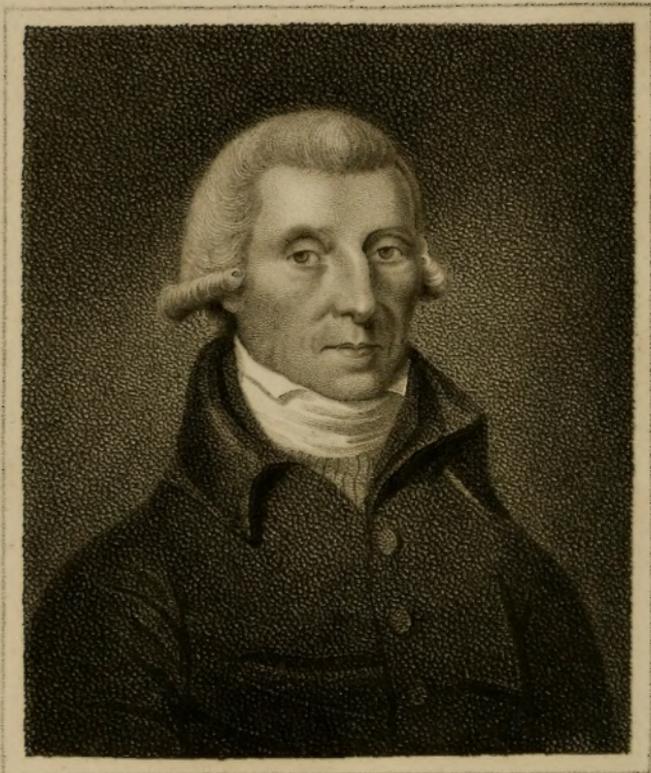


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*Richard Kirwan Esq.
L.L.D. F.R.S. and P.R.I.A.*

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, ETC. ETC.

“Nec araneorum 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. i.

VOL. XIV.



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THE
PHILOSOPHICAL MAGAZINE.

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By RICHARD KIRWAN, Esq. LL. D. F. R. S. and
P. R. I. A.

DEAR SIR, Dublin, Aug. 24, 1802.

WHEN I first undertook to state some objections to Dr. Hutton's Theory, I little imagined I should call forth such indignation and such illiberal personalities as appeared in the second edition of that work; but however hurt the self-love of an author might have been by an attack on his favourite ideas, I had still less reason to foresee that the same style of hostility would have been persisted in by any person to whom I had given no offence whatsoever. Mr. Playfair's Illustrations of the Huttonian Theory, which I have seen only a few days ago, convince me I was mistaken; he not only attempts to justify the *asperities*, as he calls them, of Dr. Hutton, but aggravates them by new invectives. You need not fear, Sir, that I shall pollute the pages of your journal by the vulgar mode of retaliation; I shall make no reflections on his defence of Dr. Hutton's Theory: enough has been said on that subject. I shall content myself with repelling his unprovoked and unmerited attacks on myself.

To effect this, however, I shall be obliged to state his abusive paragraphs, and thus expose their indecency. It is the only vengeance I shall take; he, probably, will account it none.

Page 119. "To assert, that in the economy of the world we see no mark either of a beginning or an end, is very different from affirming, that the world had no beginning, and will have no end. The first is a conclusion justified by common sense as well as sound philosophy; while the second is a presumptuous and unwarrantable assertion." Here I must deny that the first assertion, namely, that we see no mark of a beginning, is a conclusion justified by common sense and sound philosophy.

Mr. De Luc, Saussure, and Dolomieu, were not deficient either in common sense or sound philosophy, yet they all assert that we may discover evident marks of the beginning of the world in its present state: nay, Dr. Hutton himself allows it, for he judged the actual world to have proceeded from a preceding, and asserts that it will have an end. What Mr. Playfair must then mean is, that we can see no trace of the beginning of this succession of worlds. Of such succession, it is true, we can trace no beginning, because it is merely fictitious: but while Dr. Hutton asserted the reality of such a succession without assigning any limit, it was natural for me, who was totally unacquainted with him, to infer that he really judged it to have no beginning: this conclusion was so natural, that it occurred to others long before I had written on this subject. Mr. Williams, his countryman, who was probably acquainted with him, says, "That Dr. Hutton aims at establishing the belief of the eternity of the world, is evident from the whole drift of his system, and from his own words; for he concludes his singular Theory with these singular expressions: 'Having in the natural history of the earth seen a succession of worlds, we may from this conclude that there is a system in nature—in like manner as, from seeing the revolutions of the planets, it is concluded that there is a system by which they are intended to continue these revolutions. But, if the succession of worlds is established in the system of nature, it is in vain to look for any thing higher in the origin of the earth. The result, therefore, of our present inquiry is, that we find no vestige of a beginning, no prospect of an end.'"—Williams's Natural History of the Mineral Kingdom, Preface, lx.

Now, I ask what can be the meaning of these last words, *it is in vain to look for any thing higher in the origin of the earth*. Higher than what? Is it not plain that the meaning is, *higher* than that established succession, of which succession we can trace no beginning? And what is a succession of which we can trace, and to which we assign, no beginning? Now Dr. Hutton, in his first edition, nowhere mentioned that it had a beginning, though such beginning were not apparent on bare inspection of the actual world; was not then his meaning at least ambiguous?

So also Mr. Howard, in his learned work on the Structure of the Earth, p. 549, says: "Dr. Hutton rejects all time, the operations of his living renovating nature scorn all limits: time (says he), which measures every thing, is to nature endless and nothing." But to return to Mr. Playfair: "Mr. Kirwan, in bringing forward this rash and ill-founded
censure,

censure, was neither animated by the spirit nor guided by the maxims of true philosophy. By the spirit of philosophy he must have been induced to reflect, that such *poisoned* weapons as he was preparing to use are hardly ever allowable in scientific contest, as having a less direct tendency to overthrow the system than to hurt the person of an adversary, and to wound, perhaps incurably, his mind, his reputation, or his peace." This severe censure appears to me unmerited: of its liberality I leave others to judge. The mention of preparation of *poisoned* weapons is perfectly risible, when it is considered that the whole argument is comprehended in ten or twelve lines. If Dr. Hutton had lived either in Spain or Portugal, some hurt to his person might indeed be apprehended; but in Britain, where Mr. Hume, with impunity, trespassed much more on the received religious principles, no danger could rationally be suspected; and it were idle to think that the reputation of an author could any more be wounded by an inference obviously deducible from his principles, than by his own statement of those principles.

Mr. Playfair continues: "By the maxims of philosophy he (Mr. Kirwan) must have been reminded, that in no part of the history of nature has any mark been discovered either of the beginning or end of the present *order*." This I deny, in common with those eminent geologists already mentioned: clear traces of a *beginning* are found. "By attending to these considerations Mr. Kirwan would have avoided a very illiberal and ungenerous proceeding; and, however he might have differed from Dr. Hutton as to the *truth* of his opinions, he would not have censured their tendency with such rash and unjustifiable severity." I never once considered the tendency of his opinions, but merely their direct consequences; I had nothing to do with their tendency in a mere geological treatise.

Page 143. "It has been asserted that Dr. Hutton maintained all calcareous matter to be originally of animal formation: this position, however, is so far from being laid down by Dr. Hutton, that it belongs to an inquiry which he carefully avoided to enter on."

Page 147. "It is nevertheless true, that Dr. Hutton sometimes expressed himself as if he thought that the present calcareous rocks are *all composed of animal remains*: this conclusion, however, is more general than the facts warrant, and, from some incorrectness or ambiguity of language, is certainly more general than he intended." Yet, p. 156, treating of my account of the origin of coal mines, he says,

“It is indeed worth while to compare what is said concerning the degradation of mountains in the above quotations (from my Geological Essays) with what is advanced concerning their indestructibility in another passage of the same volume, namely, all mountains are not subject to decay; for instance, scarce any of those that consist of red granite, &c. One can be at no loss about estimating the value of a system in which such gross inconsistencies make a necessary part.” Mr. Playfair then finds a gross inconsistency in maintaining that *some* mountains are subject to decay, though *all* mountains are not; facts proved beyond the reach of contradiction; but he can see none in his own two paragraphs.

Page 157. “The quantity of hornblende and siliceous schistus necessary to be decomposed in order to produce the coal strata presently existing, is enormous. It is true that Mr. Kirwan, never at all embarrassed about preserving a similitude between nature as she now is, and as she was heretofore, lays it down, that the part of the primeval mountains, which is worn away, contained much more carbon than the part which is left behind: this, however, is an arbitrary supposition.” Not quite arbitrary neither. Mountains before the flood must have been in many respects differently circumstanced from the present; and if at present, after attaining their utmost state of consolidation, many of them are in a state of decay, much more liable to it must they have been then. Hornblende and siliceous schisti are not the only stones that contain carbon, nor are the mountains that present these rocks the only mountains that contain veins of it: many granite mountains also present them. Mr. Playfair, indeed, pays little regard to the authorities I adduce to prove the facts I allege; more impartial readers may possibly pay more.

I shall therefore quote one entitled to the highest credit. Citizen Haüy, in the third volume of his *Mineralogy*, p. 308 and 309, tells us that anthracite (native mineral carbon loaded with stony matter) belongs exclusively to primitive countries, and that the observations of Mr. Dolomieu prove the existence of carbon independently of animals and vegetables; and that anthracite was, he presumed, nothing more than pure carbon, associated, by accidental causes, with a certain quantity of iron and flux. And Mr. Duhamel has shown in a memoir, approved by the Academy of Sciences, that the argillaceous *strata* that intercede beds of coal are formed of the *detrites* of the neighbouring mountains: *Journal des Mines*, viii. p. 40; and Haüy, iii. p. 319. My system is not then quite

quite *original*, in the sarcastic sense in which Mr. Playfair applies this word; but it is evident irritation was his sole purpose.

Mr. Playfair adds, "We may also object to Mr. Kirwan, that the siliceous part of the mountain has not been chemically dissolved; it has only been abraded and worn away. Mechanical action has reduced the quartz to gravel and sand, but has not produced on it any chemical change; the carbon, therefore, could not be set loose." Mr. Kirwan has not assumed, that carbon was set loose from quartz, though it might have been from siliceous schists and other compound stones and rocks: disintegration is often effected by decomposition; thus felspar is converted into argil and siliceous particles in many instances; but this more frequently happens to stones that contain iron.

Page 158. Mr. Playfair, objecting to strata formed by *transudation*, asks what occupied the space of the coal bed before the transudation from the upper part of the mountains. The question is unfair, and very similar to the numerous difficulties objected to Dr. Black's discovery of fixed air, before its truth was generally acknowledged. A fact is often discovered, though the mode of its production be unknown; yet in this case the question is easily answered: the carbonic part of the coal in the mountain of St. George's here alluded to was formed before the upper part of the mountain was formed; it is only the bituminous ingredient that subsequently transuded from the supervenient superior strata; and I suppose it will be admitted that petrol might penetrate and coalesce with the carbonaceous part, without floating the upper part of the mountain, as Mr. Playfair ludicrously supposes. This account is so much the more probable, as this mountain is formed of a mixed calcareous stone abounding in argil; and this species of calcareous stone is of secondary formation, as Mr. Hassenfraz, the author of this memoir, truly remarks, p. 266.

Mr. Playfair concludes by remarking, "that such reasoning is so great a trespass on every principle of common sense, that to bestow any time on the refutation of it, is, in some measure, to fall under the same censure."

Page 171. "If any one asserts, as Mr. De Luc has done, that sand is a chemical deposit, a certain mode of crystallization which quartz sometimes assumes, let him draw the line which separates sand from gravel; and let him explain why quartz in the form of sand is not found in mineral veins, in granite, nor in basalt; that is, in none of the situations where the appearances of crystallization are most general and best ascertained." What is meant by a *chemical deposit*, I do not

understand; but that sand is sometimes found regularly crystallized is evident, for a whole stratum of such sand has been found at Neuilly: to expect that a substance exposed to endless friction should always be found in regular crystals would be extravagant; that of Neuilly was therefore formed on the spot in which it was found.—A vein filled with sand has been found among the mines of Peregruba in Siberia. Renouantz, Preface, xiii. Gravel and sand differ only in size, and to expect either in granite rocks would be inconsistent; but on and beside granitic mountains gravel very frequently occurs. The crystallization of basalts is so far from being ascertained, that, on the contrary, it has been demonstrably proved that basaltic prisms are not crystallized, by those that have paid most attention to this subject.—Romé de Lisle, i. p. 439; Haüy Miner. iv. 476.

Page 180. “The Neptunist, who has provided the means of dissolving the materials of the strata, has only performed half his work, and must find it a task of equal difficulty to force this powerful menstruum to part with its solution. Mr. Kirwan, aware, in some degree, of this difficulty, has attempted to obviate it in a very singular way. First, he ascribes the solution of all substances in water, or in what he calls the *chaotic fluid*, to their being created in a state of the most minute division. Next, as to the deposition, the solvent being, as he acknowledges, very insufficient in quantity, the precipitation took place (he says) on that account the more rapidly. If he means by this to say, that a precipitation without solution would take place the sooner, the more inadequate the menstruum was to dissolve the whole, the proposition may be true; but it will be of no use to explain the crystallization of minerals (the very object he had in view), because to crystallization it is not a bare subsidence of particles suspended in a fluid, but it is a passage from chemical solution to non-solution or insolubility that is required.”

My meaning is clearly stated in pages 10 and 11 of my Geological Essays, that the solids contained in the chaotic fluid were not dissolved by that fluid, but were contained in that state of minute division to which, if the fluid could of itself dissolve them, they would be reduced; and that, if the quantity of that fluid were insufficient to hold them in solution, this circumstance would hasten their crystallization, precipitation, and deposition, respectively. I did not assert that the solution was effected by the menstruum, but, on the contrary, denied it. Mr. Playfair's assertion, that crystallization is a passage from chemical solution to non-solution or insolubility, is denied by Bergman: “*Sed non tantum vere soluta*

in aqua determinatas acquirunt formas, verum etiam ni fallor satis attenuata." Bergman, ii. p. 15. It is sufficient that the particles suspended and sufficiently attenuated have an affinity to each other.

Page 22. "Barytic earth is well known to have a stronger attraction to fixed air than common calcareous earth has, so that the carbonate of barytes is able to endure a great degree of heat before its fixed air is expelled: accordingly, when exposed to an increasing heat at a certain temperature, it is brought into fusion, the fixed air still remaining united to it: if the heat be further increased the air is driven off, and the earth loses its fluidity." And, p. 185, "Carrara marble may require a heat of 6300° of Wedgwood to melt it in the open air; but under such a pressure as would retain this gas it cannot be inferred that it might not melt with the heat of a glasshouse furnace. In like manner it may be true that 280 cubic inches of air acting on charcoal cannot effect the fusion of one grain of this marble after its fixed air is driven off from it; but we cannot from thence draw any inference applicable to a case where the carbonic acid is retained, and where the action of heat is independent of atmospheric air." Now, in no experiment with which I am acquainted has native aerated barytes been fused without the expulsion of its air, or union with the earth of the crucible. Dr. Hope, indeed, fused it in a black lead crucible, but found it lost 23 per cent. nearly of its weight; which is the whole, or nearly so, of the air contained, and accordingly it made but a very slight effervescence with marine acid. Hence the position laid down, p. 22, that barolite or native carbonate of barytes may be fused and still retain its fixed air, is founded on no experiment; but from all known experiments the contrary inference is fairly deducible with respect to it, as well as with respect to Carrara marble; nor is there any reason to think that a lower heat, independent of the atmosphere, could have any other effect.

Page 201—203. The fact alluded to, namely, that shells are found incorporated in the body of a rock at a great height near Guancavelica, I have fully stated and explained in a dissertation long since printed, and which accompanies this letter; to which I shall therefore beg leave to refer*.

Page 242. "Mr. Kirwan, in order to account for the magnitude of masses of iron found in Siberia and Peru, supposes that small pieces of native iron have been originally agglutinated by petrol: this is, no doubt, the most singular of all the opinions advanced on the subject; and, as it bor-

* See the next article in the present Number.—EDIT.

rows nothing from analogy, it admits of no proof and requires no refutation." I was, however, led into this opinion by analogy with Mr. Gadd's experiments in the 32d volume of the Memoirs of Stockholm; for he tells us, that if clay and calces of iron be plentifully mixed with oil, they will form a mass which will harden even under water. If Mr. Playfair were acquainted with Mr. Chladni's opinion, that these masses were fragments of a broken planet that fell within the sphere of attraction of our globe, he might possibly think it the most *singular*; yet even so, it is probable he would not sacrifice the pleasure of bestowing that distinguished epithet on mine. However, as he judged my conjecture, I know not on what foundation, inconsistent with the principles of chemical science, I have mixed rust of iron with petrol, and afterwards with petrol to which sulphur was added, and found it disposed to coalesce in a few days.

P. 422. "One of Mr. Kirwan's objections to the deposition of materials at the bottom of the sea is thus stated:— 'Frisi has remarked, in his mathematical discourses, that if any considerable mass of matter were accumulated in the interior of the ocean, the diurnal motion of the globe would be disturbed, and consequently it would be perceptible.' The appeal made here to Frisi is singularly unfortunate, as that philosopher demonstrated the contrary to Mr. Kirwan's position. The instance just given may serve as one of many to show what confidence is to be placed in that undigested mass of facts and quotations which Mr. Kirwan, without discrimination and without discussion, has brought together from all quarters." Mr. Playfair might, however, easily infer, from the loose manner in which Frisi is quoted, (namely, in *some* of his mathematical treatises, so different from my usual manner, in which the page I take from is mentioned,) that I had not that author before me; and, in fact, I took it from Mitterpacher's Physical Description of the Earth, p. 25, who says, that according to Frisi, in the case above mentioned, the velocity with which the centre of the globe would move would be increased; omitting the calculation, and the mention that the increased velocity would not be *perceptible* for a long period of years. I hope therefore it is the only one out of the many quotations I have made in which any mistake can be found: if Mr. Playfair could find any other, he doubtless would have mentioned it. The attempt to weaken the force of the numerous facts I collected, adverse to the Huttonian theory, by calling them an *undigested* mass, is curious, and, if allowable, would furnish a very convenient and expeditious method of getting rid of

of them, but will not, I presume, appear perfectly satisfactory to an impartial public.

Page 427. The fact relative to the deltas formed in the mouth of the Bourampouter Mr. Playfair thinks I have misapprehended, because major Rennell does not assert that rivers employ *all* the materials which they carry with them, and deliver none into the sea. On the contrary, I think, they carry many of them into the sea, but not to any great distance, much less into its unfathomable depths, as Dr. Hutton asserts. The fact relative to the extension of coasts is now so well known to all modern geologists, that it were time lost to dwell longer on it: that the deltas themselves are diminished by particles detached from them, and carried into the recesses of the deep, is a remark which I do not recollect to have met with; but in some instances, where they consist merely of sand, they are often diminished by the winds: that even the argillaceous particles are not carried far into the sea, may be seen in Morse's American Geography, p. 49, Irish edition.

I decline entering into any further discussion of Mr. Playfair's replies to some other objection made by me to the Huttonian theory. The intelligent reader will meet with many confident and arrogant assertions of which he probably will require some proof, as in p. 481 and 482; many that are perfectly unsatisfactory or even contradictory, as where he allows that the impulsive motion of the waves against the shores is greater at a *small* distance from them, and yet asserts that the *detrites* of the shores are conveyed to a *great* distance. He also affirms with great confidence, that as the flowing of the tide requires just six hours, and the ebbing of it also six hours, the quantity of matter moved, and its velocity, must be just the same: p. 432. In the abstract this is certainly true, and in the middle of the ocean; but in most harbours the contrary happens: thus La Lande tells us that in the harbours of Brest, Dunkirk, Bordeaux, and Rouen, the ebb tide is about a quarter and often half of an hour slower than the flow: vol. iv. p. 117. These exceptions, I am persuaded, he is well acquainted with; but his *hurry and impatience** (if I may be permitted to use his own expressions) to combat my assertions led him to overlook them. He is much at a loss to account for the remains of elephants and of the rhinoceros found in Siberia, and thinks it most probable that they belonged to ancient species of those ani-

* These are the causes to which he ascribes the many mistakes he supposes me to have committed in combating the Huttonian theory; to reason he thinks me incapable.

mals that could endure the severity of a Siberian winter: p. 475. If I had advanced such an opinion, it is probable he would be equally at a loss to find an epithet sufficiently severe to stigmatize it.

P. 481. It is evident, he says, that my geological writings are the work of a man who has not seen nature with his own eyes. This, I suppose, he infers from the total absence of observations made by myself. It is however pretty notorious here, that I have visited, traversed, and examined, most of the numerous mountains in this country; but I thought that in a controversy of this nature, the testimonies of persons who had taken no part in it, and who had seen much more than I have, would be more effectual and convincing: it is much easier to vilify my writings than to answer them.

No absurdity appears to Mr. Playfair so great as the attempt to connect the Mosaic history of the creation of the earth with any philosophical inquiry concerning it: this attempt he thinks injurious both to the freedom of philosophical investigation and to the dignity of religion: p. 477. The text of Moses he thinks covered with a veil which cannot be torn off, and must be considered as if it never existed: p. 478. Yet in other parts of his work he seems himself sensible of the extravagance of this assertion taken in the most extensive sense, p. 126; he seems to limit it to the *age, figure, and motion* of the *earth*; which no geologist ever pretended to infer from the Mosaic text, in which no mention of them is to be found, no more than they have the explanation of the act of creation itself; a notion which he also unjustly ascribes to them: but the series of events which took place after the creation of the earth, are too plainly mentioned to be overlooked or misunderstood: to say that this account is so obscure as not to be intelligible, is tantamount to saying that it is useless. It was never pretended that Moses intended to write a treatise of geology, any more than that Greek or Latin historians intended to give a treatise of astronomy from their occasional mention of eclipses or comets; nor is the genuine philosophical investigation of those phenomena any more impeded in one case than in the other: on the contrary, due notice is taken of their accounts by all astronomers. But there is a species of investigation, abusively called *philosophical*, which abstracts from historical accounts either of the creation or of the flood, as if the accounts given of both by Moses were unworthy of credit: to this objection the Huttonian theory is certainly liable, though I

never charged it upon it: so far was I from wishing to make use of what Mr. Playfair called poisoned weapons, as he unjustly accuses me of having done.

It is in vain Mr. Playfair seeks to compare geology with astronomy and zoology; neither of these sciences requires any notice to be taken of the original constitution of their objects, their actual state being very nearly the same as their primordial state: but, where hybrid species occur, their origin never fails of being attended to.

In geology, the case is very different: here we meet with objects whose original state must have been very different from their actual state. Rocks or stones presenting regular forms must of necessity have been originally in a state from which such forms could arise. Masses now hardened into stone, but presenting the impressions either of vegetables or of other stones, must have been originally in a soft state. Calcareous stones filled with shells must have been originally in a state fitted for the admission of those shells; hence geologists necessarily recur to a state of inanimate nature prior to the present. This is admitted by Dr. Hutton as well as by Neptunists; but he thinks the present state to have originated from a gradual destruction of a former, as that did from a still more antient: still the most antient of these worlds either resembled the present, or it did not: if not, we can say nothing of it; if it did, the same difficulties must occur, and consequently its primordial state must have been different from its subsequent state, as this state is supposed to have been similar to the present. The crystallized or soft state of our present rocks Dr. Hutton thinks proceeded from an igneous fusion of the materials of a prior world: but he cannot suppose this of the first of these worlds; its similarity with ours must therefore be otherwise accounted for.

I shall here conclude my observations on Mr. Playfair's observations. Controversies managed as this has been by him and Dr. Hutton, whose favourite method of answering objections consists in depreiating or sneering at the understanding, and undermining the credit of their author, are a disgrace to philosophy, and sufficiently expose the weakness of the cause that obliges to have recourse to such expedients.

I am, &c. &c.

Mr. Tilloch.

RICHARD KIRWAN.

II. *An Illustration and Confirmation of some Facts mentioned in an Essay on the primitive State of the Globe.* By RICHARD KIRWAN, Esq. LL.D. F.R.S. and P.R.I.A.

THERE is a remarkable fact stated in this essay, with respect to which the Mosaic account is fully at issue with the most plausible of the lately devised philosophic theories of the primitive state of the globe, namely, the emersion of some portion of land from the primæval ocean previous to the creation of fish: Moses expressly affirming, Buffon, the anonymous author of *L'Histoire du Monde primitif*, and many others, expressly denying it. In proof of the Mosaic account, I alleged that no petrifications were found imbedded and incorporated in masses of stone in such countries as were elevated 8500 or 9000 feet above the actual level of the sea—for instance, in the great Tartarian platform and the elevated regions of Siberia—though in all interior regions of the same extent such petrifications were abundantly found, at least in limestones; but even in these none were found in those elevated tracts, as I proved by the testimonies of all the philosophic travellers who have traversed and examined them.

Bouguer and Don Ulloa* attest the same fact with respect to Quito and the lofty regions of South America, having met with none in ninety leagues from a little north of the equator to Cuenca, between 2° and 3° south of it, Quito being elevated 9374 feet above the level of the sea. I even doubted whether the petrifications found by Mr. De Luc on mount Grenier, at the height of 7800 feet, were incorporated in the body of any stony mass; but he has since assured me that they were: now the shells he found being *cornua ammonis*, a species of those called *pelagicæ*, it would thence appear that the sea had risen still higher, though not above 1000 feet.

To repel this proof of the Mosaic account, it has been replied by the laborious, learned, and eloquent writer of *L'Histoire du Monde primitif*, and others, that the keen air existing in these elevated regions had long ago decomposed and consumed the shells that might have been there deposited; but, as the stones still remain, it is evident that the shells incorporated in their interior must also have remained, if any such were ever contained in them.

However, it is insisted that petrified shells have been found at a far superior height to that which I stated as the highest

* Bouguer, *Figure de la Terre*, p. 65. Don Ulloa, *Mem. Philosoph.* vol. i. p. 363.

limit at which they could be found, namely 9000 feet, for that those which I quoted as proofs of a subsequent deluge, found, according to Don Ulloa, at the height of 14,220 feet in Peru, were in reality petrified. To this account, as it was only a hearsay report of Gentil, who had it from Don Ulloa, I own I did not give full credit; at least I thought the circumstance of their having been petrified and imbedded in a rock not probable: since that time I have met with a work, composed by Don Ulloa himself, entitled *Mémoires Philosophiques, Historiques et Physiques*, in the first volume of which, p. 34 and 364, the fact of the shells being petrified and imbedded in a rock is fully stated and confirmed: but I shall here satisfactorily prove that the height at which they were found did not exceed, nor even equal, 9000 feet above the level of the sea; and, secondly, that they were left there by a deluge that succeeded the emersion of land from the primæval ocean.

First, Gentil tells us, *Mém. Par.* 1771, p. 439, in 8vo., that these shells were found on a mountain near Guancavelica, a small town or village between 12° and 13° south latitude, which mountain, he says, is far from being one of the highest of the Cordeliers; and that on the spot in which the shells were found, the mercury in the barometer stood at the height of 17 inches one line and $\frac{1}{4}$ = 17,103 inches; from which he infers that this spot was elevated 2200 toises over the level of the sea, = 13,869 English feet. This height I shall now show to have been falsely estimated.

Don Ulloa tells us, p. 34 of the abovementioned work, and Gentil repeats after him, that, at the village of Guancavelica, near but somewhat below this spot, the mercury stood at the height of 18 inches one line and half. Now Bouguer, *Figure de la Terre*, p. 36, expressly says that Quito is elevated from 14 to 1500 toises only over the level of the sea, and is the highest *inhabited* part of the globe: Guancavelica, therefore, which is inhabited, and must have been well known to Bouguer, cannot be so high as Quito. Quito was geometrically measured, Guancavelica was not.

Bouguer also tells us, *ibid.* in note, that the mercury at Quito stands at the height of twenty inches and one line: how then is it possible that it should stand at eighteen inches and one line at Guancavelica, which must be much lower, if the barometer were not ill constructed? No difference of temperature between Quito and Guancavelica could cause such an enormous difference as two inches in the mercurial height. The art and necessity of freeing barometers from air were not generally

generally known * before Mr. De Luc's immortal work on the modifications of the atmosphere, which was not published till upwards of thirty years after Don Ulloa's experiments. The air, then, remaining in his barometer, which he probably filled at Lima, in whose territory Guancavelica lies, under a pressure of 28 or between 27 and 28 (French) inches, must have considerably expanded and depressed the column of mercury under it when brought up a mountain of, perhaps, 7000 or 8000 feet high; and hence this mercurial column remained so low at Guancavelica as eighteen inches and one line.

That in these circumstances the air contained in the barometer might cause a difference of three inches or more between the height at which mercury purged of air would stand, appears by the experiments of Cassini, *Mém. Par.* 1740, *sur la Méridienne de Paris*, p. 172; for he found that the mercury, freed from air by ebullition in the tube, stood four or five lines higher than in barometers filled without that precaution. Nay, cardinal Luynes found the difference betwixt such barometers to amount sometimes to fourteen lines; *Mém. Par.* 1768, p. 490, in 8vo. How great must it therefore be in barometers transported to greater heights than that at which they were filled?

Moreover, Don Ulloa expressly tells us that the mountain on which these shells were found was *every where habitable*, *Mém. Philosophiques*, p. 34 and 35; which it could not be, and would be expressly contradicted by Bouguer, if its height were 13,000 English feet over the surface of the sea. From all which I conclude that the height of the mercurial column, if the barometers had been properly constructed, would have been about 22 French inches, = 23,44 English; and, as the temperature was remarkably cold, this would indicate a height of about 8200 feet above the level of the sea.

But, secondly, let the height be what it may, it is certain that these shells were deposited there after the emerision of land from the primitive ocean, and consequently by a subsequent deluge; for Don Ulloa expressly tells us, that in the same rocks in which these shells are found, *petrified wood* is also found; *Mém. Philosophiques*, p. 372. This wood must have grown on dry land, and must have been floated when

* I say, not generally known, because, though Mr. Du Fay had shown the advantage of expelling air from the mercury in the tube, in *Mém. Par.* 1723, and Cassini had followed that method in measuring the heights of Puy de Dome and Mont d'Or in 1740, yet it was not generally adopted until Mr. De Luc had proved its necessity, and perfected the method of performing it, in 1772. See De Luc, i. p. 58.

the shells were deposited, since both are found in the same rocks. It must have been brought thither by a deluge, as no wood can at present grow there, as Don Ulloa also attests. The shells are for the most part bivalves, which geologists allow to form petrifications of the most modern date.

Lastly, La Peyrouse mentions that he discovered marine shells on mount Perdu, the highest of the Pyrenees, at the height of nearly 10,000 feet. How he ascertained the height is not mentioned: but that these shells were deposited by the deluge is certain; for at the same height he found also the bones of land animals petrified. *Journal des Mines*, xxxvii. p. 59, 60, and 64.

III. *An Essay on the Colours obtained from the metallic Oxides, and fixed by Fusion on different vitreous Bodies.*
By ALEXANDER BROGNIART, Director of the National Manufactory of Porcelain at Sevres, Engineer of Mines, &c.

[Concluded from p. 348 of our last volume.]

A SMALL book, entitled *L'Origine de l'Art de la Peinture sur Verre*, published at Paris in 1693, and the *Traité de l'Art de la Verrerie**, by Neri and Kunckel, seem to be the first works that contain a pretty complete description of the art of painting on glass. Those since published, even the large work of Level, which forms part of the arts and manufactures of the academy, and what is said in the *Encyclopédie Methodique*, are merely compilations from the two preceding works.

It is very remarkable, that if the processes described in these works were strictly followed, as we did in regard to some, it would never be possible to form the colours for which they pretend to give recipes. They only put the able artist in the way, but he must always make amendments or additions. This was the case with C. Miraud, who has the care of preparing the colours at the manufactory of Sevres. He was obliged, rather from his own knowledge than the information contained in the above books, to make the colours employed for painting on glass.

The limits of a memoir will not allow me to enter into historical details respecting the art of painting on glass: a full history of it has been given in the work of Level above mentioned. The matters and fluxes which enter into the

* There is an English translation of this work entitled *Neri's Art of Glass*.

composition of the colours employed on glass are, in general, the same as those applied to porcelain. Neither of them differ but in their proportions; but there are a great number of enamel or porcelain colours which cannot be applied to glass, where they are deprived of the white ground which serves to give them relief. When seen by refraction, several of them entirely change their tone, and assume a dirty tint, which can be of no use: we shall make them known when we come to treat of colours in particular. Those which can be employed on this body change sometimes in baking, and acquire a great transparency. In general they are not beautiful; but, when placed between the light and the eye, they then seem to answer the only object that can be proposed in painting on glass.

The baking plates of painted glass presents more difficulties than might be supposed. Care must be taken not to disfigure the piece, or alter the colours: all the works we have read recommend a bed of gypsum. This method has sometimes succeeded; but the glass, for the most part, becomes white and full of cracks. It appears that glass too alkaline (and alkalis are the most common in white glass) suffers itself to be attacked warm by the sulphuric acid of the sulphate of lime. We were easily able to bake pieces of glass much larger than those before painted, by placing them on very straight plates of earth or of soft porcelain.

