converts vegetable mucilage and fecular into ſugar, the following experiments were made:

Barley ſoaked in water for 24 hours was introduced in a wine glaſs into a jar containing common air, inverted over water and kept in a temperature between 60° and 70°. In 5 days it began to grow, and in 4 weeks the ſhoots were half an inch long. At the end of 10 weeks vegetation was ſtill going on, and the air in the jar had ſomewhat diminiſhed: the barley was very ſweet, and nearly malted. The air was found to conſiſt of azotic and carbonic acid gas, in the proportion of 20 to 6, the whole of the oxygen being either abſorbed or united to carbon.

Barley ſoaked for 48 hours introduced as in the laſt experiment into a jar containing oxygen gas, inverted over water to which ſulphuric acid had been added, began to grow at the end of 3 days. In 10 days the water had riſen in the jar, the gas being diminiſhed about one third. The barley ſmelled like malt, and was ſweet. The gas was found to con-

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fiſt of 64 parts carbonic acid, 32 azote and 4 oxygen; from which it would appear that the oxygen employed had contained originally about 20 per cent. of azotic gas.

The ſame experiment was repeated over mercury. In 3 days the barley began to grow. At the end of 10 days the gas, which continued of the original bulk, was found to conſiſt of carbonic acid gas, containing $\frac{1}{50}$th of its bulk of oxygen gas. The barley was partly converted into malt.

Another experiment with common air was made at the ſame time: the barley did not begin to grow till the end of the 4th, and at the end of the 10th day had made much leſs progreſs than that in the oxygen. The air had increaſed a little, and was found to conſiſt of carbonic acid and azotic gas, in the proportion of 1 to 2, and a very ſmall quantity of oxygen. The barley taſted ſweet.

Soaked barley was introduced into a jar *filled with* and inverted over mercury. At the end of 12 days a very conſiderable quantity of gas, found to be carbonic acid, was produced; but no vegetation had taken place, nor any other ſenſible change in the barley.

Another portion of the ſame ſoaked barley, expoſed to nitrous gas over water, at the end of 10 days had undergone no apparent change. The gas, which was diminiſhed a little, contained about $\frac{1}{9}$th of its bulk of carbonic acid gas: the remainder was pure nitrous gas, as was manifeſt from the diminution it underwent when mixed with pure air. The nitrous gas which diſappeared muſt have been abſorbed either by the barley or the water: the carbonic acid gas which was produced is accounted for by the laſt experiment.

Two other portions were expoſed, the one to hydrogenous and the other to azotic gas. In 14 days no vegetation in either. Both the gaſes had increaſed about $\frac{1}{5}$th in bulk, and contained each from $\frac{1}{3}$d to $\frac{1}{4}$th of carbonic acid, the remainder being the original gaſes not ſenſibly changed. The barley in the hydrogen taſted muſty—no ſweetneſs.

It is manifeſt from theſe experiments that oxygen is abſo-

lutely

lutely neceſſary for the converſion of vegetable mucilage and fecula into ſugar. In no inſtance was ſaccharine matter formed where this was not preſent. Mr. C. thinks that the oxygen is chiefly abſorbed by the barley, though part may alſo go to the formation of the carbonic acid; for carbonic acid was formed in conſiderable quantity without the preſence of oxygen gas, which he conceives muſt proceed from the decompoſition of the water, its oxygen uniting with the carbonaceous principle of the barley, while its hydrogen is fixed, which may be neceſſary to the formation of the ſaccharine principle. He infers, therefore, that vegetable mucilage is converted into ſugar, by being deprived of part of its carbon, while at the ſame time it unites with a greater proportion of oxygen, and probably alſo with hydrogen from the decompoſition of the water. Thus then both from analyſis and ſyntheſis it appears that ſugar contains more oxygen than gum or mucilage; and it ſhould follow, that ſugar deprived of its oxygen muſt loſe its ſweetneſs and form a kind of gum. To accompliſh this was the object of the following experiments:

Some ſyrup was introduced into a jar filled with and inverted over mercury: to this was admitted an equal quantity of the phoſphuret of lime: a conſiderable production of phoſphoric gas almoſt immediately took place, and the mercury deſcended in the jar. At the end of 8 days the ſyrup, inſtead of a ſweet, had a bitter aſtringent taſte. When filtered, alcohol produced a copious white precipitate in flakes, reſembling mucilage ſeparated from water by the ſame ſubſtance.

To refined ſugar diſſolved in alcohol phoſphuret of lime was added: no gas was diſengaged, nor any action produced. The mixture was allowed to remain in an open vial till the alcohol had evaporated; diſtilled water was added, but no diſengagement of gas took place, the phoſphuret having been decompoſed and converted principally into phoſphat of lime. The mixture being filtered and the clear liquor evaporated, there remained a ſubſtance, extremely tenacious, which had much the appearance of gum arabic: its taſte was bitter with a ſlight degree of ſweetneſs; when ſqueezed between the teeth it had exactly the feel of gum, but more tenacious; it was not ſoluble in alcohol, at leaſt in any quantity; and burned on red hot iron like gum, leaving a bulky and inſipid charcoal.—That this converſion of the ſaccharine principle into a gum was effected by the abſtraction of oxygen, is highly probable from the nature of the ſubſtance employed; for there are few ſubſtances which have a ſtronger affinity for oxygen than phoſphuret of lime.

Solutions of ſugar were mixed with different ſulphurets, and agitated with nitrous gas in cloſe veſſels. The ſulphurets, eſpecially that of potaſh, deſtroyed the ſaccharine taſte; but owing to the ſolubility of the different products, the nature of the change could not be accurately aſcertained. The action of the nitrous gas was more doubtful.

To be ſatisfied how far the effects produced in the former experiments might be owing to the abſtraction of oxygen, Mr. C. added to ſolutions of ſugar in water both lime and pure potaſh, and boiled the mixtures. The lime combined with and gave to the ſugar a bitter aſtringent taſte; but it was ſtill ſweet: alcohol put to the filtered ſolution produced a precipitate in white flakes, ſimilar to that in the experiment with the phoſphuret, and which appeared to be a combination of ſugar with lime. Vitriolic acid likewiſe precipitated the lime in the form of ſelenite, and in a great meaſure reſtored the natural taſte. Some of the filtered ſolution being evaporated by a gentle heat, there remained a ſemitranſparent ſubſtance, much more tenacious than the thickeſt ſyrup, but leſs ſo than that produced by the phoſphuret of lime: it had a rough bitter taſte, with a certain degree of ſweetneſs. The potaſh likewiſe appeared to combine with the ſugar, the ſweet taſte being more completely deſtroyed than by the lime: but on the addition of ſulphuric acid ſulphat of potaſh was formed; and this being precipitated by alcohol,

alcohol, the ſweetneſs was completely reſtored. When alcohol was added to a ſolution of ſugar and pure potaſh, after it had been boiled to the conſiſtence of a ſyrup, no union took place: though agitated, the alcohol ſtill ſwam pure on the top—which ſeems to prove that a new compound is formed by theſe ſubſtances, inſoluble in this fluid, though both are completely ſo in a ſeparate ſtate.

Having converted ſugar into a ſpecies of gum, by abſtracting a portion of its oxygen, ſeveral experiments were made to change gum, by adding oxygen, into a kind of ſugar, but without ſucceſs. The gum went rapidly into the acid ſtate, eſpecially when expoſed to the action of the oxygenated muriatic acid gas. From the failure of theſe trials, it was ſuſpected that mucilages were not ſo ſimple as had been generally ſuppoſed: to throw ſome light on this ſubject the following comparative experiments were made:

An ounce of powdered gum arabic was expoſed to heat in a coated glaſs retort, as in the firſt two experiments, only here the pneumato-chemical apparatus was adapted—the heat was gradually applied as before*. The charry reſiduum burned very ſlowly; but when expoſed to a ſtrong heat in an open crucible, it left a whitiſh powder, which was found to be lime and a ſmall proportion of calcareous phoſphat. The pyromucous acid being ſuperſaturated with lime, a ſtrong ſmell of ammonia was inſtantly perceived; and a piece of paper dipped in muriatic acid being held over the veſſel, copious white fumes were immediately produced—azote therefore forms a conſtituent part of the gum. The gas collected in the pneumatic apparatus was carbonic acid mixed with that ſpecies of hydrocarbonat which is obtained by heat from moiſtened charcoal. Two ounce meaſures of the gas, well freed from carbonic acid, were mixed with $1\frac{1}{2}$ of very pure oxygen gas, and fired, by the electric ſpark, in

* For the amount of the products in this and the ſubſequent experiments ſee the table, page 374.

a strong glass jar, inverted over mercury: when fired they were reduced to 1 measure, which was all absorbed by lime water, admitted for the purpose, except a small particle which was found from the nitrous test to be pure air. From many experiments Mr. Cruickshank found that 12 measures of oxygen gas, united with carbon, produce 10 of carbonic acid gas. Hence it follows, that the quantity of oxygen gas necessary to the formation of carbonic acid gas must in this case have been 1·1 measures or a little better; the remaining ·4 therefore were consumed in the production of water, and would be sufficient to saturate ·8 of hydrogen, equal in weight to ·048 of a gr. nearly.—Now 1 oz. measure of carbonic acid gas weighs ·864 of a gr. and this contains ·24 of pure charcoal; hence the quantity of charcoal to hydrogen in this inflammable gas must be as ·24 to ·048, or 5 to 1. But one measure of pure hydrocarbonat, such as may be obtained from the decomposition of camphor, by making its vapour pass through a red hot earthen tube, or from the distillation of animal substances, opium, &c. requires 2 of pure air to saturate it, and the quantity of carbonic acid amounts to 1·45, which makes the proportion of carbon to hydrogen as 12 or 13 to 1: hence these gases differ materially, and ought not to be confounded. Indeed the difference between them is manifest from the manner in which they burn when mixed with common air, and brought into contact with an ignited body: pure hydrocarbonat burns slowly with a perfectly white flame, and never detonates—on the contrary, the compound inflammable gas, just mentioned, burns rapidly with a reddish blue flame and more or less of a detonation. It was necessary to mention this circumstance, as much confusion might be produced by applying the same name to substances considerably different. It is remarkable that ether, decomposed by heat, affords pure hydrocarbonat, while alcohol yields the mixed species.

An ounce of gum tragacanth treated in the same manner

as

as the gum arabic, gave the same kinds of products; but the quantity of ammonia disengaged from the pyromucous acid by superfaturating it with lime was considerably greater than from that afforded by the gum arabic.

Having thus discovered lime in both of these gums, reagents were employed to see if in this way that earth could be detected. Sulphuric acid was dropped into a solution of gum arabic: after standing for some hours a number of needle-like crystals were deposited: these being separated were re-dissolved in distilled water; the oxalat of ammonia was then added, and a copious precipitation of oxalat of lime immediately took place.

From these experiments it is manifest that gums consist of oxygen, hydrogen, carbon, azot and lime.

The pyromucous acid, obtained from sugar by the same process of distillation which had been employed on the gums, being superfaturated with lime, no ammonia could be perceived—sugar therefore does not contain azot: neither does it contain lime; for the charcoal, which was of a beautiful black colour, burned out completely when exposed to a strong red heat.

Sugar of milk being distilled in the same manner, and the products treated in the way already described, was found to contain lime in the charry residuum; and, contrary to what might have been expected, the quantity of ammonia disengaged from the pyromucous acid obtained from it was so small that it could hardly be detected—It therefore contains hardly any azot.

Experiments were next made to ascertain the quantity of oxalic basis or radical contained in each of these substances.

One ounce of sugar was added to 6 oz. of concentrated nitrous acid diluted with an equal bulk of water: when the action had ceased, heat was applied, and the evaporation continued till the liquor was reduced to about 1 oz. by measure: when cold the crystals were separated by filtration,

and

and the remaining fluid was again evaporated till the whoſe when cold ſhot into a maſs of cryſtals, leaving only a few drops which refuſed to cryſtallize.

One ounce of gum arabic was treated in the ſame manner; the laſt cryſtals obtained were mixed with an inſoluble white powder, which was ſeparated by the addition of diſtilled water, and was found to be oxalat of lime.—One ounce of gum tragacanth was alſo ſubjected to the ſame proceſs.

The cryſtals obtained from ſugar of milk by the ſame proceſs were mixed with a white powder, which, being but little ſoluble in water, was readily ſeparated, and appeared to be the ſaccholactic acid of Scheele. (See Phil. Mag. Vol. II. p. 246.)

Honey treated in the ſame manner exhibited no ſigns of ſaccholactic acid.

The Table ſubjoined to the preſent article will ſhew at one view the different products reſulting from deſtructive diſtillation, with their relative proportions; and likewiſe thoſe obtained by the nitrous acid.

From theſe experiments it appears that ſugar conſiſts merely of carbon, hydrogen, and oxygen; that gum differs from ſugar, not only in containing a leſs proportion of oxygen, but, alſo, by its combination with lime and azot; and that the ſugar of milk differs from both, as it contains the radical of the ſaccholactic acid—in other reſpects, however, it approaches very nearly to the nature of vegetable ſugar. Does the milk of carnivorous and graminivorous animals yield the ſame proportion of this acid, and is this ſugar itſelf always of the ſame nature?

From the well known facts reſpecting vinous fermentation, there is now reaſon to ſuppoſe that no ſubſtances but thoſe which conſiſt ſimply of carbon, hydrogen and oxygen are ſuſceptible of it; and that an union with a fourth changes the nature of the compound ſo much as to render this proceſs impracticable. To a ſolution of ſugar digeſted with freſh

fresh slacked quick lime, and to another digested with potash, some good yeast was added—to an equal quantity of solution of sugar alone the same quantity of yeast was added: the last began to ferment in 12 hours, and in a few days ran into the acetous state—the other two did not ferment: the temperature of the room during the experiments was from 65° to 75°.

A solution of the sugar of milk, to which a proper quantity of yeast was added, began to ferment in four days: at the end of 16, when the process had ceased, it had the smell of cyder, but rather more of the flavour of apples, was very sour, and reddened the tincture of litmus: with the oxyd of lead it formed a sweet saline mass composed of slender prismatic crystals, not deliquescent—the acid therefore contained, or was common vinegar.

In the attempts to convert gum into sugar by combining oxygen with it, as before stated, it ran into the acid state. To see if any thing like fermentation preceded this state, or if this effect could be produced by mere exposure to the air, without the addition of some substance containing much oxygen, as the nitrous or oxygenated muriatic acids, a solution of gum arabic was mixed with yeast as in the last experiments, but no fermentation was perceivable at the end of 26 days. It appears that the azot and lime combined with the carbon in gum prevents the vinous, and consequently the acetous fermentation. Similar experiments were made upon a strong decoction of beef, with, and without yeast, but no fermentation followed. Indeed it has been so generally admitted that vegetable and animal mucilages, when pure, are not susceptible of the vinous fermentation, that, had not a contrary opinion been lately advanced, these experiments upon them would have been conceived unnecessary.

TABLE.

Subſtances employed 1 oz. of each.	Products obtained by heat.				Productsobtained by nitrous acid.	
	Charcoal, &c.	Pyromucous acid, &c.	Carbonic acid gas.	Hydrocarbonat.	Oxalic acid.	Other ſubſtances.
	oz. drs. grs.	oz. drs. grs.	oz. meaſures	oz. meaſures	oz. drs. grs.	
Sugar - - -	0 2 0	0 4 30	41	119	0 4 20	None
Honey - - -					0 4 4	None
Sugar of milk -	0 1 0	0 6 0	31	103	0 3 18	30 gr. ſaccholactic acid
Gum arabic - -	0 1 36 and lime 10 0 1 46	0 3 30 with ſome ammonia	93	180	0 3 30	Oxalat of lime 6 gr.
Gum tragacanth	0 1 33 and lime 12 0 1 45	0 4 5 with ſome ammonia	78	91	0 3 10	Oxalat of lime 10 gr.

V. *On the different Proportions of the Metals employed in the Preparation of soft Solder.*

WHEN lead, tin, and bismuth are mixed in a certain proportion, they produce a metal exceedingly fusible, which is known by the name of soft solder; but which, from its singular properties, may be applied with advantage to many other useful purposes. Newton, and after him Kraft and Musschenbroek, observed, that 5 parts of bismuth, 3 of tin and 2 of lead, also 5 parts of bismuth, 4 of tin and 1 part of lead, melted with a heat of 220 degrees of Fahrenheit, and they found that various mixtures of this kind were fusible by a heat not much greater than that of boiling water. At a later period V. Rose, a German naturalist, discovered that a mixture of 4 parts of bismuth, 2 of tin and 2 of lead, as Kunkel recommended for soldering tin; and d'Arcet among the French, that a mixture of 8 parts of bismuth, 3 of tin and 5 of lead; or 8 of bismuth, 4 of tin and 4 of lead; or 8 of bismuth, 2 of tin and 6 of lead; also 16 of bismuth, 7 of tin and 9 of lead, all melted, or at least became soft, in boiling water.

According to the experiments made by Professor Gmelin, respecting the fusion of these three metals, a mixture, such as that before recommended by Homberg to anatomists for injecting into the vessels of their preparations, consisting of 2 parts of bismuth, 1 part of tin and 1 of lead, which is the same as Rose proposed, gave a metal that was fused in boiling water. A mixture of 6 or more parts of bismuth, 6 of tin and 3 of lead, or 1 part of bismuth, 2 parts of tin and 2 of lead, gave, according to Klein, the solder used by the tin-button-makers. The same workmen use also for soldering, according to Klein, a mixture of 4 parts of bismuth, 3 parts of tin and 5 parts of lead. Among the many soft solders employed by the tin-men, a mixture of one part of bismuth, 2 parts of tin, and 1 part of lead, is, according to

Klein, very much employed. Respecting this kind of solder, the experiments of Professor Gmelin give the following result: one part of bismuth, 2 parts of tin, and 1 part of lead, melt in boiling water. According to Klein, the tinmen employ for soldering, a mixture of 1 part of bismuth, 24 parts of tin, and 4 parts of lead. Eight parts of bismuth, 3 of tin and 5 of lead, gave a metal exceedingly like tin in its colour and brightness, but very brittle; in water beginning to boil, it became not only soft, but was completely fused. This imitation, however, may be better accomplished by the mixture of Professor Lichtenberg, which consists of 5 parts of bismuth, 3 of tin and 2 of lead. This metal is very like the former, though not so brittle; but it seemed to melt in hot water even before it came to boil.

VI. *Physical Observations on the East or Baltic Sea. By* F. W. OTTO. *From* Abriss einer Naturgeschichte des Meeres. *Berlin* 1792 *and* 1794. 2 *Vols.* 8*vo.*

THE Baltic is a real mediterranean sea, and not a lake, as M. de Buffon endeavours to shew, in his general work on natural history. It is every where surrounded by the land, except where it is connected with the North Sea by three narrow passages, the Sound *, and the large and lesser Belt. At

* The passage through the Sound is now of less importance since the construction of the Holstein canal, which joins the Baltic to the German Ocean. The idea of this junction was conceived under Frederic IV. Duke of Schleswig Holstein, but was not undertaken till the Russian government agreed to co-operate in promoting its success. It was begun in the spring of the year 1777, and was carried on by contractors, who engaged, for a certain yearly sum, to complete a certain portion of it. This canal, the whole length of which, from Kieler-Ford to Rendsburg, is equal to 10,650 poles, of sixteen feet each, proceeds on a level with the Baltic to the first lock at Holtenach, where it rises eight feet six inches. It then proceeds to the second lock at Knop, 745 poles distant from Kieler-Ford, which has a rise of eight feet six inches, and then continues to near

At Pillau and Memel it communicates with two large lakes, the Frisch Haff and Curisch Haff; which, however, both contain fresh water. The former, according to the account of some writers, was occasioned by a violent wind, which prevailed in the year 1190, and, continuing for more than twelve years, drove up so much sand from the bottom of the sea that the present tongue of land was raised; and the gulph, which now forms the Haff, separated from the Baltic. But this opinion is the more to be doubted, as the

near Suensdorf, where the third lock is situated, having a rise of the same height. Here the upper canal begins, and proceeds for the distance of 2413 poles, between Schwartenbec and Wittenbec, to the fourth lock at the Upper Eyder near Schinkel. This upper canal, which serves as a reservoir, has an influx of water from the neighbouring lakes sufficient for the purposes of navigation, and is twenty-five feet six inches higher than the level of the Baltic. At the fourth lock the canal falls seven feet four inches two lines; proceeds 1438 poles in the Eyder to the fifth lock at Nedderholten, where there is also a fall of the same height; and having continued by Seestede to Steinwarp, 2901 poles, little more art is employed, because the Eyder between that place and Rendsburg has almost naturally the sufficient depth and breadth. A sixth lock is constructed at Rendsburg, as the tide flows up there in the Eyder, and makes with the ebb a difference of one foot seven inches. The breadth of this canal, at the bottom, is fifty-four feet, and, at the surface of the water, ninety feet. It is nine feet deep, and navigable for ships of from 150 to 160 tons burthen. The locks, therefore, between the gates, are 100 feet in length and 27 feet in breadth. Along the banks there is a path ten feet broad, and another of twelve feet, for the horses which are employed to draw the vessels. The number of vessels which passed through this canal in 1797 amounted to 2105, of which 1393 were laden with merchandize and the rest in ballast. Of the former 41 were Danish vessels bound to foreign ports; and 129 bound from foreign countries to Danish or other northern ports; 539 were from the Baltic; 170 from the North Sea; and 78 were bound to or coming from Altona. Among the foreign ships were 24 English, 22 Dutch, 430 from East Friesland, 191 from the duchy of Oldenburg, 9 from Jevern, 89 from Popenbourg, 9 from Bremen, 8 from Hamburgh, 6 from Lubec, 44 from Hanoverian ports, 81 from Mecklenburg, 81 from Swedish Pomerania, 106 from Prussia, 11 from Courland and Russia, and 62 from Sweden. EDIT.

Curisch Haff is of the same nature with the Frisch Haff, and yet no one refers its origin to any tempestuous wind of the like kind. It is, on the other hand, certain that great changes have taken place in regard to the strait by which the Baltic is connected with this lake. At first it was situated immediately under the mountain on which the castle of Lochstedt stands, and at that time was deep and roomy; but in the year 1311, or according to other accounts 1395, it was entirely choaked up with sand by an uncommonly violent storm of wind which prevailed in the months of August and September; and this account is highly probable, as the valley between the Haff and the sea still shews evident traces of the course of the water, while the sand hills, raised towards the shore, are a further proof of this natural revolution. An opening was consequently formed opposite to the castle of Balga, between the villages Faglee and Schineergrube, which was fifteen ells in depth; but which, in a few years, experienced a like fate, being choaked up with sand. The irruption of the Haff then followed, close to the so called Pfundbude or light-house, situated on a mountain as a guide to ships which enter it, and the water was nine fathoms in depth; but, at length, this strait being filled up with sand, the Haff became united to the sea at Pillau, in the year 1510. The depth of this opening was at first nine fathoms; but it from time to time increased, so that, at present, it can be entered by the largest vessels.

It has long been observed that the water in the Baltic is cooler, even in the hottest summers, than that of other seas. The waves also never rise here to such a height as in the North Sea, but they follow each other with greater rapidity. In calm weather, therefore, it breaks with much less violence on the coast than is the case in other seas, when the weather is equally still. It has been remarked also, that when it breaks on the shores of Prussia, in particular, there arises a stronger spray and agitation than on any of the neighbouring coasts of other countries; and this is said to be observed, above

above all, at the time when the firſt ſnow appears, and in the beginning of the ſpring.

In the next place, the water of the Baltic is leſs ſaline than that of other ſeas; the cauſe of which, in all probability, is to be aſcribed to the great number of rivers that fall into it. For this reaſon its gravity is likewiſe leſs, and veſſels cannot ſail in it with the ſame velocity as in the North Sea. For the ſame reaſon alſo it is more liable to corruption. The number of the ſtreams which empty themſelves into this ſea amount, according to Buffon, to forty; and among theſe the Oder, the Weichſel, &c. are the moſt conſiderable. Notwithſtanding the great quantity of water ſupplied by theſe rivers, the Baltic does not ſenſibly increaſe. Its principal efflux, towards the North Sea, is the Sound; though Engliſh navigators have found there, at the depth of four or five fathoms, a ſunken current, running in a contrary direction to that at the ſurface.

The Baltic is not ſubject to a regular ebbing and flowing, as it is ſurrounded by land, and is united with the North Sea only by the Sound and the two Belts: this circumſtance has given occaſion to its being called the inactive ſea (*mare pigrum*). During a long continuance of the weſt wind its natural efflux is prevented, and a great deal of water forced into it from the North Sea; ſo that it then riſes on the coaſts a little above its uſual level. This connection, however, with the German ocean is ſometimes the cauſe that the ebbing and flowing of the latter, though weak, coöperates with the Baltic, ſo that traces of their effects may be ſometimes perceived.

We are aſſured by hiſtory that this ſea has been ſometimes totally frozen during ſevere cold. This was the caſe in the year 1333, at which time people could travel on the ice from Lubec to Pruſſia and Denmark; and on this account huts were erected in different places for the accommodation of travellers. A like phenomenon occurred in 1399 and 1533; and in 1423 people could walk and ride over the

 ſea

sea in a straight line from Konigsberg to Lubec. Six years after this sea was every where covered with ice, in such a manner that journeys of the like kind were undertaken not only from Prussia to Holstein, but also from Mecklenburg to Denmark; and this was done likewise in 1459. In the strong frost of the year 1709, the ice extended so far on the Baltic, from the Prussian coast, that people on the highest steeples on the shore could not see where it ended; and this no doubt was the case during the cold of the year 1740, which exceeded the former some degrees.

The depth of the Baltic, in most places, never exceeds fifty fathoms. In some few places of the Gulph of Bothnia no bottom indeed is to be found; but in others, quite near, the depth is not more than fifty fathoms.

In regard to the decrease of water in the Baltic, much has been said for and against it; but nothing certain can be determined on this point. Mr. Otto is of opinion that the contradictions, apparent on the first view of the subject, might be reconciled by attending to the times. The period of the decrease of water in this sea, of which the still existing remains of marine productions are incontrovertible proofs, belongs to the most remote ages. Since the time when the Baltic was confined within its present boundaries, the decrease and increase of its water are merely apparent; as it may have happened, from various causes, that land may have been gained in one quarter and lost in another. Large rivers, which flow with great rapidity, may, for example, have carried with them into the sea a great deal of earth and sand, by which the beds at their mouths may have been raised, and the banks extended towards the sea.

VII. *Exami-*

VII. *Examination of the Experiments and new Obſervations of* G. PEARSON, *M.D. on Human Urinary Concretions; and a Compariſon of the Reſults obtained by that Chemiſt with thoſe of* SCHEELE, BERGMAN, *and ſome of the French Chemiſts. By M.* FOURCROY. *From* Annales de Chimie, *Vol. XXVII.*

[Concluded from page 272.]

MY view in commencing my labours on this ſubject was not only to eſtabliſh the facts announced by Scheele, but alſo to purſue much farther the examination of urinary calculi; and to add to it that of all the animal concretions I could procure. This plan will be found partly executed in the details I have publiſhed. 1. On the inteſtinal calculus of the horſe, which I found to be a triple ſalt, formed of 2 parts of phoſphat of magneſia and 1 part of the phoſphat of ammonia. 2. On a renal calculus of the ſame animal, in which I diſcovered 3 parts of the carbonat of lime and 1 part of the phoſphat of lime, without any matter analogous to that in the human calculus. 3. On a calculus of a cat, which gave me 3 parts of the carbonat of lime and 1 part of the phoſphat of lime. 4. On the tartar of the teeth, which I found to be pure phoſphat of lime. 5. On the calculus of the human reins, the nature of which I determined to be perfectly ſimilar to that of the calculus of the bladder. In the examination of ſeveral concretions, different from thoſe of the urinary calculus, I was prior to Dr. Pearſon by more than ten years, and my labours had been publiſhed five years when he communicated his to the Royal Society of London; yet he has not quoted my work, though he has done nothing but repeated and confirmed my experiments.

With regard to the human urinary calculus, I had examined a ſufficient number to be able to trace out the general characters which I thought it neceſſary to add to thoſe

those given by Scheele. Having indeed represented it, after this illustrious chemist, as a solid acid crystallised in laminæ, insipid, giving a faint red tinge to blue colours, soluble in caustic alkalies and in the nitric acid, assuming with the latter a beautiful red colour, decomposable by fire, yielding a great deal of the carbonic acid and little oil; the weakest of all the acids; containing lime and alkaline phosphats only by accident. I add to these characters the following properties established by the analysis of a great number of varieties of these concretions: 1. Their solution in water reddens turnsole paper. 2. They give the prussic acid by distillation, and by the action of the nitric acid. 3. The calculus of the human bladder contains but little hydrogen, since it gives but little oil; and but little oxygen, since it furnishes but a very small proportion of the prussic and carbonic acids.

The experiments which I afterwards described on the four calculi carefully treated by different agents, may be taken, according to all the other experiments, which I did not think it necessary to describe in the same manner, as an account of the properties of the urinary calculus considered as a genus; and I must indeed here observe, there are none of them which do not present results more or less similar. Thus: 1. The augmentation of its weight in water, into which the calculus was entirely immersed. 2. The earthy smell of marl which it diffuses, when diluted as a powder in this liquid. 3. The little alteration it exhibits, and the imputrescibility it preserves during more than fifteen days under water at a temperature above 12 degrees (57° Fahr.). 4. Its almost perfect solubility in 2000 times its weight of water, when repeatedly treated in powder. 5. Its solubility in less than half that quantity of boiling water; its separation only partial in lamellated crystals by cooling—the manner of obtaining it thus pure. 6. Its property of reddening turnsole paper, when after this purification it is rubbed on this paper with a little water. 7. Its solution in lime-water, which

which by expofure to the air foon depofits both carbonat of lime and the lithic acid feparate from each other, proves that the atmofpheric carbonic acid decompofes the calcareous lithiat which was there formed. 8. Its almoft total folubility (except $\frac{1}{12}$) in a ley of cauftic potafh, which often difengages much ammonia. 9. Its precipitation of a golden yellow colour from this alkaline folution by the acetous acid, which feparates from it the lithic acid in fmall white brilliant and almoft pulverulent needles, and which furnifhes more than a half of the cryftallifed lithiat of potafh. 10. This precipitation of the lithic acid from the alkaline folution by the acetous acid, given as a good procefs for procuring this animal acid pure. 11. The folubility of the calculus fometimes entire, fometimes in powder, in the oxygenated muriatic acid, which at firft afforded me the hope of a lithontriptic; but which being deftroyed by other fucceffive experiments prefented only a fingular fact worthy of being further inveftigated. 12. The action of the fire and diftillation in a retort upon the calculus of the human bladder, ufing a quantity five times greater than that employed by Dr. Pearfon, and which gave me as products near a quarter of a fublimated lamellated acid, ftill analogous to the lithic acid; fome drops only of water and thick oil, fixed, containing a little pruffiat of ammonia; $\frac{1}{8}$ concrete carbonat of ammonia, a bulk of more than fix kilogrammes of water in gas, $\frac{2}{3}$ of which were carbonic acid; a coal weighing a little more than a quarter of the calculus, and which yielded only $\frac{1}{80}$ of its weight of afhes, without any fenfible trace of lime.

All thefe facts, which I was obliged to concentrate here in fome manner in order to render them more ftriking, ferved to confirm the firft refults of Scheele and Bergmann; and enabled me to add feveral obfervations which had efcaped them. I had concluded with them that the human urinary calculus, whether that of the reins or that of the bladder, contained a matter different from all other animal fubftance, ſtance, not found in any other humours of the human body, nor in any of thoſe of the bodies of the different animals now known; a weak concrete acid, almoſt inſoluble, the principal ſolvents of which were the cauſtic alkalies; that this particular acid very little hydrogenated and oxygenated, but much charged with carbon and azot, was an immediate production of the reins and of the diureſis, or of the formation of urine; that it was ſometimes joined with ſome parts of the phoſphats of lime, of ſoda, and of ammonia, with a colouring animal matter; but that theſe different ſubſtances, foreign to the lithic acid, ſeemed to be only acceſſories, variable in their proportions, which might not have been found there at all, and which did not ſeem to conſtitute the particular eſſence of it.

I may add to this notice of my labours, which are already pretty old, that the experiments I have had occaſion to make for ten years paſt on this animal matter, either for ſome particular purpoſe or in the courſe of my annual lectures, by confirming me more and more in my former ideas, agreeing with thoſe of Scheele and Bergmann, have only taught me that ſome human urinary calculi contain phoſphat of lime, inſoluble in water and in pure alkalies, and the alteration which the lithic acid experiences by the action of the nitric acid when boiled in the latter—an alteration during which there is diſengaged carbonic acid gas, azotic gas, and the pruſſic acid gas; ſo that the calculous matter appears to me really to change its nature during this action of the nitric acid. But all this ought not to change any thing of my opinions in regard to the particular character and acid properties of the peculiar matter of the human urinary calculus.

C. Fourcroy then aſks, whether the labours of Dr. Pearſon have given different reſults, and of ſuch a nature as ſhould induce the French chemiſts to give up their former ideas reſpecting the nature of the peculiar matter of the human urinary calculus; or whether his experiments are ſufficiently concluſive to induce them to admit its non-acidity, and conſider it as an oxyd? He inſiſts that Dr. Pearſon has not correctly comprehended the labours either of the Swediſh or French chemiſts; that he has improperly believed that they gave the name of lithic acid to the ſublimate of the calculus obtained by fire, whereas they gave it, either to the entire calculus as it comes from the reins or the bladder, when wholly formed of that ſubſtance, or, to this matter obtained by cooling a ſolution of it in water, or by precipitating it from an alkaline ſolution by the acetous acid; and that the pretended oxyd is really Scheele's acid, at firſt called the bezoardic, and ſince, in the new nomenclature, the lithic acid.

Dr. Pearſon gives a larger proportion of inſoluble matter than his predeceſſors, ſtating it at almoſt $\frac{1}{3}$d of the mixed calculi which he employed; but Fourcroy oppoſes to this what Dr. Pearſon ſays in another place, "that he found ſome calculi contain even $\frac{199}{200}$ths of the ſoluble part;" and remarks, that there is no reaſon to doubt that the greater part of human urinary concretions contain a much greater proportion of matter ſoluble in alkalies than that of which he has given the analyſis. The diſengagement of ammonia obſerved by Dr. Pearſon, which accompanies the ſolution of the calculus in pure ſoda, was alſo ſeen by Scheele, and obſerved and carefully deſcribed by Fourcroy.

The ſoapy and unctuous feel, ſays Fourcroy, of the ſpontaneous depoſit formed in the alkaline ſolution of the calculus manifeſtly ariſes from the ſuperabundance of alkali; we perceive here the ſeparation of our lithiat of potaſh from its ſaturated ſolution; and I may remark, that this is what I have pointed out in my reſearches, by ſaying that the lithiat of potaſh eaſily ſeparates in cryſtals from its concentrated and ſaturated ſolution. This ſoapy depoſit of Dr. Pearſon is nevertheleſs ſoluble in water, and precipitated by acids without being re-diſſolved: this is a decompoſition of the lithiat of of potash and the separation of the lithic acid. According to the author, this solution was not rendered turbid by the carbonic acid. I had made exactly the same observation.