Of Colours in particular.

After collecting the general phænomena exhibited by each class of vitrifiable colours, considered in regard to the body on which they are applied, I must make known the most interesting particular phænomena exhibited by each principal kind of colours employed on soft porcelain and glass in a porcelain furnace.

Of Reds, Purples, and Violets, made from Gold.

Carmine red is obtained by the purple precipitate of Cassius: it is mixed with about six parts of its flux; and this mixture is employed directly, without being fused. It is then of a dirty violet, but by baking it acquires a beautiful red carmine colour: it is, however, exceedingly delicate; a little too much heat and carbonaceous vapours easily spoil it. On this account it is more beautiful when baked with charcoal than with wood.

This colour and the purple, which is very little different, as well as all the shades obtained from it, by mixing it with other colours, really change on all porcelain and in every hand.

hand. But it is the only one that changes on hard porcelain. Its place may be supplied by a rose colour from iron which does not change; so that by suppressing the carmine made with gold, and substituting for it the rose oxide of iron here alluded to, you may exhibit a palette composed of colours none of which change in a remarkable manner. This rose-coloured oxide of iron has been long known; but it was not employed on enamel, because on that substance it changes too much. As the painters on enamel, however, have become the painters on porcelain, they have preserved their antient method.

It might be believed that, by first reducing to a vitreous matter the colour called *carmine* already mixed with its flux, it might be made to assume its last tint. But the heat necessary to fuse this vitreous mass destroys the red colour, as I have experienced. Besides, it is remarked that, to obtain this colour very beautiful, it must be exposed to the fire as few times as possible.

The carmine for soft porcelain is made with fulminating gold slowly decomposed, and muriate of silver: no tin enters into it; which proves that the combination of the oxide of this metal with that of gold is not necessary to the existence of the purple colour.

Violet is made also with purple oxide of gold. A greater quantity of lead in the flux is what gives it this colour, which is almost the same crude or baked.

These three colours totally disappear when exposed to a great porcelain heat.

Carmine and purple have given us in glass tints only of a dirty violet. The violet, on the other hand, produces on glass a very beautiful effect, but it is liable to turn blue. I have not yet been able to discover the cause of this singular change, which I saw for the first time a few days ago.

Red, Rose, and Brown Colours extracted from Iron.

These colours are made from red oxide of iron prepared with nitric acid. These oxides are further calcined by keeping them exposed to the action of heat. If heated too much, they pass to brown.

Their flux is composed of borax, sand, and minium, in small quantity.

These oxides give rose and red colours capable of supplying the place of the same colours made with oxide of gold. When properly employed on hard porcelain, they do not change at all. I have caused roses to be painted with these colours, and found no difference between the baked flower and that

not baked, except what might be expected to result from the brilliancy given to colours by fusion.

These colours may be employed indiscriminately, either previously fused or not fused.

In a great heat they in part disappear, or produce a dull brick red ground, which is not agreeable.

The composition of them is the same both for soft porcelain and for glass. They do not change on the latter; but on soft porcelain they disappear almost entirely on the first exposure to heat, and to make any thing remain they must be employed very deep.

This singular effect must be ascribed to the presence of lead in the crust or glazing. I assured myself of this by a very simple experiment. I placed this colour on window glass, and, having exposed it to a strong baking, it did not change.

I covered several parts of it with minium; and again exposing it to the fire, the colour was totally removed in the places where the red oxide of lead had been applied.

By performing this operation on a larger scale in close vessels, a large quantity of oxygen gas was disengaged.

It appears to me that this observation clearly proves the action of oxidated lead on glass as a destroyer of colour: it is seen that it does not act, as was believed, by burning the combustible bodies, which might tarnish the glass, but by dissolving, discolouring, or volatilizing with it the oxide of iron, which might alter its transparency.

Yellows.

Yellows are colours which require a great deal of care in the fabrication on account of the lead which they contain, and which, approaching sometimes to the metallic state, produces on them black spots.

The yellows for hard and soft porcelain are the same: they are composed of the oxide of lead, white oxide of antimony, and sand.

Oxide of tin is sometimes mixed with them; and when it is required to have them livelier, and nearer the colour *du sauci*, red oxide of iron is added, the too great redness of which is dissipated in the previous fusion to which they are exposed by the action of the lead contained in this yellow. These colours when once made never change: they disappear, however, almost entirely when exposed to a porcelain heat.

These yellows cannot be applied to glass: they are too opaque and dirty. That employed by the old painters on glass has, on the contrary, a beautiful transparency, is exceedingly brilliant, and of a colour which approaches near to that of gold. The processes which they gave clearly showed that
silver

silver formed part of their composition; but, when exactly followed, nothing satisfactory was obtained. C. Miraud, whom I have already had occasion to mention, has found means to make as beautiful paintings on glass as the ancients, by employing muriate of silver, oxide of zinc, white argil, and yellow oxide of iron. These colours are applied on glass merely pounded, and without a flux. The oxide of iron brings the yellow to that colour which it ought to have after baking, and contributes with the argil and oxide of zinc to decompose the muriate of silver without deoxidating the silver. After the baking, there remains a dud which has not penetrated into the glass, and which is easily removed.

This yellow, when employed thicker, gives darker shades, and produces a ruffet.

Blues.

It is well known that these are obtained from the oxide of cobalt. All chemists are acquainted with the preparation of them. Those of Sevres, which are justly esteemed for their beauty, are indebted for it only to the care employed in manufacturing them, and to the quality of the porcelain, which appears more proper for receiving them in proportion to the degree of heat it can bear:

I remarked respecting the oxide of cobalt a fact which is perhaps not known to chemists: it is volatile in a violent heat: it is to this property we must ascribe the blueish tint always assumed by white in the neighbourhood of the blue. I have placed expressly on purpose, in the same case, a white piece close to a blue one, and found that the side of the white piece next the blue became evidently blueish.

The blue of hard porcelain, destined for what is called the ground for a great heat (*les fonds au grand feu*), is fused with feld-spar; that of soft porcelain has for its flux silica, potash, and lead: it is not volatilized like the preceding, but the heat it experiences is very inferior to that of hard porcelain.

These colours, when previously fused, do not change at all in the application.

Blues on glass exhibit the same phenomena as those on soft porcelain.

Greens.

The greens employed in painting are made with green oxide of copper, or, sometimes, with a mixture of yellow or blue. They must be previously fused with their flux, otherwise they will become black; but after this first fusion they no longer change.

They cannot stand a strong heat, as it would make them disappear entirely. Green grounds for a strong heat are composed with the oxides of cobalt and nickel, but a brownish green only is obtained.

Blueish greens called *celestial blues*, which were formerly colours very much in vogue, can be applied only upon soft porcelain; on hard porcelain they constantly become scaly, because potash enters into their composition.

These greens cannot be applied on glass: they give a dirty colour. To obtain a green on glass, it is necessary to put yellow on one side, and blue, more or less pale, on the other. This colour may be made also by a mixture of blue with yellow oxide of iron. I hope to obtain from oxide of chrome a direct green colour. The trials I have made give me reason to hope for success. Pure chromate of lead, which I applied to porcelain in a strong heat, gave me a pretty beautiful green of great intensity and very fixed.

Bistres and Ruffets.

These are obtained by mixtures in different proportions of manganese, brown oxide of copper, and oxide of iron from ombre earth. They are also previously fused with their flux, so that they do not change in any manner on soft porcelain, as lead has not the same action on oxide of manganese as on that of iron, as I assured myself by an experiment similar to that already mentioned.

This colour fades very speedily on glass.

Ruffet grounds in a great heat, known under the name of *tortoise-shell grounds*, are made in the same manner. Their flux is feld-spar: no titanium enters into their composition, though said so in all printed works. Titanium was not known at the manufactory of Sevres when I arrived there. I treated this singular metal in various ways, and never obtained but grounds of a pale dirty yellow, and very variable in its tone,

Blacks.

Blacks are the colours most difficult to be obtained very beautiful. No metallic oxide gives alone a beautiful black. Manganese is that which approaches nearest to it. Iron gives an opaque, dull, cloudy black, which changes very easily to red: the colour-makers, therefore, to obtain a black which they could not hope for from the best theorist, have united several metallic oxides which separately do not give black, and have obtained a very beautiful colour, which, however, is liable to become scaly and dull.

These

These oxides are those of manganese, the brown oxides of copper, and a little of the oxide of cobalt. The gray is obtained by suppressing the copper, and increasing the dose of the flux.

The manufactory of Sevres is the only one which has hitherto produced beautiful blacks in a strong heat. This is owing rather to the quality of its paste than to any peculiar processes, since it does not conceal them. It is by darkening the blue by the oxides of manganese and iron that they are able in that manufactory to obtain very brilliant blacks.

Having here made known the principles of the fabrication of each principal colour, it may be readily conceived that by mixing these colours together all the shades possible may be obtained. It is evident also that care in the preparation, choice in the raw materials, and a just proportion of doses, must produce in the results differences very sensible to an eye accustomed to painting. A mere knowledge of the composition of the colours does not give the talent of executing them well.

In recapitulating the facts above mentioned, to present them under another general point of view, it is seen :

1st, That among colours generally employed on hard porcelain one only is susceptible of changing, viz. carmine, and the tints into which it enters : that its place may be supplied by the reds of iron, and that no colour then changes.

I have presented to the Institute a head not baked, executed according to this method ; and the painting of two roses, that of the one baked, and that of the other not baked. It has been seen that there was no difference between them.

2d, That among the colours for soft porcelain and enamel, several change in a considerable degree. These are principally the reds of gold and iron, the yellows, the greens, the browns. They have not been replaced by others, because this kind of painting has been almost abandoned.

3d, That several of the colours on glass change also by acquiring complete transparency. These in particular are the yellows and greens.

4th, That it is neither by calcining the colours in a higher degree, nor previously fusing them, as supposed by some, that they are prevented from changing, since these means really alter the changing colours, and produce no effect on the rest. The change which several colours experience on soft porcelain and on glass does not then depend on the nature of their composition, but rather on that of the body on which they are applied.

Consequently, by suppressing from the colours of hard porcelain the carmine of gold, which is not indispensably necessary, we shall have a series of colours which do not change, and which will be absolutely similar to those presented to the Institute in the year 6.

IV. *Memoir on Tubes rendered harmonious by Hydrogen Gas. Read before the Society of Physics and Natural History of Geneva, by G. DELARIVE, Ex-President of the Royal Society of Edinburgh, and Member of the Medical Colleges of London and Geneva*.*

IN a former sitting, our learned colleague professor Piclet communicated to the society a series of researches on tubes rendered harmonious by means of hydrogen gas, and explained the different musical phænomena to which these tubes give birth. He pointed out the influence of the length of the tube; of its breadth, and of the place where the gas is burnt; and explained the nature of the sounds produced. In regard to the cause of the sound, he offered only conjectures: as his labour was not directed to that object, it is under this point of view that I have resumed it.

Professor Brugnatelli, in my opinion, is the first person who published the experiment; which I shall endeavour to explain. It had been invented by a German: I shall here give a view of the principal circumstances attending it.

If a current of inflamed hydrogen gas be introduced into a tube the substance of which is elastic and sonorous, such as glass, metal, dry wood, &c., this tube, after the interval of some seconds, will emit a harmonic sound: if it be open at both extremities, the sound will be strong and full. The experiment may, however, succeed with a tube closed hermetically at one end, provided its diameter be so large as to admit of a circulation of the atmospheric air in sufficient quantity to maintain the combustion of the gas. The conditions essentially necessary for this purpose are: 1st, That the substance of the tube be elastic, proper for producing an echo; that is to say, for reflecting the undulations which proceed from the sonorous point: a tube of paper or pasteboard will emit no sound. 2d, The flame must be produced by a current of hydrogen gas. An inflamed jet of the vapour of spirit of wine or ether, a lighted taper, &c. are incapable of making the tube emit any sound.

* From the *Journal de Physique*, Fruclidor, an. 10.

Let us now examine what takes place in this experiment. There must be a certain point, which may be called the *sonorous point*: it is at this point that the vibrations which communicate to the air an undulatory motion are produced. This point is the place of combustion: for by changing the position of that place the sounds may be varied, as M. Pictet proved by a series of experiments. This gentleman observed also in that point, by means of the smoke with which he filled the tube, a continual succession of vibrations. These vibrations give birth to undulations, which are propagated with a known and determined velocity, and striking the sides of the tube, are reflected with the same velocity as that with which they reached them. When the distance of the sides of the tube is such that the reflections backwards and forwards are isochronous with the vibrations natural to the sonorous cause, the sound increases in intensity, and becomes musically appreciable. It appears also that the reflected undulations re-act on the primitive vibrations produced in the place of combustion, and render them harmonically regular with them; for a certain space of time is almost always necessary before the instrument has acquired a regular and full sound: the tone of the tube will be higher or lower according to the greater or less number of undulations which take place in a given time.

There is another essential fact to be observed in the experiment which we here examine: the temperature of the column of air is not the same throughout its whole length. At the sonorous point, that is to say, the place of combustion, the temperature is exceedingly high; it is such, that the extremity of the aperture of the glass through which the hydrogen gas issues is constantly in a state of incandescence: if an inflamed jet of the vapour of spirit of wine or ether be substituted for a current of hydrogen gas, the heat is visibly weaker. According to some experiments it appears probable also that the temperature of the chamber where the experiment is made, and the purity of the air in the chamber, may have some influence on the result.

The object of my researches was to discover the cause of these phenomena, and how, and by what means, these sonorous vibrations are produced. During the combustion of hydrogen gas, it is well known that there is a production of water, and this water appears under the form of vapours. The place of the combustion being at a high temperature, these vapours must acquire a large volume; but, coming immediately into contact with air less heated, their volume must be rapidly diminished. A vacuum therefore must be formed,

into which the air rushes to be repelled by the new vapours, that contract in their turn. Is it from this alternate motion, produced by the great expansion and subsequent contraction of the vapours, that the sonorous vibrations result * ?

Such were the conjectures which might be formed on the probable cause of this phenomenon, when I accidentally met with a fact which appeared to me to give them some weight.

I had a thermometer tube about a line in diameter, at the extremity of which a small bulb was blown. In this bulb was a drop of water, which I wished to expel: for this purpose I exposed the bulb several times to the flame of a spirit-of-wine lamp. I was agreeably surprised to hear the tube emit a harmonious sound.

To repeat this experiment with success, the tube employed must be from 1 to 2 or 3 lines in diameter: its length may be about from 3 to 4 or 5 inches: it must have blown at one of its extremities a bulb the diameter of which is about triple that of the tube. It is not necessary that it should be regular. It even appears that, if it were a little flatted, the sound emitted would be higher. Into this bulb introduce a little quantity of water or mercury, and then expose it to a strong heat: that of a common spirit-of-wine lamp will, in general, be sufficient; but the flame must be large and strong when the operation is performed with a large tube. After the bulb has been exposed for some moments to the heat, it will emit a sound. Tubes of a large diameter produce a sound lower

* It appears to me probable that the sound produced by the air which rushes into the vacuum is more intense than that which results from an expansive force. The dreadful noise occasioned by the detonation of bubbles of hydrogen gas and oxygen is well known, and yet the lightest objects which surround the vessel are not even agitated by it; whence we may conclude that this phenomenon is produced by the sudden vacuum resulting from the destruction of the gas. The detonation of an inflammable gas pistol is much stronger than that of the air-gun, though the effect is less considerable; probably because in the pistol a vacuum succeeds the first expansive force. Every body is acquainted with that children's plaything called the humming top. It consists of a hollow sphere with an aperture at the circumference, which being made to turn rapidly on its axis produces a very strong humming noise. What is the cause of this noise? The same, in my opinion, as that above mentioned: the centrifugal force expels the air from the sphere through its aperture; a kind of vacuum is formed in it, the exterior air continually tends to enter it, and is immediately repelled, and hence a series of sonorous oscillations. — The AUTHOR.

The effect here spoken of seems rather to arise from the velocity with which the edge or lip of the orifice meets the air; for the same sound may be produced by directing a stream of air against the lip when the top is stationary. — EDIT.

than others. The size of the bulb appears to me also to contribute towards the same effect. The sound will be permanent for some moments; it will then gradually decrease, and at length will entirely cease. By suffering the apparatus to cool, and taking care to make the liquid condensed along the sides of the tube to descend into the bulb, the experiment may be repeated as often as may be thought proper.

Such is the experiment by means of which, in my opinion, the phenomenon of the harmonious tubes may be explained in a satisfactory manner. Let us now examine what takes place in tubes with a bulb, and what are the essential conditions necessary to make them emit a sound, and let us endeavour to discover the cause of this sound. We shall then compare them with the tubes employed with hydrogen gas, and shall examine in what these two instruments resemble each other in the effects they produce, the differences they exhibit under the same relations, and the causes of these differences.

The essential conditions necessary to make tubes with a bulb resound are: 1st, That the vessel has a bulb: I was never able to excite sonorous vibrations in a tube simply closed at one of its extremities. 2d, This bulb must contain an evaporable liquid: water succeeds very well; but it is attended with the disadvantage of forming in the tube, when it passes from the state of vapour to the liquid state, a small drop which often obstructs it entirely, and, sometimes, falling on the heated part of the glass, occasions a rupture. Mercury is not attended with the same defect: I was never able to produce sounds with ether, spirit of wine, or concentrated sulphuric acid. The quantity of liquid contained in the bulb is not a matter of indifference; it must be as small as possible: if there be too much, the tube becomes filled with vapours, which completely expel the air from it, and, heating it every where in an uniform manner, it no longer emits any sound. The third essential condition is the application of a strong heat to the bulb while the rest of the tube remains cold; for, if there be not a very striking difference of temperature between the bulb and the tube, there will be no sonorous effect. In the last place, the presence of atmospheric air is indispensably necessary: if it be entirely expelled, no effect can be produced. In all the periods of the experiment it will be found that the vapour fills only a certain portion of the instrument, and that it always contains air. I made several trials to determine exactly the space occupied by the vapour at the moment when the sound is heard; and I have found that, in small tubes at least, this space is somewhat less than

than the volume of the bulb. To determine it, I shut with my finger the orifice of the tube: at the moment when it began to sound, I immersed the orifice in mercury, removed my finger, and left the apparatus to cool. The vapour became condensed; and I could judge, by the quantity of mercury which the pressure of the atmospheric air made to ascend in the tube, the space which the vapour had occupied.

Such are the four conditions essentially necessary for obtaining sounds: a bulb at the extremity of the tube; the presence of a very small quantity of water or mercury in the bulb; the application of a strong heat to the bulb while the rest of the tube remains cold; and, in the last place, the simultaneous presence in the apparatus of vapour and atmospheric air. It is not necessary to add, that the orifice of the tube must always be open. Let us now examine what may be the cause of the sound. I wished first to ascertain whether any chemical decomposition of the liquid employed took place. For this purpose I took a tube of such a length that the liquid might be entirely condensed in it. I weighed it carefully before I made the experiment: I then made it emit sounds, and found, after producing this effect several times, that its weight had neither increased nor decreased; whence I concluded that caloric produces no chemical effect on the liquid, and that the latter merely undergoes successive evaporation and condensation. Is it to this evaporation, then, of the liquid, and its condensation, that the sounds ought to be ascribed? At first I believed that this question might be answered in the affirmative; but the following considerations made me change my opinion: I first observed that there might be a successive evaporation and condensation, without the tube emitting any sound, on applying to the bulb a sufficient heat, but less intense than that necessary for making the tube sound. Secondly, in making the experiment with a drop of water, I constantly found that the moment when the apparatus began to enter into action was that when the whole of the water was evaporated, and, consequently, when the heat acted on the vapour: if a single atom of liquid remained in the bulb, the tube was mute. From this fact I conclude that the sound is produced by the action of the caloric on the vapour, and the reaction of the latter on the atmospheric air. The following is the manner in which I conceive that this phenomenon takes place: The vapour contained in the bulb receives, by an addition of caloric conveyed to it from every part in a large quantity, an increase of volume and of elasticity; it proceeds with force from the bulb to the tube, and expels the air contained in it; but this air and the sides

of the tube take from it, at the moment of contact, a portion of the caloric, its volume decreases, at the same instant a vacuum takes place, and the air resumes its primitive space. A new addition of caloric restores to the vapour its whole elasticity, a part of which it soon loses in the same manner. This is a consequence of the oscillations of that nature which give to the air an undulatory movement. The undulations reflected by the sides of the tube become sonorous and appreciable when they are isochronous with the oscillations produced by the cause I have indicated. From some tubes it is impossible to produce any sound: in these I am of opinion that the reflected undulations cannot harmonize with the primitive oscillations, and that the one destroy the other. In tubes with bulbs, the sound, after a certain time, becomes weaker, and at length ceases. This may be explained by the propagation of heat along the sides. When the bulb is very warm, and the tube cold, the vapour which rises from the bulb suddenly loses a part of its volume, and the oscillations thus produced are strong and frequent; but when the tube has acquired a certain degree of heat, the vapour gradually decreases in volume by passing from a very hot temperature into a place less warm indeed, but which, however, has a sufficient degree of heat to make the oscillations, which become weaker and fainter, to cease at length entirely. That such is the cause of the cessation of the sound may be proved by applying a strong heat to the part of the tube already heated, maintaining at the same time the same degree of heat under the bulb: by these means the limits of the temperatures are again very abrupt, and the sound will be reproduced in its full force. It may be readily conceived that the substance of the tube must be some matter a non-conductor of heat: glass, therefore, is preferable.

Let us now compare the apparatus of a tube having a bulb with those tubes in which hydrogen gas is employed. In the latter we have every thing necessary for the production of sound, a vapour very hot, and consequently highly elastic; for, as already observed, the place of the combustion is at so high a temperature that the beak of the glass is constantly red. This hot and elastic vapour, at the moment of its production, is in contact with the cold air, which enters the tube at the bottom and issues at the top; its volume must then decrease a moment after it has touched that cold air: new hot vapours succeed the former, and contract in their turn. This alternate expansion and contraction gives birth to the undulatory movement of the air, and sonorous undulations.

We have already seen that an inflamed jet of spirit of wine or of ether cannot make the tube sound. This is a new proof of what I have advanced, that to produce sound there must be a great difference between the temperature of the vapour and that of the surrounding air. In this case there is a successive formation and condensation of vapour, for the water streams along the sides of the tube; but the place of combustion has a much inferior degree of heat to what it has when hydrogen gas is burnt, and consequently the vapour produced has less heat as well as less elasticity. This case is analogous to that already mentioned, when we said that a successive evaporation and condensation of the liquid might be produced in a tube having a bulb, without any sonorous effects, by exposing the bulb to a certain degree of heat, but less intense than that necessary for making the tube emit a sound. We should not be surprised if less heat were produced by the combustion of spirit of wine, or ether, than by that of hydrogen gas, when it is considered that in the latter case all the caloric contained in this gas, and in the oxygen of the atmospheric air consumed, becomes sensible heat, and unites itself entirely with the vapour produced. On the other hand, in the combustion of an inflammable substance, such as spirit of wine, we have only the caloric of the oxygen consumed, rendered sensible, and which is in a great measure absorbed by the formation of carbonic acid gas, so that it is only the excess which joins the vapour. It is therefore not astonishing that we have not heat sufficient to give to this vapour all the elasticity necessary for the production of sound: the presence of the carbonic acid gas resulting from the combustion may also be an obstacle to the sonorous vibrations.

In tubes employed with hydrogen gas, the sound is much stronger than in those having bulbs: besides, in the former it is permanent, in the latter it continues only a few moments. The reason of this is as follows: In the apparatus with hydrogen gas the tube is open at both extremities, consequently there is formed a current of fresh air, which enters at the bottom and issues at the top; this current of air sweeping along with the hot and elastic vapours receives their impulse, and, by taking from them a portion of caloric, diminishes their volume: we find here, therefore, the most essential condition for the production of an intense and permanent sound, viz. a great difference between the temperature of the air and that of the vapour; and this difference always remains the same by the continual renovation of the air; but this does not take place in tubes with bulbs, and therefore the sound they emit is weaker and of shorter duration.

From

From this principle, that the great difference between the temperature of the vapour and air is necessary for the production of sound, it may be easily conceived that every thing which tends to augment the heat of the current of air, and to diminish that produced by the combustion of the gas, will tend also to weaken or even to annihilate the sound of the tube: but these two circumstances are united in a warm chamber filled with people: the current of air, instead of being cool, is hot, and the quantity of oxygen being there less, the heat produced will be of less strength. It needs therefore excite no astonishment, that in such chambers the experiment does not always succeed.

Brugnatelli produced sounds in tubes merely by the combustion of phosphorus. Some philosophers, conceiving that the sonorous effects were owing in a peculiar manner to the hydrogen gas, have been induced to infer the presence of that substance in phosphorus. From what has been said, is it not more simple to explain this phænomenon by the production of the phosphorous acid under the form of vapours, which receive a great degree of elasticity from the caloric disengaged during the combustion, and the volume of which is soon diminished by the contact of the cold air? We find there the alternate expansion and contraction necessary for communicating to the air the undulatory motion proper for producing sounds.

Such are the few observations I have had an opportunity of making on harmonious tubes; I hope they will prove in some measure interesting to those particularly engaged with this branch of philosophy, and that they will contribute towards making them pay attention to this curious fact hitherto neglected.

V. *On Painting.* By Mr. E. DAYES, Painter.

ESSAY V.

On Invention.

Then, hold Invention, all thy powers diffuse,
Of all thy sisters thou the noblest muse;
Thee ev'ry art, thee ev'ry grace inspires,
Thee Phoebus fills with all his brightest fires.

MASON'S FRESNOY.

WE should never forget that the value of every art arises from the degree of mental capacity requisite to its production, and the degree of instruction or pleasure resulting therefrom.

Hence

Hence invention is justly ranked as the first and most noble part of the art; by it we distinguish the philosopher from the mere painter, for he whose powers are confined to imitation deserves no better name.

Invention not only relates to the way in which the artist tells the story, but, in a higher sense, requires the aid of such probable incidents as may contribute to its further illustration. Raphael, in his Paul at Lystra, has finely contrived to show the miracle wrought, by making one of the spectators, full of wonder and astonishment, lifting up the drapery to examine the limbs that have acquired their proper shape. N. Poussin, to convey an idea of the size of Polyphemus, has placed him on the distant mountains, and, by interposing a great medium of air, has separated him from the figures of the same size on the fore-ground, and thereby produced a gigantic effect that beggars all description. Barry, in his picture of Elysium, has represented spiritual beings conducting the earth, thereby indicating that the world is governed by a supreme intelligence*.

The laws that govern historical painting are not confined to it, but extend to every other species of composition: hence it becomes the most noble part of the art, and from which all the others are but as so many branches. It not only requires a thorough knowledge of the human figure, but its attire, with landscape, architecture, &c.; so that we may justly term it the only universal part of the art.

Some men, who term themselves artists, move in an orbit so confined that their motions are scarcely discernible without the aid of some strong magnifier. Unfortunately for the arts, the trifler meets with the most success; perhaps the higher parts of the art are not so immediately within the reach of the capacity of the common observer: like jewels, their intrinsic value is known but to few. Sir Joshua justly observes, "that the lowest style will be the most popular, as it falls within the compass of ignorance itself; and the vulgar will always be pleased with what is natural, in the confined and misunderstood sense of the word." Wisdom is rather an unprofitable commodity; for we too often find in life the

* The above is one of a series of pictures preserved in the great room of the Society of Arts in the Adelphi. In these pictures the artist may be said to have invented his subjects altogether, and has so connected them as to illustrate that great moral truth, "that the attainment of happiness, individual as well as public, depends on the cultivation of the human faculties." They exhibit a fine system of ethics, at the same time that they express, in a most determined and masterly way, the beauty and advantages of legislation.

most ignorant the most successful, and the most successful the most honoured.

The great artists of former times did not only practise history, but portrait, nay even landscape, and often excelled in architecture: then it was that one good work was enough to insure a man success and fortune, while now twenty hasty ones will scarcely furnish him bread. Little and poor spirits have formerly made them separate studies, and their inability disqualified them from teaching on a more liberal and extensive scale, and now the practice of many is insignificant and contemptible.

Man loves himself, and of course is interested in whatever relates thereto: hence the great end of painting should be, recording actions of great personal patience, sufferance, or heroism; but, above all, embodying some important moral truth for the edification of mankind.

Some lofty theme let judgment first supply,
Supremely fraught with grace and majesty;
For fancy copious, free to ev'ry charm
That lines can circumscribe, or colours warm:
Still happier if that artful theme dispense
A poignant moral and instructive sense.

MASON'S FRESNOY.

That part of painting termed the ornamental may please and delight; but he who in his works combines sublimity with sentiment, may be justly said to have reached one of the highest points of human felicity, and does an honour to the ignorant by raising them from their own native insignificance to rank with the highest order of earthly beings:

The dullest genius cannot fail
To find the moral of my tale:
That the distinguish'd part of men,
With compass, pencil, sword, or pen,
Should in life's visit leave their name,
In characters which may proclaim,
That they with ardour strove to raise
At once their arts and country's praise.

PRIOR.

In the choice of our subject we should prefer those best known, and, if possible, such a one as may carry with it a general interest. As a poet, Milton was particularly happy in his *Paradise Lost*; it is not the destruction of a city, or the conduct of a colony, but the fate of worlds, which involved the happiness of mankind at large. The Greek and Roman history with their fables, also the history of our own nation, and the works of our best poets, furnish infinite matter for study, as well as those grand and sublime subjects that occur in the Old and New Testament.

But in our choice from the above, or any other work, we are not bound, like cattle, to follow a leader; the subjects unhandled are endless; those in the Bible abound from the most simple pastoral to such as are in the highest degree sublime. Besides, by exerting a proper degree of independence we shall not only be left free to act, but thereby stand the greater chance to give our works the character of originality. What could be more mortifying than to have it said that the best part of our picture was pitifully stolen from another? This would render us like the poor animal when stripped of his borrowed clothes, in which he looked so formidable, when behold he proved a mere ass! Such a conduct cannot be justified by any example found in a great master, whatever proofs he had given of his powers of invention, and it would be equally unpardonable in an artist of less celebrity. Nothing can be so contemptible as that poorness of spirit that goes limping after another, crawling over objects like a slug, and leaving nothing but slime behind: he never can be great that does not greatly dare. The mind, acting from its own impulse, will energize with more vigour than it possibly could by seeing objects through the medium of another's feelings. He who imitates the manner of another debases himself, by giving his company to the servant when the mistress is ready to entertain him.

Prints and drawings are useful to please the eye or enrich our thoughts, or, by having them before us, to keep up the fervour of the mind while employed on similar works of our own: then it is we may catch a grace from a figure, a grand or beautiful cast of drapery, or a thought that may give energy or brilliancy to our own, and that without copying. Collections of good prints are highly valuable to the artist; they add a nobleness to his conceptions, and raise and warm his imagination: so do fine descriptions in history and poetry. The prints after Raphael, M. Angelo, and the Caracci, will afford a fund of entertainment and instruction; and fine instances of forms in the back-grounds of Titian and Paul Veronese will be found with occasional good composition. Rubens's prints by Bolswert will be highly worthy attention, as well as those after the most celebrated French and British artists.

We should be careful not to suffer our pursuits to be interrupted by vulgar opinions or prejudices, but pursue our studies full of the conviction, "that patience and perseverance will lead to perfection." Nothing can be more absurd than to imagine one person too lively for such a study, another too grave, or a third too sober or honest for a genius: the fact is, if we suffer the opinions of others to affect our choice or over-

power

power our resolves, we resign ourselves up to the most ignominious slavery, by giving up the right of regulating our own lives. When we have arrived at this part of the art, we must place some confidence in our own skill, otherwise we shall be liable to perpetual embarrassment from the various opinions of others; we should rest satisfied if our works do not violate any principle in nature or rule of art. He who is doubtful of his own abilities will derive little advantage from the remarks of others, and the result of his inquiry will produce a mass of crude and independent hints, that cannot possibly be reconciled, or collected into one point. A proper confidence is necessary; he cannot hope to succeed, who, before he begins, doubts if his abilities be equal to the undertaking.

As it is the great end of art to strike the imagination, when we have made choice of a subject that is lofty, grand, or beautiful, we must be careful that it does not suffer in our hands by the introduction of poor or mean thoughts, ugly, insignificant, or common-place objects. Bassan, whatever subject he chose, represented it by the peasants of his own country; which deprived it of every merit but such as depended on colour and effect. How opposite the conduct of Raphael in the Cartoons! who, knowing how much was expected from those who practised the great style, has infused all the nobleness he was master of into his apostles, notwithstanding history furnishes no authority for so doing. As we cannot make our hero talk greatly, we must make him appear capable of great actions, by adding all the externals of dignity and grandeur correspondent to high sentiment and great action; a power which all men wish, but few attain.

As it is in our power, so it is our duty, to produce that unity which nature does not always do. Thomson has finely heightened the death of Amelia by the thunder-storm. A murder perpetrated in a gloomy day, or at night, will affect our feelings more strongly than in a broad glaring light.

Events become more compact, and of course more interesting, by making the inanimate scenes of nature more dreadful or lovely, or by adding a more sublime cast to the human countenance.

Though many things in nature and art exceed expectation, yet nothing sensible has the power to exceed or even equal the capacity of thought: it is from this power of the mind the artist derives his advantage. Mountains may be imagined loftier or more picturesque, lakes more extensive and clear, rivers more rapid or slow, rocks more vast and wild,

caverns more gloomy, ruins more majestic, and the whole face of nature dressed in sun or shade as best suits our purpose, while we may render the human figure more beautiful or grand.

The painter of history, like the historian, represents the *event*, not the *man*, which is the province of the portrait-painter and biographer.

The Dutch have treated history under circumstances so purely local, that Christ has appeared in the storm in a common fishing-boat with the tri-coloured flag flying; and Dabla cutting a lock from a huge black peruke of the end of the 17th century.

Two advantages result from going to remote history for our subjects: one is, it becomes more venerable; another is, that the inaccuracies of *costume* are not so easily perceived.

The two divisions of history generally rank under the grand style, and what sir Joshua terms the ornamental, but which from its delighting in variety is better described by the word *picturesque*, which is oftener applied, and not of so debasing a nature. The picturesque is founded on an union of the regular and irregular, the grand or simple, or the regular only: for instance, the arch of a bridge which is uniform is simple and grand, but being broken it becomes irregular or picturesque: decorations of ivy have a similar effect. A head and body seen in front, with the hair flowing uniformly on each side, as we sometimes see in the portraits of Giorgione and Titian, is grand: incline the head, and vary the hair on one side, it changes its character to the picturesque. Similar groups, nay, even single figures, perfectly alike, often characterize the highest simplicity of composition, as in some of Raphael's pictures, and of which there is a fine instance by Titian in the church of the Friars of St. Francis at Venice; an etching of which, by Le Febre, is in every one's hand. Poussin showed it in his landscapes, in his buildings, and in the straight and parallel stems and uniform foliage of his trees. The picturesque, on the contrary, is seen in the contrasted groups of Rubens; the crossing and winding of the stems, irregular foliage of trees, and in broken buildings; *but ever accompanied with a beautiful choice*; for, as before observed, if the picturesque was to be separated from the beautiful: there would be nothing left worthy the dignity of painting.

The grand style requires the greatest simplicity of conduct: the rejection of all things little is necessary to its completion, not only as to disposition, form, the minutiae of colour and effect, but to the total disregard of all the trickery of penciling:

above

above all, if our subject is lofty, we must be careful not to admit any thought that is trifling or mean; a fault many of the old masters are not entirely free from;

The drapery should partake of the same great character: all the minute parts must be rejected, the folds should be broad and simple, possess an easy communication, and gracefully follow each other as by chance.

The application of those styles must depend on the nature of the subject all together; the choice of the Roman school required a simplicity of conduct which must necessarily run through the whole picture. The subjects of the Cartons would suffer by a destruction of the unity, from changing the character of any part: the unaffected composition, solemnity of colour, the broad and simple folds of the drapery, form a whole that would be destroyed by attaching showy colour, or changing the character of the composition or drapery to the picturesque. But sportive scenes, feasts, processions, and marriage ceremonies, such as were principally chosen by the Venetians, perfectly agree with that picturesque effect arising from splendour of colour, opposition of light and shade, contrast, and variety of draperies.

This character appears to arise (as before observed) out of the very nature of the subject. Who that wished to represent an assassination would introduce splendid colours, or great vivacity of light? On the contrary, would he not rather use sad and solemn ones, with darkness, obscurity, and great depth?

What has reduced the Venetian school is want of expression. Paul Veronese, in his picture of Mary Magdalen anointing the feet of Jesus, has made it a mere eating-match of Venetian senators; and Tintoret, in his Marriage at Cana, has made the company scarcely notice the miracle of turning the water into wine.

True history should never have its gravity disturbed by any improbable or impossible circumstance. What can be more absurd than Raphael's flying apostles in the Attila, the angels in the battle of Constantine, or St. Cecilia in the same picture with St. Paul, St. John, St. Augustin, and Mary Magdalen? The same artist in the School of Athens has confounded all the circumstances of time and place. How unlike is the conduct of a great modern artist, who, in bringing together a number of great characters that lived at remote periods from each other, has wisely placed them in Elysium? In the picture by Titian, in the church of St. Francis in Venice (formerly alluded to), we find the Virgin

and Child, St. Peter, St. Francis, and Venetian senators, to the entire destruction of chronology.

Those who choose to exert their fancy had better invent their subject altogether, and not falsify a fact by going to true history, where invention can never justify the introduction of allegoric fiction. It detracts from the merit of Constantine as a conqueror, by bringing the host of heaven to his aid: without it we may suppose he could not have overcome his more powerful partner in the empire. But the highest joke is to find Heliodorus plundering the temple of Jerusalem (as related in the second book of Maccabees), and pope Julius present as a spectator.

I lose my patience, and I own it too,
When works are censur'd not as bad, but new;
While, if our elders break all reason's laws,
These fools demand not pardon, but applause. POPE.

Without racking our invention for fables above the comprehension of the vulgar, there are many fine moral stories for the practice of those who can afford the time and expense necessary to their completion; such as the patient resignation of that first of mortal men, Socrates, at his death; Curtius leaping into the gulf; the Decii devoting themselves for their country; the sudden reverse of fortune in Marius at the ruins of Carthage; the folly of Candaules in exposing his wife's beauty to his friend Gyges; the desire of fame in Cæsar weeping before the statue of Alexander; the virtue of Phocion in refusing the bribes of Alexander; and the piety of Æneas in preserving his father from the flames of Troy; with numberless others that must occur to every one's recollection.

The Florentine and Roman schools have seized on the most prominent parts of the arts, and, having perfected them, left but little to do for those who followed beyond embellishing: whatever was strong and forcible they seized in their mighty grasp; hence those who have succeeded them as they polished have lost vigour and expression. The Caracci attempted it, and with some of their scholars were often successful, and for dignity and expression ranked next after the above great schools. The Venetians appear scarcely to have thought of it in the rich bustle of their pictures. Rubens among the Flemings ranks first: and when the Dutch attempted at expression it was always low and vulgar; Rembrandt was such, with a desperate bad choice of figure. Raphaël for expression justly ranks before any other painter, of which there are fine examples at hand in the Cartons at

Windfor.

Windſor caſtle, and which by the firſt judges are ranked among the beſt of his works, if not the very beſt. They are unqueſtionably preferable to any of his pictures in the Vatican, for purity of invention and hiſtoric truth. His eaſel pictures are generally poor.

By expreſſion we do not confine ourſelves to the face merely, but to the juſtneſs of the general action. That expreſſion is juſtly placed at the head of the art is evident from its difficulty, for to expreſs well we muſt in ourſelves feel the paſſion we wiſh to repreſent. He who wiſhes to wring another's heart with anguiſh muſt feel as exquisitely himſelf: hence the neceſſity of recurring to nature, and not depending on the feelings of another, as the manneriſt ever muſt. We ſhall obtain but little advantage in this inſtance from a model: we muſt therefore recur to ourſelves; and in ſo doing the looking-glaſs will become our beſt friend: for, as Pope obſerves,

They beſt ſhall paint them who can feel them moſt.

The paſſions, as they are called, by Le Brun are overcharged, ſo much ſo as to have become caricatures. There is no laying down rules for what muſt ever depend on the feelings. Next to nature, the antique heads of the Laocoon, the dying Alexander, the Niobes, and many others, will be well worth conſulting: but expreſſion muſt be general; we ſee agony in the fingers and toes of the Laocoon as ſtrong as in the face. Domenichino and Pouſſin were great in expreſſion; but, as before obſerved, Raphael is the firſt modern.

It would be an unpardonable neglect to overlook a work of Britiſh art, that for expreſſion would diſpute precedence with the beſt of the Roman ſchool. Where ſhall we ſee paternal deſpair repreſented with more force and truth than in ſir Joſhua Reynolds's count Ugolino, or the horrors of death pronounced in a more determined and maſterly manner than in the children? We need ſay no more: Sweetneſs and Truth were his handmaids; and when he died the Graces would no longer remain on the earth. Where encouragement has been offered, the Britiſh artiſts have done their duty: in portrait and landſcape they equal, if not exceed, the beſt; and in hiſtory ſome works have appeared honourable in the higheſt degree to the nation. They will be ſufficient to ſhow to poſterity the powers of the art in the time we live: a few good works are enough, perhaps, in an ungrateful age*.

If

* I am juſtified in uſing the words ungrateful age, by the ſingular neglect ſhown at the ſale of Maſſon's pictures by Britiſh artiſts. Art, like

If we wish to know much, we must see many things of a kind, that by comparing them we may acquire a more perfect idea of the thing than the real object conveys; and those ideas we are bound to improve till we understand the true principles of general nature, or unaccompanied with those peculiarities that mark the defects of the individuals in each species.

When we have determined on a subject, we must with all due expedition make a sketch of the principal persons concerned in the event, or whatever constitutes the feature of the picture, without regard to dress or any of the lesser incidents, as much of the fire and spirit of the actions, as well as the grandeur of the whole, depends on the first impression. We must then do by our sketch as Virgil said he did by his works, "lick them into shape;" for, as the first part depends on the imagination, so the second is the result of judgment: we are then to prune or add till the whole comes into perfect ordonnance, choosing such objects as are strikingly noble or beautiful, and adding such accessory circumstances as may best contribute to illustrate the story. In our progress with the sketch we may add a second or third group, settle the dresses and the back-ground, whether landscape or architecture, the disposition of the masses, and complete the whole by slightly tinting it.

We are bound to preserve a whole throughout our work, as well as an unity of time and place: we should therefore avoid every thing local; even a well-known face or figure destroys interest, by rendering the work familiar.

Laireffe whimsically describes a picture of the deluge, painted by an artist of his time, as made up of absurdities. Among other things jumbled together is "the grave of Mahomet, rolls of Virginia tobacco, a cardinal's cap, a child in a gogart, pickled herrings, a smutch-pot and pencils, all the toys from a Nuremberg toy-shop, the records of the imperial chamber at Spire," and, to crown the whole, "the Vatican," and the artist's own dear self "sitting on the fore-ground sketching every thing after the life." The man must be ignorant indeed who could be guilty of

like beauty, having once withered, can never be restored. Constantine, with all his wealth and power, could not resuscitate it, but was obliged to rebuilde Rome to adorn his new city. Rouse, countrymen, rouse! you will add to your own immortality, and give vigour to the labours of the artist, by encouraging the noble walk of history painting. How renowned have the popes Julius and Leo, with the Medici, become from so doing! The present opportunity lost may never be regained. Why should we not contend for the empire of wisdom as well as of the sea?

such

such gross errors. An artist possessing common sense will never act so absurdly as to mix in the same picture things antique and modern; an error common among the Venetian, Flemish, and Dutch masters.

If the subject we mean to handle lies in Egypt, Athens, or Rome, let us endeavour to transport ourselves thither by the warmth and activity of our imagination, and, by removing every thing local, lead the spectator through the delightful and magical mazes of science, so that he may actually imagine the scene transacting before his eyes.

VI. *Extract of a Memoir on Argental Mercury. Read before the French National Institute, by C. CORDIER, Engineer of Mines*.*

THE mineral called formerly native amalgam of silver, and which since the labours of C. Haüy is now known under the name of *argental mercury*, is one of those natural metallic combinations, the mineralogical and chemical properties of which had been the least perfectly described and examined. It is however probable that an accurate knowledge of this species would have been obtained, had not its great rarity prevented chemists from sacrificing the only specimens of it which they possessed in order to subject them to complete examination. The places where argental mercury is found are the mines of Rosenar in Hungary, those of Morfeldt in the ci-devant Palatinate, now the department of Mont-Tonnerre, and particularly those of Muschel-Landberg in the same country: these are the only mines by which it has been hitherto furnished.

Though this mineral is at present too rare to be the object of the labours of the miner, it will be seen that it deserves the attention of the mineralogist, and to make a figure among the most remarkable of the metallic species.

Argental mercury is found always disseminated throughout the mass of the veins, sometimes in very thin leaves which fill up the fissures, sometimes in small crystals totally engaged in the matrix, or entirely insulated in the cavities.

This mineral substance has the colour and resplendence of silver or polished tin, or rather more frequently of liquid mercury, because it almost always retains at its surface a thin stratum of the last mentioned metal.

Its regular forms are the dodecaedral-rhomboidal, and all its modifications.

* From the *Journal des Mines*, No. 67.

The small lamellæform leaves of argental mercury are for the most part bent, and follow the undulations of the rock to which they are applied. Their surface is generally smooth and polished, but much less than that of its crystals. This metal is easily scratched by a piece of sharp-pointed steel. By scraping it loses almost all its splendour, and becomes dull. When rubbed on copper, it leaves a white metallic trace. It is brittle and easily broken: its consistence approaches to that of martial pyrites. Its fracture is conchoid, and exhibits no appearance of laminae. The fragments of it are indetermined, with very obtuse edges.

Its specific gravity, determined from a mean of several experiments, is 14.1192; argental mercury therefore, next to platina and gold, is the heaviest of bodies. When this mineral is heated at the blow-pipe, the mercury becomes volatilized, and a small button of silver may be easily obtained.

The varieties of the regular forms are, 1st, The perfect rhomboidal dodecaedron (fig. 1. Plate III). The incidence of the two contiguous faces is 120° . The crystals not being susceptible of any mechanical division, it is not possible to know precisely whether this solid be the primitive form of argental mercury, as is probable, and as we shall suppose it to be, in order to have the expression of the laws of decrement and the value of the angles. This supposition can produce no error, because the results of the calculation may be easily transferred, so as to apply them to the octaedron, the tetraedron, or the cube, which are the only other forms possible.

2d, The dodecaedron truncated on the six solid angles composed of four planes. The six new faces are produced in virtue of a decrement by one row: they belong to the cube, and make with the faces of the primitive form angles of 135° . According to the ingenious method of C. Haüy, the abridged expression of the laws of decrement which produce this form is $P \overset{1}{E}$.

3d, The same as the preceding, the place of each ridge of which is supplied by a facet making an angle of 150° with the adjacent primitive face: these new facets take place by the subtraction of a row of moleculeæ on all the edges. Its expression is $P \overset{1}{B} \overset{1}{E}$.

4th, The dodecaedron truncated on all the ridges and all the solid angles, and having new facets on the edges of the truncatures which take place on the edges, and the solid angles composed of four planes. This form, which had not
been

been before observed, is the most complex of all those exhibited by mineral substances. It is produced by the intersection of the faces which belong to the following six kinds of regular or symmetric solids, viz. the cube, the octaedron, the rhomboidal dodecaedron, the solid with 24 trapezoidal facets, the solid with 24 isosceles triangular facets, and the solid with 48 scalene triangular facets. The complete crystal is terminated by 122 faces. The expression of this form, represented fig. 2, is $P^1 B^2 B^1 A^1 E^1 E^1$.

The incidence of the faces of the primitive form with those of the octaedron is $125^\circ 15' 52''$; with those of the solid having 24 triangular facets is $153^\circ 28' 4''$; with those of the solid having 48 faces $16^\circ 53' 36''$.

Hitherto no complete anatomy of argental mercury has been published; mineralogists were satisfied with acquiring an approximate knowledge of its composition from simple experiments: it was therefore of importance to determine with accuracy the elementary principles of this mineral, and to fix the proportions. This analysis was attended with no kind of difficulty*.

Sixty parts of this mineral were exposed in a crucible to the action of a low heat, which was successively increased, and continued as long as was necessary to volatilize all the mercury. The crystals, without suffering any sensible loss of volume, were changed into spongy masses, which towards the end of the operation sunk down and united into a metallic button: the weight of this button was found to be 16.5 parts, from which it was concluded that the weight of the mercury volatilized was 43.5.

This button was perfectly malleable, and had all the appearances of the purest silver. To ascertain its purity it was exposed to the action of nitric acid proved by nitrate of silver. The solution was effected without any residuum.

Oxygenated muriatic acid was poured into the solution, and the precipitate of muriate of silver was collected on the filter. The liquor tried by carbonate of potash furnished no precipitate; the silver then contained no foreign metallic substance.

In regard to the state of the mercury in its combination, it is certainly not necessary to prove that it exists in a solid state. To be convinced of it, nothing will be necessary but

* The crystals subjected to analysis were covered with a stratum of liquid mercury, which was removed by pressing them between the fingers in soft wax.

to consider; first, that it forms almost three fourths of the whole mass; in the next place, that the specific density of the natural combination not only surpasses, by a great deal, the mean specific density of silver and liquid mercury, but also that it is much more considerable than that of the latter metal, which is the heavier of the two. The specific gravity indeed of the combination, calculated according to the formula of C. Haüy, would be only 12.5448, supposing the mercury liquid, whereas it is 14.1192; that of the mercury is only 13.5681.

A hundred parts of argental mercury, solid and crystallised, contain then of solid mercury - -	72.5
Silver - - - - -	27.5

100

Two other trials, made indeed with quantities less considerable, gave absolutely the same proportions.

The identity of the results of the analysis of this mineral, its peculiar specific gravity, its faculty of crystallizing, its consistence, and all the other mineralogical characters belonging to it, evidently prove that it ought to be considered as a real chemical combination, possessing fixed and invariable proportions, and that it is with propriety that a particular species has been formed of it in the mineralogical nomenclature.

It may be of utility to remark here how improper the denomination of native amalgam was to denote this mineral substance. The name still employed in chemistry and the arts does not denote a solid combination, but a paste-like mixture, composed of exceedingly small crystals of argental mercury, adhering to each other by the medium of a certain quantity of liquid mercury. The consistence of the masses of artificial amalgam is even very variable: it may be increased or diminished at pleasure, sometimes by adding mercury, sometimes by taking away a part of this metal, interposed by means of a proper filter, such as a piece of shammy leather. It is the difficulty, perhaps, of separating entirely the excess of mercury in the solid combination that has occasioned a belief that silver and mercury may be combined in all proportions: this opinion seems to be as unfounded as that in consequence of which argil, rendered ductile by the means of water, was considered as a real combination, the proportions of which might be indefinitely varied. It is proper to add, that at the common temperature argental mercury is always perfectly solid, and besides

that it is insoluble in liquid mercury: this has been ascertained by experiment.

An exact knowledge of the specific density of argental mercury, as well as of the proportions of its two component principles, has suggested the idea of making some researches in regard to the density of solid mercury. Chemists have set out with the supposition that the moléculæ of the two metals experience no dilatation nor penetration in combining: knowing the specific gravity of silver = 10.4743, that of argental mercury = 14.1192, and the ratio of the two metals $\frac{2}{7}$, it will be found that the specific gravity of solid mercury ought to be 16.2662. In the case of there being a penetration of moléculæ, as is probable, the real density would be somewhat less: on the other hand, if there be dilatation, it will be found to be more considerable. In a word, this approximative result ought the less to be neglected, as it is probable that it will be always very difficult to attain *directly* to an estimation perfectly exact.

VII. *Extract of a Notice, read in the French National Institute, on a new Variety of Epidote.* By CHAMPEAUX and CRESSAC, Engineers of Mines*.

THE substance which forms the object of this notice was found in the primitive chain which traverses the country of the Grisons, and unites the mountains of St. Gothard to those of the Tyrol.

It has always been found united to a variety of red garnet, which Saussure has described † as a particular species under the name of *hyacinth de Dissentis*. To complete the description of this species, he gives a short description of the substance which forms the subject of this article, and he gives it the name of *phrenite*, because he thought he could distinguish in it characters which brought it near to the phrenite of Oisans.

In this description we shall follow the method adopted by professor Haüy.

Essential Character.

Divisible in a direction parallel to the planes of a right rhomboidal prism, which form with each other angles of $114^{\circ} 37'$ and $65^{\circ} 23'$.

* From the *Journal des Mines*, No. 67.

† Voyage dans les Alpes, 5: 1902.

Physical Characters.

Specific gravity 3.3739. This character was proved on the purest fragments that could be procured.

Hardness. It easily scratches glass; it is with difficulty scratched by quartz; strikes fire with steel.

Transparency. Pellucid on the edges.

Colour. Bright gray.

Electricity. None by heat; acquires none by long continued friction.

Geometric Characters.

Primitive form. A right prism with rhombal bases; inclination of the planes M and T of the prism (fig. 3, Plate III.) $114^{\circ} 37'$ and $65^{\circ} 23'$. The divisions parallel to the planes are generally very close; the laminae are seldom observed in the direction of the bases.

Structure. Very sensibly lamellar: the natural joinings seem to be somewhat closer in one direction than in another.

Fracture. Conchoid, shining, with small cavities: it takes place only in one direction, that of the bases; in that of the planes of the prism nothing is obtained but laminae, which manifest the structure.

Chemical Characters.

With the blow-pipe. On the first application of heat the colour becomes less dark; the angles and the ridges then fuse into a yellowish enamel, which grows brown in a continued heat, and is converted into scoria: if a thin plate be subjected to experiment, it becomes corneous before it is scorified.

Acids, cold. Acids have no action on it.

It results from this examination, and particularly the consideration of the essential character, that the substance in question belongs to the epidote; for it can be divided in a direction parallel to the planes of a right rhomboidal prism, which form with each other angles of $114^{\circ} 37'$ and $65^{\circ} 23'$. It sometimes happens that there is observed above the planes of the prism facets oblique to the axes, which might give reason to suppose that they are parallel to the bases, and thence be led into an error respecting the determination of the primitive form; but an attentive examination shows that they belong to other crystals which penetrate the former; and besides, the examination of a form, sufficiently prominent to admit of applying to it the laws of structure, has proved that observation agrees with calculation.

This

This form, which has not yet been described among the known varieties of the epidote, results:

1st, From a decrement by one row on the edges G of the prism (fig. 3.) corresponding to the acute angles of the base.

2d, From a mixt decrement on the left, by four rows in breadth and three in height, on the other edges H .

3d, From a decrement by three rows to the left on the same edges. This is that which constitutes the new variety.

The preceding laws do not mark entirely the planes M and T .

4th, In the last place, from a decrement by one row on the acute angles E of the rhombus of the base. The latter reaching its limits, makes the face P disappear entirely.

It follows from this structure that the characteristic sign of the crystal will be $G M^3 H H T E$; and the form produced being a prism of ten planes and diedral summits (fig. 4.), we may thence deduce the denomination of quadricecimal, which will express the four faces of the summits and the ten of the prism.

Calculation has given for the inclination of the face x produced on the adjacent plane M $63^\circ 23'$, and on the declining plane T $131^\circ 17'$; results which are agreeable to those obtained by geometry.

Independently of the form already described there have been observed also secondary crystals presenting at their surface parallel striæ. This, no doubt, is that described by Saussure in the following words: *striæ, as if in the form of lustrions*. In a word, we may mention as pseudomorphic the forms of emarginated garnet, to which this epidote of Dufrenoy has been associated; for sometimes it covers it entirely by being moulded over it, and sometimes it is completely covered by it in such a manner, that one of the two substances cannot be seen but by the fracture of the other.

The observation of this new variety proves that the determination of mineral substances merely by their exterior characters is exceedingly defective; for the latter by its faces is very distinct from the species to which it belongs, but the geometric characters assign to it in the methodical system its real place.

We shall remark also that the epidote is a substance the varieties of which differ from each other according to the countries where they have been found: to be convinced of this, nothing will be necessary but to compare that of Dauphiny with that of Arendal and that of Dillenberg. Their aspect

aspect is so peculiar that nothing can prove their identity but analysis and the laws of structure.

We shall compare this new variety of the epidote only with the phrenite, because it is under this name that it is described by Saussure: it differs from it by its specific gravity in the ratio of 33 to 36, and by its structure, as it exhibits evident sections in two directions, while the phrenite exhibits only one: in a word, it is not electric by heat.

The rock which accompanies it is composed of the substance of the garnet, the epidote itself, calcareous stone, and quartz. These elements sometimes are in proportions nearly equal; but it happens for the most part that the matter of the garnet predominates. In some specimens the epidote is disposed in thin zones between crystals of garnet, on which it is moulded: it appears also in amorphous masses pretty voluminous. Nothing certain can be said in regard to its position; but it may be affirmed that it is found in the cavities or fissures of primitive mountains. We do not think that it has ever yet been found in its proper place by any naturalist; and the case is the same with the other productions of St. Gothard. The dealers in crystals go in quest of them, and sell them to travellers.

VIII. Note on a Variety of carbonated Lime found near Port Seguin, Department of Vienne. By C. CRESSAC, Engineer of Mines*.

THIS variety, which has not yet been described, results from a combination of the three following laws of decrement:

1st, That which produces the prismatic by a decrement of two rows in the inferior angle c (fig. 5. Pl. III.)

2d, That which produces the inverse by a row on the right and left of the angle E.

3d, That which produces the equi-axis by a decrement of one row on the edge B:

The representative sign of this variety, represented fig. 6, is $\begin{matrix} E & E & E & B \\ c & E & E & \\ & & & B \end{matrix}$; it has been called by C. Haüy *co-ordonate*

carbonated lime. This name is deduced from the position of the facets produced by the three decrements in question.

* From the *Journal des Mines*, No. 67.

These facets are situated on the same side, and are separated by parallel ridges.

Inclination of c to g	116° 33' 54"
----- of c to f	153 26 6
----- of g to f	143 7 48.

IX. Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron. By EDWARD HOWARD, Esq. F.R.S.

[Concluded from p. 336 of our last Volume.]

THE connection which naturally exists between one mass of native iron and another, immediately turns our attention to the native iron in Siberia, described by Pallas; and this, we are told, the Tartars considered as a sacred relic, which had dropped from heaven. The nickel found in the one mass, and the traditionary history of the other, not to compare the globular bodies of stone from the Benares with the globular concavities and the earthy matter of the Siberian iron, tend to the formation of a chain between fallen stones and all kinds of native iron. How far any real affinity exists between these several substances, very obliging friends have afforded me an opportunity to form some judgment. I am indebted to Mr. Greville and Mr. Hatchett for portions of almost every known native iron; and the count de Bournon has done me the favour particularly to describe them as follows.

Description of various Kinds of Native Iron. By the Count de Bournon.

The great number of particles of iron, in a perfectly metallic state, contained in the stone from Bohemia, and the said particles being so near each other, naturally lead to some reflections respecting the existence of native iron, which, by many mineralogists, is still considered as problematical. Let us suppose for a moment, that these particles of iron were to approach still more nearly to each other, so as absolutely to come into contact, and in that manner to form a kind of chain, folded upon itself in the interior part of the substance, and leaving a great number of cavities between the links of the chain so folded. Let us then suppose, that the earthy substance with which these cavities are filled, being very porous, and having but a small degree of consistence, should (as may happen by a variety of causes) be destroyed. It is

plain, that if such a destruction were to take place, the iron alone would remain; and, being thus left bare, it would appear in the form of a mass, more or less considerable, of a cellular texture, and as it were ramified; such a form, in short, as that in which most of the native irons we are acquainted with have been found. May it not be fair to attribute to such an origin the native iron found in Bohemia, a specimen of which was presented by the Academy of Freyberg to baron Born, and which came, with the rest of his collection, into the hands of Mr. Greville? May not such also, notwithstanding the enormity of its bulk, be the origin of the mass of native iron found in Siberia, near Mount Kemirs, by the celebrated Pallas?

We have already seen, in the results of the analyses made by Mr. Howard, of the various stones above described, that he constantly found a certain proportion of nickel mixed with the iron they contained. This circumstance recalls to our notice the observations that were made by Mr. Proust, some time ago, respecting the mixture of nickel in the native iron of South America; and tends to give some additional support to the opinion hinted at in the foregoing paragraph.

The circumstances just mentioned naturally gave to Mr. Howard, as well as to me, a desire to know whether the native iron from Siberia, and that from Bohemia, were also mixed with nickel. Mr. Howard, consequently, lost no time in proceeding upon this important investigation. The native iron of Siberia presents some very interesting peculiarities, and has often been referred to, but has not yet been properly described; it is therefore with great pleasure that I add the following description of it, and of some other kinds of native iron, to the description I have already given of the various stones said to have fallen on the earth.

I feel the greater satisfaction in doing this, as the noble collection of Mr. Greville contains two specimens of this iron, in perfect condition; one of which weighs several pounds, and was sent to Mr. Greville by Mr. Pallas himself: on this account, therefore, I enjoy an advantage that many of the authors who have spoken of this iron probably wanted.

One of these pieces has a cellular and ramified texture, analogous to that of some very porous and light volcanic scoria; this is the usual texture of the specimens of this kind of iron, which are preserved in the various mineralogical collections in Europe. When it is attentively examined, there may be perceived in it, not only empty cells, but also impressions or cavities, of greater or less depth, and sometimes perfectly found, which appear evidently to be the result of the com-

pression of hard bodies which were situated there, and which, when they came away, left the surface of these cavities quite smooth, and having the lustre of polished metal. Here and there, in some of these cavities, there remains a transparent substance, of a yellowish green colour, of which I shall treat more particularly when I come to the description of the second of the specimens above mentioned. It is very clear that the cavities here spoken of owe their existence to this transparent substance; and that the polish of the cavities arises merely from the compression of the said substance, and is the natural consequence of its surface having been in perfect contact with that of the iron.

This iron is very malleable: it may be easily cut with a knife; and may be as easily flattened or extended by means of a hammer. Its specific gravity is 6487; which, however, is very much under that of iron which has been merely melted, and has not been forged. The specific gravity of the native iron of Bohemia, which is nearly as malleable and as easy to be cut, is still less: I found it not to exceed 6146. This low degree of gravity appears to be owing partly to the oxidization of the surface of the iron, and partly to there being, in the interior part of its substance, a number of small cavities, which are often rendered visible by fracture, and which have their surfaces also oxidized. The fracture of this iron presents the same shining and silvery white colour as the common cast iron known by the name of white cast iron: but its grain is much smoother and finer; it is also much more malleable when cold. Bergman says that this iron is brittle when heated to a red heat. I have frequently tried it in that state, and have constantly found it to be malleable. The same remark may be applied to the native iron from South America, and also to that from Senegal.

The second of the two specimens mentioned above, and which weighs several pounds, presents an aspect that differs, in some respects, from that of the preceding specimen. The most considerable part of it forms a solid compact mass, in which there is not to be perceived the smallest appearance of pores or cavities; but there arises upon its surface a kind of ramified or cellular part, similar, in every respect, to the specimen already described, and every where completely connected with the substance of the mass itself.

If the compact part of this piece is examined with attention, it will be perceived that it is not entirely composed of iron in the metallic state, but that it is mixed with nearly an equal quantity of the transparent substance of a yellowish green colour, (sometimes also of a greenish yellow,) already

spoken of in the description of the other specimen. This substance is mixed with the iron in such a manner, that if the whole of the former could be removed, the remaining part would consist merely of iron in the metallic state, and would present the same cellular appearance as the preceding specimen, and the ramified or cellular part of the specimen now described.

This stony part, separated from the iron, appears in the form of small nodules, generally of an irregular shape, but sometimes nearly globular: they have a perfectly smooth and shining surface, so as very often to present the appearance of small balls of glass; a circumstance that has led many persons to suppose them the result of a real vitrification. Some of these nodules have several irregular facets, produced by the compression of the iron in which they were inclosed; but I have never observed in them any appearances that could lead me to suspect they had the slightest tendency whatever to assume a determined crystalline form.

This substance is always more or less transparent. It is sufficiently hard to cut glass, but has no effect upon quartz. It is very brittle: its fracture is usually conchoid; but I could perceive that it broke in any particular direction, in such a way that I could consider the fracture as a natural one. It becomes electric by friction. Its specific gravity is from 3263 to 3300. It is very refractory: I kept it, for some time, exposed to a degree of heat sufficiently strong to oxidize, to a considerable depth, the iron crucible in which it was placed, without its having undergone any alteration, except that of having acquired a greater degree of intensity in its colour. Its transparency was not at all diminished. I think, therefore, there is not the smallest reason to allow any probability to the opinion that it ought to be considered as a kind of glass.

Of all substances hitherto known, that with which it seems to have the greatest analogy is the peridot, (the chrysolite of Werner,) to which some mineralogists have referred it. The result of Mr. Howard's analysis of it is nearly the same as that of the analysis of the peridot made by Mr. Klaproth.

The hardness and infusibility of this substance are nearly the same as those of the peridot; but it seems to have a rather less degree of specific gravity: that of two very perfect crystals of peridot I found to be from 3340 to 3375. The crystalline forms of the substance here described, if ever we should be able to determine them, would clear up our doubts respecting the analogy between the two substances. If we consider the compact part of the specimen now treated of, particularly the strong connection that appears to exist between the iron and the

the transparent substance, and the great resistance we experience when we attempt to separate them, we cannot help being surpris'd, that almost all the specimens of this mass of metallic iron that have been brought to Europe are in the cellular state already described, owing apparently to the total, or almost total, destruction of the transparent substance. But, besides the fragility of this substance, the specimen in question helps very much to explain the above circumstance, inasmuch as many of the nodules of the transparent substance belonging to it are in a state of real decomposition. In that state, they are changed into a white opaque substance, which, upon being lightly pressed or squeezed between the fingers, crumbles into a gritty dry powder. This decomposition may be observed to have taken place in various degrees: in many of the nodules, the substance is merely become friable, without being much altered in its appearance; whereas, some of those which are in a state of complete decomposition are of an ochreous reddish yellow colour: it is, however, easy to distinguish that this colour does not belong to them, but is owing only to the oxidizement of the adjacent particles of iron.