The precipitate formed in the alkaline solution of the calculus by the sulphuric acid is of principal importance to my investigation, since it is this precipitate which forms the real difference between us, and to which our whole attention should be directed. It is really our lithic acid which Dr. Pearson will not acknowledge as an acid, and in which he thinks he has found a sufficient number of characters, different from what I had assigned to it, to induce him to consider it as a peculiar animal matter, and to name it the uric or ouric oxyd. Insipidity, the quality of being inodorous, insolubility in the mouth, solubility in 800 parts of boiling water, the warm solution not reddening turnsole paper, crystallisation by cooling, solubility in caustic soda and lime water, insolubility in alkaline carbonates, non-precipitation of soap, but precipitation of alkaline sulphurets, solubility in the nitric acid, and the red pink colour which its nitric solution assumes when evaporated—these are all the results of the experiments of Dr. Pearson, none of which, except the non-coloration of turnsole, differ from what Scheele and myself have given; but this difference can have arisen only from the manner of performing the experiment, or from Dr. Pearson having made his on some matter foreign to the lithic acid. The shade of the colour of the nitric solution which Scheele announced to be of a beautiful red or blood red, Dr. Pearson says was a pink red; and it is to this tint, which he alludes to several times in his dissertation, that he attaches the peculiar character of his uric oxyd.

As to the action of fire either on the human urinary calculus entire or on the precipitate from its alkaline solution by the sulphuric acid, which I have shewn to be our pure lithic acid, I have described with much more care and accuracy than he has in his Memoir, the products of the distillation

lation of this matter which I obtained from a quantity at leaſt ſix times as large as that which he employed.

In what regards the acid and cryſtalline ſublimate obtained in the diſtillation, except the apparatus of a bent tube deſtined to ſeparate the products, I can ſee nothing new; only here the author gave himſelf needleſs trouble to ſearch for our lithic acid in this manner, ſince, as I have already ſaid, it was not this product of the ſublimation and decompoſition by fire that I diſtinguiſhed by the name of the lithic acid in our nomenclature.

The attempts made by Dr. Pearſon to acidify his ſuppoſed oxyd by the nitric acid and the oxygenated muriatic acid could not poſſibly ſucceed: like thoſe who preceded him, he found that the calculus was changed into carbonic acid and ammonia.

Reſpecting the portions of the calculi not ſoluble in alkali, and which, Dr. Pearſon aſſerts, exhibited to him all the properties of phoſphat of lime, I ſhall obſerve, that if by this fact he ſeems to deviate more from thoſe who went before him, it was only from two calculi, mixed in equal parts, that he obtained ſuch a reſult, and that the very variable difference of the proportion of the ſubſtances ſoluble and inſoluble in the 300 urinary concretions, which he ſays he examined comparatively, can furniſh no oppoſition to the reſult of Scheele in regard to the matter called *lithic acid*.

As to the product of the numerous experiments which Dr. Pearſon tried on more than 300 human urinary calculi, which he compared with each other, I find no other difference between what he announces and what was announced by his predeceſſors, but the variety of the nature which theſe experiments ſhewed to him between theſe concretions—a variety which, however, always ſhews the greateſt proportion in the kind of matter called by him the ouric oxyd. It is in this reſult that Dr. Pearſon deviates moſt from Scheele, who aſſerted that all the calculi of the human bladder reſembled each other and exhibited no difference. We muft however add to this fact, which forms one of the new points of the differtation of Dr. Pearfon, that of the difcovery of his ouric oxyd in arthritic concretions. But it may be readily perceived, that this difference between our author and the chemifts whom he feems to combat no way affects the intimate nature of the real calculous fubftance, and it is only on the latter that it is of importance to fix the opinions of philofophers.

The queftion between us is now reduced to this fimple point: Ought the properties of the matter which conftitutes the urinary calculus to induce us to confider it as a peculiar acid, or only as an animal oxyd?

It is fufficiently agreed, that every fubftance more or lefs foluble in water, that turns fome blue colours red, that, above all, is fufceptible of uniting ftrongly and readily with alkalies, and of forming with them cryftallifable compounds, in fuch a manner that their peculiar attractive power for each of thefe falifiable bafes, as well as their affinities, compared to that of other well known acids, may be eftimated, ought to be ranked among the number of acids. Thus the metals called *tungften*, *molybdena*, and *chrome*, faturated with oxygen by complete combuftion, have naturally affumed a place in the clafs of and next to the moft powerful and longeft known acids. It is thus in particular that the matter contained in the gall-nut which blackens iron; that which colours it blue, and which is furnifhed by the decompofition of animal fubftances, have received the character of acid bodies, and the names of the *gallic acid* and *pruffic acid*. It is, in fhort, from the fame confiderations that our *lithic acid* has been placed in the fame clafs or referred to the fame genus. It has not indeed any four tafte, and is very little foluble in water; but it reddens turnfole paper when it is rubbed on it with a little water, and it combines rapidly with cauftic alkalies, and brings them to the ftate of falts by faturation. If it does not decompofe foap or alkaline carbonates, it it precipitates the ſulphures; and we muſt not forget that Scheele repreſents it as the weakeſt of all acids. Why then ſhould Dr. Pearſon, without any new facts reſpecting its characters, wiſh to include it among the oxyds? Are the latter even taken in the claſs of ternary or quaternary oxyds, vegetable or animal, ſoluble like it in alkalies; and do they ſaturate them? Is this owing to its little ſolubility? But the ſaccharine oxyd is very ſoluble in water without ſaturating alkalies. Is it not manifeſt, on the contrary, that it wants one of the principal characters of theſe complex oxyds, among which the French pneumatic chemiſtry claſſes a great number of organic compounds? Does it not reject this acidification, ſo eaſy in other oxyds of the ſame kind, that change ſo rapidly into the oxalic or acetous acids by the action of the nitric and oxygenated muriatic acids, as Dr. Pearſon has ſo carefully confirmed? How came he not to perceive, that this difference between it and the other vegetable or animal oxyds required from chemiſts that they ſhould place it in another claſs of bodies; and that, too much oxygenated, no doubt, to paſs to a new ſtate of acidity, being already itſelf as much ſo as the nature of its compoſition would admit, it could not but loſe its combination by the ſtrong action of the oxygenating compounds, and paſs, as was really the caſe, to the laſt term of animal decompoſition, the ſtate of a double binary compound; the carbonic acid and ammonia? I am even aſtoniſhed that Dr. Pearſon, in analyſing this body with that ſpirit of inveſtigation which he employed, was not more inclined than other chemiſts to preſerve the acid character to this compound, and that he was not averſe to compare it with oxyds, ſince he found in it ſo many characters oppoſite to thoſe of the known oxyds. If we indeed take from the compound oxyds contained in organic bodies that character, ſo ſtriking, of becoming acid by a greater proportion of oxygen, we ſhall at once efface every thing clear and preciſe which this denomination preſents to the mind, and ſubſtitute at once darkneſs for light.

All that Dr. Pearson has done gives more ſtrength ſtill to the well founded opinion which has cauſed this body to be claſſed among the acids. It differs particularly from the oxyds by its unalterability, its imputreſcibility, its ſolubility in alkalies, its reſiſtance to acidification; and it would be deranging to no purpoſe the reſults and opinions of modern chemiſtry to place it in that claſs of compounds with which it in reality has no relation. I ſhall then continue with all the French chemiſts to conſider human urinary calculi as containing, moſt frequently, and, ſometimes, altogether, a weak acid, the characters of which were well determined before Dr. Pearſon, and even confirmed by his reſearches.

I ſhall add one important obſervation, that of all the acids it is that which cryſtalliſes the ſooneſt, and whoſe moleculæ perhaps are moſt altered; which aſſumes with the greateſt eaſe the concrete and ſparry form, under which, as it is ſeen in regular calculi and in compact ſtrata, it almoſt eludes the action of the moſt powerful re-agents and ſolvents; and it is to this laſt property, the moſt terrible and afflicting for humanity, that what is called the ſtone in the bladder muſt without doubt reſiſt the action of all the known ſolvents, and has hitherto given no hopes of the diſcovery of a lithontriptic.

In the preſent ſtate of chemiſtry the particular matter of human urinary calculi appears only as a combination, where abundance of carbon and azot united to a ſmall quantity of hydrogen are inclined to a ſlight acidification by the fixed oxygen which they contain. The proportion even of theſe primitive materials has not yet been determined. After having examined the labours of Dr. Pearſon, I muſt agree with him, that the name *lithic acid* given to this animal concretion, and which has been borrowed from the medical term lithiaſis, deſerves that reproach of impropriety which he beſtows on it. I am of opinion that we might adopt with advantage that of *ouric acid*, ſince this body has not yet been found but in the urine of man; and that even if future experiments ſhould confirm the diſcovery of Dr. Pearſon, who ſays he found the ſame acid in arthritic concretions, this denomination would ſtill be very proper, either becauſe the conſtant ſeat of this acid is the human urine, or becauſe it is always more abundant there than in articulations attacked by the gout; or, in the laſt place, becauſe it appears, in ſome meaſure, in fits of that diſeaſe, to be driven and carried from its uſual channel towards the extremities of the bones, the articular membranes of which it irritates.

VIII. *On the Invention of the Euphon, and other acouſtic Diſcoveries of* C. F. F. CHLADNI, *Doctor of Philoſophy and Law, Fellow of the Royal Society of Gottingen, correſponding Member of the Imperial Academy of Sciences at Peterſburgh, &c.*

MANY perſons who intereſted themſelves in favour of Dr. Chladni and his inventions having expreſſed a wiſh of becoming acquainted with the hiſtory of them, the Doctor drew up a ſhort paper on that ſubject, which he tranſmitted to one of the German Journals*, and from which we have extracted the following particulars. The author firſt obſerves, that the invention of the euphon and all his other acouſtic diſcoveries were not the effects of chance, but the fruit of long and continued reflection. The rather confined education which he received, both in his father's houſe and at the ſchool of Grimma, did not produce on him the uſual but a contrary effect, as it inclined him very early to think and to act for himſelf. At the age of only ſix or ſeven, when he ought to have been otherwiſe employed, he would ſit whole hours ſtudying maps and books of geography, and wiſh, at the ſame time, that he might have an opportunity of travelling over all the countries which he ſaw repreſented before him. His father, firſt profeſſor of law at Wittenberg, who,

* Magazin für das neueſte aus der Phyſik, vol. ix. part 4, p. 100.

who, according to the then uſual cuſtom, had converted the original Hungarian family name into that of Chladenius, was deſirous that the author, his only ſon, ſhould apply himſelf to the law, though it was contrary to his inclination. Dr. Chladni, therefore, ſtudied law firſt at Wittenberg, and then at Leipſic, and, after the uſual forms, took his degree of doctor. On his father's death he quitted this line, for which he had no attachment, and, devoting himſelf entirely to the ſtudy of nature, delivered lectures on phyſical and mathematical ſubjects to qualify himſelf for a profeſſorſhip which he had ſome hopes of obtaining. In his 19th year he began to learn to play the harpſichord; and he afterwards read a great many of the principal works on the theory of muſic, by which he found that the phyſico-mathematical part of that ſcience was far more defective than other branches of natural philoſophy. Being therefore poſſeſſed with an idea that his time could not be better employed than in endeavouring to make diſcoveries in this department, he accordingly tried various experiments on the vibrations of ſtrings and the different kinds of vibration in cylindric pieces of wood, firſt diſcovered, through calculation, by the elder Euler; and found that, though a great deal had been ſaid on the nature of theſe elaſtic bodies, yet the manner of vibration and the proportion of tones in other elaſtic bodies, which do not proceed, as in the former, in ſtraight lines, but depend on the vibration of whole ſurfaces, were totally unknown, and that the little which had been written on that ſubject, by ſome authors, did not correſpond with nature. He had already long remarked, that every plate of glaſs or metal emitted various tones according as it was held and ſtruck in different places; and he was deſirous to diſcover the cauſe of this difference, which no one had ever examined. He fixed in a vice the axle of a braſs plate which belonged to a poliſhing machine, and found, that by drawing the bow of a violin over it, he produced very different tones, which were ſtronger and of longer duration than thoſe obtained

merely

merely by striking it. The observation, that not only strings but also other elastic bodies may be made to produce sounds by drawing a violin bow over them, Dr. Chladni does not give as a discovery of his own; as the so called iron violin has been long known, and as he had read of an instrument, constructed in Italy *, where glass or metal bells were made to sound by means of two or more violin bows drawn over them. But the idea of employing this instrument to examine vibrating tones was first entertained by himself. Having accurately remarked the tones produced by the abovementioned metal plate, he found that they gave a progression which corresponded with the squares of 2, 3, 4, &c. Not long before he had read, in the Transactions of the Royal Society of Gottingen, the observations of Mr. Lichtenberg on the phenomena produced by strewing pounded resin over a glass plate or cake of resin, and he repeated many of his experiments. This led him to the idea that, perhaps, the various vibratory movements of such a plate would be discovered by a diversity of phenomena, if he strewed over it sand or any thing of the like kind. By this experiment there was produced a star-formed figure; and the author, having continued his researches, published the result of them in a work entitled, Discoveries respecting the Theory of Sound, printed at Leipsic in 1787 †. It contains a multitude of new observations on the vibrations of different bodies, the proportions of the tones of which had been incorrectly given by others; on the vibrations which are produced by vibration and rotation conjointly; on the longitudinal vibrations of a string, first announced by the author; and upon various other circumstances relating to acoustics. The author addressed this work to the Academy of Sciences at Petersburgh, with a view, perhaps, that it might give occasion to analytical investigations on the same subject. J. Ber-

* In all probability the harmonica of the Abbé Mazzuchi.

† Entdeckungen über die Theorie des Klanges, Leipsic, 1787. 4to.

noulli,

noulli, who, next to the elder Euler, had made confiderable additions to the fcience of acouftics, and who unfortunately loft his life foon after, while bathing in the Neva, endeavoured, in confequence of the above work, to determine by calculation the vibrations of a fquare plate; but the refult did not agree with experience, and Dr. Chladni does not think it poffible to advance one ftep in this theory by analyfis alone.

While Dr. Chladni was employed in thefe inveftigations, his fituation was exceedingly unpleafant. He, however, did not fuffer his courage to be depreffed, but exerted his abilities the more, in order that he might procure for himfelf better means of fubfiftence. As he had examined the nature of fo many fonorous bodies, he refolved to invent a new mufical inftrument; and he began to confider whether it might not be poffible by rubbing glafs tubes in a ftraight line, with the wet fingers, to produce founds in the fame manner as is done in the harmonica by rubbing them circularly. That glafs tubes, like thofe in his euphon, would not merely by fuch rubbing emit any tones, he had long known by theory and experience; and he therefore applied himfelf to the folution of the difficult queftion, in what manner the inftrument ought to be conftructed to anfwer the intended purpofe. After various fruitlefs attempts for a year and a half, during which his imagination was fo full of the idea, that fometimes in his dreams he thought he faw the inftrument and heard its tones, that is, like thofe of the harmonica, but with more diftinctnefs and lefs confufion, he at length, in a ftate between fleeping and waking, obtained a folution of the problem which had given fo much employment to his thoughts. On the fecond of June 1789, being tired with walking, he fat down on a chair, about nine in the evening, to enjoy a fhort flumber; but fcarcely had he clofed his eyes when the image of an inftrument, fuch as he wifhed for, feemed to prefent itfelf before him, and terrified him fo much that he awoke as if he had been ftruck by an electric fhock. He imme-

immediately started up in a kind of enthusiasm; and made a series of experiments which convinced him that what he had seen was perfectly right, and that he had it now in his power to carry his design into execution. He made his experiments and constructed his first instrument in so private a manner, that no person knew any thing of them. On the 8th of March 1790 his first instrument of this kind was completed; and in a few days he was able to play on it some easy pieces of music. It was now necessary to give to this instrument, as it was entirely new, a new name, and that of *euphon*, which signifies an instrument that has a pleasant sound, appeared to him the most proper.

The first instrument of this kind made by Dr. Chladni was in sound, and particularly in the higher tones, as good as those which he made afterwards; but the construction was deficient in strength, so that every week some hours were necessary to keep it in proper repair; and it was impossible to convey it the distance of a mile without almost totally destroying it. Dr. Chladni also for want of better tubes employed those used for thermometers, and marked the whole and half tones by a coating of sealing-wax on the under side; but as the wax, owing to the moisture and vibration, often cracked and flew off, it was attended with danger to the eyes. It was, therefore, extremely difficult to give to the construction of the instrument sufficient strength; but this the inventor at length accomplished, so that his new euphon cannot be injured or put out of tune either by playing or by carriage. The third instrument constructed by Dr. Chladni was somewhat different from the first and the second; as the fore part, which in the two former rose upwards with an oblique angle, stood at right angles, so that it could be transported with ease in a particular carriage made for that purpose. Instead of the thermometer tubes used in the first, the doctor now employs tubes of different colours. In the second instrument those for the whole tones were of dark green glass; but he used for the half

tones,

tones, in both, a milk white kind of glafs. In a word, the euphon has fome refemblance to a fmall writing-defk. When opened, the above-mentioned glafs tubes, of the thicknefs of the barrel of a quill and about fixteen inches long, are feen in a horizontal pofition. They are wetted with water, by means of a fponge, and ftroked with the wet fingers in the direction of their length, fo that the increafe of the tone depends merely on the ftronger or weaker preffure, and the flower or quicker movement of the fingers. The number of tubes at prefent is forty-two. In the back part there is a perpendicular founding-board divided in the middle, through which the tubes pafs. It appears therefore that the euphon ought not to be confidered as an altered or improved harmonica, but as a totally new and different inftrument. In regard to fweetnefs of found, it approaches very near to the harmonica; but it has feveral advantages which no unprejudiced perfon, who examines both inftruments, will deny.

In the firft place it is fimpler, both in regard to its conftruction and the movement neceffary to produce the found, as neither turning nor ftamping is required, but merely the movement of the finger.