From the above observations it will not be difficult to conceive the possibility of the total, or nearly total, destruction of the transparent substance; and also, the appearance the pieces of iron must naturally present when deprived of it. I cannot help observing likewise, that there appears to exist a very interesting analogy between these transparent nodules and the globules I described as making part of the stones said to have fallen on the earth. This analogy, though not a very strong one, may lead us to suppose that the two substances are similar in their nature, but that the globules are less pure, and contain a greater quantity of iron.

The native iron from Bohemia is a compact mass, similar to the compact part of the large specimen of iron from Siberia, which has just been described: like that, also, it contains a number of globular bodies or nodules; but they are not in such great proportion as in the Siberian iron. They are besides perfectly opaque, and very much resemble the most compact of the globules belonging to the stones said to have fallen on the earth.

Examination of the Iron from South America.

I have already observed, that my experiments coincided with those of Mr. Proust. He obtained 50 grains of sulphate of nickel from 100 of this mass. The process I have so frequently

quently mentioned yielded me 80 grains of oxide of iron from 62 of the metal; which indicates about $7\frac{1}{2}$ of nickel, or about 10 per cent.

Examination of the Siberian Iron.

100 grains of this iron gave 127 of oxide of iron: hence it should contain about 17 per cent. of nickel.

The yellow substance belonging to this iron was analysed in the same way as the globular bodies, and the earthy parts, of the stone from Benares.

The proportions resulting from the analysis of 50 grains, and from some previous experiments on other particles, were,

Silica	-	-	-	-	27
Magnesia	-	-	-	-	$13\frac{1}{2}$
Oxide of iron	-	-	-	-	$8\frac{1}{2}$
Oxide of nickel	-	-	-	-	$\frac{1}{2}$
					$49\frac{1}{2}$

Examination of the Bohemian Iron.

$26\frac{1}{2}$ grains of this metal left about $1\frac{1}{2}$ grain of earthy matter, insoluble in nitric acid; and, by ammonia, afforded 30 grains of oxide of iron, inducing an estimation of nearly 5 of nickel.

Examination of Iron from Senegal, brought by General O'Hara, and given to me by Mr. Hatchett.

In this experiment, 199 grains of oxide were produced from 145 grains of metal: hence there may be an estimation of 8 grains in 145, or between 5 and 6 per cent. of nickel.

It will appear, from a collected view of the preceding pages and authorities, that a number of stones asserted to have fallen under similar circumstances have precisely the same characters. The stones from Benares, the stone from Yorkshire, that from Sienna, and a fragment of one from Bohemia, have a relation to each other not to be questioned.

1st, They have all pyrites of a peculiar character.

2dly, They have all a coating of black oxide of iron.

3dly, They all contain an alloy of iron and nickel. And,

4thly, The earths which serve to them as a sort of connecting medium, correspond in their nature, and nearly in their proportions.

Moreover, in the stones from Benares, pyrites and globular bodies are exceedingly distinct. In the others they are more or less definite; and that from Sienna had one of its globules

globules transparent. Meteors, or lightning, attended the descent of the stones at Benares and at Sienna. Such coincidence of circumstances, and the unquestionable authorities I have adduced, must, I imagine, remove all doubt as to the descent of these stony substances; for to disbelieve, on the mere ground of incomprehensibility, would be to dispute most of the works of nature.

Respecting the kinds of iron called native, they all contain nickel. The mass in South America is hollow, has concavities, and appears to have been in a soft or welding state, because it has received various impressions.

The Siberian iron has globular concavities, in part filled with a transparent substance, which, the proportional quantity of oxide of iron excepted, has nearly the composition of the globules in the stone from Benares.

The iron from Bohemia adheres to earthy matter studded with globular bodies.

The Senegal iron had been completely mutilated before it came under my examination.

From these facts I shall draw no conclusion, but submit the following queries:

1st, Have not all fallen stones, and what are called native irons, the same origin?

2dly, Are all, or any, the produce or the bodies of meteors?

And, lastly, Might not the stone from Yorkshire have formed a meteor in regions too elevated to be discovered?

Specimens of the Benares and Yorkshire stones have been deposited, by the president, in the British Museum.

X. *Considerations on Dr. HUTTON'S Theory of Rain: read before the Askejian Society, in the Session 1801-2. By LUKE HOWARD, Esq. F. L. S.*

IN an essay presented to the Royal Society of Edinburgh, and inserted in the first volume of their Transactions, Dr. Hutton investigates the rule directing the action and effects of heat and cold on the atmosphere, in order to establish a theory of rain on this principle, that the mixture of portions of air saturated with water, and at differing temperatures, will uniformly produce the condensation of a portion of water.

“This rule of condensation,” says Dr. Hutton, “may be applied to the theory of rain, which is the distillation of water first dissolved in the atmosphere, and then condensed from that state of solution.

“ The cause of rain, though often exerted, will not always produce the full effect; a scanty condensation of aqueous vapour produces *mists* on the earth, and *clouds* in the atmosphere above: and taking the gradation from one extreme of transparent atmosphere to the other of the densest cloud, from the falling of the gentlest mist to the heaviest rain, hail, and snow, we have an indefinite variety of appearances, all flowing from one simple principle.”

On the visible steam produced by the breath of animals and by heated water, in a cold atmosphere, the author remarks that this appearance is not the effect of the genuine principles of heat and cold; that, to explain it, the knowledge of a particular law is requisite; and that the effects of heat and cold, in relation to air and vapour, are not uniform. The law alluded to is thus laid down:

“ The dissolving power of air on water may vary in different proportions to the heat. The solution may vary as the heat, or in a greater or less ratio, i. e. the increments of each may be constant, or, those of the heat being constant, the increments of the solution may be accelerated or retarded.

“ This may be represented geometrically (see fig. 7, Plate III). Let CH represent the scale of the thermometer; $ambr$, perpendicular ordinates, the quantity of water held in solution by a given quantity of air of the temperatures a and b . Join mr , and draw the curves mgr , mdr : then it is evident that the ordinates to mr mark a solution varying as the heat; the ordinates to mdr a solution varying in a greater ratio, and to mgr in a less ratio than the heat.

“ The ordinates to line mr , drawn from a point denoting the temperature of the mixture, represent the quantity of water contained (dissolved or not) in a unit of the mixture; for the ordinates $marb$ are as the quantities contained in a unit of air of temperatures a and b ; and as upon mixture the heat and water are uniformly dissolved (diffused?), they vary in the same proportion, and may be expressed by the same measure.

“ Supposing equable solution, mix equal portions of saturated air, temperatures 10 and 40; the mixture of temperature 25 is represented by op , which also represents the quantity of water in a unit of the mixture, and the quantity held in solution by a unit of air at temperature 25.

“ So two portions of temperature 40, being mixed with one of temperature 10, the temperature produced 30 will be expressed by uq .

“ In the curve mdr let equal portions of the solution at

40 and at 10 be mixed; then op is the quantity of water contained in this mixture at the mean heat 25, while oe is the ordinate of solution: consequently ep is the quantity of water that cannot be retained in solution in the mean temperature produced by the mixture.

“ In the curve mgr let equal portions at 10 and 40 be mixed; and the ordinate being drawn in the mean 25, sk will be the whole power of solution, and the quantity of water that air is capable of dissolving in this degree of heat; but op being the quantity of water actually in the mixture, the air is under-saturated by the quantity pk .

“ Thus the actual curve of evaporation being known, the effect of any mixture of two portions at different temperatures may be ascertained. If the solution of water in air increases equally with the heat, there will be neither superior under-saturation in a mixture of portions at different temperatures.

“ If the solution increases with the heat but in a decreasing rate, there will be under-saturation; if it increases with the heat but in an increasing rate, there will be super-saturation.

“ The last case applies to the phænomena of breath and steam* rendered visible in mixing with air colder than themselves, and to various appearances that may occur in mixing together several portions of air differently saturated with humidity and at different temperatures: for it is not every mixture of air at different temperatures that forms a visible condensation, this effect depending on the degree of saturation with humidity. But if two portions of the atmosphere, both saturated with humidity, should be mixed, let there be but a difference in their temperatures, a condensation proportionate to this difference will take place.

“ At present, from the influence of the ascending sun,

* Aqueous gas at 212° (or steam) produces visible clouds in mixing with air at a lower temperature; but steam is not a solution of water in air, neither is this appearance peculiar to it, but attends the cooling (in contact with air) of the transparent vapours of camphor and all volatile oils, as well as of benzoic acid and other substances quite insoluble in air. The sublimation of the latter very aptly exemplifies to a spectator of it that momentary production of snow which has been witnessed when the intensely cold and dense air of northern climates has been suddenly admitted into the moist and warm atmosphere of the apartments in use there.

Visible steam arises from the differing capacities of air and of vapour for caloric. The former, in acquiring temperature from the latter, robs it of a portion of its constituent caloric: hence a momentary reproduction of water, which is afterwards deposited or dissolved according to circumstances. *Note by the Author of the present Essay.*

two opposite currents of air are formed in the summer hemisphere, one moving along the surface of the earth from the pole to the equator, the other flowing above. These opposite currents, while separate, might pass each other without producing rain; but when sufficient portions are mixed, not only clouds but showers will be produced, since the sudden formation of a mean degree of heat, in the mixture of two portions of different temperatures, must condense a quantity of vapour sufficient to form rain.

“ Without this law of condensation of evaporation neither rain nor dew could take place any where in the summer hemisphere, perhaps not even in tropical latitudes: there would be evaporation and a general tendency to saturate the atmosphere with water, but the mixture of different portions of air would only temper the saturation without producing a condensation of vapour in the mean degrees of heat. At night, from the influence of the cold, the atmosphere would become gradually clouded; this cloudiness would increase to a general distillation of condensed vapour, which would be uniformly continued until the returning summer should change the state of condensation to evaporation; and instead of the beautiful return of seasons, tempered with various degrees of heat and refreshing showers, six months rain and six months drought would follow each other in an invariable succession.”

Such is the hypothesis which Dr. Hutton is willing we should consider as the theory of rain, and which he proceeds to apply to natural appearances; seeming to experience no great difficulty in solving by it every problem that occurs, as the solstitial, equinoctial, and other periodical rains, the comparative state of different climates and of land and sea, as to its frequency and quantity, &c. But, if we except a short remark on hail and thunder storms (which seems only to give occasion to a confession of our imperfect knowledge of atmospherical electricity), in no instance does the doctor avail himself of the aid of any other principle than the mixture of currents of air in traversing the irregular surface of the globe, and consequent precipitation of water, to account for the whole train of phenomena constituting the subject of meteorology.

The simplicity of this theory, the imposing air of a diagram at its introduction, the ingenious and descriptive manner of the application, all contribute to render it sufficiently plausible. It is rather extraordinary that the objections urged against it by De Luc * should have extended no further than

* *Idées sur la Météorologie*, tome ii. p. 67.

It appears they did. It would however be readily granted, I suppose, by each of these philosophers, that hypotheses, of whatsoever kind, ought not to be admitted into science without the most rigorous examination, and that doubt has a right to keep the door shut until some passport of the demonstrative kind is obtained either from nature or experiment. A geometrical representation of what *may be* is not a sufficient foundation whereon to assert what *is* a law of nature. Let us therefore examine how far this theory, which does not appear to be supported by any direct experiment, will bear the test of the excellent and decisive ones whereon the doctrine of capacities has been established by Black, Crawford, and Lavoisier.

The author first assumes, as a law of nature, the position, that the solution of water in air increases with the temperature (heat), but in an increasing ratio. On this he grounds a second, the substance of which is, that if two portions of air, saturated with water and at differing temperatures, be mixed, the mean proportion will not be soluble at the mean temperature, and therefore a part will be precipitated.

The first position may be true, or it may not; perhaps nothing short of actual experiment can satisfactorily ascertain the actual curve of evaporation*.

The second depends entirely on conditions which the doctor has taken for granted in each of the three cases of evaporation stated by him, and which, on the received principles of caloric, can belong to no one of them. These conditions withdrawn, the theory of rain, like its subject, falls to the ground, and the diagram proves as unsubstantial as the bow with which the shower is decorated. To make this appear, it is only necessary to produce the following practical results, which apply equally, whether we regard caloric as matter or motion.

A homogeneous substance, or two substances having equal capacities for caloric, being mixed in equal portions at unequal temperatures, the temperature of the mixture is found to be in the arithmetical mean.

But heterogeneous substances, and those in other respects homogeneous, but differing in capacity, being mixed in like manner, give a temperature which either exceeds or falls below the arithmetical mean, and approaches towards that of the two substances which possessed the greater capacity.

* Experiments decisive of this very question were made about this time, and the results presented to the Literary and Philosophical Society of Manchester by John Dalton, esq. We shall have occasion to notice his paper further on.

The capacity of water (which Crawford terms the comparative heat) being taken at 1,000, that of air proves by his experiments to be as 1,790, and that of aqueous vapour as 1,550, at equal weights and temperatures.

Then if to dry air we add successive portions of water at increasing temperatures, we are forming a *compound* (not merely heating a *homogeneous* mass), the nature of which, as in all other respects, so in that of the capacity for caloric, must still continue approaching to that of aqueous vapour.

Now in any two portions of this compound, *formed* at different temperatures, the capacities will differ. It will be less in that which was saturated at the higher temperature; and whatsoever may have been the precise rate at which the solution advanced at increasing temperatures, the mixture of the two portions will not produce a temperature in the arithmetical mean, but below it, as being most influenced by the drier portion.

Thus is the principal condition invalidated, viz. that portions of saturated air at differing temperatures will possess, after mixture, a temperature in the arithmetical mean. This argument may appear at first sight still to favour the conclusion respecting the mixture in the curve *m d r*, since, if precipitation take place at the mean temperature, much more should it at a lower than the mean: but perhaps it may be easy to demonstrate, on the same principles as before, that the temperature of such a compound, as it results from this circumstance of mixture only, will in no case affect the state of solution, and that neither super- nor under-saturation will ensue therefrom.

We will take for this purpose the curve *m d r*, and examine the real circumstances of a solution advancing with the temperature but in an accelerated ratio; premising that the question regards the effects of heat (caloric) *only* as the cause both of increased temperature and increased solution, and that, according to Crawford, equal additions of this (the capacity of the receiving body continuing unchanged) produce equal expansions in the common thermometer.

That the solution of water in air goes on increasing with the temperature of the compound is true, and it is equally so that it increases *at the expense of that power which gives the temperature*; for water held by air is itself in the state of gas, and gas of whatsoever kind requires a large proportion of caloric for its constitution, which is not at all measurable by the thermometer.

Supposing therefore a unit of *dry* air at a certain temperature to consist of 0,005 measures of liquid base and 0,995 caloric,

caloric, and that one part of caloric will raise its temperature one degree in any part of the scale; if we wish to convert this into a unit of *moist* air at the same temperature, it will not be sufficient merely to add the proportion of water, suppose 0,001; for this water, being itself a *liquid base*, will require nearly as much *additional* caloric to constitute it gas, as the portion of air which was necessarily excluded from the unit took away with it. When we have added this proportion of caloric (which would have raised the dry air many degrees in temperature) together with the water, we shall have a unit of saturated air.

Further, if we would raise the temperature of the latter 10, 20, or 200 degrees, and still preserve the saturation, we shall find it impossible to proceed without an expense of power adequate to the rate of solution, besides that proportion which is employed in raising the temperature through those successive intervals of the scale which are taken as the standard of solution.

Now, in the case of equably advancing solution, if, as often as the thermometer has risen 10° , a quantity of caloric equal to 100° has been imperceptibly supplied in addition, this is of no importance in the issue, since the temperature is still a true *proportionate* measure of the power of solution in the extremes and in the mean: but in those of accelerated and retarded solution it is otherwise; for here the very terms of the proposition require that, as we advance in the scale, each degree of temperature may answer to 10, 12, 16, 24, of solution, or inversely, and consequently to similar proportions of *added power*. Now if in each unit successively saturated at different degrees there enters the due proportion of power which it needs must, then in every mixture that can be made of them the total power of solution as well as the whole quantity of water will be present, and there will be neither super- nor under-saturation let the temperature resulting from the mixture be what it may*.

Admitting, therefore, that caloric, or the *cause of temperature*, is also a necessary constituent part of aqueous vapour in whatsoever way it be formed, and that the doctrine of capacities is well founded, we must reject the theory of Dr. Hutton altogether.

P. S. Whether the phrase of "the dissolving power of air on water" was connected in the mind of Dr. Hutton with

* The remainder of the paper, as read before the society, is suppressed by desire of the author, who has communicated what follows in its place, and in which his reasons for this will appear.—EDITOR.

the idea of some other power operating jointly with the heat, such as an attraction between the base of air and water, I am not qualified to determine; but were it so, this would in no wise affect the previous reasoning, as the conclusion rests entirely on the temperature, *i. e.* in the doctor's view, the caloric present, though they are in fact two distinct considerations which he has blended.

In the concluding part of this essay, as it was originally written, I had discussed the subject of the solution of water in air, and the several modes of its precipitation, on chemical principles; regarding moist air as a ternary compound of base of air, water, and caloric, formed and subsisting by chemical attractions, and decomposed by the operation of the same.

Having since perused the excellent work of my friend John Dalton *, which I have before alluded to, and having seen and repeated some of the principal experiments therein detailed, I must acknowledge that, although I might plead the authority of a Kirwan † in support of the chemical theory of evaporation, I am now disposed to give up the idea of a proper solution of water in air *in toto*.

It appears to me that nothing need be more clear, simple, and conclusive, than the experiments and deductions by which the author attempts to prove that the evaporation of water and several other liquids is a process uniformly regulated by their temperature, the effect of the latter in equal surfaces being the same *in vacuo* and under the full pressure of the atmosphere; the presence of which has no other influence than by its motion to multiply the surface of the liquid and carry away the vapour produced; whence the difference of quantity evaporated in equal times in a moving and a stagnant atmosphere. The solvent power of air on water may also, therefore, be safely classed among those causes which are not needful to the effect in question, and therefore not to be retained in philosophical reasoning.

* Experimental Essays on the Constitution of mixed Gases; on the Force of Steam or Vapour from Water and other Liquids in different Temperatures, both in a Torricellian Vacuum and in Air; on Evaporation; and on the Expansion of Gases by Heat.—*Manchester Memoirs*, vol. v. part 2. 1801.

† Of the Variations of the Atmosphere, inserted in the Irish Transactions 1801.

XI. *General Considerations on Vegetable Extracts.* By
C. PARMENTIER.

[Concluded from p. 386 of our last Volume.]

Juices of Plants.

TO prepare these juices, they recommend to collect the plants when they are in full vegetation, to clean them carefully, to pound them in a marble mortar, to press them inclosed in a hair bag, after having added to them a little water, but only when they are either a little too aqueous or too mucilaginous.

All the sap-vessels of the plant, or others, are broken by the action of the pestle; all the liquids which they contained flow off, together with the green fecula and the attenuated remains of the vegetable.

They recommend to purify the juices either by rest, or by the heat of boiling water, or by means of the white of an egg, or by making them pass through gray paper.

The first method is fit for the juices of fruits.

The second may be employed for all the juices of herbs destined to make extracts.

The third may be employed for all juices, infusions, or decoctions, that do not contain tannin.

The fourth is necessary for all juices the virtues of which exist chiefly in the volatile principles.

It is preferred in pharmacy for magisterial juices, whether they be volatile or not; the two viscous juices excepted.

Maceration—Infusion—Decoction.

In maceration, the cold water is attracted by the dry vegetable substances: it introduces itself into them, swells them up, and renders fluid whatever is soluble.

It has been found that maceration is sufficient to obtain from quassia, and even quinquina, the real active parts contained in them.

In infusion, caloric more abundant than in maceration renders the water more penetrating, more active, and more solvent; it becomes charged with a much greater number of the principles of the vegetable. The preparers of medicines make use of it in preference for dry herbs and for leaves, which, like fenna, for example, cannot bear ebullition without losing their virtues.

In decoction, the water saturated with caloric acquires a much greater energy: it penetrates in a more intimate man-

ner the vegetable subjected to its action; it forces to become soluble the substances which were not so at a lower temperature; it melts and separates those which are oily or resinous; it dissipates those which are volatile; and several of them it combines or decomposes.

They expose to the action of boiling water those plants or parts of plants only which are exceedingly hard, and in which there exists nothing volatile; and they often subject these substances to maceration and infusion before they expose them to ebullition.

In evaporation, the water charged with the soluble principles of the vegetables gradually abandons them to unite with caloric, and to form with it a volatile fluid known under the name of vapour: by these means, the principles before diluted become concentrated, and assume consistence, the state and name of extracts.

They prescribe a gentle fire for the evaporation of the juices, macerations, and infusions, and a stronger fire for decoctions, taking care to choose large and shallow evaporating vessels, and to stir the liquors to facilitate the evaporation of the water, and to prevent the extract from being burnt.

And to prevent that alteration of which the principles of vegetables, when highly diluted with water and exposed to the heat of an evaporation too long continued, are susceptible, they recommend to employ only the necessary quantity of water, paying attention to the solidity of the substances exposed to maceration, infusion, and decoction. They take care also to employ for all their operations very pure water, sensible that it is only when it is in this state that it is fit for boiling pulse.

During the evaporation of several juices or decoctions, some phenomena occurred which did not escape their notice.

They remarked, when preparing several extracts which they called saponaceous, that liquors became turbid; that their surface was covered with a pellicle which separated into flakes, were precipitated, and formed incrustations susceptible of being burnt at the bottom of the evaporating vessels.

It was Baumé in particular who paid attention to these precipitates; he says they were saline.

The preparers of such medicines have also found that, during the cooling of the decoctions of roots or barks abundant in resinous matter, and during the evaporation of several of these decoctions, precipitates more or less abundant were formed, which, according to the opinion of Baumé, were owing to the resin, more or less altered, of the vegetables employed.

These

These precipitates, some of which were thought by Baumé to be saline and others resinous, have been considered by Pelletier as earthy substances, and are ascribed by the modern chemists to the union which several of the immediate principles of vegetables contained in the juices have formed with oxygen, which makes them lose their solubility in water.

C. Deschamps junior, apothecary at Lyons, is of opinion that they are a mixture of lime, extractive matter, oily or resinous substances in some, and an astringent resinous substance in others; sometimes of a little calcareous salt, and sometimes of a little silex or alumine.

As the observations and experiments on which he founds his opinion may, by laying aside what he thinks unfavourable to oxygen, be exceedingly useful in the preparation of extracts, we refer to his memoir published in the *Annales de Chimie* for the year 7.

It results, from the most essential facts announced in the memoir of C. Deschamps :

1st. That there exists, in the vegetable juices or decoctions which he subjected to examination, a neutral salt, the base of which has always been found to be lime, sometimes mixed with a little silex and alumine, and of which the acid is often different.

2d. That this saline combination, not very energetic of itself, is weakened when diluted with water, and is easily destroyed by ebullition, like many others, when the acid in it is not in excess, while it maintains itself, and is not altered when the acid is superabundant in it.

3d. That the decomposition of this salt, when it takes place, is only momentary, since the deposits become redissolved towards the end of the evaporation by the same acid which has abandoned them; and which then, notwithstanding the loss it has sustained in its quantity, resumes sufficient force to re-establish things nearly in their first state.

Hence arises the necessity of not separating deposits which prevent acids from being acid and deliquescent.

4th. That these deposits, the major part of which is lime, which carries with it, more or less combined, sometimes an oily extractive, sometimes a resino-astringent substance, and sometimes a little essential salt, itself not being decomposed, do not take place when the juices are not diluted with water, when maceration and infusion are substituted for ebullition, and when the evaporation is effected in a gentle heat.

By uniting the facts contained in the memoir of C. Deschamps with the observations of the chemists above men-

tioned, we may see how extracts must be prepared in general: but there is one which requires peculiar processes, that must be made known.

1st. Robs of the elder and buckthorn are made with juices which have been extracted 24 hours before from the berries of these two shrubs.

During that time, these juices become charged with the extractive colouring part lodged under the skin of the berries, and by these means acquire more virtue.

2d. Extract of juniper is obtained by maceration of fresh juniper berries which have been bruised. They are evaporated in a gentle heat, after being made to pass through flannel.

It is saccharine and aromatic: it would be acrid and resinous, if ebullition were employed. Baumé, however, has prescribed it; but he made it light, and recommended not to bruise the berries.

3d. Extracts of cassia and tamarinds are all products of the maceration and pulp of these fruits.

Infusion of tamarinds, cold, is attended with the inconvenience of suffering their essential salt to be precipitated during the evaporation.

4th. Extract of the corn poppy is produced by carefully infusing the dried flowers.

5th. That obtained from saffron is very abundant; almost the whole of its stamina are converted into extract; so that it may be considered as useless to subject them to this preparation, which, altering their virtue a little, does not reduce them to a less volume.

6th. The extract of coloquintida is made with a decoction of the pulp of that fruit freed from the seeds. To render it sweeter, and make it less susceptible of griping the bowels, it ought to be deprived of its resin.

Baumé caused it to be redissolved in cold water. He filtered the liquor, and the resin remained on the paper. This operation he repeated three times.

7th. Opium is brought to us from Turkey. The practice of making it near the ruins of Thebes has been lost. The inhabitants of Egypt still cultivate the plant which furnishes it; but only to eat the seeds, which they are fond of, as well as of all other emulsive seeds.

Opium is an extract prepared from the expressed juice of the leaves, stems, and heads of the white poppy.

That used in commerce is very impure. The preparer of opium dissolves it in water, makes the liquor pass through flannel,

flannel, and evaporates it in a *balneum mariae*. When he wishes to make it more tranquilizing than narcotic, he subjects it to both the following preparations :

The first consists in cutting the opium into slices, boiling it in the quantity of water necessary to dissolve every thing soluble it contains, straining the liquor, evaporating it to a half, putting it into a tin cucurbit immersed in a sand bath over a fire maintained three months night and day, adding water in proportion as it is evaporated, scraping from time to time the bottom of the evaporating vessel, to prevent the resin which is precipitated from being burnt, straining the liquor when three months are elapsed, and then evaporating.

A solid extract, called opium, is obtained by long digestion of all the extracts of opium : this is the one most esteemed by Baumé. The second process is that employed by Joffe to extract the gluten from the farina of wheat.

The opium is exposed under the cock of a vessel which produces only a small stream of water, where it is kneaded : its extractive matter is dissolved, and the resinous part remains in the hands ; the liquor is then filtrated, and it is evaporated to the consistence of extract.

The third method of correcting opium is that recommended by Baumé for freeing the extract of coloquintida from the prejudicial resin which it contains, viz. solution, cold filtration, and evaporation. But as the resin of opium is more difficult to be removed than that of coloquintida, these three operations are repeated six times successively.

8th. It is customary to purify by solution and filtration extracts of the acacia, hypocistis, cachou, and liquorice, sold in the shops. But an exact pharmacopolist will prefer preparing the last-mentioned article himself from the liquorice of our gardens : he will treat it by infusion, and will thus obtain a brown extract of a sweet taste and very agreeable, while the other is black and acrid, and often contains charcoal and always copper, both taken from the bottom of the basin by scraping it with an iron spatula.

9th. Extract of fenna ought to be made from an infusion of the leaves : strong decoction would add to the extractive substance given by infusion, a mucilaginous matter which would weaken its virtue.

10th. Extracts of hemlock, stramonium, hyoscyamus, and bella-dona, were prepared by Storek from the unpurified juices of these plants.

It is much better to evaporate these juices after they have been purified and mixed at the end of the baking, the green *fecula* being separated.

11th. The dry extracts of La Garaye are all made by simple maceration evaporated in a *balneum mariæ*, or in a stove, on flat dishes; they form very thin scales.

La Garaye filtered his liquors a second time when they were half evaporated; but this second filtration is useless if there exists no deposit, and it is hurtful if there be one; because in separating it, instead of suffering it to be redissolved, the extract acquires the property of attracting moisture more strongly.

The process employed by La Garaye for preparing his extracts alters as little as possible the substances they contain.

12th. Extracts made from such fresh-gathered roots as contain mucous bodies in states of solution and of insolubility, that is to say, mucilage, properly called starch, also have need, as already said, of a preliminary preparation to make them lose the latter substance, capable of becoming mouldy when by the aid of warm water it has assumed the state of jelly.

But this starch does not hurt extracts prepared with infusions or decoctions of the same roots dried, because the mucilage of the roots is destroyed or modified by the desiccation.

13th. Several pharmacopolists having observed this change which desiccation produces in the state of the mucous part of plants, have thought that it would be of advantage to prepare extracts from dried plants, especially in regard to plants highly mucilaginous, such as burrage.

Experience has taught them that extracts more abundant, and which keep longer without alteration, may be obtained by this method.

Is the extractive principle increased by desiccation at the expense of the mucilage, or does the mucilage by drying in the plants assume a state which approaches very near to that of extractive matter?

14th. There are some extracts in which it is necessary to retain a resino-gummy or extracto-resinous substance: this may be effected by successively treating the plant which contains it with water and with alcohol. The result of these two solutions, intimately mixed and properly concentrated, gives this kind of extract.

15th. Sometimes wine is employed in order to have only one infusion to make, and to fulfil the same indication; but it is probable that the end proposed in this case is not obtained.

Wine, indeed, besides its not dissolving so well the two required principles, is attended with the inconvenience of furnishing not only the extractive substance proper to it, but also

also an acid, which must necessarily have a greater or less action on the extractive matter of the vegetables, change its nature, and increase in the extracts the tendency they have to deliquescence.

16th. Vinegar extracts very badly the principles of vegetables; it generally alters them, or is altered by them.

It may however be still employed as a solvent in regard to squills, garlic, resinous gums, and as a vehicle of the odours and colours of some flowers.

17th. Extracts by highly rectified alcohol are resins; by weak alcohol they are resins mixed with gummy or extractive substances.

Vegetable substances subjected to the action of alcohol are dry, and much divided: this action is assisted by a degree of heat more or less considerable. The vessel in which the operation is performed must be sufficiently large to allow the vapours to circulate.

When the solution has been made and filtered, water is poured over it, and the alcohol abandons the resin to unite with the water; or it is subjected to distillation, and the alcohol passes off in vapours, leaving the resin free in the same manner.

18th. If jalap, for example, has been employed, to obtain the resin, and if it be intended to procure the gummy extract of this root, the exhausted residuum of the resin must be treated with water, after which the infusion is filtered and evaporated.

It results from these general considerations on vegetable extracts, that the pharmacoplist, if he proceeds methodically, will always have the satisfaction of furnishing the healing art with medicines containing the whole of the immediate products of vegetables, and consequently susceptible of producing the effects which essentially belong to them.

XII. *Description of a Three-blast Fusing Furnace, constructed in the Chemical Laboratory of the French School of Mines.*

By P. TORELLI-NARCI, attached to the Council of Mines.

THIS furnace is destined for fusing different mineral substances, in order to ascertain the nature of them; and the experience of six years has shown that it answers the intended purpose. By its means a very intense heat is obtained, and it was employed by C. Clouet for repeating his experiments

on the conversion of forged iron into cast steel, which were attended with full success.

Chemists who have seen this furnace seemed desirous of being better acquainted with the construction of it: the council even transmitted drawings of it to several persons; and what has hitherto prevented a description of it from being given was a desire to ascertain its power by longer use.

I long ago conceived the idea of a fusing furnace, in which the wind was distributed in three tuyeres placed in its circumference, and at equal distances from each other; but I had no opportunity of realizing this idea till I became attached to the council of mines.

Nearly seven years ago a plan was in agitation for constructing in the laboratory of the school a fusing furnace capable of producing a very great degree of heat, in order to operate with facility and speed on larger quantities of mineral, and consequently to obtain more precision in the trials which might be made than had been obtained by the small furnaces before employed for docimastic experiments,

I proposed my ideas: they were approved by the council of mines; and I was ordered to cause the furnace I am about to describe to be constructed. The principal difference between it and those before used for the same purpose is, that in the present one the wind is introduced through three tuyeres, placed at equal distances from each other in its circumference, whereas in common furnaces it enters only by one.

This furnace is round, both outside and inside, and constructed of very refractory bricks, secured by iron hoops in such a manner that they cannot be displaced. It rests on a square base of strong mason-work, raised to a sufficient height above the ground to render it easy to manage.

The bellows are four feet in length, and the mean breadth of them is about 20 or 21 inches: they are of wood, and the joints are covered with white leather. The upper part consists of five folds and two half folds; the inferior, of two folds and two half folds. They are placed 8 or 9 feet* above a wooden box, the joints of which are covered with leather, and into which the wind as it comes from the bellows is conveyed by a copper pipe, three inches in diameter, adjusted to the upper part of the box. The box itself is supported by two iron bars built into the wall. From the lower part of this box descend, in a vertical direction, three pipes

* This height is arbitrary; it depends in part on the manner in which the bellows are disposed, and on the height of the chamber in which the furnace is placed.

of copper, two inches in diameter, bent at right angles about 45 inches below it, to bring them into a horizontal position, and to convey the wind to the furnace, which is about six feet distant. The extremities of these pipes are fitted into three tuyeres of forged iron, fixed at equal distances around the circumference of the furnace: these three pipes are more or less curved or bent, to convey the wind into the furnace by the three apertures made for that purpose.