2. It produces its found fpeedier; fo that as foon as it is touched you may have the tone as full as the inftrument is capable of giving it; whereas, in the harmonica, the tones, particularly the lower ones, muft be made to increafe gradually.

3. It has more diftinctnefs in quick paffages, becaufe the tones do not refound fo long as in the harmonica, where the found of one low tone is often heard when you wifh only to hear the following tone.

4. The unifon is purer than is generally the cafe in the harmonica, where it is difficult to have perfect glaffes, which in every part give like tones with mathematical exactnefs. It is however as difficult to be tuned as the harmonica.

5. It

5. It does not affect the nerves of the performer; for a person scarcely feels a weak agitation in the fingers; whereas in the harmonica, particularly in concords of the lower notes, the agitation extends to the arms and even through the whole body of the performer.

6. The expence of this instrument will be much less in future than that of the harmonica.

7. When one of the tubes breaks, or any other part is deranged, it can be soon repaired, and at very little expence; whereas, when one of the glasses of the harmonica breaks, it requires much time and is very difficult to procure another capable of giving the same tone as the former, and which will correspond sufficiently with the series of the rest.

Though Dr. Chladni has been much occupied with the construction and improvement of the euphon, he has, however, still continued his researches respecting the theory of sound, and collected materials for a continuation of his essay before mentioned, which contain abundance of valuable matter. In one paper, which may be found in the Berlin Musical Journal for August 1792, he has given some very accurate observations respecting the longitudinal vibrations of a string, first announced by himself, which depend upon laws of nature totally different from those of the usual vibrations. Dr. Chladni transmitted also, a few years ago, to the Friendly Society of the Searchers into Nature at Berlin, in order to fulfill his duty as a member, two essays, one of which contained observations on the tones produced in a tube by burning inflammable air; from which it appears that these tones, first remarked by Mr. De Luc, are nothing else than pipe tones, as the sonorous body is not the tube but the column of air contained in it. The other essay was entitled Collections towards promoting a better Explanation of the Doctrine of Sound. The author here shews how this part of the science of nature, not yet sufficiently elucidated by any one writer, ought to be treated, according to his opinion,

opinion, ſo as to approach neareſt to the propoſed end; and he gives a ſhort ſketch of his method, which contains alſo ſome new obſervations*.

IX. *Account of a ſimple Method of repreſenting the different Cryſtalline Forms by very ſhort Signs, expreſſing the Laws of Decrement to which their Structure is ſubjected.* By C. Hauy. *From* Journal des Mines, *An. IV. No.* 23.

THE different cryſtals belonging to each mineral ſubſtance are connected with one identical primitive form, which, in its turn, ſerves to connect them in common. An accurate knowledge of theſe mutual relations depends upon that of the laws to which their ſtructure is ſubjected, and of which the effect is to determine the number and aſſortment of the planes arranged around the primitive form, in order to produce the ſecondary forms. By a neceſſary conſequence the naturaliſt, who is familiar with the progreſs of theſe laws, needs often only to keep in his eye the primitive form, and an account of the decrements which its angles or edges undergo, to repreſent to himſelf the polyedron thence reſulting, and to ſee, in ſome meaſure, in idea, the metamorphoſis of the nucleus from which this polyedron originates.

Theſe conſiderations induced me to conceive the idea of converting into very conciſe language, analogous to that of algebraic analyſis, a definition of the different laws by which ſecondary cryſtals are determined; and thus to compoſe a kind of formulæ repreſentative of theſe cryſtals. To accompliſh this, it will be ſufficient to diſtinguiſh by letters the angles and edges of the primitive form, and to accompany theſe letters with figures pointing out the decrement which

* Dr. Chladni is the author alſo of a Diſſertation on the Maſs of Iron found by Profeſſor Pallas in Siberia, and of ſome papers on fire-balls. See Phil. Mag. vol. ii. p. 1, 225, and 337.

ſuch

ſuch an angle or edge undergoes, and of which the reſult is this or that ſecondary form. I have endeavoured to ſubject the arrangement of the letters to a regular progreſs in relation with the order of the alphabet; ſo that this arrangement might appear as if occurring naturally of itſelf.

1. Let us ſuppoſe that fig. 1. repreſents an oblique angled parallelopipedon, the faces of which have angles different in meaſure, and which are the primitive form of a particular kind of mineral ſuch as feld ſpar *. Having adopted the vowels to denote, in general, the ſolid angles, place the four firſt A E I O at the four angles of the upper baſis, following the order of the alphabet, and at the ſame time the common mode of writing, which is to begin at the top and to proceed from right to left. (See *fig.* 2. where the arrangement of the letters in lines is rendered ſenſible to the eye.)

2. Having adopted the conſonants to denote the edges, in general, place, according to the ſame rule, the firſt ſix B C D F G H on the middle of the ſides of the upper baſe, (*fig.* 1.) and on the two longitudinal edges of the lateral face, which firſt preſents itſelf from left to right.

3. Laſtly, place on the middle of the upper baſe and the two lateral faces, ſituated in front, the three letters P M T, which are the firſt of the ſyllables that form the word primitive.

4. Each of the four ſolid angles or of the ſix edges, denoted by letters, is ſuſceptible, in the preſent caſe, on account of the irregular form of the parallelopipedon, of undergoing peculiar laws of decrement; but as theſe laws act with the greateſt poſſible ſymmetry, at leaſt in common, every thing that takes place on one of the angles or edges, pointed out, is repeated on the angle or edge diametrically oppoſite among thoſe which remained unoccupied; ſo that the latter is ſuppoſed to perform the ſame function as the former.

* The parallelopipedon is ſuppoſed to be repreſented in ſuch a manner that the angle B A C, fartheſt from the obſerver, is one of the angles of the baſe.

former. For example, A*p* (*fig.* 3.), being the ſame form as fig. 1. the decrements which the angle A undergoes, occaſion ſimilar ones on the angle *p* (*fig.* 3.). The caſe is the ſame with the edge A *r*, in regard to the edge O *p*; of I *u* in regard to E *s*, &c. After this, nothing is neceſſary but to denote the number of ſolid angles or edges which undergo decrements really diſtinct, becauſe the latter actually contain thoſe which take place on the analogous angles or edges.

5. It will, however, be ſometimes neceſſary to point out theſe laſt angles or edges; and in that caſe we may employ the ſmall letters which bear the ſame names as the large letters employed in figure 1; that is to ſay, that *p* (*fig.* 3.) be denoted by *a*; *s p* by *c*; *p u* by *b*, &c. But it will not be requiſite to mark theſe ſmall letters on the figure. It will be ſufficient to introduce them in the ſign of the cryſtal; becauſe they may be eaſily referred, in idea, each to its proper place.

6. To denote the effects of decrements by one, two, three or more ranges, in breadth, the figures 1, 2, 3, 4, &c. may be employed, as ſhall be explained hereafter; and to denote the effects of decrements by two, three, &c. ranges in height, the fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. may be uſed.

7. The three letters P M T will ſerve to denote either the form of the nucleus, without any modification, when they compoſe alone the ſign of the cryſtal, or the faces which would be parallel to thoſe of the nucleus in caſe the decrements did not extend to their limits; and theſe letters will then be combined in the ſign of the cryſtal with thoſe which have relation to the angles or the edges on which the decrements act.

8. The principal or moſt ſimple decrement, in regard to any ſolid angle whatever, ſuch as O, may take place either on the baſe P or on the plane T, which is to the right of the obſerver, or on the plane M ſituated to the left. But it muſt be remarked that the obſerver is ſuppoſed to move

3 round

round the cryſtal till he is oppoſite the angle on which the decrements he is conſidering take place; or, what amounts to the ſame thing, that he is ſuppoſed to turn the cryſtal until the angle in queſtion is found oppoſite to him; and it is in regard to this poſition that ſuch a decrement is ſaid to take place towards his right or towards his left. For example, if the angle A be under conſideration, we muſt conceive that the obſerver, who at firſt was oppoſite to the point O, has placed himſelf oppoſite to A; then, by ſtill ſuppoſing figure 3 to repreſent the ſame ſolid as figure 1, the decrements to the right will be thoſe which take place on the plane A E *s r*, parallel to the diagonal drawn from E to *r*; and the decrements to the left will take place on the plane A I *u r*, parallel to the diagonal which goes from I to *r*. We ſhall ſee hereafter the advantage of viewing in this manner, in regard to the uniformity of method.

9. To denote the firſt of the three decrements of which I have ſpoken, or that which takes place on the baſe P, the indicating figure muſt be placed above the letter. To denote the ſecond, or that which takes place towards the right, the figure muſt have the uſual place of an exponent on the right, and towards the top of the letter; and the third, or that which takes place towards the left, muſt be denoted by placing the figure towards the left, and, in the like manner, towards the top of the letter.

Thus $\overset{2}{O}$ will expreſs the effect of a decrement by two ranges in breadth, parallel to the diagonal of the plane P, which paſſes through the angle E (*fig.* 1); O^3 the effect of a decrement by three ranges, parallel to the diagonal of the face T, which paſſes through the angle I; and ${}^4O$ the effect of a decrement by four ranges parallel to the diagonal of the face M, which paſſes through the angle E.

10. In regard to the decrements on the edges, thoſe which take place towards the contour B C F D of the baſe may be expreſſed by a figure placed above or below the let-

ter, according as their effect operates upwards or downwards, departing from the edge to which they are referred; and those that regard the longitudinal edges G, H, may be denoted by an exponent placed either in the usual manner or on the left of the letter, according as they take place either to the right or the left.

Thus $\overset{2}{D}$ will express a decrement by two ranges proceeding from D towards C; $\overset{3}{C}$ a decrement by three ranges proceeding from C to D; $\underset{2}{D}$, a decrement by two ranges descending on the face M; ^{3}H a decrement by three ranges proceeding from H towards G, &c. To determine the direction of the decrements to the right or left of any ridge, we must proceed as in regard to the decrements which affect the angles (8). For example, the decrements to the left of the edge G will be those which take place in proceeding from E *s* to A *r* (*fig.* 3).

12. In the case in which we should be obliged to denote, by means of a small letter, such as *d*, a decrement on the edge, opposite to that which bears the large letter D, we ought to consider the crystal as turned upside down: Thus $\overset{2}{d}$ would express a decrement by two ranges ascending on the inferior base *p*; as $\overset{2}{D}$ expresses one which ascends on the upper base P. For the same reason $\underset{3}{c}$ would express a decrement by three ranges proceeding from *sp* (*fig.* 3.) towards EO.

13. If the same angle or the same edge undergoes several successive decrements, on the same side, or several decrements, in regard to different sides, we may be satisfied with writing one letter accompanied with different figures indicating the decrements.

Thus $\overset{2}{\underset{3}{D}}$ (*fig.* 1.) will denote two decrements on the edge D; one by two ranges ascending above the base P, and the other by three ranges descending on the plane M. $^{2}H^{2}$ will denote two decrements by two ranges on both sides of the edge H, &c.

14. If

14. If there are mixed decrements, they may be denoted, according to the ſame principles, by employing the fractions $\frac{1}{2}$ $\frac{2}{3}$ $\frac{3}{4}$, &c. the numerators of which refer to decrement in breadth, and the denominators to decrement in height.

15. It now remains to diſcover a method of repreſenting the intermediary decrements. An example will convey an idea of that which I have adopted. Let AEOI (*fig.* 4.) be the ſame face as fig. 1; and let us ſuppoſe a decrement by a range of double moleculæ, according to lines parallel to $x\,y$, ſo that O y may meaſure lines equal to two ſides of a molecula, and O x lines merely equal to one ſide. This decrement, therefore, may be denoted thus ($\overset{1}{O}$ D^1 F^2): firſt the parentheſis ſhews that the decrement is intermediary; $\overset{1}{O}$ ſhews that it takes place by one range on the angle denoted by the ſame letter, and that it refers to the baſe; D^1 F^2 indicate, that for one edge of molecula ſubtracted along the ſide D, there are two edges ſubtracted along the ſide F.

16. It is uſeful to have a language to expreſs theſe different ſigns in ſuch a manner that they may be eaſily written when dictated. The ſigns O^2, ${}^3O$ might be enounced by ſaying, O two at the right, O three at the left. To enounce $\overset{2}{O}$, $\underset{4}{O}$ we might ſay, O under two, O above four: and laſtly, the ſign ($\overset{1}{O}$ D^1 F^2) might be thus enounced: In a parentheſis O under one, D one, F two.

17. Let us now give an example of the combination of theſe different ſigns in the expreſſion of a compound cryſtalline form. But it will firſt be neceſſary to determine the order according to which the letters that concur to form one expreſſion ought to be arranged. Should we admit the alphabetic order, the reſult would be a ſort of confuſion in the view preſented by the formula. It appears therefore more natural to adopt that order which would direct the obſerver in the deſcription of the ſame cryſtal; that is to ſay, to begin by the priſm or the mean part; to indicate its different faces

as they prefent themfelves to the eye, and then to proceed to the faces of the fummit, or of the pyramid. This will be illuftrated by the different examples we fhall mention in the courfe of this article.

Let *z v* (*fig.* 5.) be the variety of feld-fpar, named *fimilaire*, the primitive form of which is reprefented fig. 1. In this variety the plane *n q x r* (*fig.* 5.) refults from a decrement by two ranges on the edge G (*fig.* 1.), proceeding towards H; the plane *r k s p v x* (*fig.* 5.) is parallel to the plane M (*fig.* 1.), which is concealed only in part by the effect of the decrement. The plane *s u m p* is parallel to the plane T; the pentagon *k z y u s* arifes from a decrement by two ranges on the angle I, parallel to the diagonal which proceeds from A to O; and, in the laft place, as this decrement does not reach its limits, the fummit bears a fecond pentagon *z l n r k* parallel to the bafe P. All this defcription may be thus expreffed by five letters, G^2 M T $\overset{2}{I}$ P.

18. Let us next proceed to parallelopipedons of a more regular form; and let us firft confider the cafe in which they differ from the rhomboid. We fhall fuppofe that the parallelopipedon is the fame as that of fig. 1, the form of which has varied, fo as to become more fymmetrical. In confequence of this variation, certain folid or falient angles, which were different in the firft parallelopipedon, have become equal: whatever takes place in the one is repeated in the other; and confequently they muft be marked with the fame letter. Thus, in algebra, certain folutions are fimplified in the particular cafes in which a quantity at firft fuppofed to be different from another becomes equal to it.

19. Let us conceive, for example, that the primitive form is a right prifm, the bafe of which is the oblique-angled parallelograms (*fig.* 6.), and we fhall have O = A, I = E, &c. We muft then fubftitute on both fides the fecond letter for the firft, as feen in the figure. By continuing to run over the different modifications of the parallelopipedon, we fhall fee them pafs through different degrees of fimplicity, analogous

logous to thoſe of the forms themſelves, and we ſhall have ſucceſſively:

20. For the oblique priſm having rhombuſes for its baſes the expreſſion repreſented figure 7;

21. For the right priſm with rectangular baſes that ſeen figure 8;

22. For the right priſm having rhombuſes for its baſes that of figure 9;

23. For the right priſm with ſquare baſes that of figure 10,

24. And, in the laſt place, for the cube that of figure 11. Here the baſe only is denoted by letters, becauſe what takes place in regard to this baſe may be applied to any one of the other faces.

25. For all theſe different primitive forms a method of figures, analogous to that which I have adopted for the oblique-angled parallelopipedon of figure 1, may be followed; but the letters of the ſame name, figured in the ſame manner, need not be repeated.

One example will ſerve to give an idea of this method. Let *ar* (*fig.* 12.) be the moſt common variety of the cymophane, the nucleus of which is a rectangular parallelopipedon, ſuch as that ſeen fig. 8. The ſign of the ſecondary cryſtal will be, $M\,T\,{}^{2}G\,G^{2}\,\overset{1}{B}\,A^{\frac{3}{2}}\,{}^{\frac{3}{2}}A$, in which M correſponds to *g o b l n r*, T to *b e t s*, ${}^{2}G$ to *f g n m*, G^{2} to *b e t l*, $\overset{1}{B}$ to *d a c f*, or *b a c e*, $A^{\frac{3}{2}}$ to *c f g o*, and ${}^{\frac{3}{2}}A$ to *c e b o*.

To illuſtrate better the ſteps which have conducted to this expreſſion, let us point out, for a moment, all the angles and all the edges by as many particular letters, as if the parallelopipedon were oblique-angled. (*See fig.* 13.)

The ſign then will become $M\,T\,{}^{2}G\,H^{2}\,\overset{1}{B}\,\overset{1}{F}\,E^{\frac{3}{2}}\,{}^{\frac{3}{2}}O$; but by comparing figure 13 with figure 8, we ſee that H = G, F = B, O = A; by ſubſtituting then in the place of the firſt letters their values, we ſhall have $M\,T\,{}^{2}G\,G^{2}\,\overset{1}{B}\,\overset{1}{B}\,A^{\frac{3}{2}}\,{}^{\frac{3}{2}}A$, which amounts to the expreſſion above ſhewn, by ſuppreſſing the uſeleſs repetition of $\overset{1}{B}$.

26. It reſults from the preceding, that we muſt avoid con-

 founding,

founding, for example, $^{2}G\,G^{2}$ with G G. The first sign denotes decrements which take place on the faces *t* T (*fig.* 8.), proceeding from the edges G towards those which correspond with them behind the parallelopipedon; and the second denotes decrements which take place on the face M proceeding to meet each other. If the two decrements took place simultaneously, their representative sign would be $^{2}G^{2}$.

In the preceding signs, each letter, such as ^{2}G or G^{2}, cannot be applied but to one edge situated as that letter itself to the right or left; but $^{2}G^{2}$ may be applied indifferently to both edges: for this reason it is needless to repeat that letter.

27. Let us give a new example, taken from the *topaze distique*, called commonly the Saxon topaz (*fig.* 15.). If we suppose figure 9 to represent the primitive form, which is a right prism, with rhombuses for its bases, we shall have as the sign of the variety in question $^{3}G^{3}\ M\ \overset{2.3}{B}\ \overset{1.2}{E}\ P$, which is explained in the following manner: 1. The planes similar to *o t z q r* (*fig.* 14.) arise from a decrement by three ranges on each side of the edges G (*fig.* 9); 2d, the planes *t y* A *z*, *s y* A *p*, are parallel to the planes M, and thus the preceding decrement has not attained to its limits; 3d, the facets *h k y t v*, *n k y s b*, and *g h k i*, *b u k i*, arise from two successive decrements on the edges B, one by two ranges, and the other by three; 4th, the facets *a c g h v x m*, and those which correspond to them, on the other side, arise from two successive decrements on the angles E, one by one range, and the other by two ranges; 5th, in the last place, the terminating face *c d f l i g* corresponds to the base P of the primitive form.

28. It may be readily concluded from the same principles, that the dodecaedron with rhombuses for its planes, originating from the cube (*fig.* 8.), is expressed by the single letter $\overset{1}{B}$; that the octaedron originating from the same nucleus, has for sign $\overset{1}{A}$, &c.

29. The rhomboid, supposing it placed under the most natural aspect, that is to say, in such a manner that the two solid angles composed of three planes with equal angles be

upon

upon one and the ſame vertical axis, has properly no baſe, but only two ſummits, which are the extremities of the axis. Theſe angles and edges may be denoted as ſeen figure 15. The letter *e* makes known that the angle which bears it is ſimilar to that marked with the ſame large letter; ſo that if all the lateral angles had their indications expreſſed, the three neareſt the upper ſummit would bear the letter E, and the three next to the lower ſummit, and which are viſibly oppoſite to the firſt, would have for their indicative letter *e*.

As the rhomboid has its ſix faces equal and ſimilar, it is only neceſſary to conſider the decrements in regard to one of the faces, ſuch as that which bears the letter P, becauſe all the reſt are only repetitions of the latter. This being laid down, 1ſt, the decrements which depart from the upper angle A, or from the upper edge B, will have their indicating figure placed below the letter A or B; 2d, thoſe which depart from the lateral angles E will be denoted by the ſame letter written twice, one on the right, and the other on the left; 3d, in regard to thoſe which depart from the lower angle *e*, or from the lower edge D, the figure deſtined to expreſs them will be placed above the letter *e* or D.

Let us ſuppoſe, for example, that figure 16 repreſents analogical carbonat of lime, in which the vertical faces *e c p g*, *o g r z*, &c. reſult from a decrement by two ranges on the angles *e* (*fig*. 15.); the oblique faces *mdce*, *b e g o*, &c. from a decrement by two ranges on the edges D, and the terminating faces *i m c b*, *i f t b*, from a decrement by a range on the edges B, we ſhall have the following ſign $\overset{2}{e}\ \overset{2}{D}\ \underset{1}{B}$.

30. The other primitive forms, after what I have ſaid in regard to the parallelopipedon, will be attended with no difficulty. I ſhall run them over in ſucceſſion. Figure 17 repreſents the expreſſion of the octaedron with ſcalene triangles; figure 18 that of the octaedron with iſoſceles triangles, and figure 19 that of the regular octaedron. To place the figures, which accompany the letters, we ſhall conform to what has been ſaid in regard to the rhomboid. Thus (*fig*. 18.)

we must put the figure below for the decrements which proceed from A to B; above for those that depart from D; and at the side for those which depart from E.

If we wished to denote the result of a decrement by one range on all the angles of the regular octaedron (*fig.* 19.), we should write $\underset{1}{A}\ {}^{1}A^{1}$; and to indicate the result of a decrement by a range on all the edges we should write $\underset{1}{B}\ \overset{1}{B}$. The first of these decrements produces a cube, and the second a dodecaedron with rhombuses for its planes.

31. In some kinds of crystals, as those of the nitrat of potash, the octaedron, the surface of which is composed of eight isosceles triangles, similar four to four, must be situated as represented figure 20, in order that the secondary crystals may be in the most natural position; that is to say, that the edges at the junction of the two pyramids composing the octaedron may be, one in a vertical direction as F, and the rest in a horizontal direction as B. By comparing fig. 20 with fig. 21, where the letters have been placed as if all the angles and all the edges had peculiar functions, we shall readily conceive the distribution adopted figure 20, and brought back to the symmetry of the real primitive figure; for, in the present case, we have E = A, D = C, G = F. The indicating figure must be placed below the letter for decrements departing from B; and on one side or below it for those departing from A, according as their effect shall be directed towards B or F.

32. The tetraedron being always regular, when it becomes the primitive form, its expression will be represented figure 22. To indicate, for example, a decrement by three ranges on all the edges we must put $\underset{3}{B}$ and $\overset{3}{B}$; and to denote one by two ranges, on all the angles, we must put $\underset{2}{A}\ {}^{2}A^{2}$, as in the case of the regular octaedron.

33. A short view of figure 23 will be sufficient to give an idea of the method of denoting the regular hexaedral prism in ordinary cases; and with regard to the manner of placing the

the figures I ſhall not enlarge on it, as it may be eaſily deduced from what we have adopted in regard to quadrangular priſms. But, it ſometimes happens that three of the ſolid angles, taken alternately, are replaced by facets, while the intermediary angles remain untouched. In that caſe the expreſſion of the priſm will be that ſeen fig. 24.

34. The rhomboidal dodecaedron, in certain ſpecies, as that of red ſilver ore, has ſix of its faces which perform the functions of the planes of a priſm ; while the ſix other faces enter into the analogy of rhomboids (29) ; ſo that the faces of each order may undergo particular decrements, independently of thoſe which regard the faces of the other order. Figure 25 repreſents the expreſſion of this dodecaedron. Each face of the ſummit, in the ſame caſe, may be conſidered as the baſe of an oblique quadrilateral priſm (20), and the adjacent planes as belonging to the ſame priſm. Thus the manner of placing the letters which indicate the decrements, and the figures that accompany theſe letters, will be analogous to that which takes place in quadrilateral priſms.

35. In other ſpecies, ſuch as that of the garnet and ſulphure of zinc, each ſolid angle, compoſed of three planes, may be aſſimilated to the ſummit of an obtuſe rhomboid ; and thus by employing figures only for one face we ſhall have the expreſſion repreſented by figure 26.

36. We ſhall not employ the ſign of the dodecaedron with iſoſceles triangular planes, becauſe it is more natural to ſubſtitute the rhomboid from which it ariſes, as we have more ſimple laws of decrement.

37. It remains to give the means of repreſenting a particular caſe which takes place in certain cryſtals, where the parts oppoſite to thoſe that obey certain laws of decrement remain untouched, or are modified by different laws. This caſe belongs, in a particular manner, to turmalins ; and it is eaſy then to indicate the difference by means of a zero. For example, in the very obtuſe turmalin, the nucleus of which we ſhall ſuppoſe repreſented figure 15, the priſm which is enneagonal has ſix of its planes produced by ſub-

tractions

tractions of one range on the ſix edges D, D, &c.; and the other three by ſubtractions of two ranges on three only of the angles E or *e*. Moreover, the inferior ſummit has ſimply three faces parallel to thoſe of the nucleus; while on the ſuperior ſummit the three edges B are each replaced by a facet, in conſequence of a decrement by one range which does not attain to its limits. The repreſentative ſign of this form will be: $\overset{1}{D}\,\overset{2}{e}\,\overset{2.0}{E}\,P\,\underset{1}{B},\ \underset{1.0}{b}$. The quantities $\overset{2.0}{E}$, $\underset{1.0}{b}$ ſhew, the firſt that the angles oppoſite to *e* undergo no decrement, and the other that the edges oppoſite to B remain alſo untouched. If theſe edges were ſubjected to a different law, taking place by two ranges, the ſign would become $\overset{1}{D}\,\overset{2}{e}\,\overset{2.0}{E}\,P\,\underset{1}{B}\,\underset{2}{b}$. According to this we are ſuppoſed to admit that the decrements, repreſented by a large letter, do not implicitly contain like decrements analogous to the ſmall letter of the ſame name; or reciprocally, that if the ſecond letter ſhould not enter into the expreſſion of the ſign with a different figure, we ſhould not place there the ſame figure accompanied with a zero. In the firſt caſe, each of the two letters expreſſes a decrement which is peculiar to the edges or angles it denotes; in the ſecond, that which is affected by a zero ſhews that the angle or edge it denotes undergoes no decrement.

38. Let us ſtill quote the variety of the ſulphure of zinc, which exhibits the dodecaedron having rhombuſes for its planes, the four ſolid angles of which, compoſed of three planes, are replaced by triangular facets ſituated like the faces of a tetraedron, while the oppoſite angles remain untouched *. By always adopting figure 16 to repreſent the primitive form, we ſhould thus expreſs the variety in queſtion: $A\ a\ \overset{1}{A}\ \overset{1.0}{a}$.

39. I have enlarged upon the explanation of the principles of this method, that I might, if poſſible, omit nothing

* This variety is ſtill modified by other facets, of which, for the greater ſimplicity, no notice is taken.

which

which may ſerve to give a clear idea of it, and enable an obſerver to repreſent immediately a ſecondary cryſtal of a given form. But if any one ſhould confine himſelf merely to a knowledge of the ſigns employed in this method, and ſhould only wiſh to read them, without being deſirous to know the art of writing them, a few ſimple rules only will be neceſſary to be known, which I ſhall here briefly mention; they will form a review of the preceding details.

1. Every vowel employed in the ſign of a cryſtal denotes the ſolid angle, marked with the ſame vowel on the figure repreſenting the nucleus; and every conſonant indicates the edge which bears that conſonant, or the face, the middle of which it occupies on the figure of the nucleus.

2. Each vowel and each conſonant is accompanied with one or more figures; the values of which, as well as the poſitions, indicate the laws of decrement which the angles or correſponding edges undergo. We muſt except the three conſonants P, M, T, each of which, when it forms part of the ſign of a cryſtal, indicates that the cryſtal has faces parallel to that which bears this letter.

3. Each letter, comprehended in the ſign of a cryſtal, is underſtood, with the cipher or ciphers that accompany it, on all the angles or edges, which perform the ſame functions as that which, in the figure, is immediately marked with the letter in queſtion.

4. Every whole number, placed above a letter, indicates a decrement in breadth, which aſcends in departing from the angle or edge marked with that letter.

5. Every whole number, placed below a letter, indicates a decrement which deſcends in departing either from the ſummit or the edge which bears that letter *.

* Alluſion is made here to the general progreſs of decrements, to which the particular caſes that ſeem to make an exception are referred. For example, if the decrement took place by one range on the angle at the ſummit of a rhomboid, the face produced would be horizontal; but this decrement enters into thoſe which are deſcending, and of which it is, as it were, the boundary.

6. Every

6. Every whole number, placed towards the top and on the right or left of a letter, denotes a decrement which takes place to the right or left of the angle, or of the edge marked with the same letter.

7. Every letter, such as $^3H^2$ or $\overset{2.3}{G}$, which bears several figures, placed different ways or in the same manner, indicates that the corresponding edge or angle undergoes, at the same time, different kinds of decrements announced by the numbers.

8. The fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. which have unity for numerator, denote decrements in height by two, three, four ranges, &c.

9. The fractions $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{2}$, &c. each term of which is greater than unity, denote mixed decrements by two ranges in breadth and three in height, or by three ranges in breadth and four in height, or by three in breadth and two in height.

10. The parenthesis, such as ($\overset{3}{O}$ D^1 F^2), denotes an intermediary decrement. The letter $\overset{3}{O}$ indicates: first that the decrement takes place by three ranges on the angle O, and that its effect is ascending. D^1 F^2 make known that for one edge of moleculæ subtracted along the side marked D, there are two edges subtracted along the side marked F.

11. Every small letter, comprehended in the sign of a crystal, indicates the angle or edge diametrically opposite to that which bears the large letter of the same name on the figure; or the small letter in question is omitted as superfluous.

12. We must except the letter *e*, which is always found on the figure of the rhomboid, and which indicates the angle opposite to that which bears the letter E.

13. When a sign contains two letters of the same name, one large and the other small, with different figures, the two angles or two edges opposite to which these letters correspond, are supposed to undergo each separately the law of decrement indicated by the figure that accompanies it.

14. Every

14. Every letter, whether large or ſmall, marked with a figure followed by a zero, makes known that the decrement indicated by this figure has no effect on the angle or edge to which that letter belongs.

X. *Curious Fact reſpecting the Natural Hiſtory of the Otter. By* C. POISSONNIER, *Juſtice of Peace of the Canton of Bonnat, Department of la Creuze. From* Le Moniteur Univerſel, *Nivoſe* 21, *An. VII.*

I HAD conſidered as a fable what Father Vaniere ſays, in the fifteenth book of his poem called *Prædium Ruſticum*, in regard to an otter which he had tamed to ſuch a degree that it would plunge before his eyes into a canal of vaſt extent, and bring to him with great fidelity the prey it had caught. From the accounts I had read in the works of different naturaliſts, I believed that this animal was of a nature ſo ferocious that it was no way ſuſceptible of being tamed; but I am now convinced of the contrary. Having procured a young otter in the month of Germinal laſt, it has fully repaid all the care and attention I beſtowed on it; for it goes regularly every morning to take a turn on the banks of the ſmall river Creuze, which runs at the diſtance of about a hundred paces from my habitation, and ſeldom returns without bringing me a fiſh ſtill alive. To whatever diſtance it goes, it always returns with the utmoſt punctuality to the ſmall kennel which I have conſtructed for it.

It has been ſaid alſo that this animal is amphibious, but I have found the contrary to be the caſe. My otter never plunges into the water but to catch its prey, and it returns as ſpeedily as poſſible to the banks, where it ſhakes itſelf like a ſmall water-ſpaniel. If it is obliged to remain under water for any length of time, it raiſes its head in order to breathe; from which I conclude that the otter ſwims better than other animals; but is not amphibious, ſince it cannot live under water above half an hour.

XI. *Letters*

XI. *Letters from some of the Men of Science engaged in the French Expedition to Egypt.*

LETTER I.

Cairo, Thermidor 25th, An. VI.

THE Commission of the Sciences remained a month at Rosetta, until Egypt was entirely subdued. I am busily employed at present in the department to which I belong. I have had the good fortune to be encouraged and protected by General Menou, who commanded in the province of Rosetta. He gave me an escort, to enable me to penetrate the Delta, and to hunt for animals. I have found a number of very interesting birds. To observe them alive, describe them zoologically and anatomically; to prepare stuffed skins and skeletons, have been my occupation in the most agreeable country of Egypt. I have made many new observations, which I intend to write down for the Institute of Cairo.

The botanists are very unfortunate in regard to their science. Egypt has scarcely furnished them with twenty different species; and, besides, they have lost all the paper which they brought with them. The case has been the same with my spirit of wine and powder for stuffing birds. These articles were on board the *Patriote*, which was lost in the harbour of Alexandria. This vessel had on board also the effects of the aëronauts.

The most astonishing tree here is the sycamore-fig. One of these trees is sufficient to shade several of the peasants' huts, with the oxen that raise water to water the meadows by means of wheels.

LETTER II.

Alexandria, Thermidor 25th.

THE naturalists are all employed each in his own department. The mineralogists have not found any thing of importance. They have been occupied only in examining the

the changes occaſioned in the land by the winds of Lybia. The ruins have furniſhed them a much more abundant harveſt. The thouſands of columns which every where occur have preſented them with granites, *breches**, and Egyptian marble of the greateſt beauty. The monuments, aſtoniſhing on account of their bulk, which are ſeen here, have already given us a ſpecimen of the wonders we ſhall behold in Upper Egypt. Pompey's pillar, and the column called Cleopatra's needle, do not, however, make ſo much impreſſion as an Egyptian vaſe covered with hieroglyphics, and in perfect preſervation. This vaſe ſtands in the great moſque of the Arab town; and I hope that you will ſee it in Paris, notwithſtanding its enormous weight.

I have examined with C. Champi the ſtones of which the walls of the Arab town are built. They are corroded to the very centre in ſuch a manner as might induce people to believe that ſaltpetre here is very abundant; but we were ſurpriſed to find ſcarcely any thing except ſea-ſalt and a very ſmall quantity of a nitrat, the nature of which we have not been able to determine, as we had not the neceſſary means, but which, in all probability, is nitrat of lime. I am employed in getting repaired the boxes which contain our chemical apparatus, and which have ſuffered conſiderably. More than half of the ſulphuric acid has been loſt, and has injured the boxes.

The aſtronomers are employed with the eſtabliſhment of a ſolid baſe, that is to ſay, with the conſtruction of two pillars of maſon-work. They will depart ſoon, in order to form the triangles neceſſary for making a map of the country. The military, civil, and geographical engineers are now conſtructing a plan of Alexandria and the environs.

Conté is employed in collecting ſpecimens of all the arts of the country. He has formed a plan alſo of a very ſimple

* The French give this appellation to a very ſhining hard kind of marble found in the Pyrenees. Edit.

telegraph,

telegraph, to be eſtabliſhed on the coaſts and in the road to Cairo.

Alexandria ſtands in the middle of a deſert. The Turkiſh town is built at the expence of that of the Arabs, where nothing has been preſerved untouched but the ciſterns, none of which have been formed under the new town. The objects of culture here conſiſt of beautiful palms, which have a ſomewhat diſmal appearance, fig-trees, the *cactus opuntia*, and wretched vegetables, to which the inhabitants do much honour by giving them the names of cabbages, ſorrel, parſley, &c. The onions, however, deſerve particular attention. They are much harder, a little more pointed in their form, and have a ſomewhat ſtronger taſte than thoſe of Europe. The grapes which we have ate here for a fortnight paſt are brought by water from Roſetta and Cyprus: water-melons, which are abundant, come alſo from Roſetta: they are cultivated here, but in ſmall quantities.