About six inches below the box is adjusted, on each of the three tubes, which descend in a vertical direction, a brass cock about three inches of interior diameter: these cocks serve to intercept entirely the communication between the bellows and the furnace; and by opening them all more or less, or each of them separately, any required quantity of wind may be obtained*.

These cocks are well fixed to the tubes, and kept in their place by two clips of iron suited to the diameters of the tubes, and forming a kind of three collars, which by means of four screws embrace and confine them: these pieces of iron are themselves made fast to two crutches of iron, which support the box and are fixed to it by screws. The box is kept on the crutches by two straps, which embrace it at each extremity, and are fixed by female screws, which are fitted to screws on the ends of these straps after they have passed through the horizontal part of the two crutches.

To give the proper strength to this furnace, a solid square was constructed of mason-work, about a foot larger on each side than the exterior diameter of the sides of the furnace, which were from 21 to 22 inches from outside to outside. Bricks were placed on the ground in the middle of this erection for the extent of 18 inches, in order to form a bottom, and on this base were placed the sides of the furnace constructed in the manner about to be described.

I caused to be forged two iron hoops six lines in thickness, from 2 to 2½ inches in breadth, and about 22 inches of exterior diameter: these two circles were fastened together by three bars of iron, the distance of their exterior edge being

* Care must be taken, when the action of the bellows ceases, to shut the cocks, especially when coals are used in the furnace; for the hydrogen disengaged from that mineral substance ascends into the box and when the bellows are again made to act, may inflame, and cause a violent explosion, or even burst the bellows. This accident once took place in the furnace here described: the box burst with a loud noise on the first stroke of the bellows, the fire which filled them having suddenly inflamed; but by good fortune no person was hurt. The same thing happened at the house of C. Berthollet, in the month of Paris: one of his bellows burst with a horrid explosion at the moment when they were put in motion.

kept at about nine inches, the height of the bricks: these bars are pierced with holes towards the end riveted on the circles, and placed at equal distances on their circumference. One of the extremes of each of these three bars is left of a sufficient length to pass beyond the lower circle about an inch, in order to make them enter into three holes formed in the brick-work which forms the bottom of the furnace, and by these means to prevent the furnace from becoming de-ranged.

This kind of iron frame was filled with bricks similar to those employed for the bottom of the furnace: they were rubbed one on the other to smooth them, and the corners were a little rounded; so that, being placed upright with their broad sides applied to the iron hoops, the narrow side stood inwards. By these means all these bricks were adjusted in such a manner as to touch each other by their broadest faces, and to form the sides of the furnace, the thickness of which was equal to the breadth of the bricks, and its depth to their length. Three apertures were reserved for the tuyeres which terminate the three tubes that convey the wind, by cutting from as many bricks a portion equal to the thickness of a brick.

These bricks thus adjusted were taken from the iron frame, and then replaced, putting between them a cement to connect them firmly and to fill up the joints. The dust produced by cutting the bricks was reserved for this purpose; and I desired the workman to mix with it a small quantity of clay diluted in a great deal of water, in order to make a puddle for daubing over the bricks, and in particular to put between them no more than was necessary for filling the joints and the small space left between their faces in consequence of any inequality left in dressing them.

The furnace thus constructed was then placed on its base, a stratum of the same mortar employed for filling up the joinings of the bricks being first interposed. The extremities of the three iron bars projecting beyond the lower circle were placed in the holes left in the base to receive them. The body of the furnace encircled with iron, both by its weight and the gentle blows given to the iron hoops above the bars which connected them, expelled the excess of the mortar, and caused a part of it to enter and unite with that which filled up the joints of the brick-work of the circumference, which rendered it immoveable.

The bellows is secured as usual by crutches of iron and supporters fixed in the wall and to the floor: the handle is disposed in such a manner, that the rope which makes it act

may be pulled by the same person who manages the fire of the furnace, which in certain cases is necessary.

The tuyeres of forged iron which receive the ends of the copper tubes are secured in their proper apertures in the circumference of the furnace by pieces of brick and mortar similar to that employed for filling up the joints; and the ends of the copper pipes introduced into these tuyeres are luted with the same mortar, a little thickened with brick-dust.

The aperture of these tuyeres towards the interior of the furnace is only nine lines in diameter; on which account, as the volume of air furnished by the bellows cannot pass so quick as it is produced, it becomes condensed in the box placed above the cocks. By these means a very uniform blast is obtained; which can also be regulated by opening more or fewer of the cocks.

During more than six years, since this furnace was constructed, it has suffered no derangement: it is not even cracked. It is however worn in the inside by the violence of the heat it has experienced, which has increased its diameter about two inches. The parts round the three tuyeres have also got hollowed, so that it has need of being repaired. It is intended to make it deeper, and to have a kind of moveable muffs or linings made of fire-clay, in order that its diameter may be reduced at pleasure; it is meant also to construct it in such a manner, as to deposit the rest or support for the crucible, not on the bottom of the furnace, but on bars of forged iron placed at the distance of some inches from that bottom, so as to leave below them a vacuity in which the blast of the bellows may be diffused, and from which it may rise, passing between the bars to traverse the mass of charcoal which surrounds the crucible. The blast will then produce a more uniform fire, and the flame can no longer be directed against the sides of the crucibles; so that the risk of their breaking by sudden inequalities in the heat will be much less.

This alteration is going to be immediately carried into execution, and the method proposed for doing it is as follows:

A round frame will be made of forged iron, in which bricks will be placed in the same manner as above described. In the lower part of the furnace an aperture will be reserved for raking out the ashes, which will be closed by means of a door of baked earth carefully luted with clay. Some inches above the bottom of the furnace will be placed a grate of forged iron, and between this grate and the bottom of the furnace the tuyeres will terminate, and the blast be introduced. Muffs or linings of very refractory earth will then
be

be introduced, so as to descend to this grate. There will be two of them, one within the other, and both within the body of the furnace. At the lower part these muffs will be furnished with a rim, projecting outward so as to leave between the body of the furnace and the muffs a vacancy, which will be luted at the bottom with clay, and which will be filled with pounded glass, or any other substance a bad conductor of heat.

The interior muff, or both of them, may be removed at pleasure to obtain a furnace of greater or less capacity according to the operations to be performed. It is proposed to make the muffs wider at the top than at the bottom.

Explanation of the Figures (Plate I).

Fig. 1. Plan of the bellows and of the furnace. AB, the bellows made of wood, the folds of which are also of wood covered with leather on the joints. CD, the handle which serves for moving the bellows. E, a copper tube which conveys the wind of the bellows into the box FG, in which it is condensed. FG, a box of wood serving as a reservoir for the wind condensed by the bellows. HI, KL, MN, three pipes adapted to the box FG, and which convey the wind into the inside of the furnace by three tuyeres, I, L, N. OP, mason-work to support the horizontal pipes. Q, the furnace properly so called, the form of which is circular, and which is placed on the square mason-work R, S, T, U.

Fig. 2. Elevation of the furnace, the pipes which convey the blast, the cocks, the condensing box, and the bellows. AB, the bellows mounted in their place, and supported by the iron-work necessary for securing it, which is fixed in the wall and to the floor. CD, the handle which serves for moving the bellows. E, the copper pipe which conveys the blast of the bellows to the box FG in which it is condensed. At G is a hole shut by a large cork stopper, which can be opened at pleasure. This box is supported by two crutches of iron *f, g*, and *b, i*, built into the wall, and on which it is fixed by two iron stirrups *l, m*.

Fig. 3. One of the crutches and its stirrup are seen represented sidewise at *f, g, l*; the extremities, *n, o*, are built into the wall, and the two ends, *p, q*, of the iron piece which keeps the box on the horizontal traverse of the crutch, are tapped, and receive screws which make them fast to the crutch *f, g*. HI, KL, MN, are three pipes which convey the wind into the interior of the furnace. Q, R, S, T, U, mason-work on which is placed the furnace Q, and which serves

serves it as a bottom. OP, masonry which serves to support the three pipes that convey the wind to the furnace. XYZ, fig. 2. are the three cocks fixed to the three pipes which proceed from the box to convey the wind to the furnace.

In fig. 4., the dimensions of which are double those of fig. 2., may be seen the details of one of these cocks.

At *r, s, t*, the body of the cock is seen in front; the stopper being taken out shows at *r* and at *t* the two holes which receive the tubes that communicate either with the box or with the tuyeres. *u* exhibits the body of the cock seen on one side; *v* the key with its aperture *x*, and its head *y*. This key, turned round more or less in its socket, serves to give more or less wind. 1, 2, 3, iron clips which secure the cocks at the distance they ought to be from each other, and connect them at the same time to the iron crutches which support the air-box.

Fig. 5. a plan of these two clips. They are bent at the places marked 1, 2, 3, to embrace the body of the three cocks, and secure them in such a manner that they cannot be damaged when they are opened or shut.

Fig. 6 and 7 represent the plane and section of the changes and additions proposed to be made when the furnace is reconstructed. At I, L, and N, are seen the extremities of the three pipes that enter the forged iron tuyeres, and convey the wind to the interior of the furnace. *a, b, and c*, indicate the thickness at the upper part of each of the muffs and of the body of the furnace, between which there are two vacuities filled with pounded glass or some other bad conductor of heat. *d*, the grate on which are deposited the rests of baked earth destined to receive the crucibles. *e*, the crucible, luted and attached with clay to a rest of baked earth.

Note by the Author on the Furnaces which have several Tuyeres.

The advantage arising in large founderies from the application of two or three tuyeres instead of one, is well known; but I do not believe that such an arrangement was ever adopted in small furnaces,

At Treibach, in Carinthia, C. Le Febre, and Hassenfratz member of the council and inspector of mines, saw, about twenty years ago, a large furnace with two tuyeres; drawings of which they brought to France, and which they represented in the third plate of *l'Art de fabriquer les Canons*, by Monge: two pairs of Bellows supply wind through two opposite tuyeres, and since that arrangement the daily product of metal has been double.

In England, Mr. Wilkinson has employed several years, for fusing iron ore by coke, furnaces of less height than those which he used before, and he supplies wind by three tuyeres placed at equal distances in the circumference of the furnace.

XIII. *On a metallic Solution, which forms a Yellow Ink, that appears and disappears like that of Hellot. Read before the French National Institute, by C. GILLET-LAUMONT, Associate*.*

SOME time ago, having thrown into the fire a solution of a mixture of sulphate of copper and muriate of ammonia, where it produced very agreeable colours, some of it fell upon a piece of paper placed in the chimney, which became of a bright yellow colour. Having taken the paper from the chimney, I was much astonished, some moments after, to find that it was no longer coloured: on again exposing it to heat the colour reappeared, and disappeared in like manner on cooling.

I tried lately to repeat this experiment; and I obtained from these two salts, mixed nearly in equal parts, a solution of a bright yellow colour when warm, and of a beautiful emerald green when cold, which at first gave crystals in oblique prisms with rhomboidal bases, and then blue crystals in flat octaedra.

This liquor and the solution of the crystals gave a yellow ink, which appeared yellow with heat, and disappeared with cold, but still better with moisture.

I observed that these solutions are indebted for this property only to the muriate of copper, which when employed alone does not produce the same effect.

On comparing this ink with that given by the muriate of cobalt, known under the name of the sympathetic ink of Hellot, it is seen that all these kinds of ink are indebted for the property which they have of disappearing, only to metallic muriates, which powerfully attract the moisture of surrounding bodies.

The yellow ink produced by the muriate of copper and the solutions which contain it (very different from those which, being at first invisible, remain fixed after they have appeared) gives by its colour a variety very distinct from that of Hellot, which is of a sea green: with the latter it forms varied tints of an emerald green.

* From the *Journal des Mines*, No. 58.

They may be made to appear at pleasure by the aid of heat, and to disappear very speedily by putting the writing between the folds of paper somewhat moist: but I must here observe, that it requires much care to make the experiment succeed completely, and that a certain degree of heat must not be exceeded; otherwise, the paper being scorched, the writing can no longer disappear.

XIV. *A Short View of the Craniognomic System of Dr. GALL, of Vienna. By L. BOJANUS, M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Observers of Man*.*

AT all periods, a desire to find in the exterior of man certain marks indicative of his interior faculties, his passions, his morals, &c., has induced the learned to establish systems of physiognomy more or less satisfactory. The most striking of these systems are those of Bapista Porta and Lavater, the theory of the facial angle, and the system of Dr. Gall.

In regard to the first, who employed himself in comparing the contours of the human figure with those of beasts, observers have determined its value, and consider his principles as the fruit of a disordered imagination, as too bold, too little founded on rational observation, and absolutely uncertain in its application.

The system of Lavater has had more success; but while we revere the genius of that celebrated man, who was truly a great observer, we cannot help acknowledging the instability of the basis on which all the opinions he advances rest; and the mind is not satisfied with truths which can be appreciated only by an imagination equally exalted, and a touch so delicate as that of the author.

The theory of the facial angle, which embraces a wider field than the system of Lavater, leaves us in uncertainty respecting the detail of the faculties, and gives us only general points of view; but it presents us with this truth, of the greatest importance—that the facial angle increases in size in proportion to the faculties of animals: and in this it coincides

* From the *Magazin Encyclopédique*, No. 4, Messidor, an. 10. Dr. Bojanus in a note says: "As this historical explanation is by no means intended to prove the truth of Dr. Gall's system, it can lead to no decisive opinion on this system, which will be established by its author on solid reasoning and convincing testimony. It is necessary also (says he) to observe, that the passages marked with inverted commas do not rest on the authority of Dr. Gall."

in an evident manner with the general results of the system of Dr. Gall.

Without entering into an exact detail of the laborious route which this learned philosopher pursued, to be enabled to establish a certain basis in a science hitherto hypothetical, we shall examine briefly his fundamental principles.

1. *The Brain is the material Organ of the internal Faculties.*

Far from attempting to decide the metaphysical questions on the nature of the soul, or what may be supposed as the occult cause of the internal faculties, we are, however, forced to admit a material organ for their action.

But, as it is observed that these faculties are found only where the brain exists; that they are lost with it; that disease and læsion of the brain have a sensible influence on their degree and their action; that the volume of the brain increases in direct proportion to the faculties of animals; it is not venturing too far to consider the brain as the material and intermediate organ.

[It might be here objected, that in several cases individuals have lost a considerable portion of the substance of the brain without the faculties being sensibly diminished; but it is to be observed that the greater part of the cerebral organs exist double, and that the observations mentioned are not exact.]

2. *The Brain contains different Organs independent on each other for the different Faculties*.*

The internal faculties do not always exist in the same proportion to each other. There are some men who have a great deal of genius without having a memory, who have courage without circumspection, and who possess a metaphysical spirit without being good observers.

Besides, the phænomena of dreaming, of somnambulism, of delirium, &c. prove to us that the internal faculties do not always act together; that there is often a very great activity of one, while the rest are not sensible.

Thus in old age, and sometimes in disease, such, for example, as madness, several faculties are lost, while others subsist: besides, a continued employment of the same faculty sensibly diminishes its energy: if we employ another, we find it has all the force of which it is susceptible; and if we return to the former faculty, it is observed that it has resumed

* This idea of independence ought not to destroy that principle of animal organisation, that all the parts are in a reciprocal ratio: it ought to mark only, that the action of one organ does not absolutely imply the same degree in another.

its usual vigour. It is thus that, when fatigued with reading an abstract philosophical work, we proceed with pleasure to a poetical one, and then resume with the same attention our former occupation.

All these phenomena prove that the faculties are distinct and independent of each other, and we are inclined to believe that the case is the same with their material organs.

[We do not entirely agree with this idea of Dr. Gall, and we believe, on the contrary, that the separation of the material organs ought to be considered as the cause of the distinction of the internal faculties. It appears, to us at least, that by supposing the faculties themselves as originally separated we cannot save ourselves from falling into materialism, which exists when the mind is no longer considered as unity.]

3. *The Expansion of the Organs contained in the Cranium is in the direct Ratio of the Force of their corresponding Faculties.*

This principle, dictated by analogy, rests on this axiom, that throughout all nature the faculties are always found to be proportioned to their relative organs; and the truth of it is proved in a special manner by the particular observations of Dr. Gall.

It is however to be remarked, that exercise has a great influence on the force of the faculties, and that an organ moderately expanded, but often exercised, can give a faculty superior to that which accompanies a very extensive organ never put in action; as we see that a man of a weak conformation acquires, by continued exercise, strength superior to another of a more athletic structure.

[We must here mention an opinion which seems to result immediately from this principle, and which, however, is false: it is, that the volume of the brain, in general, is in the direct ratio of the energy of its faculties. Observation has proved to Dr. Gall, that we cannot judge of the strength of the faculties but by the development of the separate organs which form distinct eminences in the cranium; and that a cranium perfectly round, of whatever size it may be, is never a proof of many or of great faculties.]

I do not recollect to have heard the reason assigned by Dr. Gall, but, in my opinion, these brains may be considered as in a state analogous to obesity; and as we do not judge of the muscular force of a man or an animal by the volume of their members, but by the development of the muscles in particular, I think we ought, in like manner, to judge of the strength

strength of the faculties by the development of the relative organs.

In the last place, the 4th principle, the most important for practice in regard to the system of Dr. Gall, is:

We may judge of these different organs and of their faculties by the exterior form of the cranium.

The truth of this principle is founded upon another, viz. that the conformation of the cranium depends on that of the brain; a truth generally acknowledged, and proved by the anterior part of the brain, by the impressions in the anterior part of the cranium, and by other facts.

[There are skulls, it is true, in which an external protuberance of the bone corresponds to an interior one; and this irregularity, which is found sometimes as a disease, and most commonly at an advanced age, when the cerebral organs do not oppose the same resistance to the cranium, renders the practice of Dr. Gall's system, in some measure, uncertain.]

Guided by these principles, Dr. Gall examines the nature of the skull, compares the crania of animals and those of men analogous and different in faculties. His researches have proved to him, in a manner almost incontestable, not only the above truths, but that the faculties of animals are analogous to those of man; that what we call instinct in animals is found also in the latter, such as attachment, cunning, circumspection, courage, &c.; that the quantity of the organs fixes the difference of the genus of animals, their reciprocal proportion that of individuals; that the disposition originally given to each faculty by nature may be called forth by exercise and favourable circumstances, and sometimes by disease, but that it never can be created in the case where it has not been given by nature*; that the accumulation of the organs takes place in a constant manner from the hind part forwards, from the bottom to the top, in such a manner, that animals in proportion as they approach man in the quantity of their faculties have the superior and anterior part of the brain more expanded; and, in the last place, that in the most perfect animal, man, there are organs in the anterior and superior parts of the frontal bone, and of the parietals, destined for faculties which belong to them exclusively. "It is under the latter point of view that the discoveries of Dr. Gall agree perfectly with the theory of the facial angle, which seems still farther to establish the truth of them."

In regard to the details of Dr. Gall's system, and the enu-

* The germ of every organ must exist in embryo, if the expansion of that organ is to be afterwards called forth.

meration of the different organs which he found, it is difficult to give an exact and satisfactory description of them, when illustrated with the number of facts and examples which he employs to prove, in an evident manner, what he advances; I shall however attempt the enumeration, being persuaded that it will contain several illustrations of the author's manner of considering the subject, and give a true idea of the method to be pursued to attain to his results *.

1. *Organ of the Tenacity of Life.*

The first organ which the author thinks he has found is that of the *tenacity of life* (*tenacitas vitæ*): he considers the medulla oblongata as the seat of it; and as the circumference of the large occipital foramen is in the direct ratio of the extent of the medulla oblongata, he employs the size of this hole to judge of the intensity of the life of an animal.

The observations which serve to support this opinion are, that this hole is generally larger in the crania of women than those of men; that it is constantly large in the cat, the otter, the beaver, the badger, &c., animals well known to have a very tenacious life. Besides, there are no speedier means of killing an animal than to cut the medulla oblongata.

2. *Organ of the Instinct of Self-preservation.*

A little further forward in the medulla oblongata, at the place where it leaves the brain, the author places the *organ of the love of life*, or of the *instinct of self-preservation*.

As animals furnish no instances of suicide, it was only from the human race he could procure examples in favour of this position; and several cases of suicide, in which this part of the brain was diseased, determined him to consider it as the organ of that faculty: he does not, however, consider it as an absolute truth; he waits for further examples to serve as proofs.

3. *Organ for the Choice of Nourishment.*

The organs for the choice of nourishment are found, according to the author, in the quadrigemini tubercles; the anterior of which are larger in carnivorous animals, the posterior more expanded in graminivorous, and which in omnivorous are of equal size.

4. *Cerebral Organs of the external Senses.*

The middle part of the base of the brain is destined to the

* Compare the different articles with the corresponding numbers in the figure, Pl. II.

external senses. This is the region from which the nerves distributed to the organs of these senses proceed.

5. *The Organ of Instinct and Copulation.*

The *organ of instinct and copulation* is situated at the base of the occipital bone, behind the medulla oblongata and the large occipital foramen.

This organ never expands but at the age of puberty, and its increase has a great influence on the form of the nape of the neck, because to this part of the cranium its muscles are affixed.

In animals castrated before the age of puberty, the expansion of this organ does not take place. It is certain that the bull has the chest much broader than the ox, and that "horses subjected to castration before their chest is full have that part always slender."

In the ape, the hare, and cock, this organ is very apparent; and in pigeons and sparrows the occipital forms a particular bag, which seems to be an appendage of the head; and it is well known that these animals are exceedingly ardent in copulation. The same disposition is sometimes found in the cranium of man; and Dr. Gall has in his collection the skulls of several fools, who were distinguished by their lasciviousness, and whose occipital bone presents an enormous projection.

6. *Organ of the reciprocal Love of Parents and Children.*

The *organ of the reciprocal love of parents and children* occupies the whole posterior and superior part of the occipital: by its position it is intimately connected with the preceding organ, the action of which must necessarily have an influence upon it. "Sometimes its excessive expansion contributes to produce that prolongation of the occipital in the form of a bag, mentioned in the preceding article."

This organ in general is more striking in women than in men, and throughout all nature more so in the female than in the male sex: it is very apparent, in particular, among apes, whose love for their young is so well known that it has become proverbial.

"In general, all animals which show a great deal of attachment to their young are provided with it; and it appears to us that pigeons, the male and female of which both sit on the eggs, and which feed their young by a sort of rumination, may be given as an example."

The cuckow, which never rears its young, is almost entirely destitute of this organ.

7. *Organ of Attachment and Friendship.*

At the posterior and middle part of the parietals, and the lateral part of the occipital, is the organ of attachment or friendship.

“Its position brings it into intimate connection with the two preceding organs, and it appears that these organs have an action together, especially in animals destined to live in society.”

Dogs show the most surprising marks of attachment; and the instances are furnished chiefly by the barbets, bassets, and house-dogs. These species, therefore, are distinguished by a large head, on which is found the expansion of this organ behind and above the zygomatic apophysis. The gre-hound, which is the least susceptible of attachment, has the head narrower behind, and in general is destitute of this organ.

8. *Organ of Courage.*

It is the posterior and inferior angle of the parietal that corresponds to the angle of courage. It contributes to enlarge the size of the head, and to separate the ears from each other. Its proximity to the three preceding organs explains to us the fury of animals in rutting-time, and the excess of courage in those which have young, or which protect the female and the individuals of their society.

It is very striking in the hyæna, the lion, the wolf, some species of dogs, and particularly in the wild boar, the temerity of which is well known.

On the other hand, the ass, the gre-hound, the sheep, and the hare, which are distinguished by their timidity, are entirely destitute of this organ: their head is straight posteriorly, and their ears are very near to each other.

A very surprising phænomenon seems to support the opinion of Dr. Gall on the seat of this organ: it is a certain involuntary motion of man when he loses courage. He scratches behind his ears, as if desirous to excite the action of the organ which gives him that faculty.

[We have remarked a movement in cats which appears to have some resemblance to the above, and which relates to the organ of attachment. When fawning on man, they always present the posterior part of the head to rub it against him.]

9. *Organ of the Instinct to assassinate.*

Before the organ of courage, towards the middle of the lateral part of the parietals, resides the organ of the instinct to assassinate.

It appears in all carnivorous animals which live on prey. Dr. Gall found it in the crania of several assassins who had been executed.

10. *Unknown Organs.*

Two organs which correspond to the temporal bone are as yet unknown in regard to their functions.

11. *Organ of Cunning.*

The organ of cunning occupies the anterior and inferior part of the parietals: it appears in all animals distinguished by that faculty; such as the fox, polecat, domestic cat, the diver*, and is in intimate connection with the *organ of theft*, which constitutes a prolongation of it towards the orbit, and which is found in the cat, some dogs, and the magpie.

It is, perhaps, to the development of this organ that we ought to ascribe the great width in the heads of the Calmoucs, among whom a propensity to thieving is a national characteristic.

12. *Organ of Circumspection.*

The organ of circumspection is found in the middle of the parietals, above the organ of cunning and that of the instinct of assassination.

The excessive development of it produces irresolution; want of it, stupidity: it is very striking in the chamois goat, and roe-buck, the circumspection of which is singular, and which never travel on an unknown road without great precaution.

It is found also in animals which do not quit their habitations but in the night-time, such as the owl, otter, &c.

[To be continued.]

XV. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES, BERLIN.

THIS Academy has proposed the following as subjects for

Prize Questions:

I. The Mathematical Class offers a triple prize for the best dissertation on the obliquity of the ecliptic.

Papers on this subject will be received till the 1st of May 1806.

* One observation difficult to be arranged is, that Dr. Gall always found this organ developed in poets: he gives no explanation, but his observation is correct.

II. The

II. The Class of the Belles Lettres has again proposed the question respecting the Goths and Gothicism, with the following variations and definitions, and offers a double prize.

1st. Did the northern tribes, the Goths, Vandals, Suevi, Longobardi, Franks, Burgundians, Anglo-Saxons, &c., who divided the western possessions among them, bring with them from their own country any thing peculiar in their arts and sciences? or, Cannot it be rather proved that every kind of mental culture which these people acquired was obtained from their intercourse with the old inhabitants of the Roman empire, and from their being mixed with them by their conquests?

2d. Ought we therefore to ascribe to these people a peculiar style in their literature and arts? or, Are the specimens of these arts which occur in the middle ages only modifications of the antient Greek style, produced after the decline of the Roman empire by the new political, religious, and moral situation of these people?

3d. And, if the latter be the case, what are the distinguishing marks of the productions of the middle ages in literature and the fine arts? What is the proper order in which they follow each other? What influence had the cultivation of the fine arts among the Arabs on those of the western part of Europe? When and through what channels was this influence perceptible, and by what signs was it distinguished?

Papers on this subject will be received till the 1st of May 1804.

III. The following is the question proposed by the Physical Class:—Has electricity any influence on matters in a state of fermentation? Does it contribute to, or impede, fermentation? Does it produce any change in the products of fermentation? What advantage can be derived from calling forth this matter in order to improve the art of preparing wine, beer, vinegar, and brandy?

Papers on this subject will be received till the 1st of May 1803.

IV. The following is the question proposed by the Philosophical Class:—Is the moral worth of an action to be taken into consideration in the application of a criminal law? And if this be the case, how far can it be done?

Papers on this subject will be received till the 1st of May 1803.

ACADEMY OF THE USEFUL SCIENCES, ERFURT.

The question proposed last year, which has not yet been answered, is again put by the Academy as

A Prize Question;

What useful application can be made in chemistry of the temperature below zero of Reaumur's thermometer; and how far is it possible, by artificial means, to lower the temperature?

The prize for the best answer is thirty ducats, and papers will be received till the end of July 1803.

FRENCH NATIONAL INSTITUTE.

Prize Questions.

The Class of the Moral and Political Sciences has proposed the following question as the subject of a prize:

To determine how the faculty of thinking ought to be decomposed, and what are its elementary faculties?

The prize will be a gold medal of the weight of five hectogrammes (about 70l. sterling), and will be decreed in the public sitting of Germinal, year 12 of the republic. Papers will be received only to the 15th of Nivose the same year.

The Class of the Moral and Political Sciences proposed in the year 9, as the subject for a prize in geography, the following question:

To compare the geographical knowledge of Ptolemy respecting the interior of Africa with that which has been transmitted to us by later geographers and historians, except in regard to Egypt and the coasts of Barbary from Tunis to Morocco?

As the papers transmitted to the class did not answer the conditions, the class proposes the same question as the subject of a prize for the year 11.

The prize will be a gold medal of the same value as the former, and will be adjudged in the public sitting of Messidor, year 12. The period for receiving papers the same as above.

In the sitting of Germinal 15, year 8, the Class of the Mathematical and Philosophical Sciences proposed as the subject of a prize the following question:

To determine, by anatomical and chemical observations and experiments, what are the phenomena of the torpor which certain animals, such as the marmot, dormouse, &c. experience during winter in regard to the circulation of the blood, respiration, and irritability; to determine what are the causes of this sleep, and why peculiar to these animals.

The

The class was of opinion that neither of the two memoirs transmitted to it contained a sufficient illustration of the subject to be entitled to the prize, but that the observations in them were sufficiently interesting to deserve honourable mention. The author of the memoir No. 1, with the motto *Incerta facies inter vitam et mortem*, does not explain the necessary distinctions between the ways in which the different classes of animals spend the winter, and does not give sufficient details in regard to their peculiar habits and the differences in their manner of life. He speaks only of some of the mammalia; but he gives anatomical details respecting the diaphragmatic nerves, and those known under the name of nerves of the eighth pair, as well as the thymic gland, and the muscles which serve to determine the form which the animal assumes during its torpor. He gives also some curious observations on the degree of temperature into which the animal enters when in that state: it was chiefly on the *mus axillanarius*; the bat, *vespertilio murinus*; the hedgehog, *erinaceus europæus*; and the marmot, *arctomys marmotta*, that these observations were made.

One-half of the memoir No. 2, having the motto *Quid mirum si non ascendunt in altum ardua aggressi?* is devoted to general observations on life and death, and on the different modifications of life. Without considering these preliminary observations foreign to the object which the author proposes, in our opinion he has given them too much extent. He then makes a distinction between animals which pass the winter in a state of torpor. He separates those whose torpor is properly a deep and prolonged sleep, which he calls *vita soporosa*, from those whose torpor is a real suspension of the vital functions, which he calls *vita interrupta*. Among the former he examines the bear, *ursus arctos*; the hedgehog, the bat, the marmot, the dormouse, *myoxus glis* Schreber.; the wood-rat or muscardin, *myoxus muscardinus* Schreber.; and the hamster, *mus cricetus* Linn. He enlarges a great deal on their habits, their kind of life, and the manner in which they pass their state of torpor; but gives few details in regard to their anatomy. He however observes, as the author of the former, the size of the diaphragmatic nerves and the eight trisplanchnic pair, particularly in bats, but does not speak of the state of the thymus. Among animals of the second he distinguishes those which are provided with organs of circulation, as the amphibia, and those which have no apparent organs of that kind, as is the case with insects; but of the amphibia he examines only frogs, and gives no details respecting the torpor of insects. His observations on the frog

are very extensive: he supports them by very curious observations on the respiration of that animal; the structure of the organs which serve for that purpose; the properties he ascribes to the skin of these animals; the causes which make them move during the time of their perfect life, and those which preserve them during their state of torpor.

We invite the authors to give more extent to those parts of their labour on which they have bestowed the least care: the talents they have displayed in their memoirs do not permit us to doubt that they will fully accomplish their object.

The class again proposes the same subject. The prize will be doubled, and will consist of two kilogrammes of gold (about 280l. sterling). The memoirs must be transmitted to the secretary of the Institute before the 15th of Messidor, year 12. The determination of the class will be published in the public sitting of Vendemiaire, year 13.

GALVANIC SOCIETY, PARIS.

The sitting of the Galvanic Society at the Oratoire, on the 14th of October, was remarkable both on account of the presence of the learned men and distinguished philosophers who compose it, and of the nature of the experiments made on cold-blooded and warm-blooded animals.

C. Aldini conducted these experiments with a great deal of method. The principal ones were as follow:

1st. Several frogs recently skinned exhibited in succession the phænomenon of a very sensible contraction without the interposition of any metallic substance, and by the mere contact of the nerves of each with the muscles.

2d. The animal arc was several times obtained, and rendered sensible by the same dispositions as in the preceding experiment.

3d. The phænomenon of simultaneous muscular contraction, in three frogs recently prepared, and placed at the side of each other in the same direction, was produced at first by the aid of silver alone. But C. Aldini, being desirous to prove that the fluid which acted on these animals was not metallic electricity, changed the position of the intermediate frog by placing the superior extremity of the trunk of the latter parallel to the inferior extremities of the other two. A contraction being then observed in the first and last without producing any effect on that placed in the middle, C. Aldini concluded, that, as the fluid did not pursue the shortest way of communication, it could not be the electric fluid of metals, one of the general laws of which does not allow it to deviate from the shortest route.