The Bedouin Arabs who inhabit the deſert, and who feed there their flocks, which they afterwards bring for ſale to Alexandria, wear a white dreſs that appeared to me to have a great reſemblance to the ancient Roman habit, and which produces a very fine effect. The painters, when I aſked what they thought of it, entertained the ſame opinion. The men here are ſtrong, of large ſize, and well proportioned. This, no doubt, is owing to the dreſs worn by the children and the lower claſſes, which is merely a blue ſhirt. They take a great deal of exerciſe, and their ſtrength is expanded at a very early age.

We have been all indiſpoſed: this is a tribute we muſt pay to a climate ſo different from our own, and above all to the difference of nouriſhment. Though the heat here is only 22 or 23 (81 or 84 Fahr.), on account of the ſea-breeze which cools the atmoſphere, the hygrometric diſpoſition of the air has a powerful effect on the animal economy. It never rains at this ſeaſon, but in the evening there is an abundant fall of dew, to which are afcribed thofe difeafes of the eyes that afflict the inhabitants.

The plague, fo much dreaded in Europe, creates no uneafinefs here, though it ftill exifts in fome houfes of the city. People walk in the ftreets with as much confidence as if they were not expofed to the danger of touching an infected perfon, and catching that cruel malady. Dubois, the furgeon, has had a great deal of converfation with a phyfician who has long practifed in this country. He affured him that the plague is not fo dangerous as it is generally reprefented, and that many perfons, attacked by epidemic difeafes, die for want of affiftance, becaufe the terror infpired by the plague is ftronger than all the ties of affection. A lazaretto was eftablifhed here almoft as foon as we arrived. It is fituated in the ancient ifle of Pharos, at the entrance of the old harbour.

[To be continued.]

XII. *On the Culture of Poppies and the Extraction of Opium in the Eaft Indies. By* ARTHUR WILLIAM DEVIS, *Efq. From the* Tranfactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

I SEND for the acceptance of the Society a fmall iron inftrument, called, by the natives of Hindooftan, Nehrea, and ufed by them for making incifions in the capfules of the plants for the extraction of opium.

This inftrument (the exact dimenfions of which are fhewn Plate XI. Fig. 4,) is formed of two thin pieces of plate iron, fharpened at the broad femicircular edge; and each being wound round with thread, the two are faftened together by other thread wound round both *.

As the cultivation of the poppy in this country for the preparation of opium has lately engaged the attention of

* One of the inftruments is referved in the Society's repofitory.

this Society, I have taken the liberty to ſubjoin a few extracts from a memorandum on the ſubject, part of a work on the arts, manufactures, and agriculture, of Hindooſtan, collected at various times during my reſidence in India. I do not pretend to any practical knowledge; but if it may afford the leaſt hint to thoſe engaged in the purſuit, I ſhall feel great pleaſure in the communication.

The greateſt quantity of opium imported from India is prepared in the province of Behar, the ſoil of which moſtly conſiſts of clay, with a conſiderable portion of ſand. The richeſt ſoils of this deſcription are preferred by the natives for the cultivation of the poppy, which is the *Papaver ſomniferum* of Linnæus. The ground is ploughed ſixteen or eighteen times, and manured with the dung of cattle folded on it at night, or rotten cow-dung; the manure is ploughed in, and the ground thoroughly broken and carefully levelled with the harrow. The ſeed is ſown in the broad-caſt way; and the field is then divided into ſquares of four or five feet, leaving an interval, which is raiſed ſix inches; and on theſe ridges a channel is excavated to convey water to every ſquare, from a well near the field. The plants are five or ſix inches from each other, and are watered once a week, or oftener, until they are ſufficiently ripe for the extraction of the opium. About ſeven days after the flowers fall, when the capſules diſcover to the preſſure a degree of hardneſs, they begin to collect the opium. At ſun-ſet, a double inciſion is made on each capſule, from the ſtalk upwards, at one ſtroke of the nehrea: the operation is repeated every ſecond day, for a fortnight or three weeks. The juice which has exuded during the night, from the wounds made the preceding evening, is ſcraped off the capſule with a ſmall iron ſcoop; this is done early in the morning before the dew is diſperſed. The ſeeds are valuable for the oil they contain, and, as an article of food, are in great requeſt with the natives.

2

XIII. De-

XIII. *Description of the Mangle invented by Mr.* JEE. *Extracted from the* Transactions of the Society for the Encouragement of Arts, &c.* *Vol. XVI.*

THIS mangle (see Plate XI.) is so constructed that the handle is required to be turned one way only, which moves the machine more steadily and safer for the linen, than by varying the turning of the handle.

Fig. 1, is a perspective view of the mangle when at work. The letters of reference answer to the same parts as in fig. 2; but here the great wheel is hid by a board which lies on the frame B.

A, fig. 2, is the great wheel, 15 inches in diameter, the teeth of which, being on the under side, cannot be seen in this view; B is the arbor on which the pinion C is fastened, which is worked by the winch D. The pinion causing the large wheel to revolve, works the crank E F, (the part E is 21 inches long) which being fastened to the moveable bed K by a pivot at G causes it to move forward and backward, by one continued motion of the winch, guided in its place by the pulleys I I I I. H H are two levers for raising the bed to put in or take out the linen which is wound on the rollers L L: this is effected by the open studs G G at the ends of the bed being brought alternately over the ends H of the levers, the other ends of which are then pressed down by the hand.

Fig. 3 is a front view of one of the open studs.

* In consideration of the merit of this invention, the Society voted their silver medal to Mr. Jee. Two complete models are reserved in their repository for the use of the public.

XIV. *Communication from Dr.* THORNTON, *Physician of the General Dispensary, relative to Trials made with the different Factitious Gases.*

SIR,

Duke-street, Grosvenor-square, Jan. 1, 1799.

THE introduction of PNEUMATIC MEDICINE promises, I think, much improvement to the *ars medendi*. Its effects deserve, therefore, to be made public; and through the channel of your excellent Magazine, I shall lay before the public the result of numerous trials with the different gases, as experienced either by me or others.

Mr. Tilloch. R. J. THORNTON.

A Case of Dyspepsia.

Mrs. Appleby, wife of the Rev. William Appleby, Wooten, Lincolnshire, laboured under dyspeptic complaints upwards of twelve years. Nine physicians had tried their art, but to no purpose. The disorder seemed to gain ground, and was accompanied with violent spasms and a paralysis of her lower extremities. Dr. Harrison of Horncastle, who last attended her, desired she would try the *oxygenating* system; and conjointly with Dr. Darling of Glandford Bridge, it was effected in this manner. Bark and *oxymuriate* of potash were given, and *oxygen air* inhaled; and the change produced was so great, that to the surprise of the whole neighbourhood this lady was soon perfectly restored.

N. B. The Editor begs leave to inform the Public, that these interesting communications will be *continued* regularly every month; and that Dr. Thornton would be obliged to any Gentleman for his correspondence on the subject of the airs, which will be regularly transmitted to the Editor of the Philosophical Magazine for publication.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

FRANCE.

THE National Inftitute, in its public fitting Nivofe 15, An. VII, propofed the following prize fubjects:

GRAMMAR.

This clafs not having received any paper that feemed worthy of the prize before announced, have prolonged the term of competition to the next year, and propofe the fame fubject under the following form: "To examine what the French language has gained in clearnefs and elegance, and what it may have loft in *naïveté* and energy fince the time of Amyot to the prefent day."

The prize is a gold medal of the value of five hectogrammes. It will be adjudged in the public fitting of Germinal 15, An. VIII. The papers muft be written in French, and tranfmitted before the 1ft Nivofe, An. VIII.

This clafs alfo propofed: "To point out the means proper for giving new activity to the ftudy of the Greek and Latin languages in France."

The prize the fame as the above, and will be adjudged in the public fitting of Meffidor 15, Year VIII. The memoirs muft be tranfmitted before the 1ft of Germinal the fame year.

MATHEMATICS.

The Academy of Sciences had propofed as the fubject of the mathematical prize, for 1794, an inveftigation of the orbit of the firft comet of 1770. Aftronomers have tried, but without ſucceſs, to ſubject the obſervations made of that comet to the laws of parabolic motion. Proſperin and Pingré employed themſelves particularly in this reſearch, and mathematicians are indebted to Duſejour for an important piece of labour, in which he has reduced to leſs than a degree the *maximum* of the errors of the parabolic hypotheſis. Lexell was able to repreſent with preciſion theſe obſervations in an ellipſis deſcribed in the courſe of five years and a half; but as this comet was not ſeen before 1770, and has not appeared ſince, ſo rapid a revolution ſeems inadmiſſible; unleſs we ſuppoſe that the comet experienced, before its appearance, very ſtrong perturbations, which brought its aphelion much nearer to the ſun; and that, after its diſappearance, it experienced contrary perturbations, which removed that aphelion to a very great diſtance. We find, indeed, that, in the ellipſe alluded to, the comet paſſed very near to Jupiter at theſe two epochs. Theſe ſuppoſitions, however, are very improbable; and ought not to be admitted until we are well aſſured that the obſerved motion of the comet cannot be repreſented in a non-re-entering orbit (*orbite non rentrante*) or at leaſt one very much elongated.

To clear up this remarkable phenomenon in the ſyſtem of the world, the Inſtitute propoſes:

1. To diſcuſs all the obſervations which can be found of the comet of 1770, by determining, if neceſſary, the poſitions of the ſtars with which it was compared.

2. To examine, with care, whether the obſervations can be repreſented in a non-re-entering orbit.

3. Should that be found impoſſible, to determine the elements of the elliptic orbit, which correſpond moſt exactly with theſe obſervations. But to give to the calculations all the preciſion neceſſary, and to leave no doubt of the juſtneſs of the conſequences deduced from them, it will be abſolutely required that attention be paid to the following points:

1. To free the obſerved longitudes and latitudes from the

effects

effects of parallax, aberration and nutation, in order to obtain the true positions, and that there may be no need to employ, in the calculation of the geocentric places, but the longitudes counted from the mean equinox.

2. To employ in the calculus the true place of the sun; that is to say, augmented 20 seconds for aberration, and counted from the mean equinox.

3. To give, for each observation, the difference of the observed place of the comet, and that deduced from calculation; and to join to these differences the corrections to be made in the heliocentric longitudes and latitudes, in order to make the error of the geocentric places vanish.

4. To give the error which must be produced on the geocentric place by an error of 10 seconds in the calculated longitude of the sun; and to determine also the effect of a small error in the radius vector of the earth.

5. Lastly, though the nebulosity which surrounds comets generally prevents their phases from being well distinguished, it will not be useless to examine whether these phases could have had any sensible influence on the observed places; and, in that case, they must be taken into the account, if possible.

By paying attention to all these points, which, for the most part, have been hitherto neglected, it may be at length possible to discover whether the movements of that comet may not really be represented in a non-re-entering orbit, or whether the irregularities observed in its course may not have been owing, in a great measure, to the elements of the earth's orbit, which are not perhaps sufficiently well determined to give with precision the geocentric places of a planet which approached so near the earth.

The prize is a kilogramme of gold. Papers on this subject will not be received beyond the 15th of Messidor, An. VIII. The Institute will announce the piece which has gained the prize in its public sitting of Nivose 15, An. IX.

PROCEEDINGS OF THE FRENCH NATIONAL INSTITUTE.

IN the above fitting C. Paliffot Beauvoir read a memoir on the rattle-fnake. The author afferts that this reptile is not fo terrible, nor of fo ferocious a nature, as is commonly believed. There are even certain times of the year when it is extremely gentle, and will fuffer itfelf to be laid hold of with the hand. C. Paliffot caught nine rattle-fnakes in the courfe of two hours, while hunting with an American, in the United States; and he faw one at the houfe of the fame American, which had been kept there for five years. Some have pretended that the females devour their young; but C. Paliffot fays that they only place them in their mouth, and carry them in that manner when threatened with danger. As a proof of this, he relates the following curious anecdote: one day he faw a female rattle-fnake accompanied by five young ones of about the fize of the barrel of a quill. The young ones, frightened by the noife which he made, took fhelter in the mouth of the mother, which carried them to a little diftance. Having followed and concealed himfelf, the young recovered courage; quitted their retreat and began to fport on the grafs, till, being alarmed by the noife which he again made, they returned to their former afylum. This fcene was repeated feveral times, and C. Paliffot declares that different people told him they had been witneffes of the fame thing.

C. Peyre read a memoir on the danger to which the National Library is expofed from fire, owing to the buildings in its vicinity.

C. Teffier gave an account of the refearches he had made on the ordinary and poffible duration of geftation or pregnancy. The author made a great many experiments on the females of different animals, fuch as cows, mares, fwine, rabbits, &c. In more than a hundred cows the time of geftation varied from eight months twenty days to ten months feven days. Thofe made on mares and rabbits

gave

gave variations equally great. In regard to the human ſpecies, the obſervations which ought to ſerve as certain data are very imperfect; but pregnancy, according to C. Teſſier, may be prolonged a quarter beyond the uſual time. A child, therefore, ſays the author, born beyond the eleventh month of the widowhood of the mother ought not to be any impeachment of her chaſtity. And ſuch was the ſentence paſſed by a celebrated decree of the parliament of Paris, which declared as legitimate a prince of Condé born eleven months after the death of his father *.

The ſitting was terminated by the reading of an allegorical poem in two cantos, by C. Colin-Harleville, entitled, The Adventures of Melpomene and Thalia.

INSTITUTE AT CAIRO.

THE National Inſtitute of Paris having received minutes of the eight firſt ſittings of the Inſtitute of Cairo, they were read to the three claſſes in their ſittings of the 26th, 27th, and 28th of Frimaire.

The Inſtitute of Cairo, formed by Bonaparte after the model of that of France, conſiſts of four claſſes: mathematics, the phyſical ſciences, political economy, literature, and the

* An inſtance of the ſame kind, which occurred at Rome, is related by Aulus Gellius. A woman of a reſpectable character brought forth a child in the eleventh month after the death of her huſband. The woman was accuſed of having violated her chaſtity; but the emperor Adrian, under whoſe reign the affair happened, decreed that it was poſſible for pregnancy to be extended to that period. The following are the author's words: Præterea ego de partu humano, præterquam quæ ſcripta in libris legi, hoc quoque veniſſe uſu Romæ comperi. Fœminam bonis atque honeſtis moribus non ambigua pudicitia, in undecimo menſe, poſt mariti mortem, peperiſſe; factumque eſſe negotium propter rationem temporis, quaſi marito mortuo poſtea concepiſſet, quoniam decem viri in decem menſibus gigni hominem, non in undecimo ſcripſiſſent: ſed divum Hadrianum, cauſa cognita, decreviſſe in undecimo quoque menſe partum edi poſſe: idque ipſum ejus rei decretum nos legimus. In eo decreto Hadrianus id ſtatuere ſe dicit requiſitis veterum philoſophorum et medicorum ſententiis. *A. Gell. Noct. Att.* lib. iii. cap. 16. EDIT.

fine

fine arts. The members who compofe the firft clafs are: Andreoffi, Bonaparte, Coftaz, Fourier, Girard, Lep re, Leroi, Malus, Monge, Nouet, Quefnot, Horace Say. Thofe which compofe the phyfical clafs are: Berthollet, Champy, Conté, Delifle, Defcotils, Defgenettes, Dolomieu, Dubois, Geoffroy, Savigny. Thofe who compofe the clafs of political economy are: Cafarelli, Gloutier, Pouffielgue, Sulkowfky, Sucy, Tallien. Thofe who compofe the clafs of literature and the arts are: Denon, Dutertre, Norry, Parfeval, Redouté, Rigel, Venturi, D. Raphael.

The objects with which the Inftitute will be occupied are: 1. The propagation of knowledge in Egypt. 2. Refearches into the natural hiftory, induftry and hiftory of Egypt. The Inftitute, which meets on the firft and fixth of every decade, held its firft fitting on the 6th of Fructidor, An. VI. In this fitting Monge was appointed prefident, and Bonaparte vice-prefident. General Bonaparte then propofed the fix following queftions: 1. Are the ovens employed for baking ammunition bread capable of any improvement in regard to the expence of fuel, and what are thefe improvements?

2. Does Egypt furnifh any thing which can be fubftituted for hops in the brewing of beer?

3. What are the beft means to cool and purify the water of the Nile?

4. In the prefent ftate of things at Cairo, whether is it moft convenient to conftruct a wind-mill or a water-mill?

5. Does Egypt furnifh refources for manufacturing gunpowder, and what are thefe refources?

6. What is the ftate of jurifprudence, of judiciary order civil and criminal, and of education in Egypt? What improvements are poffible in thefe departments, and wifhed for by the natives?

Second Sitting, Fructidor 11.

C. Andreoffi made a report on the fifth queftion propofed by by Bonaparte in the preceding fitting. He first observed, that Egypt does not furnish sulphur, and that this article was formerly procured from Venice. The Commission were of opinion that it might be procured from Sicily. The charcoal employed in Egypt is from the lupine, which is burnt in trenches and afterwards sifted. The saltpetre is indigenous; and it is even said that veins of it are found in the neighbourhood of Cairo: it is manufactured in the same manner as in Europe. It is there in the state of a real nitrat of potash, and not of lime, as in France: it is baked with the straw of Turkey corn, and purified with the white of an egg. Gunpowder is manufactured with the hand, and the workmen labour quite naked. Each mortar contains fifteen pounds, and it is pounded for seven hours. The pestles weigh from nineteen to twenty-five pounds each. The wages of the workmen are from twenty to twenty-five paras: they add water to it, and to granulate the powder it is sifted. This powder is excellent, and cheaper than that made in France. The inhabitants manufactured 2000 cantars annually, a great deal of which was exported to Leghorn. The beys had very little powder. Mourad-bey had no more than 1500 cantars. This manufactory might with care be easily increased, and considerable quantities of gun-powder might be sent from Egypt to Europe.

Cit. Monge read a memoir on that optical phenomenon called by the French sailors *mirage*.

It often happens at sea, that a ship seen at a distance appears as if painted in the sky, and not to be supported by the water. A similar effect was observed by the French in the course of their march through the Desert: the villages seen at a distance seemed to be built on an island in the middle of a lake. In proportion as they approached, the apparent surface of the water became narrower; when they were only at a small distance, it disappeared, and the same illusion began, in regard to the next village. C. Monge ascribes this effect to a diminution of the density of the lower stratum of the atmosphere.

mofphere. This diminution in the Defert is produced by the increafe of heat arifing from that communicated by the rays of the fun to the fand with which this ftratum is in immediate contact. At fea it takes place when, by particular circumftances, fuch as the action of the wind, the lower ftratum of the atmofphere holds in folution a greater quantity of water than the other ftrata. In this ftate of things the rays of light, which come from the lower parts of the heavens, having arrived at the furface that feparates the lefs denfe ftratum from thofe above it, do not pafs through that ftratum, but are reflected, and paint in the eye of the obferver an image of the heavens, which appearing to him to be below the horizon, he takes it for water, when the phenomenon occurs at land. If he is at fea, he thinks he fees in the heavens all the objects which float on that part of the furface occupied by the image of the heavens.

Third Sitting, Fructidor 16.

C. Berthollet read a memoir on the formation of ammonia under feveral circumftances where the exiftence of it has not hitherto been fuppofed.

C. Sulkowfky read a defcription of the route from Cairo to Salehié. The route which the French army followed in purfuing Ibrahim Bey had been before unknown. Thofe who proceed from Cairo by the gate of Nafr firft enter the Defert where there are a great many houfes now deferted. The village of Elmalarié, which is found on this route, was the ancient Heliopolis. In another village called Elmare there are thoufands of palm trees. To the right of this route there is nothing except fandy deferts; but on the left there is abundance of cultivated land. The places through which the army paffed were Lacoubey, Elhanea, Elmenié, Belbeys, Souva, Coraim, Salehié, and a great many others, which it only traverfed in the courfe of a rapid march.

C. Berthollet communicated the refult of his examination of the gun-powder found in the caftle of Cairo. This powder

der contained only $\frac{5}{32}$ ($2\frac{1}{2}$ ounces per pound) of ſaltpetre; the reſt was ſulphur, charcoal, earth, and muriat of ſoda.

C. Monge read a memoir on ſome ancient monuments found at Cairo. We learn by this memoir: 1. That at a place called the *Sazar*, in a receſs incloſed by a grate ſituated in the ſtreet conducting from the building where the Inſtitute ſits to the caſtle of Cairo, there was a granite vaſe, covered with hieroglyphics both within and without. This vaſe had ſome reſemblance to one found in the great moſque at Alexandria, but the dimenſion of the hieroglyphics was larger. C. Monge requeſted that the Inſtitute would take the neceſſary meaſures to get this monument removed to a proper place, till an opportunity could be found of ſending it to France. 2. That in the caſtle of Cairo, after having paſſed the place called Joſeph's Caſtle, there was a door-threſhold, formed of a fragment of a poliſhed obeliſk of baſaltes, the hieroglyphics of which were in good preſervation. C. Monge made a ſimilar requeſt in regard to this monument.

C. Monge preſented to the aſſembly a ſpecimen of the ſtone employed for the maſon-work of the caſtle of Cairo. This ſtone is of the ſame nature as the rock on which the caſtle is built, and is compoſed of that ſhell called *numiſmal*, becauſe it reſembles ſmall pieces of money. Theſe ſhells may be eaſily ſplit in the direction of their thickneſs. In the inſide of them is ſeen a delicate ſpiral, which, at different points of its courſe, divides itſelf into ſeveral branches. This ſpiral ſerved as a lodging for the animal which conſtructed the ſhell. The old walls of Laon, in the department of Aiſne, are of a compoſition perfectly ſimilar.

Fourth Sitting, Fructidor 21.

C. Sulkowſky informed his colleagues that he had obſerved a buſt of Iſis on the banks of the Nile near Terané, and two ſtones with hieroglyphics in a garden of the ſame village. He requeſted that they might be tranſported to Cairo, and [illegible] in the place where the Inſtitute met.

C. Geoffroy

C. Geoffroy read a memoir, from which it refults that the oftrich exhibits only the rudiments of that organifation neceffary for flying. All the apparent inftruments of flying in that bird are conftructed in fuch a manner as to preclude the poffibility of it. Extent of wing and confiftence of feathers are not the only things wanting. It is not provided with mufcles fufficient to raife it and fupport it in the air, and its air veficles are of lefs fize than thofe found in other birds.

Fifth Sitting, Fructidor 26.

A commiffion having been appointed to make a report on the fuel moft advantageous to be ufed for heating the camp-ovens, and on the means to reduce the confumption, C. H. Say prefented that report, the refult of which was, that the ftalks of the carthamus or fafranum, reeds, and the ftraw of maize, would furnifh a fufficiency of fuel to heat the ovens, and at a moderate expence.

C. Bonaparte prefented to the Inftitute a copy of the *Connoiffance des Temps* for the year VII; and invited the Inftitute to employ themfelves in the formation of an almanack. C. Monge, Nouet, Dom Raphael, and Beauchamp were charged with this object. This almanack was to comprehend a triple divifion of time according to the cuftom of the French, that of the Cophts, and that of the Muffulmans.

C. Fourier read a memoir on the general folution of algebraic equations.

C. Parfeval read a tranflation of a fragment of Taffo taken from the 17th canto.

C. Defgenettes read fome obfervations on various difeafes which ill-informed perfons might confound with the plague, and from which he proved them to be very different.

Sixth Sitting, 1ft Comp. Day, Year VI.

C. Beauchamp prefented a fhort calendar, which might be immediately printed for the ufe of the army. This calendar contained the old and the new divifion of time. C. Beauchamp

Beauchamp communicated alſo ſeveral aſtronomical obſervations, which are to be publiſhed in the Memoirs of the Inſtitute.

C. Berthollet read a letter addreſſed to him by C. Laplace, member of the French National Inſtitute. That geometrician recommended to him to make obſervations of the occultations of the ſtars by the moon. The ſame member gave an account alſo of the proceſſes employed in Egypt for making indigo. They are exceedingly ſimple, but imperfect. It appeared, however, that by means of ſome ſlight changes the quality of this article might be much improved.

C. Fourier read a note on the plan of a machine moved by wind, which might be employed for watering land. The wheel expoſed to the action of the wind is horizontal. All its parts are fixed, and the wings are ſo ſituated that they always turn in the ſame direction, whatever be the direction of the wind.

Seventh Sitting, Vendemiaire 6, An. VII.

C. Norry read a memoir concerning the column of Alexandria called Pompey's Pillar, in which he gave the dimenſions of the principal parts of that monument. On this occaſion C. Dolomieu offered an opinion reſpecting the period when this column was erected, according to which it ought to be referred to the age that followed the reign of Conſtantine. The chapiter and pedeſtal exhibit the character of degradation, which diſtinguiſhes the architecture of that time; but the ſhaft ſeems to belong to an earlier period, when that art ſtill retained all its purity.

C. Savigny read a memoir on a new ſpecies of *nymphæa*. The author gave an account of the characters common to that plant and thoſe which bear the ſame name, and pointed out the differences.

C. Dutertre read a memoir on the eſtabliſhment of a ſchool of drawing. His propoſal was referred to a commiſſion compoſed of C. Denon, Rigel, Dutertre, Redouté, Sucy and Norry.

C. Coſtaz read a memoir, in which he explained the variations in the colour of the ſea.

C. Parſeval read a poetical tranſlation of a fragment of the 16th canto of Taſſo's Jeruſalem Delivered.

Eighth Sitting, Vendemiaire 11.

Fifty mummies of birds ſent to the Inſtitute were delivered to a commiſſion compoſed of Bonaparte, Geoffroy, Dolomieu and ſome others, in order to be examined.

Porte, a French inhabitant of Cairo engaged in the manufactory of indigo, preſented ſpecimens of it to the Inſtitute.

C. Larrey communicated a memoir on opthalmiæ.

C. Beauchamp read a memoir on his voyage from Conſtantinople to Trebiſonde.

C. Deliſle read a memoir on the palm which bears the fruit called *domm.* It is the *cuſſiophora* of Theophraſtus.

C. Dolomieu read a memoir, in which he ſhewed the neceſſity of ſtudying ancient geography and geology. He fixes the ſite of the ancient Alexandria between two hills of ſandy calcareous ſtone. He explained the ſucceſſive changes which that city experienced, and is of opinion, that the ſea muſt have riſen a foot ſince the time of Ptolemy.

The above pieces when delivered were accompanied by the firſt number of a new Journal entitled, LA DECADE EGYPTIENNE, *Journal littéraire et d'Economie politique, An.* VII. *de la Republique Françaiſe,* 10 *Vendemiaire.*

This journal is publiſhed every tenth day. Each number conſiſts of two ſheets and a half octavo, and coſts 20 ſous French money, or 10 francs for 12 numbers. Subſcriptions received by C. Marc-Aurele, printer to the army, French quarter at Cairo. It was accompanied by a proſpectus announcing that this journal would be merely literary; that no intelligence or political diſcuſſions would be admitted; but that every thing relating to the arts and ſciences, commerce, both in a general and particular point of view, civil and criminal legiſlation, moral and religious inſtitutions, would be thankfully received.

MISCELLANEOUS.

COATING FOR GLASS RETORTS, &c.

Profeſſor Wurzer at Bonn, in a letter to Profeſſor Götling of Jena, ſays: "It is not merely economy that makes us deſirous of obtaining good coating for glaſs apparatus, but becauſe the labour beſtowed on many proceſſes is often rendered entirely uſeleſs by the veſſel not being able to ſtand the neceſſary degree of heat. As circumſtances during a certain time prevented me from obtaining new glaſs apparatus, I made various trials to ſupply that deficiency, and found the following coating of the greateſt ſervice. I took fragments of porcelain coarſely pulveriſed and well ſifted, and as much pure clay, which I previouſly ſoftened with as much of a ſaturated ſolution of muriat of ſoda as was requiſite to give the whole the proper conſiſtence, and then proceeded in the uſual manner. My glaſſes," adds Profeſſor Wurzer, "which are coated with this ſubſtance, often ſtand an incredible degree of heat without breaking."

FREEZING OF MERCURY.

The ſevere cold which was experienced in London at Chriſtmas afforded an opportunity to Mr. Pepys junior, and ſeveral other able chemiſts, to repeat the experiments of Mr. Lowitz, of Peterſburgh, on the production of extraordinary cold. The reſult confirmed the truth of them. When the thermometer was at 17 of Fahr. a mixture of ſnow and muriat of lime produced ſuch a degree of cold as to freeze a quantity of mercury in a few minutes. It was then malleable, and, when broken, exhibited a fracture ſimilar to that of zink.

At the ſame time the chemiſts in Paris were occupied in repeating Lowitz's experiments. C. Fourcroy and Vauquelin by means of the ſame mixture froze twenty pounds of mercury in a platina crucible in thirty ſeconds: mercury in a porcelain crucible took four times as long to freeze. Upon inserting the end of the finger in the mixture, it loſt, in four ſeconds, all feeling, and was not reſtored to ſenſation till after it had been held a long time in the mouth. Upon the firſt inſertion of the finger in the mixture, an acute pain was felt, as if it had been violently preſſed in a vice.

The extreme cold by our accounts from the Continent was very general over Europe.

NEW VOYAGES OF DISCOVERY.

The French Government have in contemplation a new voyage of diſcovery round the world, under the direction of Captain Baudin, who lately returned from a botanical expedition to America. Three corvettes, *le Vengeur*, *la Serpente*, and *la Menaçante*, are fitted out for this purpoſe, and will ſail as ſoon as paſſes can be procured from the Britiſh Miniſtry. They are to proceed firſt to Teneriffe, for the purpoſe of collecting plants, and thence along the coaſt of Africa to the Cape of Good Hope. They are then to ſail along the eaſtern ſide of Africa, from which one of the corvettes is to be ſent back to France with the plants, that they may not be ſpoiled by a longer voyage. The other two corvettes will then proceed to New Holland, to make geographical obſervations on the unknown parts of that iſland; and afterwards viſit the coaſt of Peru, Chili, &c. and particularly the river La Plata, which they are to ſail up as far as they poſſibly can.

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Oil,

Saccharine

END OF THE SECOND VOLUME.

Fig. 4.

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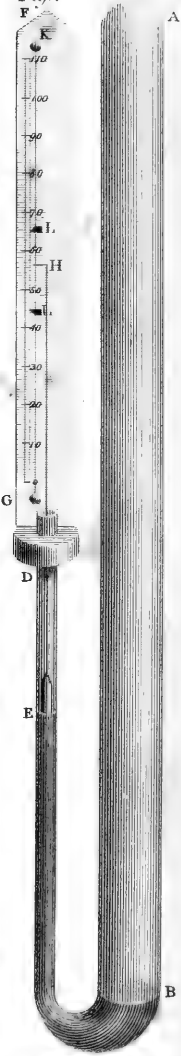

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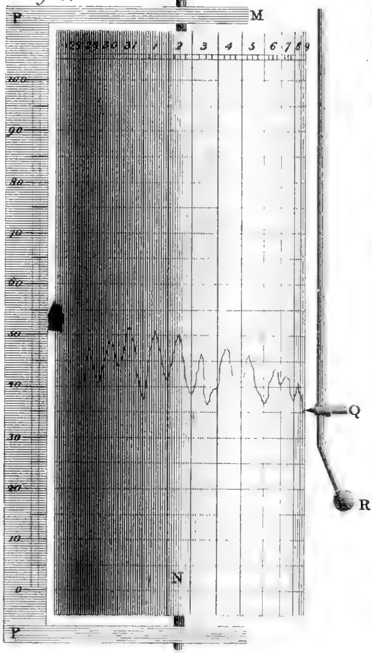

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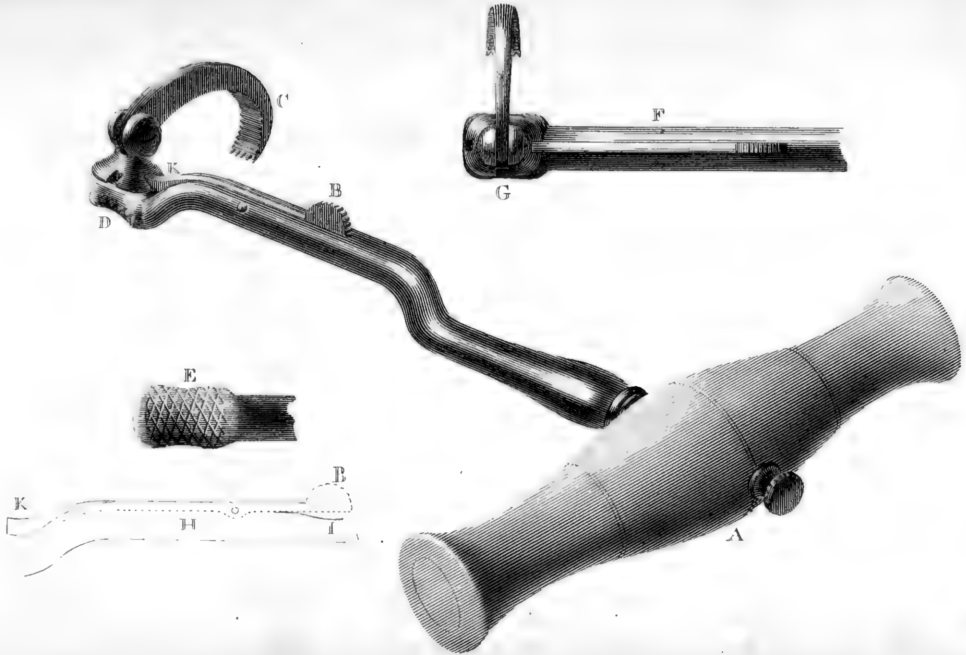

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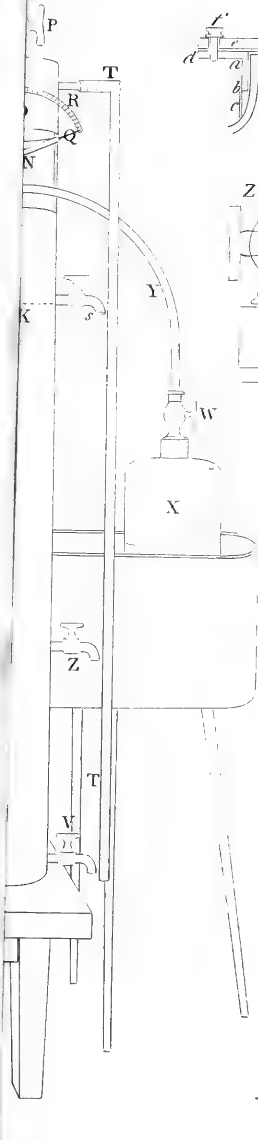

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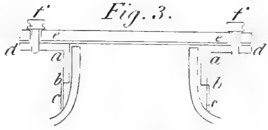

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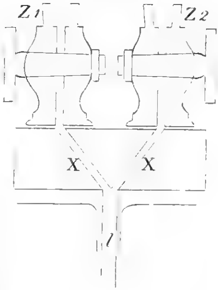