In another series of experiments the same philosopher exhibited the phenomena of the greatest excitability resulting from the application of the Galvanic conductor. 1st, Towards the medulla oblongata of the head of a warm-blooded animal recently separated from the trunk. 2d, On the trunk itself. 3d, On the head and trunk; at the same time making the anus on the one hand, and the ear on the other, communicate with the Galvanic battery. A small quantity of blood scattered over the table contributed, no doubt, to the energy of this simultaneous contraction of the two parts placed at a remarkable distance from each other. 4th, On a portion of the muscles detached from the body of the same animal.

5th. The crural nerve of a frog, brought into contact with one of the muscles of the warm-blooded animal, exhibited evident signs of contraction.

6th. The heart of the same warm-blooded animal, placed in a vessel and subjected to the impression of the galvanic battery, gave no signs of excitability. This, indeed, is one of those organs which are soonest decomposed after the death of the individual.

The members of the society paid the utmost attention to all these experiments; and the president, C. Nauche, congratulated in their name C. Aldini on the manner in which he had conducted them, and the zeal he had shown to support, by new facts, the theory of his illustrious uncle Galvani.

From these facts it seems to result, 1st, That the animal fluid supplies the place in analogous experiments of the electric fluid propagated by metals. 2d, That this animal fluid has no need of any other conductor than the organized parts. 3d, That the nerves and the muscles are the surest conductors of this fluid; and, consequently, that experiments tried either on the nervous plexus or the origin of the nerves must present the most striking and decisive effects. 4th, That the different metals, in whatever manner applied, in cases analogous to those in question, perform no other functions than that of favouring, more or less, the propagation of this universal fluid, which penetrates easily, and in preference to all others, the nervous and muscular parts of organized bodies.

TOURLET.

ACADEMY OF SCIENCES, TURIN.

The Galvanic Committee of this Academy, consisting of professors Giulio, Vassalli-Bandi, and Rossi, continue their experiments with great success.

C. Giulio will soon present to the academy two reports on
this

this subject. In the first, after recurring to the experiments which he made in 1792, 1793, and 1794, on several plants, in order to show how far they were sensible to the Galvanic influence by the simple medium of arming and of metallic arcs, he gives an account of new experiments made lately, in conjunction with Vassalli-Landi, on the different species of sensitive plants, such as the *mimosa pudica*, the *mimosa sensitiva*, the *mimosa asperata*, and the *casia sensitiva*, which prove that the muscles of their leaves are sensible to the influence of the Galvanic agent called forth by the Voltaic pile.

In the second he gives an account of the results obtained by experiments made on a man decapitated, September 18th, in one of the halls of the national college. The principal of these results were as follow:

1st. By making one extremity of the pile communicate with the interior of one ear moistened with a solution of muriate of ammonia, and the other extremity of the pile with the other ear, very strong contractions were produced in the muscles of the face: but the contractions of the temporal muscles, the pterygoid, and masseter, were particularly striking, for they elevated and agitated the lower jaw with so much force, that the gnashing of the teeth was distinctly heard at the distance of several feet.

2d. By establishing a communication between the spinal marrow and the large nervi sympathetici and vagi armed, and between different regions of the breast moistened with the same solution, and the other extremity of the pile—before the cavities were opened very strong tetanic shocks were obtained throughout the whole body; such violent palpitations of the heart, that the hand applied on the region of the fifth and sixth ribs was strongly struck by them; inspirations and expirations, with a hissing noise which accompanied the entrance and escape of the air.

3d. After opening the breast the palpitations of the heart still continued, and could be distinctly perceived: when they had ceased, they were renewed by establishing a communication between the heart and the pile, the large nervi sympathetici and vagi and the pile.

4th. By arming the abdominal aorta and the plexus cœliacus, and then making them communicate with the pile by means of two respective arcs, contractions were produced in the abdominal aorta:

These experiments, added to others announced in a report made to the academy on the 15th of August last, leave no doubt

doubt in regard to the irritable muscular contractility of the arteries, and of the influence which the nerves have in their action.

5th. By arming the anterior nervous branches of the last dorsal nerves and of the thoracic conduit, and establishing a communication between that conduit and an extremity of the pile, and the armed nerves and the other extremity, evident contractions were produced in the thoracic canal. Physiologists know what disputes have taken place for and against the irritable contractility of this canal. The experiments of the Galvanic committee of Turin remove all doubts on the subject: in a decisive manner it presents, for the first time, an irrefragable proof of the irritability of the canal of the chyle, and of the existence of muscular fibres in the tissue of that canal.

6th. One of the eyes was plucked from its orbit, and laid on a plate of glass armed with a plate of lead, so that the posterior part of the ball of the eye, the trunk of the optic nerve, and the nervous branches of the lenticular ganglion, were in contact with the plate of lead: a communication was then formed between the plate of lead and one extremity of the pile and the sclerotica, and between the transparent cornea and the other extremity of the same pile, by means of exciting arcs.

The spectators were greatly astonished to see the pupil instantly contract. An incision was made in the cornea; and a fine gold wire being brought into immediate contact with the iris and the last filaments of the ciliary nerves, a movement was observed in the iris, and a greater contraction in the pupil. There are irritable fibres then in the iris, notwithstanding what many authors have said to the contrary. But what is the direction of these fibres? The professors propose to make this a future object of research.

7th. By introducing an arming of lead into the anus, and making it communicate with the pile, while another communication was established between the surface of the intestines and the other extremity of the pile, evident contractions were produced in the muscular tunic of the intestines, especially when uncovered by the separation of the exterior membranous tunic, a continuation of the peritoneum.

8th. A long portion of the right anterior muscle of the leg being extended on a plate of glass armed with two plates of lead, the two extremities of the muscle, when touched by the two ends of the arc, without the intervention of the pile, approached each other, and the nerve immediately became

shortened

shortened one half. These motions took place even when the arming was removed.

These experiments were made in the presence of the commissary-general of the police, several professors of the Athenæum, the members of the academy, and a great number of other enlightened citizens.

XVI. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

THE following letter, addressed by A. van der Velden, surgeon and man-midwife at Workendam, to the editor of a Dutch Journal intitled *Algemeene Konst en Letter-Bode* 1802, No. 41, we have translated from that work.

“By the encouragement of some friends to humanity, and some of our principal medical men, who have exerted themselves very much to recommend the cow-pock inoculation at this place, about 140 have been inoculated by me and J. Heilijers, surgeon and man-midwife at Wondrichem. I am therefore induced to send you the following information, with the hopes that it may contribute to the preservation of those who are suffering under the small-pox. In the course of the present month I was called in by an inhabitant of this place who had the misfortune to lose two of his children by a confluent small-pox of the most malignant sort, and the third, the only one remaining, was exceedingly ill of the same disorder. Convinced that no injury could arise to the patient, I applied the vaccine, being provided with a lancet armed with good matter, and had the happiness to find, the second day after the vaccination, that the symptoms of the small-pox were much mitigated; but on the eighth, and particularly the ninth day after the vaccine inoculation, the pustules of the natural pox dried up and fell off. In the mean time the vaccine continued to operate, and the following day the child was perceptibly better, and no bad consequence ensued.

“If you think this simple case worth insertion in your Journal, as a further proof of the power and utility of the vaccine, it will give me great pleasure, especially if it shall benefit the public, and excite the attention of others.”

ANTIQUITIES.

M. Akerblad, a learned Swede, has opened a new field to the lovers of antiquities, and enlarged the boundaries of our knowledge,

knowledge, by overcoming difficulties so great, that the first critics of Europe have hitherto considered them as unformountable. He has immortalized himself by a discovery which will form an epoch in literature, and has given a solution to one of the most curious problems in erudition by discovering the antient alphabet of the Egyptians, and analysing it in his *Lettre sur l'Inscription Egyptienne de Rosette*, Paris, 8vo. de l'Imprimerie de la Republique, year 10.

This interesting pamphlet is sold at Paris by Treuttel and Würtz, bookfellers, Quai Voltaire, as well as the following work of M. Akerblad, who seems to have been born to unveil the mysteries of the East: *Inscriptionis Phœnicæ Oxoniensis nova Interpretatio*, Parisiis, an. 10, 8vo. This is a new explanation, much happier than the preceding, of a Phœnician inscription which had exercised the ingenuity of the learned Barthelemy and of Simon.

M. Akerblad had before explained, in the Memoirs of the Academy of Göttingen, for 1801, another inscription which he found in the city of Athens. He explained also in the *Magazin Encyclopedique, Ventose*, year 10, an inscription in a Coptic manuscript, which it appeared impossible to decypher, because it was written in the running hand of the Copts, till then unknown. It only remains for us to wish that M. Akerblad may proceed to London to copy, in the British Museum, and publish with his translation, the famous Coptic manuscript of Dr. Alkew intitled *Pipis Sophia*, which would throw great light on the antient philosophy of the east.

D'ANSE DE VILLOISON,
of the National Institute of France.

The Society of Antiquarians of London have caused an accurate delineation to be made of the Greek inscription, accompanied by two others in honour of Ptolemy-Epiphanes, and found on a stone in Egypt, which has since been brought to London. This delineation of the Greek inscription is of the same size as the original, that is to say, 1 foot 3 inches in height, 2½ feet in breadth, and containing 54 lines.

A copy transmitted to the Royal Society of Göttingen was laid before the members in their sitting on the 4th of September by professor Heyne, accompanied with a commentary. In the same sitting was laid before the Society of Göttingen, a paper intitled *Prævia de cunctis quas vocant Inscriptiones Persepolitânicas legendis et explicandis Retatio*, by G. F. Grotendorf, colaborator in the school of Göttingen,
who,

who, without being an orientalist, has accidentally fallen on the means of explaining this obscure writing merely by his expertness in the art of decyphering. The result of his research is, that these wedge-like figures are actually characters, and not syllables, which proceed from right to left; that the language of these inscriptions is Zendic; and that all the Persepolitan inscriptions which he has hitherto been able to explain relate to Darius Hyftaspes, and Xerxes.

ASTRONOMY.

1st. One of the most singular phænomena in astronomy is, to see the star Algol decrease in light every three days. I observed it very sensibly on the 29th of September. It was at 11 hours 15 minutes mean time that its light was the least.

2d. The eclipse of the sun on the 27th of August, which I could not see at Dijon, was observed at Viviers by C. Flaugergues, and at Marseilles by C. Thulis. The end at Viviers, 18 h. 13 m. 24"; at Marseilles, 18 h. 11 m. 24". I thence conclude that the conjunction took place at 19 h. 9 m. 46" true time at Paris.

3d. C. Pons, keeper of the observatory of Marseilles, has discovered a second comet. I sent him a small present. I have requested the minister to send him one more considerable, in order to encourage amateurs to search for comets, which are now the great desideratum in astronomy.

4th. I have carefully examined the Egyptian Zodiac which C. Denon has published. I have observed that the sign Cancer is found in the two lines; it is at the end of the ascending signs and the commencement of the descending. This seems to indicate clearly that the solstice was in the middle of Cancer. This would go back to 1470 years before the vulgar æra. But I have shown in my Astronomy, that in the time of Eudoxus, 370 years before the vulgar æra, the Greeks followed this method from some antient Egyptian tradition, which they did not correct because they made no observations.

5th. The small tables of logarithms just published, being the most correct and convenient, the ministers of the interior and the marine have determined that they shall be sent to all the national schools. DELALANDE.

NEW COMET.

In our last we announced this discovery by C. Mechain on the 28th of August, at nine in the evening, in the constellation of Serpentarius. It was rising rapidly towards the North pole,

pole, following the right side of Serpentarius and the opposite side of Hercules. It was near enough to be observed by the naked eye.

On the 2d of September C. Mechain transmitted to the Institute a report on this comet. The elements he assigned to it were as follow:

Mean time $94^{\text{h}} 24' 6''$

Right ascension $249^{\circ} 18'$

South declination $6^{\circ} 11' 31''$

TANTALITE—A NEW METAL.

A new metallic substance has lately been discovered in Sweden. It was extracted by the celebrated chemist Ekeberg from a mineral given to him by M. Geyer. This mineral, found in Finland, had been classed among the ores of tin. M. Edelerantz, of the Academy of Stockholm, transmitted a specimen of it to Delametherie, who gives the following description of it. It has a blackish colour, with the metallic aspect of crystals of oxidated tin. Its colour is equally dark; its gravity is considerable; it strongly scratches glass. Several facets are distinguished in it, but the crystal is incomplete. M. Ekeberg has extracted from this mineral a new metallic substance, to which he gives the name of *Tantalite*. It forms the twenty-third metallic substance.

SILVER AND IRON.

C. Guyton announced, 25 years ago, that iron and silver brought together into perfect fusion formed two separate buttons adhering by their surfaces. He thought he could thence conclude, contrary to the opinion of Gellert, that these two metals cannot be alloyed.

The ingenious experiments of Coulomb on magnetism having rendered it necessary for that philosopher to procure metals warranted free from iron, C. Guyton proposed to him to try a button of silver from which it appeared that nature itself had separated the iron.

The silver, indeed, did not contain a quantity of iron which could be rendered sensible by chemical re-agents, since a solution of it did not give an atom of blue with prussiate of soda. A portion of the same fragment exercised a sensible action on the magnetic bar; and Coulomb, having subjected it to his magnetic apparatus, found that it contained a thirtieth of iron.

It then became of importance to examine whether iron did not contain a certain quantity of silver. This C. Guyton did with his usual ability. He assured himself that in iron there

is an eightieth, or nearly so, of silver intimately combined; and that this quantity is sufficient to give it very remarkable properties, such as extraordinary hardness, and a fracture which presents, without continuity, rudiments of crystallization.

C. Guyton concludes from these experiments on silver and iron, as well as from those which he made on iron and lead, that it can no longer be said that these metals refuse to form an alloy, and that there is actually an union in their fusion; but that by a real quartation the greater part of the two metals separates while cooling in the ratio of their weight, and exactly as copper and lead separate in grand metallurgic operations.

RAPID DISORGANIZATION OF THE HUMAN BODY.

On the night of the 16th of March, 1802, in one of the towns of the State of Massachusetts, the body of an elderly woman evaporated and disappeared from some internal and unknown cause, in the duration of about one hour and an half. Part of the family had gone to bed, and the rest were abroad. The old woman remained awake to take care of the house. By and by one of the grand-children came home, and discovered the floor near the hearth to be on fire. An alarm was made, a light brought, and means taken to extinguish it. While these things were doing, some singular appearances were observed on the hearth and the contiguous floor. There was a sort of greasy foot and ashes, with remains of a human body, and an unusual smell in the room. All the clothes were consumed; and the grandmother was missing. It was at first supposed she had, in attempting to light her pipe of tobacco, fallen into the fire, and been burned to death. But on considering how small the fire was, and that so total a consumption could scarcely have happened if there had been ten times as much, there is more reason to conclude that this is another case of that spontaneous decomposition of the human body, of which there are several instances on record. It is to be regretted the particulars have not been more carefully noted.

XVII. *On Painting.* By Mr. E. DAYES, *Painter.*

ESSAY VI.

On Composition or Disposition.

————— but in such order all,
As, though hard wrought, may seem by chance to fall."

Duke of Buckingham.

COMPOSITION is the forming of a whole by the union of various dissimilar parts; or, in a more painter-like sense, the art of arranging the figures and other materials of a picture in such a manner that the whole may appear as if the result of chance, though produced by the most consummate art.

Before we proceed to offer such rules as are to be extracted from the works of the most esteemed masters, it may not be improper to premise what previous knowledge is necessary to enable us to produce a composition.

When we have occasion to speak of the works of certain artists, we wish at all times to be understood as referring *through them to nature*, for it must ever be remembered *that art cannot furnish its own rules.*

Some who have written on the arts have recommended particular books for the use of young artists; which is supposing a certain quantity of information sufficient to make a painter. Where he is to begin his inquiry every one knows; where to stop, no one can tell: one thing is certain, there is no danger of too much knowledge making him spoil his work.

It is of the first importance to imagine well our picture. To this end we must take every means to become well acquainted with the history whence our subject is drawn, that we may become familiar with the characters we are to represent: hence a reference to their lives becomes necessary, that we may not mistake a bad man for a good one from the flow of one good action. This is not all; time and place must be attended to, that we may not confound the customs of one people with the manners of another. The country, also, should be characterized by its trees, rivers, monuments, and public buildings, as well as the inhabitants by their dress and manners.

All this, nay more, being absolutely necessary, how is it possible that an artist with a little reading can accomplish a work like a historical picture? As well might we suppose the

merely reading Homer sufficient to enable us to design from that author without any previous historical information.

He who first acquires a knowledge of geography will not only better understand history and biography, but receive a higher relish for them than had he followed a different order of reading. What gives us an interest in Æneas, but our supposing him the founder of the mighty empire of Rome? Otherwise, he becomes a mere robber.

As all this knowledge cannot be obtained without much attention, we shall find great advantage result from making memorandums under their respective heads of the customs, manners, buildings, and other circumstances connected with historical painting; by which means we shall collect a mass of information at all times ready to refer to, and that without its interfering in the least with our practical studies. Lord Bacon justly observes, "The proceeding upon somewhat conceived in writing, doth, for the most part, facilitate dispatch; for though it should be wholly rejected, yet that negative is more pregnant of direction than an indefinite, as ashes are more generative than dust."

Those who propose to themselves to pursue the great and arduous task of history-painting, should be careful to guard against commencing their career too soon, or before they have obtained a stock sufficient to that end: some have started with so slender a capital that it has been confined to colour, *chiaroscuro*, with, now and then, a successful composition; requisites that do not sink below the superficies.

The acquirements necessary to qualify an artist to pursue the great and important part of the art we are treating of, are many: he should possess a thorough knowledge of the human figure as far as it regards his art, and its attire, with landscape, architecture, *chiaroscuro*, and colour: he should be well read in history, antiquity, and the best poets; to which he should join a knowledge of practical geometry, as the foundation of perspective; with that part of optics called chromatics, as it explains the colours of light and of natural bodies; and, withal, possess a tolerable facility of hand. Nothing can be more difficult than to fill up the character of a great artist, particularly if he proposes to raise a just and lasting reputation; and, not content, like the generality of the profession, to produce trifles, extends his views beyond the present generation by the cultivation of works that may flourish in future ages. To do this, as well as the above acquisitions he should be endowed by nature with noble and elevated sentiments; a ready and warm genius to invent, accompanied with the greatest coolness to arrange; penetration

penetration to apply a justness of character, with patience and industry to carry him through the detail: in fact, his nature should be so formed as to possess the contrarieties of hot and cold; that is, with the greatest vigour should be united the greatest caution.

O the godlike attribute of extending benefits beyond the grave! Where are now the antient heroes? Their names are scarcely remembered, and their mischiefs have long ceased to trouble; while the labours of a Homer, a Virgil, a Shakespeare, and Milton, with a long list of worthies, give bread at present to thousands!

Some one has well observed, "The great end of books is to set the mind a-going:" all we can hope from our efforts is, to raise in the mind that spirit of inquiry that may ultimately lead to an imitation of the great, the noble, or beautiful: all the rest is froth.

It was their high notions of the art that led the old masters to such an exalted perfection as to become the admiration of the civilized part of the world, and placed them among the first order of mortals, or those who have extended their services beyond their being.

Anger, hatred, and revenge, are passions possessed by every one in common with the brute; but to understand that infinitely remote point of perfection which constitutes the foundation of true art, is the reward of few.

It is a misfortune for the art, that every one imagines himself a critic in painting; all are tried by their peers but the poor painter: but let those who are in affected raptures at the touch of a pencil, or the neatness of handling, recollect they are the most trifling and insignificant parts of the art; criticism should be general in all great works: it is a common precept in art, that an attention to the whole supercedes all consideration for the parts*.

In wit, as nature, what affects our hearts
Is not the exactness of peculiar parts;
'Tis not a lip or eye we beauty call,
But the joint force and full result of all.

Pope's Essay on Criticism.

* It must not be understood that the above precept goes to recommend a neglect of the subordinate parts. Over-finiting (that is, the nicely defining the form of each part of an object, as a hand, foot, &c.) is not one of the faults of the British school. This fault, of want of care in making out the parts, is by some improperly ascribed to sir Joshua Reynolds. That great man was not without his defects; but we, as rational beings, should avoid them. It would be a poor justification for the practice of a vice, because we saw it in another. It is much to be doubted, whether the perfections of a great master will ever be properly felt by the mere imitator: the reverse is certain.

Petty criticism should be punished with silent contempt. We might as well "hew blocks of marble with a razor," or "whistle to mile-stones," as attempt to convince some people. There is an applause which is superior to all others, that is, our own, from a conviction of well doing; or, in other words, a consciousness that our industry is rewarded with improvement. He who is too anxiously eager for the applause of others, exchanges independence for uncertainty, and happiness for disappointment. Besides, he is in danger of falling into a style familiar and common, such as may best suit the ideas of ordinary life and vulgar opinion. We must be careful not to refine our delicacy to too high a pitch, otherwise we shall render ourselves liable to be wounded by every petty criticism. Many with whom our situation compels us to have an intercourse are no judges of art; others are influenced by prejudice; many delight to wound: but, whether the observation be the result of ignorance or vanity, the best mode of punishment will be neglect.

We have already noticed, under *Invention*, the two characters of composition, as the grand and picturesque; that the former applies to grave and serious subjects, while the latter appears to associate best with gay and sportive ones. Beauty and grace not only delight in, but derive their greatest power from, mild variety: hence one of the great beauties in our common writing characters results from the swell or the opposition of force and delicacy in the lines, which give grace independent of form: the same thing enriches and adds spirit to a masterly outline, to which if we join fine (we mean true) form, it will possess the first or highest kind of excellence. Among the profession there is great difference of opinion relative to composition; we should therefore wish to be understood as offering those rules that relate to matters of taste with delicacy and modesty, for fear of forcing genius into one particular track of operation.

Nothing can be more false than to suppose the art of composition subject to some positive law, or that the figures of a group should be invariably composed under some particular form. Men who look to pictures, and from them obtain all their knowledge, are apt to run into this error, and suppose, because they see a group in some celebrated picture make somewhat of an angle, that all figures to be well put together must assume the triangle. Others, in contradiction to that doctrine, maintain that the true Venetian method of composition requires the group to incline diagonally, that is, running from corner to corner of the picture, asserting that the former method is barbarous and French: another set of men call
the

the horizontal line *simplicity*, and the true Roman method, expecting to see a range of heads of an equal height running through the greatest part of the work.

He who wishes to affect with sorrow or melancholy can only expect to succeed by the removal of whatever may be likely to please, either from variety and contrast of forms, brilliancy of colour, or striking effect of light and shade; and one great aid will result from telling the story with few figures, which greatly adds to simplicity.

The great reason why Raphael is preferred for composition is his possessing a style more simple and expressive than any other. Simplicity appears to have marked the characters of the Roman and Florentine schools, as also that of the Carracci; after whom we must place Poussin, Le Sueur, Bourdon, and such others as have affected the same simple and expressive manner.

Le Brun, though an artist of great merit, has, in many instances, so crowded his composition with incidents, that the attention is entirely taken from what ought to constitute the principal feature, and the mind becomes distracted amidst a multitude of events: witness his Crucifixion, and Slaughter of the Innocents. Expression derives much of its force from simplicity. Sterne, in his *Sentimental Journey*, was obliged to take a single captive to give force to his description. What can more strongly affect our feelings than his Maria? A multitude of objects rushing on the sight destroy interest, and, in single objects, too many parts produce the same effect: hence the necessity of not over-crowding with ornaments.

It appears pretty certain that the shape of the group must depend greatly on the nature of the subject. A triumph must necessarily assume a different figure to a spectacle like a descent from the cross, because it would be so in nature.

Diversity does not carry with it so much art, or the appearance of art, as is generally supposed; for, if we diligently attend to nature, we shall find an infinite variety of formed groups resulting from the disposition of some men to sit, others to stand, the contrast of children with adults, men on horseback, the irregularities of ground, and a variety of other circumstances,—all tending to produce a diversified and irregular mass, probably assuming, more frequently than any other, a general figure approaching to the pyramid.

If we examine the most approved compositions of the Roman, Venetian, or other schools, we shall find not only the general disposition tending to the pyramidal figure, but each group taken separately,—with this difference, that in the Venetian and Flemish it is rendered more excessive. Hence,

from a dash of excess in Rubens he becomes a better master to study than any other, but he must be studied with caution. The close adhesion of his figures points out the method of composition, the striking and conspicuous manner of arranging his tints evinces the plan pursued in grouping the colours; while the union of shadow with shadow, and light with light, is seen in the breadth and vastness of his masses. By his excess we may learn, as from Diogenes in morals, who observed he acted like musicians, who gave a higher tone in order to indicate a true one.

The affectation of contrast in some artists is abominable; it looks studiously absurd to see a woman lying on the ground with a child at her breast, and another playing near her; besides the common trick of mixing, in *quantum sufficit*, naked with clothed figures; old men with young ones; side opposed to the full face; the contrast of violent motion with languid attitudes; and a thousand other petty arts to trap the unwary. Such violent opposition will never please the judicious. Where the highest degree of the picturesque is intended, it should never be carried to excess. How ridiculous would it appear in a landscape to see trees crossing each other at right angles, or one vertical and another horizontal! In this instance we may take an example from nature, whose progress from season to season is by gentle and almost imperceptible degrees, and not by violent opposition from heat to cold. By the same rule, violent fore-shortenings should be avoided; a little adds dignity, but, in general, the figures had better be composed than otherwise. We should be careful of mistaking bluster and rant for spirit and greatness. "Be not too tame neither, but let your own discretion be your tutor: suit the action to the word, with this special observance, that you overstep not the modesty of nature."

Weak minds are apt, when they attempt the expressive style, to give their figures the wild and extravagant attitudes of lunatics. That grave dignity observable in the works of the Florentine and Roman schools has entitled them to the first place in composition: the next is justly held by the Carracci, whose pupils, as they lost sight of dignity, substituted bustle and show for simple truth. The style of Guercino is forcible and strong, but less elegant and beautiful than Guido, which is easily perceived in the extremities. Poussin has great simplicity in his compositions, though his figures are sometimes too much scattered. He is remarkable for not suffering any low or vulgar thought to break in on the dignity of his story; an error sometimes committed even by Raphael. There are admirable traits of the true Roman

simplicity in the pictures of Le Sueur. They are rare jewels; and Le Brun's stoning St. Stephen is highly classical.

Most of the writers on composition in painting seem to imagine it to depend on contrast, and recommend it in the strongest manner; but violent opposition, as before stated, not only destroys simplicity, but is of all affectations the most disgusting. If opposition or contrast were a criterion of excellence, the most violent would become the most perfect; and, like a caricature, the more unlike nature the better it would be. Variety or contraposition is certainly necessary; but the degree cannot be ascertained by weight or measure, it must be learned from the works of esteemed masters. Common sense must dictate the necessity of not making all the attitudes alike, and also keep us from a contrary excess.

In a fine composition we shall discover, by an attentive examination, all the parts so depending on the whole, that the removal of any object would destroy the general good arrangement.

That variety necessary to the perfection of a group should be displayed in a single figure, especially if it be a beautiful one. If the figure is seen in front, its grace will be increased by showing the face in profile, with a slight inclination in the chest*: one of the legs being straight, the other should be thrown back; and so of each limb †: but this variety must depend on the nature of the subject, as such a contrast would ill become a philosopher, apostle, or senator.

A single figure may be considered as a group in itself, and such a studied one would by no means unite with many, any more than one taken from a number would do as a single figure.

The contrast observable in Raphael is not an affectation of variety, but the result of consummate judgment, where the erect and inactive figure is introduced to give energy and motion to the active. Contrast in him is the result of necessity arising from deep reflection, not the studied and insipid opposition of an old man, a young woman, a boy and a girl, which we often see in pictures. He knew well a philosopher or an apostle would not move like a soldier, a virgin like a matron, or children like adults; which appears to make part of that variety observable in his works. He

* See Essay on Grace in the last number of the Philosophical Magazine, and the plates.

† See the Venus de Medicis, Apollo Belvedere, and others, remarkable for grace.

appears also to have preferred the action to its termination; which renders the story more clear, and leaves the spectator delighted with a suspended motion, and in expectation of its terminating. A man represented in the act of walking, and as having terminated his step, will not have so animated an effect as one not having finished it. Much of the beauty of the Apollo Belvedere arises from the state of action he is represented under. We almost imagine he is actually moving when viewed in front.

In a great master, every thing is the result of reason: if a limb, such as a hand or foot, is concealed by drapery, it does not arise from idleness or ignorance; it is done to give beauty to some principal members, by not making too great a display of parts, or to avoid what would otherwise produce an ugly form.

The grand or expressive style will ever rank first; the other, as in the hands of Lanfranco, Cortona, &c. is only the art of agreeably filling a large picture with figures, or merely pleasing the eye: it may justly be termed *ornamental*, and ranks infinitely below the pure picturesque. *In all works of art, the philosopher will inquire whether the head or the hand is most employed.* Poussin, though admirable in composition, often excels in the accessory parts. In his Pyrrhus, the figures, and distant ground over the river, are more beautiful than the principal part; a prodigality avoided by Raphael; nor is he so noble in his best thoughts; and his women are often ordinary. We wish to be understood as always distinguishing between the grand style and the picturesque. In the former, the utmost simplicity is to be observed in the arrangement, and every thing like artifice avoided; while the latter admits of, and derives much of its character from, variety.

In a group the artist generally prefers unequal numbers, as 3, 5, 7, or 9, which unite with a better grace and afford a greater variety than any other; but, where equal numbers are used, those composed of two unequal are best, as 6, 10, and 14; but double pairs will ill accord, as 4, 8, 12, &c. The principal part of the story ought undoubtedly to occupy the centre of the picture, and the group, by assuming a rotund or semicircular form, will assist the light and shade, and enable us to bring the principal figure in light, as well as to procure masses by combining the shadows of several objects in one. In this respect Raphael has displayed so much judgment, that it appears from his works evident that he would have proved a great master in light and shade had he been permitted

permitted a longer life: however, he did enough to furnish the hint to the Venetian school.

In whatever way we may dispose our group, the principal figure ought to be rendered conspicuous, either from situation, colour, drapery, light, or from all these combined. To talk about "effect of light and shade," and thereby attempt to justify an impropriety, would be reducing painting to a style merely ornamental indeed! and make paintings of no use beyond stopping a hole in the wall.

As in the drama the hero of the piece has a greater part to sustain to distinguish him, so ours must, 'as it were, lord it over all the other objects,

Nor paint conspicuous on the foremost plain
 Whate'er is false, impertinent, and vain;
 But, like the tragic muse, thy lustre throw
 Where the chief action claims its warmest glow:

MASON'S FRESNOY.

It must not be understood that the principal figure should be more laboured or finished; that would destroy the unity which ought to prevail through the whole. In forming our groups, the greatest mass ought to be in the middle, and the little or scattered parts placed on the edges to give the whole a lightness; while some places require to be left blank for the sake of repose—for, though our picture should be filled, it should not be crowded. As we must also seek to obtain profundity proportioned to the greatness of the group, we should, to give the whole a pleasing air from a variety in its form, avoid placing the figures in a file. Rubens, whose art in grouping his figures is great, sometimes runs into excess by attaching them too much together, so as to make them appear to cling as inseparable; but, as before observed, his vices teach us what is right. The golden mean must form the object of our pursuit, we should avoid a monotony of forms as well as too great a contrast; a number of extremities following each other in the same line will generally produce a bad effect. We should also avoid showing them in the same point of view. Poussin's Sacrament of Baptism is an excellent example, where many figures are pointing, all differing from each other.

In exhibiting the naked we are bound to show the most beautiful parts, which is, generally speaking, all the joints. The neck and shoulders in the male often form a fine mass in a group. But, above all, we should never conceal the extremities, from the power of expression they display, as well as the room they allow for the skill and abilities of the artist.

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In the female, the naked is ever pleasing, while an artful concealment will augment the beauty and grace.

But treat the goddess like a modest fair,
Nor over-dress, nor leave her wholly bare;
Let not each beauty ev'ry where be spy'd,
Where half the skill is decently to hide.

POPE.

If our story requires more than one group, the same laws must influence us in the conduct of each,—they should certainly not exceed three. The principal one should prevail over the others; and, by placing it near the centre, or in the second stage of the picture, we shall afford the spectator a better opportunity of seeing it, and also furnish ourselves a better opportunity of surrounding the principal group with the other objects.

As we are bound to support an equilibrium in our composition, we ought not to crowd one part of the picture, or leave another too naked; but this must be done without adding weight to weight in a horizontal or perpendicular form. The same holds of *chiaro-scuro* and colour, where mass must support mass.

The painter, speaking to the eye, should, in the choice of his subject, be careful that it admits images striking and grand: it should burst on the spectator like an unexpected peal of thunder. The horses in the pictures of Rubens add much to the dignity, as do also his fine light and shade. As in an epic poem, there should be but one action admitted in our picture: it should be an entire, and above all, a great one, and require no further aids to its illustration than what is contained in the picture;—it ought to explain the history, not the history the painting. As we are not confined to the mere letter of the story, we may use any means consistent with probability to illustrate our subject; as we once saw in a drawing of a triumph, where the artist, to show the cause was love, decorated a car and the shields with such objects as were symbols of that passion; and, further, to show it was connected with Theseus and the Amazons, in the tablet of an arch represented that hero's battle with those heroines: but enough! an ingenious mind will find a thousand ways of displaying itself.