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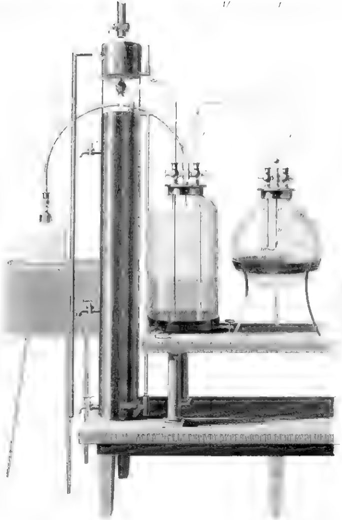


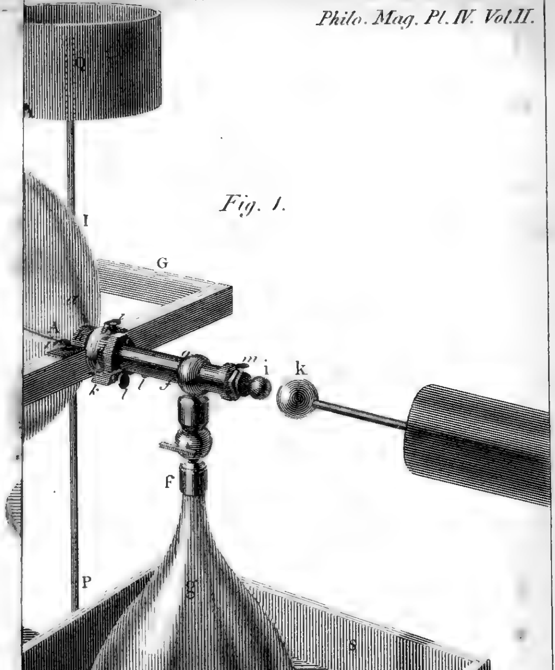
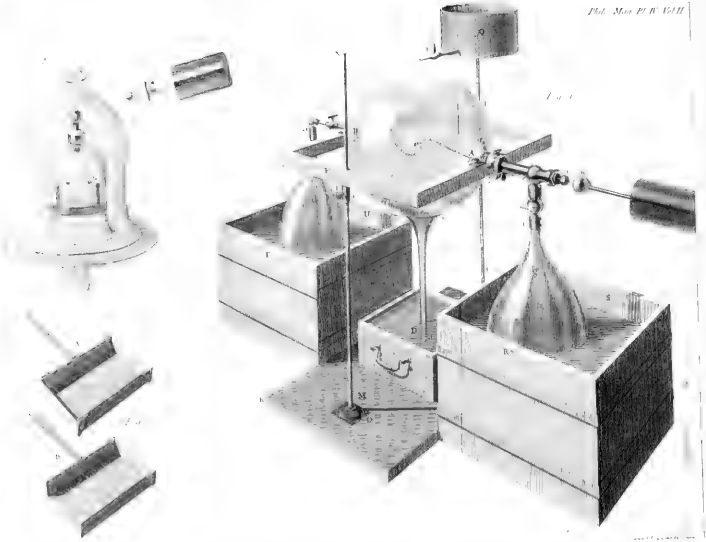


Fig. 1.

Drawn & Engraved by Lowry.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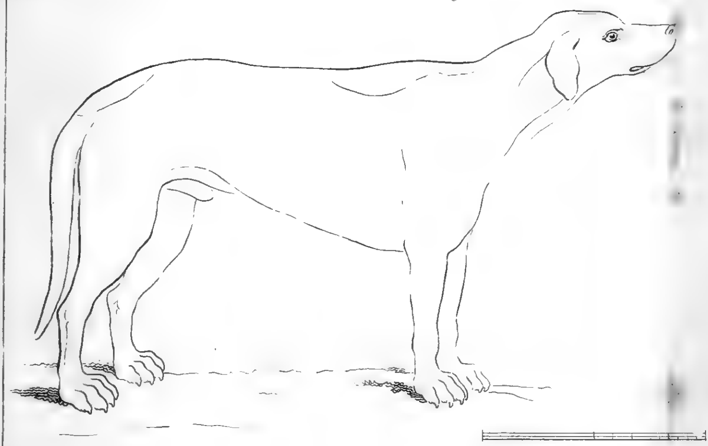
Irish Wolf Dog.



Wild Ass of Middle Asia.

Engraved by Lowry

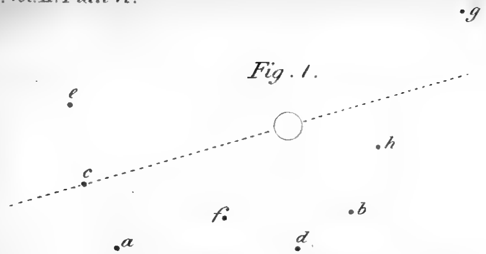


Fig. 1.

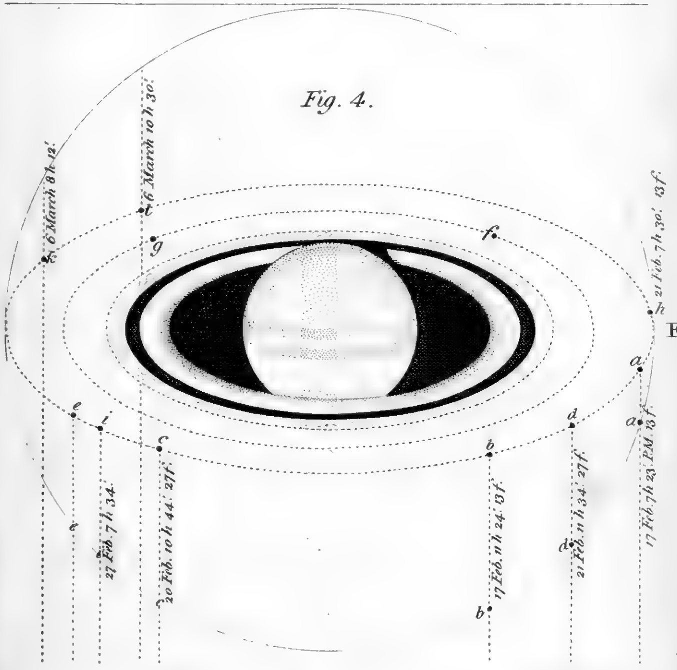


Fig. 4.

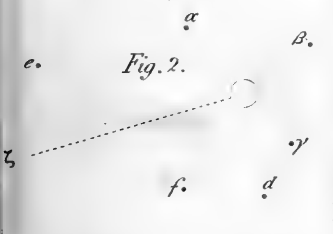


Fig. 2.

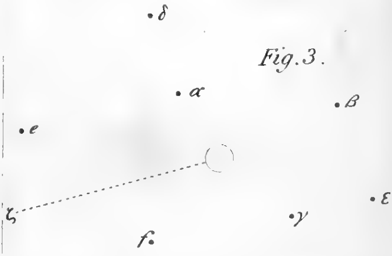


Fig. 3.

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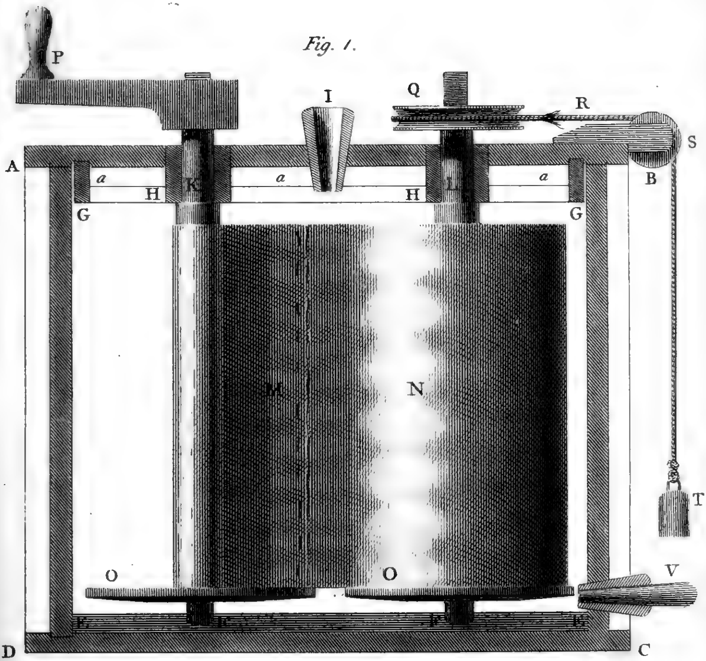
Fig. 1.



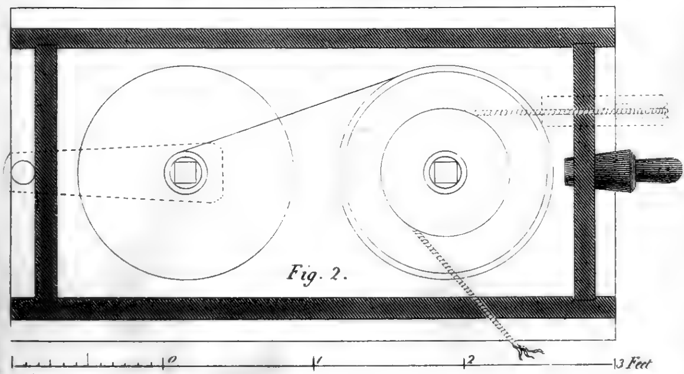


Fig. 2.

Engraved by Lowry

Fig 1

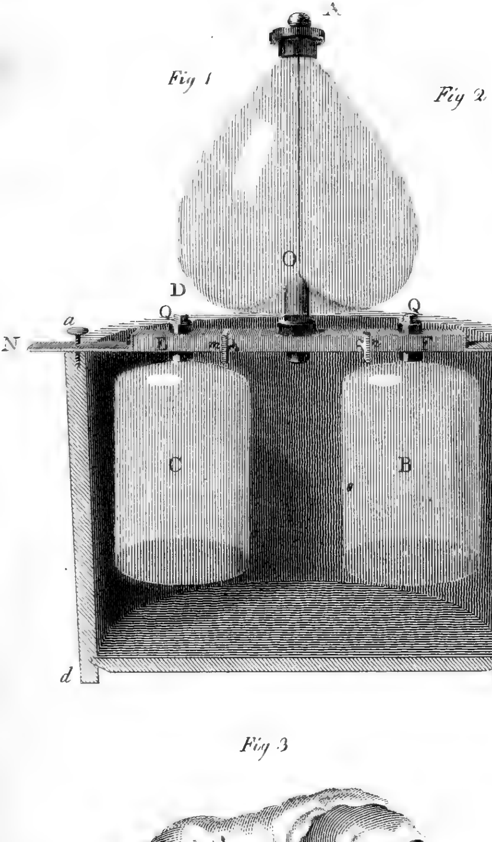


Fig 2

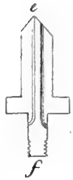
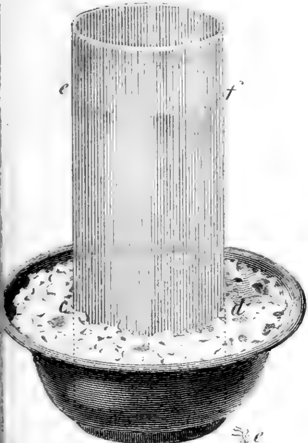


Fig 3

Lowry Sc.

Fig. 3.



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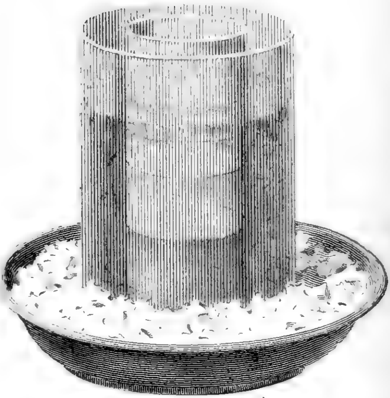
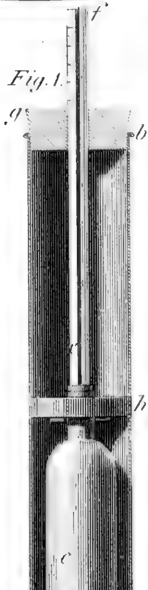


Fig. 1.



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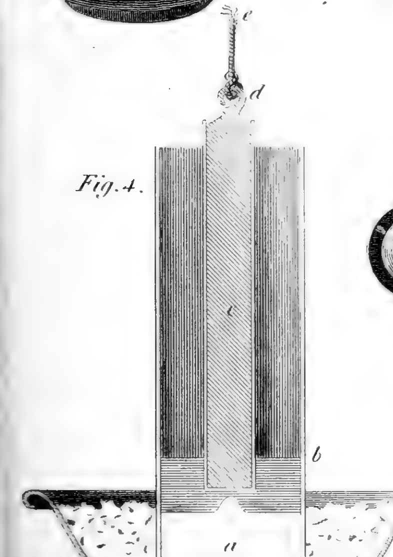
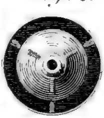
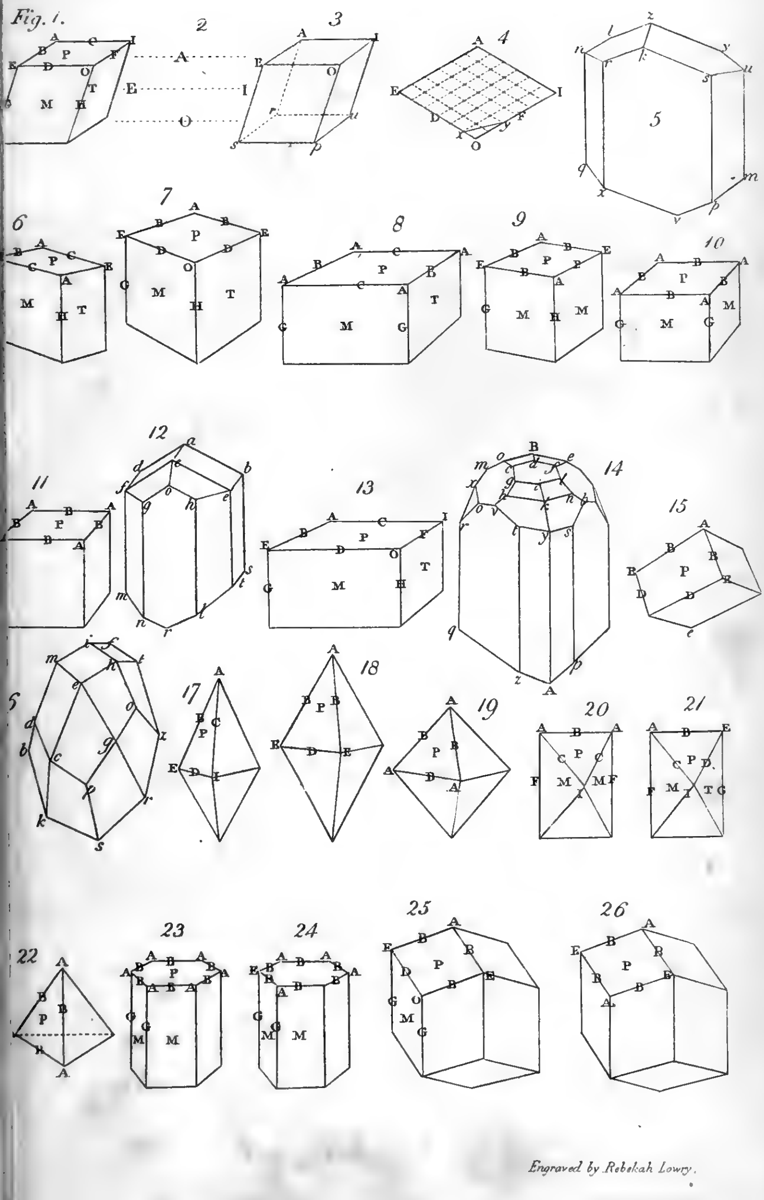


Fig. 2.

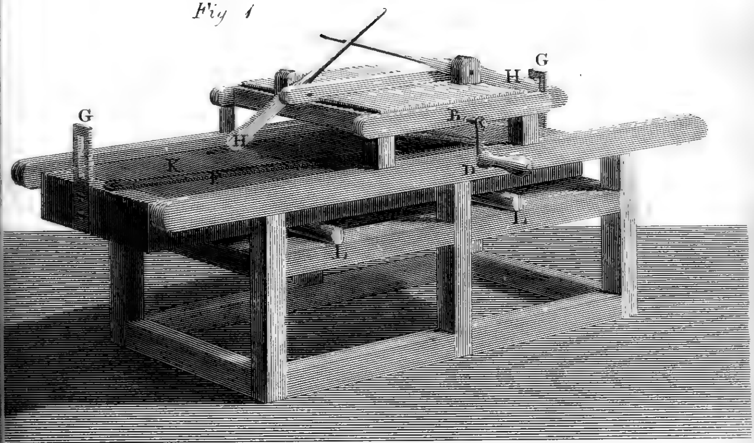


Lowry sculp.



Engraved by Rebekah Lowry.

Fig 1



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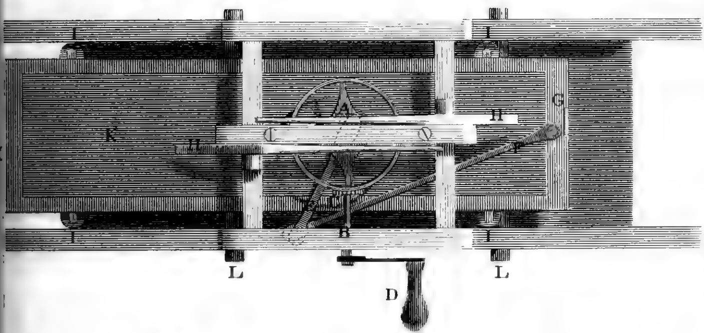

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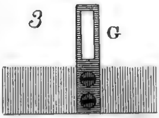

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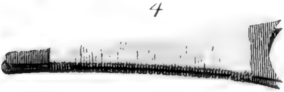

Lowry sculp.