Two actions or points of time should never be admitted in one picture. M. Angelo, in the Capella Sestini, has represented Adam and Eve eating the fruit, and expelled the garden, in the same piece! Raphael's Peter in prison, and delivery, can hardly be called one.

It must be obvious that the parts of each figure should agree

agree so as to produce a whole: for instance, a thin face should not be united with fat hands. The same unity is necessary between the figure and its attire, which should suit the degree and character of the person as well as be adapted to the age and sex.

We cannot do better than conclude this paper in the words of sir Joshua:—"My advice is this: keep your attention fixed on the higher excellencies. If you compass them and compass nothing more, you are still in the first class. We may regret the innumerable beauties which you may want: you may be imperfect, but still you will be an imperfect person of the highest order." That great man in another place, speaking of "the well grounded painter, says, "as his pre-eminence depends not upon a trick, he is free from the painful suspicions of a juggler, who lives in perpetual fear lest his trick should be discovered."

XVIII. *Observations on the Zodiac at Dendera. By the Rev. SAMUEL HENLEY, F. S. A.**

AS the report of C. Fourier concerning this zodiac and its high antiquity has made a deep impression on the minds of many, and the argument thence drawn has been deemed of great weight, in opposition to the Mosaic records and revealed religion, I send you the following observations, with the hope that they may reach those who otherwise might not see them, and have their effect upon a large class of readers, who may have too lightly acceded to Fourier's conclusion.

Denon, speaking of this zodiac as clearly proving the profound knowledge of the ancient Egyptians in astronomy, mentions the ruins which contain it, and are extant but twenty minutes ride from Dendera (antiently Tentyra), known at present under the Arabic name of Berbe. Concerning the etymology of this term, various opinions have been offered; but that by the learned De Sacy is most generally admitted. He conjectured it to have been derived from ΠΙ and ΕΡΦΕΙ, *the temple*.

Notwithstanding this conjecture was assented to by Michaelis, Wahl, and Zoega, it has been opposed by Harmann, who contends that Berba signifies a *pyramid* or *obelisk*. Though supported in this by Schultens, the interpretation rests in part on a conjecture of Herke, who for Barabi substituted Barami, which, however, in Arabic is plural; and

* Printed, with the author's corrections, from the Monthly Magazine.

on the persuasion that in Edrisi the description of Berba was more suitable to *pyramids* than *temples*. M. de Sacy replies, with considerable force, that Schultens would have done more justice to Michaelis, if, instead of indulging conjecture, he had opened some Arabic description of Egypt; for example, Macrizi's, where he would have found instances that the term could not signify *pyramids*. Accordingly, a passage is cited from that author which refers to the very place. "Of the number of Berba is that of Dendera, which is a wonderful edifice. It has 180 windows; each day the sun enters by one of these windows, and on the next by the following, till at length it reaches the last, and then returns in a contrary direction." Vassleb (*Nouvelle Relation en Forme de Journal d'un Voyage fait en Egypte*;) describes Dendera as the site of a wonderful temple of the ancient Egyptians—*d'une grandeur et d'une hauteur DEMESURE'E*; and visible at two leagues distance. He also, applying the account of Macrizi, and considering the windows as double, makes them to be as many as there are degrees in the zodiac; so that the sun, rising each day in a different degree, throws his rays through a different window, till, by thus completing his course, he finishes that of the year. For this reason, it is added, the temple is regarded as *wonderful*.

Taking these descriptions with the other compartments on the ceilings, given by Denon, one inference, drawn by M. Fourier, will be readily admitted, which is, that the state of the heavens they exhibit, corresponds with the date of the building. It remains then to determine, from the zodiac in question, what this date was. Denon, on his second visit, thus describes the temple:—"I went to the ruins, and this time took possession of them in the plenitude of repose. I was first of all delighted to find that my enthusiastic admiration of the great temple was not an illusion produced by the novelty of its appearance, since, after having seen all the other Egyptian monuments, this still appeared the most perfect in its execution, and constructed at *the happiest period of the arts and sciences*; EVERY THING IN IT is *laboured*, is interesting, is important. It would be necessary to draw the whole in its most minute detail, to possess ourselves of all that is worth carrying away."

The date of 15,000 years before the birth of Christ seems but ill to agree with this account, when contrasted with the ordinary remains of human efforts, and the uniform effect of human experience. The monuments of remote ages are more remarkable for their rude bulk than elaborate workmanship; but, if this be of the time assigned, it follows that, in the

united opinions of Denon and Fourrier, 15,000 years before Christ was *the happiest period of the arts and sciences*. So much for their joint decision!

Taking, however, this calculation independently of the structure itself, it is fairly admitted to be accurate, so far as it is founded on *equinoctial precessions*; but, reserving discussions on this head for a work shortly to be published*, it will be sufficient to observe that I had thence fixed the age of this zodiac to the very year and day *before the inscription ascertaining them was known*, and which has not, *even yet*, been explained.

The plate given from Denon † represents the zodiac in two compartments, as it exists on the opposite plat-bands of the portico of the temple. The two large figures that embrace the whole, he supposes, represent the year; and the winged emblem before their mouth, eternity, or else the passage of the sun to the solstices. The disk, at the joining of the thighs of the upper figure, he pronounces to be the sun, whence proceeds a beam of light that falls upon the head of Isis, which represents either the earth or the moon. "The sun," he continues, "situated in the sign Cancer, may perhaps show the period of the erection of the temple, whilst the figures joined to the signs may mean the fixed stars, and those in the boats the revolving bodies, the planets, and the comets." After offering these conjectures, this modest artist, under a conviction of their importance, resigns to others all further development.

Instead of adopting what Denon has conjectured, it will be proper to consider the zodiac anew. Accordingly, the female form bent over either division, is unquestionably the Isis, which by Horapollon is determined to be *the year*. The winged globe, according to Macrobius, is the sun commencing his course. The veil on the head of the Isis is that mysterious one which the famous inscription affirms no mortal had ever withdrawn. On the upper bend or shoulder of the lower figure are eight lines or units, denoting that the sun, at the cardinal points of the year, is in the eighth degree of

* A Disquisition on the Date, assigned by Fourrier, Commissioner of the Sciences and Arts in Egypt, to the ancient Zodiac there found; whence the extraordinary Darkness recorded by Phlegon, and that by the Historians of China, in the Reign of Quamvu, are identified with the Darkness at our Lord's Crucifixion; the Discordance between the Eclipse noted by Ptolemy, as seen at Arbela and Carthage, is accounted for; the further desideratum for ascertaining Longitude, required by the Board at Paris, in their Report on Burg's Tables, supplied; and hence, in Reference to the Prophecy of Balaam, the Birth of Christ is fixed.

† See Plate IV.

the sign; for so it is stated to have been by Manilius at the time of the Julian reform, and such was, according to Colamella, the adjustment of the Metonic cycle, compared with the tables of Hipparchus. The four stars, of eight rays each, are the dog-star, which governed the Egyptian year, and, being eight months visible in the upper hemisphere, had a month assigned to each ray, as the sun has twelve rays to designate the months of his course. These four stars here signify a quadrennium, when, in the Roman year, an additional, or bissextile day, was added to the 365 days, which constituted the Egyptian. Beneath are twelve other units, as making, in the bissextile year, the solar to exceed the lunar twelve days instead of eleven. The little circle, with wings, on the breast of Isis, marks a new but subordinate procession of the sun's course, after the quadrennium has been completed. The waving lines extending along the figure are the Egyptian hieroglyphic for flowing water; while the line of stars—each marking, by its six rays, as many portions of time, and, with the square comprising them, the square of that number—severally indicates four times six hours, or a day. These, amounting to seventy-nine, express two months or lunations, and twenty days over, which correspond to the two lunar months added by Numa to the Roman year; and, with the twelve days allowed as above, compensate for the difference between the ordinary lunar year and the solar bissextile, while eight days, answering to the sun's advancement in the sign, complete the given number. From the bend of the leg downward, five days are so disposed as to show the five supplementary days above twelve months, of thirty days each, that constitute the Egyptian year. This is evident from the *hornless* beetle annexed, which was, among the Egyptians, an established hieroglyphic for a month of thirty days. The three stars on the band surrounding the legs, with the four on the shoulder, symbolizing conjointly seven years, give seventy-seven days as the difference between lunar and solar time, and thus represent at once the sixty-seven days which the year, by the reform of Julius, had gone back, with the ten days between the winter solstice and the first of January, or six days with which he lengthened the months in one part of the year, and four in the other.

Having recourse to the Isis of the upper division, it will be found, that, instead of eight units on the shoulder, she exhibits but seven, whereas the last of the four stars beneath them wants two of its rays, and the units which follow are not twelve but eleven. To account for these variations, let it be observed, that, before the Julian reform, the Roman year being

being lunar, a month of twenty-two and twenty-three days alternately, named Mercedonius, was inserted after the 23^d of February, to adjust the lunar reckoning to solar; but, as in the year of the Julian reform, the twenty-three days were included, there would of course be one day's advance on the calendar computation, which would leave but seven days by the lunar account for the sun's place in the sign; whence the eleven units below would answer to the ordinary differences between the lunar year and the solar; whilst the two rays, deficient in the fourth of the stars, would point out the commencement of the lunar year at Rome on the 1st of March, and the solar of Julius on the 1st of January; or, in other words, would correspond to the augmentation of the year, computed backward, which Numa had made. The stars in squares, as before, designating days, which, to the bend of the leg, amount to sixty-seven, answer to the beginning of the year gone back by the Julian computation, while the seven in addition correspond to the sun's place in the sign, which, with the five supplementary days round the legs, make the twelve days in the last year of lunar intercalation, and, as the four divisions between them show, are coincident again with a quadrennium.

Perfectly congruent with the whole is the pyramidal figure, having a globe or sun at its top. It consists of eleven gradations, which answer to the eleven days between the solar and lunar year, and the ninety-nine divisions upon it discriminate the ninety-nine days from the winter solstice, by which Julius adjusted his reform, to the commencement of the Roman year on the 1st of April. Between, however, the Roman 1st of March and the 1st of April a month was left out, or, in other words, had gone back a sign. This is here expressed by the recess of Cancer from the zodiac, and agrees with Virgil's commencement of the year with Taurus:

*Candidus auratis aperit quum cornibus annum
Taurus—*

the precise time of which is defined by what immediately follows:

—————*et adverso cedens Canis occidit astro.*

If, now, the setting of the dog-star be placed, according to Petau, on the fourth of the kalends of May, and the sixty-seven days which the Roman year had gone back at the Julian reform, thence reckoned, we come to the 26th of February, or 1st of Thoth, at the commencement of the era of Nabonassar, which was that likewise of the Egyptian year. The changes in the Roman year having varied its form, in respect to its length, as well as the number of its months, and the days

days in them, it had accordingly receded two lunar months, and eight days over, making in the whole sixty-seven, and so fell on the 27th of April, or day of the dog-star's setting, whence the 28th of March would be the first of Aries; but as, according to Hipparchus, compared with Meton and Manilius, Julius Cæsar's year placed the sun in the eighth day of the sign, these eight days allowed, will fix the beginning of Aries at the vernal equinox, and 21st of March.

The anomalies of the Roman year being settled by the year of Nabonassar, or the Egyptian, it becomes evident, from the pyramidal figure, with the sun on its summit and the cavern beneath, signifying the *vacant interlunar cave* of the moon; that the horns of the Pan, symbolizing the horizontal beams of the dog-star, or completion of the canicular year, are placed on the common boundary of the eighth and third gradation, or day, in the eleven, which indicate the difference between lunar and solar time, or 365 and 354, to distinguish the eight days for the excess beyond the two lunations, and the three other days corresponding to the difference of the Roman lunar year, ending at the 23d of February, and the year of Nabonassar beginning on February 26, which was the first of Thoth by Egyptian reckoning.

The bandages round the head of the Pan express the same, with other notes of distinction; for, whilst the uppermost fold has eight points corresponding to eight days, as before, the second exhibits five units, to denote the five Egyptian supplementary days, which, with the five points between them, indicate ten days, as corresponding with the winter solstice, December 21, whence Julius commenced his reform, and the 1st of January, or his new year's date.

But as, under this reform, the Egyptian year corrected the Roman, so the Roman year, thus corrected, was made by Augustus the standard of the Egyptian; for, as that consisted only of twelve months, of thirty days each, with five days in addition, its commencement receded one day on every quadrennium; consequently, from the year of Nabonassar, and that of the reform of Augustus, by Julian reckoning, sixty-four days twelve hours (the year of Nabonassar, which was the Egyptian, beginning at noon, according to the canon of Ptolemy), will show that the first of Thoth, five interceding days being allowed between the Julian correction, taken as beginning from 707 of Rome, and that of Augustus, established in 725, the bissextile four days twelve hours (or, reckoned from midnight, five days), had varied from the 21st of June, or summer solstitial noon, to the 29th of August, three in the morning, at which time Augustus had fixed it:

for sixty-four days twelve hours and four days twelve hours making sixty-nine days, and exceeding the sixty-seven days of Julius by two, Augustus intercalated between the year 709 of Rome, when Julius's reform was completed, and his own, sixteen years after, one day every third year instead of every fourth; and so, instead of four bissextile days, six were inserted. Between three in the morning, when the dog-star rose, and twelve at noon, when the sun was on the meridian, were nine hours to complete the canonical day; these are accordingly expressed by as many lines on the last fold of the bandage winding round the forehead of the Pan.

Having then found, by these discriminations on the zodiac, the opening of the year, from the rise of Taurus, at the setting of the dog-star, which is exemplified by the solar circle in a crescent on the bull's neck, it will be seen that the Thoth thence proceeding is represented as a bull in a boat (for the heavenly bodies, which were the Egyptian divinities, were held to perform their revolutions in this manner), and as it has been seen from the star deprived of two rays on the shoulder of the upper Isis, as well as from the two months difference between the year of Romulus and Numa's, that the sun's place had been altered two signs, the third boat or month proceeds from Gemini to Cancer: accordingly, the foremost figure in it represents a priest taking auguries from the rise of the star, whilst the other is evidently Aquarius, or the overpowering of the Nile, at the apparent new moon of Cancer. But Cancer withdrawing from the zodiac, the overflow falls in with Leo; and here, accordingly, Harpocrates appears as on the day answering to bissextile, which is also intimated to belong to that year by the six leaves on the head of Aquarius, or the Nile. This being suppressed in the Egyptian kalendar, makes Cancer and Leo run into each other, or confounds the last day of one with the other's first. The figure preceding Leo has the star of five rays, which, indicating five months, marks Leo as the fifth sign, whilst the serpent, rising from under his feet, exhibits the Nilotic year thence beginning, as does the serpent behind the Harpocrates, with his head erected from the fourth fold, a quadrennium. The rising and setting dog-star follow, as thus corresponding in respect to fixed and moveable time. From the overflow of the Nile, in the sign Leo, we are brought on to the commencement of the year in Virgo. This is expressed by the torch with two flames, followed by a priest taking auguries at the year's beginning, which the bull's head, whose horns symbolize the apparent new moon, and star of five rays above them, sufficiently evince. This also

does the hawk, or reviviscence of nature, with a dog's head, and the two units above the same star. The two figures with stars, to intimate the five months between the rising and setting Dog, introduce Libra. The pedestal beneath the scale, with the sun on it, and a sitting figure, as if watching its shadow, under the index of the equinoctial balance, together with the sun behind, and the other attendant figures, denote the Thoth, or new year's day, beginning from that sign; whilst the fourteen articulations in the tail of the dog will be found to agree with the fourteenth year of the solar cycle, concurrent with the first lunar, when the sun entered Scorpio. The hieroglyphics next succeeding, characterize again the beginning of the year, for such are the hawk, crowned with the lotus; the wolf, sacred to the sun; and the cerastes, rising from an oar. The figures of the rising and setting star are intelligible as before. We now come to Sagittarius, an hieroglyphic, composed of a human body, with a bifrontal head of a man and a lion; the Nilotic plant, which indicates the overflow, proceeding from the veil under which both are united. The arrow on the bow is the first beam of the year, whilst the chest, fore-legs, and body to the wing, belong to Pegasus, or the horse of the morning. The hind parts of the wolf complete the reference to the new moon of Thoth, commencing from the dawn. The two divisions on the wing serve to express the distinction of the lunar and solar difference, which answers to the eleven feathers, whilst the twelve intercalations between the wing and tail of the wolf, on which a raven is seated, agree with the obtrusion of the lunar intercalation on the common form of the solar year. Over the wolf's tail is a star of five rays, pointing at the distance between the moveable and fixed Thoth, whilst the priest, under the mask of a hawk, the symbol of a commencing year, immediately follows, and, with an arrow, or first beam of the rising star, stops the further progress of the bull, which, to express the *moving* Thoth, has an hind-leg joined to his head. This symbol, indeed, with the two next that follow, is a certain key to the whole, inasmuch as they distinctly mark the fixing of the first of Thoth, the dog holding the bull's leg by a chain of nine links, ending with the star of five rays as before, whilst five of these stars, surrounding the Taurine symbol, decide their established import. The one between the horns intimates the original rise at the first of April in the Roman lunar year, at the apparent new moon, that is, the moon on its second day, to which add the intercalary month Mercedonius, and the difference is obtained of the sun's entrance on the sign, April 20, which accords

accords with the Roman commencement of the year on the Palilia. Hence, Aries is again found on the 21st of March. In perfect congruity with this is the chain of nine links annexed to the star. For, as the sidereal revolutions in a year, from meridian to meridian, are 366 days, there will consequently be a day gained by sidereal reckoning: hence, as the sun enters capricorn on the 22d of December, at noon, these nine days ascertain the difference between that time and the noon of the 1st of January, and thus account for the difference of ten days by the kalendar of Julius when he reformed the Roman year.

Having then found, in this zodiac, the key to the reforms of the Roman year, we have also the clue to that of the Egyptian, introduced by Augustus in the year of Rome 725, corresponding to the year of Nabonassar 720, and making the difference of bissextiles six Egyptian months, or 180 days; but these carried back from the 29th of August, or fixed Thoth, go to the moveable Thoth on the 26th of February. Thus, then, have we the two Thoths, before and behind Capricorn, and these 180 days, from the sun's entrance into Capricorn, with the four bissextiles between the reform of Julius and Augustus, fall in with the summer solstice on the 21st of June.

But it will be remembered that one of the dog-stars on the shoulder of Isis was defective in two rays, and that Numa augmented by two months the Roman year: if, in retrocession from Capricorn, these two months be cut off, we are stopped at the 21st of August, and thence, eight days allowed for the sun's advance in the sign, we are brought again to the 29th. To this month Augustus gave his name, and Capricorn was his appropriate symbol. Suetonius relates of him, that, on consulting in his youth Theogenes, the mathematician of Apollonia, when the circumstances of his birth were made known, Theogenes rose, surprised, and adored him. The reason of this conduct I shall elsewhere explain; but here it will be proper to observe, that, on the celebrated gem of this emperor's deification, the sign Capricorn is placed in a circle, with the dog-star behind, which, as five only of its rays can be seen, the others suppressed, will accord with the difference between the 1st of January and April, reckoned one way, and, as Augustus was born on the 23d of September, adding the difference between lunar and solar time (the Roman year being then lunar), to the 1st of January in the other. The absent three rays being thus accounted for, it will be obvious that the remaining five relate to the distance between the 23d of September and the 19th of February,

bruary, to which the four bissextile days again included between the Julian and Augustan reform, came to the 23d, when the Roman lunar year was intercalated; and again, from the 19th day of February, the eight days in the sign reach that of the 1st of Thoth, the year being bissextile, and the excess of sidereal days, from noon to noon, allowed.

It remains to observe, that, in adjusting the Roman mode of dating to the Egyptian, there is a nominal difference of three years, which will be found to be but nominal upon comparing the canon of Ptolemy. Hence what, in Roman reckoning after the reform of the kalendar, appears to be the 722d year of the city, contrasted with Egyptian time, will fall into the 725th: now, as Augustus was in his thirty-first year, when he fixed the 1st of Thoth, in the 725th year of Rome, and made this his *first* year in Egypt, the two years from that of Antony preceding were considered as suppressed. This the annexed table will show:

Year of Rome from the 21st of April.	Era of Augustus at Alexandria, from the fixed new moon of Thoth.	Dates of the Roman Empire from Coins.	First of Thoth fixed to the 29th of August, and, in bissextile years, to the 30th. The asterisks mark the bissextile.
722		A	The date commencing from Antony and New Rome.
723	*		Battle of Actium on the 5th of Thoth. Alexandria taken in the month Mefori.
724	1		The death of Cleopatra, and beginning of the Cæsars, afterward styled of Augustus, in Egypt
725	2	B	The years of Augustus began to be stricken at Alexandria on coins
726	3	Γ	The beginning of the æra of the Augusti at Rome, from the kalends of January, A. U. 727.

Thus, then, as Augustus is stated to have been born in the year of Rome 691, when the Roman year is referred to Egyptian reckoning, it will be seen that, in Roman computation, his 31st year fell into this year of reform. In perfect consistence with this, and all that has been adduced, is an inscription on the southern portal of the very temple in which this zodiac exists, and which, though hitherto *unapplied*, is given by Denon. It is rendered by Mr. Aikin thus:

“ On account of the emperor Cæsar, god, the son of Jupiter,

pitier, the deliverer, when Publius Octavius being governor, Marcus Claudius Posthumus commander in chief, and Tryphon general, the deputies of the metropolis consecrated, in virtue of the law, the Propylæum to Isis, the greatest of the goddesses, and to the associated gods of the temple, in the 31st year of Cæsar." Here the inscription breaks off, but, in the Greek, the two words ΘΩΤΘ ΣΕΒΑΣΤΗ follow. For these the French translator unaccountably substitutes—*Le College des Prêtres à l'Imperatrice*, whereas it simply signifies *on the sacred Thoth*.

It will now suffice to add, that the nineteen boats under the zodiac exhibit the nineteen years of the Metonic cycle; and to ask, Where *now* are the 15,000 years *before Christ* of the commissioner Fourier?

XIX. *Memorandums, Hints, Precepts, and Recipes, for the Use of Artists, Manufacturers, and others; including various short Processes either new or little known*.*

[Continued from Vol. xi. p. 149.]

Cements for Derbyshire Spar and other Stones.

I. **A** CEMENT for this purpose may be made with about seven or eight parts of resin and one of bees wax melted together, with a small quantity of plaister of Paris. If it is wished to make the cement fill up the place of any small chips that may have been lost, the quantity of plaister must be increased a little. When the ingredients are well mixed, and the whole is nearly cold, the mass should be well kneaded together. The pieces of spar that are to be joined must be heated until they will melt the cement, and then pressed together, some of the cement being previously interposed.

II. Melted sulphur applied to fragments of stones, previously heated (by placing them before a fire) to at least the melting point of sulphur—and then joined with the sulphur between, makes a pretty firm and durable joining.

Little deficiencies in the stone, as chips out of corners, &c. may also be filled up with melted sulphur in which some of the powder of the stone has been mixed.—Heat the stone first.

* Communications of practical approved recipes and useful hints are requested from our correspondents. We take this opportunity of thanking Messrs. Gill, Poppys, and other friends, for their favours in this way.

Temporary Cements, &c.

Workmen are often at a loss for such a cement as will hold firmly till they have no further occasion for it, and yet be easily parted when it is necessary; as in fixing glass plates to blocks to be ground for optical purposes, joining metallic plates to be turned in a lathe, &c. For such purposes a cement composed of the following ingredients will be found to answer well:

III. To four ounces of resin and 1-4th of an ounce of bees wax melted together, add four ounces of whitening (washed carbonate of lime or chalk) made previously red hot. The whitening should be put in while yet hot, that it may not have time to imbibe moisture from the atmosphere. This makes a good cement for holding optical glasses on the end of a mandril while grinding, or for similar purposes.

To cement plates of metal to the chucks of a lathe in order to turn them, the chuck should be heated, which is commonly done, by directing the flame of a candle upon it urged by a blow-pipe; the metal should also be heated in the same manner until they will melt the cement applied to them. The pieces, being then placed in contact, are adjusted centrally while the cement cools, either by holding a pointed stick in a small hole previously made in the centre of the plate by a prick punch, or by pressing a piece of wood laterally against it. When cold it will be held firm enough, by means of the cement, to bear being turned, and may be disengaged at any time by again heating it.

IV. Pitch, resin, and a very small quantity of tallow, melted together, and thickened by stirring in dry brick-dust, is employed by chasers of gold and silver articles to support and hold their work.

This mixture forms a cheap cement useful for many purposes, as fixing small steel articles on the blocks destined to hold them for polishing, and is much used at Birmingham. The proportions of the ingredients depend on the heat of the weather and the particular purpose in view. In winter, a larger portion of tallow is necessary than in summer.

V. Shell-lac is a very strong cement for holding metals, glass, or precious stones, while cutting, turning, or grinding them. The metal, &c. should be warmed to melt it.

For fastening ruby cylinders in watches and similar delicate purposes, shell-lac is also very excellent.

Memorandum.—Bees wax mixed with a little colethar (red oxide of iron) makes a good polishing tool for lenses:
use

use a little finely-washed colcothar mixed with water for the cutting material, applied between the tool and the lens.

VI. *White of Eggs*

mixed up with a little quicklime (or a bit of chalk burnt in a common fire and pounded) makes a pretty good cement for glass and porcelain. It is not absolutely necessary that the chalk be burnt, though it is generally used so.

Gum Arabic Cements:

VII. Gum arabic dissolved in as small a quantity of water as may be, and diluted to a proper consistence with gin or any proof spirit, forms a very useful cement for all purposes where gum water is commonly used, the spirit preserving it from becoming putrescent. As the spirit evaporates, more should be added. It should be stirred and mixed together at the time of using. 2. If plaster of Paris be added to gum water, it makes a cement useful to ladies in filligree works.

VIII. Gum ammoniac added to the solution of gum arabic in proof spirits very much improves the cement. It answers very well for joining broken glass and porcelain articles of ornament.

IX. *A fine transparent Glue.*

Shreds or parings of vellum or parchment, boiled for a sufficient length of time in soft water, dissolve at last into a very transparent glue. White leather, that is, skins dressed with alum instead of being tanned, will answer the same end.

Isinglass Cements.

X. A useful cement is made of this substance by either dissolving it in any proof spirit by heat, or by adding to it, when dissolved in water, an equal quantity of alcohol.

XI. An improved cement may be made by adding to the isinglass, previous to its solution in proof spirits, one third part of its weight of gum ammoniac. Expose the mixture to a boiling heat until the isinglass and gum are dissolved, and until a drop of the composition becomes stiff instantly as it cools. It will at any future time melt with a degree of heat little exceeding that of the human body, and, in consequence of so soon becoming stiff on cooling, forms a very valuable cement for many purposes, particularly for the very nice and delicate one of fixing on the antennæ, legs, &c. of insects in cabinets of natural history.

The easy melting of this cement is no objection to its use in cases where the articles themselves may afterwards be exposed to moderate heat; for it owes this property only to the

presence of the alcohol, which evaporates very soon after it has been applied.

When used to join broken glass or china, the pieces to be joined should be previously warmed. Immersion in hot water will give them a sufficient degree of heat. Wipe off the water before applying the cement, which may be laid on with a pencil: then press the pieces together, binding them with a string or a bit of soft wire if necessary.

XII. *Japanese Cement, or Rice Glue.*

This elegant cement is made by mixing rice flour intimately with cold water, and then gently boiling it. It is beautifully white, and dries almost transparent. Papers pasted together by means of this cement will sooner separate in their own substance than at the joining, which makes it extremely useful in the preparation of curious paper articles, as tea-trays, ladies' dressing boxes, and other articles which require layers of paper to be cemented together. It is in every respect preferable to common paste made with wheat flour for almost every purpose to which that article is usually applied. It answers well, in particular, for pasting into books the copies of writings taken off by copying machines on unsized silver paper.

With this composition, made with a comparatively small quantity of water, that it may have a consistence similar to plastic clay, models, busts, statues, basso-relievos, and the like, may be formed. When dry, the articles made of it are susceptible of a high polish: they are also very durable.

The Japanese make quadrille-fish of this substance, which so nearly resemble those made of mother-of-pearl, that the officers of our East Indiamen are often imposed upon.

XIII. *Glue of the Laplanders.*

The bows of the Laplanders are composed of two pieces of wood glued together; one of them of birch, which is flexible, and the other of fir of the marshes, which is stiff, in order that the bow when bent may not break, and that when unbent it may not bend. When these two pieces of wood are bent, all the points of contact endeavour to disunite themselves, and to prevent this the Laplanders employ the following cement:—They take the skins of the largest perches*, and, having dried them, moisten them in cold water until they are so soft that they may be freed from the scales, which they throw away. They then put four or five of these skins in a rein-deer's bladder, or they wrap them up in the soft

* It is probable eel-skins would answer the same purpose.—ED. T.

bark of the birch-tree in such a manner that water cannot touch them, and place them thus covered into a pot of boiling water, with a stone above them to keep them at the bottom. When they have boiled about an hour they take them from the bladder or bark, and they are then found to be soft and viscous. In this state they employ them for glueing together the two pieces of their bows, which they strongly compress and tie up until the glue is well dried. These pieces never afterwards separate.—*Transactions of the Academy of Sciences at Stockholm.*

XIV. Jewellers Cement.

In setting precious stones, pieces are sometimes broken off by accident. In such cases they often join the pieces so correctly, that an inexperienced eye cannot discover the stone to have been broken. They employ for this purpose a small piece of gum-mastic applied between the fragments, which are previously heated sufficiently to enable them to melt the interposed gum. They are then pressed together to force out the redundant quantity of gum.

In the same manner cameo heads, but without any ground, made of paste (white enamel or coloured glass) are often cemented on a piece of real stone to serve them for a ground, producing the appearance of a real onyx, from which they can with difficulty be sometimes distinguished.

Backs are also cemented to stones in the same manner, to change their hue. That is, behind a transparent stone the colour of which is wished to be altered, a thin plate of a stone of a different colour is cemented, which alters the colour of the refracted light to a mixed tint partaking of that of both. In this case, the surfaces to be joined are previously ground as flat and true as possible. They are called *dou'lets*.

XV. Turkey Cement for joining Metals, Glass, &c.

The jewellers in Turkey, who are mostly Armenians, have a curious method of ornamenting watch-cases, and similar things, with diamonds and other stones, by simply glueing them on. The stone is set in silver or gold, and the lower part of the metal made flat, or to correspond with the part to which it is to be fixed; it is then warmed gently, and the glue applied, which is so very strong that the parts never separate. This glue, which may be applied to many purposes, as it will strongly join bits of glass or polished steel, is thus made:

Dissolve five or six bits of mastic, as large as peas, in as much spirit of wine as will suffice to render it liquid; in another

other vessel dissolve as much isinglass (which has been previously soaked in water till it is swollen and soft) in French brandy or in rum, as will make two ounces, by measure, of strong glue, and add two small bits of gum-galbanum or ammoniacum, which must be rubbed or ground till they are dissolved: then mix the whole with a sufficient heat; keep it in a phial stopp'd, and when it is to be used set it in hot water.—*Eton's Survey of the Turkish Empire.*

XVI. The process above described may be simplified by adding the gum-ammoniac to the isinglass during its solution in proof spirit, and exposing the mixture to a boiling heat until it is dissolved, when the solution of mastic in alcohol may be added. The gum-ammoniac previously dissolved with the isinglass promotes the union of the mastic with the mucilage. This cement has been tried in London, and found to answer well: it stands against moisture.

Cements which resist Moisture.

Generally speaking, all cements into the composition of which gum-lac or mastic enters, of which we have already given some, possess this property.

XVII. A cement of this kind may be made by dissolving isinglass in proof spirit, to which must afterwards be added a solution of shell-lac in alcohol.

XVIII. Another cement, which will also resist moisture, may be formed by melting by heat, without water, common glue with half its weight of resin, to which must be added some red ochre to give it body; it is particularly useful for cementing hones to their frames.

XIX. Carpenters employ a cement in framing sign-boards, &c. to stand the weather, which they make by adding to a pint of well made common glue (made with water) an eighth part of that quantity of boiled linseed oil, dropping it into the glue gently, and stirring it all the time.

XX. White lead ground up with boiled linseed oil to the consistence of paint, makes a good cement for joining broken porcelain, earthen ware, and glass articles destined to hold water, &c. After the cement is applied, between the pieces they should be pressed home to each other as close as possible. The closer the better; nor need any fears be entertained that enough of cement will not be left in the joint; for the thinnest film that can be interposed will hold firmer than a thicker one would. The articles should remain undisturbed for two or three months, and before using them the cement sticking on the outside of the joint should be carefully scraped off with a knife.

XXI. *A Cement that hardens under Water.*

Mr. Gad, in the 32d volume of the Memoirs of the Academy of Stockholm, states, that if clay and calces (oxide) of iron be plentifully mixed with oil, they will form a mass which will harden even under water.

XXII. *A Glue insoluble in Water.*

Leather-dressers or glovers glue, that of fish, and that prepared with linseed oil, ceruse, and red lead, which cements pretty strongly glass, stone, and wood, still leave room to wish for one of a stronger quality.

An excellent glue may be procured from cheese. Take skim-milk cheese, free it from the rind, cut it in slices, and boil it in warm water, stirring it with a spoon until it be reduced to a strong glue which does not incorporate with water. Then throw away the warm water, pour cold water over the glue, and knead it afterwards in warm water, subjecting it to the same process several times. Put the warm glue on a grinding stone, and knead it with quicklime until you have a good glue. When you wish to use this glue you must warm it: if it be employed cold it is not so strong, but it may also be used in that manner. This glue is insoluble in water as soon as it is dry, and it becomes so in forty-eight hours after it has been applied. It may be used for glueing wood, and for cementing marble and broken stone, and earthen ware. The joining can scarcely be discovered.

Baits also for catching fish may be made of it. Fish are very fond of it, and it resists water. Boerhaave observed that no menstruum dissolved cheese, not even aqua-regia.—*Transactions of the Academy of Sciences at Stockholm.*

XXIII. *A Cement that will stand against boiling Water, and even bear a considerable Pressure of Steam.*

In joining the flanches of iron cylinders and other parts of hydraulic and steam-engines, great inconvenience is often experienced from the want of a durable cement.

Boiled linseed oil, litharge, red and white lead, mixed together to a proper consistence, and applied on each side of a piece of flannel, previously shaped to fit the joint, and then interposed between the pieces before they are brought home (as the workmen term it) to their place by the screws or other fastenings employed, make a close and durable joint.

The quantities of the ingredients may be varied without inconvenience, only taking care not to make the mass too thin with the oil. It is difficult in many cases instantly to
make

make a good fitting of large pieces of iron work, which renders it necessary sometimes to join and separate the pieces repeatedly before a proper adjustment is obtained. When this is expected, the white lead ought to predominate in the mixture, as it dries much slower than the red. A workman, knowing this fact, can be at little loss in exercising his own discretion in regulating the quantities. It is safest to err on the side of the white lead, as the durability of the cement is no way injured thereby, only a longer time is required for it to dry and harden.

When the fittings will not admit easily of so thick a substance as flannel being interposed, linen may be substituted, or even paper or thin pasteboard; the only reason for employing any thing of the kind being the convenience of handling.

This cement answers well also for joining broken stones however large. Cisterns built of square stones, put together with this cement, will never leak or want any repairs. In this case the stones need not be entirely bedded in it, an inch or even less of the edges that are to lie next the water need only be so treated: the rest of the joint may be filled with good lime.

XXIV. *Another Cement that will stand the Action of boiling Water and Steam.*

This cement, which is preferable even to the former for steam-engines, is prepared as follows:

Take 2 ounces of sal-ammoniac, 1 ounce of flowers of sulphur, and 16 ounces of cast-iron filings or borings. Mix all well together by rubbing them in a mortar, and keep the powder dry.

When the cement is wanted for use, take one part of the above powder and twenty parts of clean iron borings or filings, and blend them intimately by grinding them in a mortar. Wet the compound with water, and, when brought to a convenient consistence, apply it to the joints with a wooden or blunt iron spatula.

By a play of affinities, which those who are at all acquainted with chemistry will be at no loss to comprehend, a degree of action and reaction takes place among the ingredients, and between them and the iron surfaces, which at last causes the whole to unite as one mass. In fact, after a time, the mixture and the surfaces of the flanches become a species of pyrites (holding a very large proportion of iron), all the parts of which cohere strongly together.

XXV. *Another Cement of the same Kind.*

Take two parts flowers of sulphur and one part sal-ammoniac, and mix them together with a little water into a stiff paste.

Take also borings or turnings of cast iron in the state in which they are commonly found in works where boring and turning are carried on, viz. mixed with sand, and sift them finely to get rid of the grosser particles.

When the cement is wanted for use, dissolve a portion of the above paste in urine, or in water rendered slightly acidulous, and to the solution add a quantity of the sifted borings. This mixture, spread upon or between flanches of iron pipes, or put into the interstices of other parts of iron work, will in a little time become as hard as a stone.

XXVI. *Blood Cement.*

A cement often used by coppersmiths to lay over the rivets and edges of the sheets of copper in large boilers, to serve as an additional security to the joinings, and to secure cocks, &c. from leaking, is made by mixing pounded quicklime with ox's blood. It must be applied fresh made, as it soon gets so hard as to be unfit for use.

We believe, if the properties of this cement were duly investigated, it would be found useful for many purposes to which it has never been yet applied. It is extremely cheap, and very durable.

[To be continued occasionally.]

XX. *On a new Method of making Cement for Terraces; and the Use of liquid Pitch to render them impermeable to Water, and secure from the Attacks of Frost.* By CASIMIR PUYMAURIN.

I SHALL not speak of the nature of the different lime-cements hitherto known, as they have been fully described by various authors; I shall only observe, that a cement ought to be hard, solid, and impermeable. To obtain a hard and solid cement it has been necessary to employ different bodies which, by their aggregation with lime, dissolved in water, speedily absorb the superabundant moisture, and furnish to the particles of lime diffused throughout the cement the carbonic acid necessary for rendering it solid, and regenerating it into calcareous earth.

Vitrified

Vitrified lava, natural and artificial puzzolana, the scorizæ of furnaces, pounded bricks, bone-ashes, have been the bases of all the cements hitherto made, and they have been obtained more or less solid. Cements composed in this manner have been attended with perfect success in the southern parts of Europe, little exposed to rain: they do not absorb the exterior moisture, and the frost has not power to dilate their pores or to destroy their aggregation.

The cements of Italy, Africa, Spain, and other warm countries, unite all those qualities which can be desired by the most exact observer; but in our rainy countries, exposed to very strong frosts, cements ought to possess a more essential quality than hardness or solidity, that is to say, impermeability. Cements composed of porous bodies cannot possess this quality: being hard, and having their greatest solidity during summer, the rains of autumn gradually penetrate to their interior parts, to reduce to powder that mass which a little before had the appearance of the greatest hardness.

The inventors of the most celebrated cements have seen their experiments fail because they neglected this essential quality. The interposition of a fat body was long ago employed. Pliny and Vitruvius recommend the thick part of oil, and oil itself; but these bodies employed alone can never answer the intended purpose. Oil with the lime of cement forms a saponaceous body soluble in water: the thick part of oil contains a very large quantity of mucilage, which water dissolves or carries off.

To preserve the bottoms of vessels, and to render them impermeable to water, resinous bodies have been employed, and particularly liquid pitch. I have thought that my cement should be covered with boiling pitch, as this resinous body penetrates its pores and renders it impermeable to water. One inconvenience, however, appeared in the use of pitch, which is, its property of becoming soft during the heat of summer. This inconvenience I remedied by besprinkling the pitch with powder of lime: the lime combines with the pitch, and forms on the cement an exterior stratum of new cement resembling the famous cement of the Romans called *maltha*.

All the merit of my labour consists merely in having first employed, for preserving cements and rendering them impermeable, a fat body capable of penetrating them, of filling up their pores, and of being insoluble in water.

I shall here give the method which I employ for making my cement; but I must first observe, that there cannot be one general method of composing cements, unless lime-stone and

and sand were every where of the same quality. The observer, therefore, must examine the nature of the composition of the lime he employs, and particularly the purity of the sand and siliceous matters: he may then vary the doses of the materials of his cement as may be necessary.

Every method of making cement requires, in general, that the puzzolana, pounded brick, and scoriæ, be reduced to fine powder and sifted. This precaution is necessary for cement which is not to be covered with a resinous body: its surface thereby becomes smoother and more compact, and it is less liable to be penetrated by moisture. But this advantage is more than compensated by the fissures and cracks occasioned by the shrinking of the cement. This shrinking does not take place in cement made according to my method, because I employ all the matters hard, coarsely pounded, and in fragments of the size of a grain of wheat, and often as large as peas. These fragments broken in this manner present a great number of angles and cavities into which the calcareous part penetrates, and thus forms a kind of connected chain, which prevents those cracks and fissures so prejudicial to cement. The lime which I employed was made from hard and white limestone of the hill of Cazeres, in the department of the Upper Garonne: this lime dissolves with a sort of ebullition and a great heat, and after its solution forms a white paste without any mixture of gravelly parts: it is susceptible of swallowing, as the masons here term it, a great deal of sand and other hard matters, but it has less strength in the open air than meagre lime, which being made from marly stone contains in its composition a great many baked and vitrified argillaceous matters, which give it great strength when exposed to the open air and to water. This lime, called in the country *chaux de Bourret*, requires little sand, because the calcined and vitrified earthy parts which it contains form with it already an intimate mixture, or a kind of cement: this lime, therefore, dissolved in water, acquires in a little time the hardness of stone.

The lime I employed then was perfectly pure, without any internal mixture of heterogeneous parts, but which has no great solidity when exposed to the open air.

I found that a fifth part of lime was sufficient to give to cement that connecting quality necessary to envelop all the vitrified and siliceous parts of a calcareous stratum, and, consequently, to give it the greatest solidity. Such is the process I employed to form on a roof, constructed for two hundred years, the joists of which were at a great distance from each other, a terrace of forty square fathoms, which still exists,

and has withstood four severe winters and our scorching summers.

One precaution which I did not take, and which embarrassed me a good deal, was to pound the limestone before it was employed. The stone dissolves in water; but some stones being less calcined than others, their nucleus does not dissolve, and only becomes penetrated with moisture. When these are blended with the gravel and siliceous matters employed, at the end of some days the cement blisters and splits into small fragments, and bits of the lime which have not been dissolved are found in the state of lime flaked in the open air.

Take two measures of river pebbles well washed, or fragments of brick of the size of a nut; two of tiles and iron scales coarsely pounded, one of river sand perfectly well washed, and a measure of the lime of Cazeres, just from the kiln, and pounded.

Form a circle with the sand, and throw into the hollow the lime which has been flaked, taking care to mix it thoroughly: when the lime is well diluted leave it in that state for three hours in order that the whole lime may be dissolved; then mix with it gradually the river pebbles, the iron scales, the tiles, and the sand. This mortar must then be worked for half an hour, that every siliceous stone and fragment of tile may be well incorporated*.

Such is the manner in which I prepare cement. There are two methods of employing it; either above a pavement of brick, or below it. The former appears to be the most solid during the first year, while the other suffers the rain water to filter through it, but at the end of a certain time it acquires the most perfect solidity.

As time destroys the timber on which the mortar is placed, when a terrace is intended to be made on a floor it must be coarsely covered with sand and clay: when this covering is dry, another, composed of mortar and pretty fat sand, must be placed over it: there is no necessity for cutting the bricks, and the upper surface must be rough or notched with a chisel. This pavement must have an inclination sufficient to make the water run off.

In the month of July, when the two coverings are very dry, the cement composed in the above manner must be applied in bands of two feet in breadth; two workmen are sufficient. This stratum of cement ought to be from two

* When the cement is almost finished throw over it about a bushel of quicklime in powder. The mortar then becomes very difficult to be stirred. Or two pints of milk of lime are then to be added, which will penetrate the cement in every part.

inches and a half to three in thickness; the covering on which it is placed ought to be moistened with milk of quicklime; and the cement must be pressed down closely with the trowel, taking care to beat it with the sharp edge of that instrument. It is smoothed by the back of the trowel slightly moistened. The surface of the cement must be again pressed down, to bury the coarser parts and render the whole smooth. When the first band is finished the workman proceeds to a second, and the two bands must be carefully united to prevent their separation.

This cement soon dries, and at the end of an hour can sustain a strong pressure. It must, however, be left seven or eight days; after which the surface of it is to be slightly moistened, and then pressed down and smoothed by means of flat stones in the same manner as marble is polished. This last precaution is essentially necessary, and the solidity of the cement will depend on the care with which it has been performed. When the terrace has been constructed in this manner, the aggregation of the cement becomes stronger, and its pores are smaller and less numerous.

In order that the cement may succeed perfectly, it must be made during the great heats of July, that the superabundant water may evaporate, and that it may be perfectly dry before the autumnal rains. At the end of August, boil pitch, such as that used for ships, and spread it over the cement by means of large brushes. As this coating would render the cement not fit to be touched during summer, this inconvenience may be remedied in the following manner:—Take lime, flaked in the open air and reduced to fine powder, and, having sprinkled it over the pitch, remove, by means of a broom, the superfluous part of the lime which does not adhere to it. This lime, by combining with the pitch, will form with it a very thin stratum of cement similar to the maltha of the Romans. At the beginning of October a second stratum of pitch and lime must be laid on.

The second method of employing the cement is to place it immediately over the stratum of brick and clay, and then to cover it with a pavement of brick, mortar, and sand. I have two terraces, fifteen fathoms in length and one and a half in breadth, which appear to me to have the greatest solidity. They are not so beautiful as those where the cement covers the brick; but they can stand every kind of friction or pressure.

After making a stratum of clay and sand, spread over it a stratum of cement four inches in thickness, well beaten, and

add pebbles somewhat larger than those employed in the preceding cement, and increase the dose of lime in proportion: the cement must then be beaten with clubs like those used for smoothing the walks in the neighbourhood of Paris. It is then to be left to dry for a month, after which the surface of it must be moistened with milk of lime; and the bricks are to be placed with good lime and sand.

It is not necessary that these bricks should be ground. I have observed that, by cutting, their strength is lessened, as it destroys their upper half-vitrified surface: nothing then remains below but an earthy surface, which is soon penetrated by moisture, and which is easily destroyed by frost. Care must be taken to fill up the joints with good mortar, which must be pressed in and smoothed by the trowel, and then pitched.

Terraces constructed in this manner suffer the water for some time to filter through them in small quantity. This water charged with calcareous particles stops up the pores of the cement; no more filtration takes place: and terraces of this kind have the greatest solidity, and are exceedingly cheap. This cement may be employed with advantage for the interior of apartments; it also may supply the place of pavements of cut bricks, and costs two-thirds less.

It must be spread over a pavement of rough bricks, or bricks picked with an instrument, to the thickness of an inch or nine lines. The pebbles may be omitted, and their place supplied by fragments of tiles and iron scales coarsely pounded: it is then to be pressed down and smoothed with flat stones, but before it is painted it must be suffered to dry for a month. It is painted and waxed in the same manner as brick pavement.

Such are the details of the cement I have employed, and which has been attended with complete success. But I shall here repeat, that the doses must be varied according to the greater or less purity of the lime and of the other matters employed; and the application of pitch is merely to prevent the infiltration of water, and the destruction of the cement by frost.

XXI. *A short View of the Craniognomic System of Dr. GALL, of Vienna.* By L. BOJANUS, M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Observers of Man.

[Continued from p. 84.]

13. *Organ of the Instinct of exalting oneself.*

THE organ in the middle of the interior edge of the parietals at the upper middle part, and a little towards the posterior of the head, gives us a true idea of the difficulties which oppose the researches of Dr. Gall, and at the same time furnishes us with a striking example of the happy opinions of this great observer.

He found this organ well expanded in the chamois goat, and still more in the bouquetin; he observed the same thing in several men distinguished for their pride. It was difficult to collect all these observations into one point of view. But when he considered that the chamois goat inhabits the most elevated peaks of the mountains; that the bouquetin always endeavours to ascend higher; and that pride, when attentively examined, is only a desire of being superior to others; he was persuaded that it must be this organ which produces these effects *different in appearance*, and he considered it as the organ of the instinct of exalting oneself.

The head of the proud man, carried upwards and backwards, tends still more to confirm this opinion.

[It appears to us that the picture of the proud man, contrasted with that of the humble and modest, renders the truth of this idea still more striking. In the former, every thing is directed upwards: the hair is highly frizzled; the head is elevated; the eye-brows are arched upwards; the eye-lids are raised; the shoulders are straight; he walks on tip-toe, and looks on every thing around as beneath him. In the latter the hair hangs down naturally; the eye-brows, eye-lids, and head, are lowered, the body and knees are slightly bent: in a word, every thing denotes submission, and that he has no wish of being above others.]

14. *Organ of the Love of Glory.*

If this organ is more extended on the sides, it forms that of the love of glory; an inclination very analogous to pride.

15. *Organ of the Love of Truth.*

The function of the organ which flows itself at the posterior and superior angle of the parietals is not entirely fixed by

Dr. Gall: he, however, has some reasons for considering this angle as the seat of the organ of the love of truth, but he has not yet collected a sufficient number of facts to be fully convinced of it.

[We find some difficulty in being persuaded that there is any truth in regard to this function ascribed by Dr. Gall to the last-mentioned organ. It appears to us that an organ placed in the middle of those with which animals as well as men are provided, cannot be destined to a faculty such as truth, which belongs only to the latter.

However, the case with this faculty is perhaps the same as with that of pride, which in animals undergoes a great modification: and we confess we have seen two men, one of whom, distinguished by great veracity, was furnished with this organ in the highest degree; whereas the other, who had a most extraordinary propensity to falsehood, was so destitute of it, that his head at that place instead of a cavity exhibited a protuberance.]

In the anterior and inferior part of the frontal bone Dr. Gall has found several organs the function of which is very important.

During his first researches he considered them as the organs of the different kinds of memory; but finding afterwards that they were not only reproductive but also productive, he was induced to consider them as the organs of a particular sense, and to establish on this observation the opinion, that memory in general is only the reproductive action of all the organs: imagination, on the other hand, is their productive action.

The spontaneous movement of the man who endeavours to recollect something, seems to have a relation to these organs. He carries his hand, as if involuntarily, to the base of the forehead. This action, though not perceived by the person who performs it, is however constant, and is never confounded with that already mentioned in speaking of the organ of courage.

16. Organ of the Sense of Locality.

The organ of the sense of locality occupies the anterior part of the frontal bone which corresponds to the protuberances above the orbits (*protuberantiae supra-orbitales*); it generally accompanies those crania which are distinguished by large frontal sinuses, and which always exhibit in the inside a cavity corresponding to an eminence of the brain.

When it acts reproductively it constitutes what we call the memory of locality (*memoria localis*); on the other hand, when

when it acts productively it determines the combinations of new localities.

It is this organ which directs the blood-hound, in which it is very striking: it exists in all the birds of passage: it invites them to change their place of residence; to undertake distant voyages; and to find again their former place of habitation: the stork and swallow are provided with it in an eminent degree, and these are the animals which migrate to the greatest distance from our countries. Men furnished with it are observed to have a strong remembrance of places, and a desire for travelling: it is therefore always found in able landscape painters.

“A general who arranges his army, and who with one look must observe all the localities of the country which it occupies, cannot dispense with this organ.” Of this, the great Frederick was a striking example. At an advanced age this organ is one of those which gradually decrease: it is known also that memory of every kind, and imagination, are lost as a man grows old: the frontal sinuses are then increased interiorly; the action of the brain no longer opposes so much resistance to their expansion.

17. *Organ of the Sense of Facts (Sensus Rerum),*

The sense of facts has its corresponding organ in the inferior and anterior part of the frontal bone, in the middle of and below the preceding: it acts productively and reproductively, and in the latter case it supplies a remembrance of facts and of things.

It is an organ very necessary for education and instruction, which absolutely require that one should remember things past: in old age it is subject to the same changes as the preceding.

Among animals the elephant is particularly distinguished by the expansion of this organ. This animal remembers, with the greatest accuracy, every circumstance and fact which has any relation to it.

Among men we have found this organ not only in those who had a great deal of memory in regard to facts and things, but also in those who might be called systematic heads, who arranged facts in order, and deduced conclusions from them; and in those who had a ready conception, and who distinguished themselves by a desire of knowing every thing. It even appears to us that the operation of combining facts to deduce from them a result is one of the principal actions of this organ: the elephant, at least, which keeps in its trunk water to besprinkle, as it passes, the person who offended it

the preceding evening, arranges several facts, and deduces from them a result which is a real logical conclusion; and we are acquainted with no other organ in the elephant to which this action can be referred.

The automatous motion of a man who perceives that he has acted wrong, seems to support these conjectures: he strikes the middle of the forehead with his hand.

18. *The Organ of Painting and of the Sense for Colours.*

The organ of the sense for colours or of painting occupies the anterior part of the frontal bone below the orbit. Dr. Gall has observed this organ in all painters of great talents.

“As this discovery did not reach us till lately, we have been able to collect only a small number of observations: we have, however, observed it in some individuals; and it is very apparent in the head of Raphael, in the National Museum, No. 57.”

19. *Organ of the Sense for Numbers.*

The organ which corresponds to the inferior and exterior part of the frontal bone near the zygomatic apophysis of that bone has the function of the sense of numbers: it exists in men who have a retentive memory for numbers, and in arithmeticians, who perform with great facility the combinations of calculation: it exists in that kind of pie which has the faculty of counting as far as nine; the only instance known among animals.

“We had occasion to observe this organ on the head of a blind person at the Quinze-Vingts, who is distinguished by his arithmetical talents; and Dr. Gall has in his possession the busts of several men which furnish very instructive examples.”

20. *Organ of the musical Sense.*

Below this organ is that of the musical sense, or sense of sounds. It acts in the same manner as the other organs, productively and reproductively; it gives a memory for recollecting sounds; it facilitates new combinations of musical compositions; it incites the birds to sing: it acts in those which are learning to speak, and whose language is founded only on this remembrance of sounds.

It is absolutely wanting in animals which have no musical sense; it is very apparent in the parrot and starling; and the great musicians Gluck, Mozart, Haydn, and Pleyel, furnish striking examples of it,

21. *Organ of the Sense for Mechanics.*

In the lateral and inferior part of the frontal bone is placed the organ of the sense for mechanics. The castor, which constructs

fructs edifices, is endowed with it in an eminent degree: it exists in the field-mouse, and in birds which build their nests with a great deal of art: it is found in men who have a talent the mechanical objects, who construct with ease any kind of machine, and who distinguish themselves in the different arts that require manual labour. Though it be very difficult to judge of the existence of this organ when it is only moderately expanded, "because the *temporo-maxillary* muscle covers this part of the cranium, it is very eminent if the faculty exists in a superior degree; and it is then one of those organs respecting which there can be the least doubt."

22. *Organ of verbal Memory.*

In the interior of the orbit at the bottom of the superior part is the organ of verbal memory; it may be observed at the time of its expansion by the influence it has on the position of the globe of the eye, which it always pushes forwards, and more or less without the orbit.

Persons provided with this organ easily retain words in their memory. Dr. Gall, when young, remarked this faculty in several of his schoolfellows, who were not only distinguished for this talent, but also for very protuberant eyes. This was the first observation, which afterwards gave a direction to all his researches. A great many observations in regard to this organ have since confirmed the truth of its existence and of its function.

23. *Organ of the Sense for Languages.*

The organ at the exterior and superior part of the orbit is called by Dr. Gall the organ of the sense for languages. Its presence has a considerable influence on the position of the globe of the eye: it forces it downwards and towards the nose, and increases its distance from the superior edge of the orbit: in animals it does not exist, and therefore in the latter the globe of the eye is directed more towards the exterior and lateral part of the orbit.

Its expansion is always accompanied with a distinguished talent for languages: it is very striking in great philologues; and though it be difficult to judge externally of its existence, we have observed that it has never escaped the acute eye of Dr. Gall, and that, in regard to this point, he has never once been deceived.

24. *Organ of Memory for Persons.*

The function of the organ at the upper and interior part of the orbit has not yet been discovered by Dr. Gall; but several

observations on man and animals, such as the dog and horse, have induced him to suppose it to be the organ of memory for persons. Its expansion, like that of the preceding, must have an influence on the position of the eye; it must contribute to remove it from the upper edge of the orbit, and to push it towards the exterior and lateral part, if an equal expansion of the preceding organ does not counterbalance its effect.

25. *Organ of Liberality.*

The organ of liberality is placed in the anterior part of the frontal bone, above those of the sense of locality and of the sense for painting (16 and 18), and close to the musical sense (20): a very great expansion of it accompanies prodigality: it is wanting in misers, and in these this part of the frontal bone exhibits a cavity. Dr. Gall has in his possession numerous examples of it.

“The proximity of the organ of music and of the sense for painting (18 and 2) seems often to favour the expansion of that of liberality; and this, perhaps, is one of the reasons why we so often find prodigals among those men who excel by their talents for these two arts.”

We constantly observe, that the older a man grows the more niggardly he becomes: at an advanced age, therefore, the diminution of this organ is so striking, that it sometimes gives rise to a very considerable extension of the frontal sinuses.

26. *Organ of the Spirit of Comparison.*

The organ above the sense for facts in the middle of the forehead is destined for a faculty which Dr. Gall calls the comparative spirit (*judicium comparativum*). It forms an oblong eminence, and is found in men who in speaking have a ready command of figures or tropes; who are not at a loss for expressions; who relate well, and have a great deal of loquence.

27. *Organ of the metaphysical Spirit.*

If this organ is more expanded towards the sides, so that it forms a round eminence which rises in the middle of the forehead, it indicates a metaphysical spirit. Among the busts of the ancient philosophers that of Socrates in particular affords one of the most striking examples of this organ. Among the modern philosophers, I shall mention only Kant, as one of the most celebrated.

[recollect that the forehead of one of my first schoolfellows, whom we styled the philosopher, on account of his attachment

tachment to the abstract sciences, exhibited a very sensible expansion of this organ.]

28. *Organ of the Spirit of Observation.*

The organ of the spirit of observation extends over the whole anterior part of the frontal bone, and its expansion brings the forehead nearer, in a greater or less degree, to the vertical line. It is found in particular in the crania of the observers of all ages. The celebrated physician Frank is endowed with it in an eminent degree; and Dr. Gall himself is evidently furnished with it.

29. *Organ of the Spirit of Satire.*

The organ of the spirit for satire and wit (*witz* of the Germans, and *facetie* of the French,) corresponds to the frontal protuberances. Dr. Gall observed several examples which prove the truth of this opinion; and we have never found it to fail.

30. *Organ of Mildness.*

The organ of mildness is situated in the middle of the forehead above that of the spirit of comparison (26). It forms that oblong elevation which is constantly found in the heads of Christ and Mary painted by Raphael and Coreggio, and greatly contributes to give them an engaging character of mildness and benevolence: it always accompanies the crania of men naturally mild, and is wanting in those who are malevolent and revengeful*.

Among animals, the roe-buck, hind, pigeon, &c. are provided with it: on the other hand, it is wanting in animals of prey, such as the eagle, warling, tiger, fox, &c. The frontal bone, then, instead of being arched and elevated, is depressed and hollow.

31. *Organ of Theatrical Talents.*

A very striking enlargement of the summit of the frontal bone arises from the expansion of the organ for representing sentiments by gestures, or of theatrical talents.

“Dr. Gall has collected many observations which prove the truth of this opinion; and it cannot fail to be observed by those who examine with attention the heads of the great actors of the different theatres of Paris.”

[We think we have observed also that this organ is particularly expanded in the deaf and dumb; and this we ascribe to the necessity which these persons are under of keeping it in

* That mildness which results from the principles of morality is not here meant, but that which exists by instinct, without being the consequence of moral reflection.

continual action—an exercise which must necessarily favour the improvement of it.]

32. *Organ of Theosophia.*

The organ of theosophia occupies the most elevated part of the frontal bone. All the representations of the old saints preserved to us afford very instructive examples; and if there be one destitute of this character, it is certain that it is also void of expression.

An *excessive* expansion of it is observed in religious fanatics, and in men become religious by superstition. It is the seat of this organ which, according to Dr. Gall, has induced all nations to consider their gods as above them in an elevated place in the heavens. When we consider, indeed, this object with a philosophic eye, there is no more reason for placing the deity above the globe than below it.

33. *Organ of Perseverance.*

The last of the organs hitherto found by Dr. Gall is that of perseverance, constancy, and firmness of character: it is situated at the anterior and superior part of the parietals in the middle of the head. When it exists in excess it gives obstinacy; and inconsistency is the consequence of a want of it.

“In regard to those parts of the cranium in which Dr. Gall has not yet found organs, it is probable that his further researches will some day enable him to discover more; and the work he intends to publish will furnish us with further details on the subject. It belongs therefore to him to convince us, in an incontrovertible manner, of the truth of his system, a detail of which cannot be satisfactory in a treatise so incomplete.”

We find it necessary to remark also, that all the organs here enumerated cannot be distinctly perceived but in individuals who possess any faculty in an eminent degree; and that it is impossible to judge properly of a moderate talent, when its organ is too much confounded with the neighbouring ones.

“In regard to the objections made to the system of Dr. Gall, that it *leads immediately to materialism*, we do not see the philosophical reasons on which it is founded. Even if we suppose organs for the interior faculties, the immense distance between thought and matter still remains the same; objects of so heterogeneous a nature are not susceptible of being classed together. Besides, the will still remains entire: it is it which ought to counterbalance the action of the organs; and the passions ought to be restrained by morality.

XXII. Letter from Count MOROZZO to C. LACEPEDE,
 Senator and Member of the French National Institute, on
 an Ichneumon brought from Egypt*.

IN the middle of April 1802, C. Aimet, chef de bataillon in the corps of engineers, brought to Rome a young ichneumon which he had caught in Egypt. I took the earliest opportunity of examining it; and, as I made some very interesting observations in regard to the natural history of this animal, I communicate them to you with pleasure.

The Greeks and the Romans called it the *ichneumon*: it is the *mangouste* of Buffon, and the *mus Pharaonis* of Prosper Alpinus. It is a pretty animal, about the size of a cat, with a long tail; its hair is rough and of considerable length; it cannot be compared to any thing better than the bristles of the wild boar. It is radiated transversely with three colours, viz grayish white, fawn or russet colour, and black. Each hair has five or six transverse rings, like the quills of the porcupine: the length of these hairs from the body is an inch or an inch and a half; they are shorter on the tail, and in particular at the head, which gives to the animal a neat appearance.

The head, and particularly the muzzle, are very small; it has beautiful teeth like those of the dog; two canine, six incisive teeth, and eight grinders in each mandible, making in the whole thirty-two. It has small ears of a brown colour without hair; they adhere to the head like those of apes. Its eyes are small and lively. An observation which I made in regard to the eyes will be mentioned hereafter.

Its colour varies a great deal according to the place in which it is viewed. When observed towards the side of the head it appears to be grayish black; when looked at behind, it appears to be reddish. The legs, and particularly those before, are short: it has five toes on each foot, four before and one smaller behind. The two middle toes on each foot are longer. The nails are black, like those of the dog.

The young ichneumon is very familiar and domestic: it is fond of being caressed; it is much afraid of cold; and though the temperature of Rome is very mild, it was gratified by having a covering now and then thrown over it; sometimes even a chaffing-dish was placed near it. Very often it lies down in a round form on a chair or on the bed, which

* From the *Journal de Physique, Mss. or*, an. 10.

it leaps upon with great agility, and conceals its head between its thighs to keep itself warm.

This individual is a female: it has below its parts of sex a large bag, which has been described by all naturalists: it is asserted that during the great heats it opens this bag in order to cool itself. Jonston gives a very good description of this conduit, which is as follows:—"Meatum denique extra foramen excrementi per amplum, undique pilis cinctus, pudendo muliebri non dissimilem, quem magno urgenti cætu operiri solet. Hinc scriptores omnes indiscriminatim ichneumones et mares et fœminas arbitrati sunt*." From this conduit an odoriferous liquor distills: the individual in question, on the approach of a dog, opens this bag, and the dog immediately retires: no odour however is perceived at the time. The measurement of the different parts, which I took from the animal itself, is as follows:

Whole length from the muzzle to the extremity of the tail	Foot	In.	Lin.
- - - - -	2	5	3

It wanted, however, a small bit at the extremity of the tail, which seemed to have been cut off, and which may be estimated at an inch or an inch and a half †.

Measures in Detail.

	Foot.	In.	Lin.
Length of the head	0	4	4
Length of the body	1	2	5
Length of the tail	0	10	6
<hr/>			
Total	2	5	3
Circumference taken at the thickest part of the body	1	0	4
Circumference of the muzzle below the eye	0	4	6
Height of the fore-legs	0	5	2

The figure given by Buffon is very good, and has a perfect resemblance to the individual here described. The figure of Aldrovandi is also very correct. The case, however, is not the same with those of Jonston and Prosper Alpinus.

In regard to the description which Buffon has given of the mangouste, it is traced out with the same pencil which has so well delineated the other animals: he has separated fable

* Jonston Hist. Animal. quad. p. 105.

† Kämpfer, in the description which he gives of the ichneumon or mangouste in his *Amœnitates Exoticæ*, p. 574, says that it was two feet and a half in length from the head to the extremity of the tail.

from history, and has described its habits with great propriety. Two observations, however, which I had an opportunity of making, and which appear of importance, seem to have escaped him.

1st. That the animal has a kind of interior eye-lid, which passes over the globe of the eye as in nocturnal birds; but with this difference, that in the eye of owls this membrane rises and falls in a direction which I would call perpendicular from the bill to the summit of the head, while in the individual in question it proceeds laterally from the nostrils to the ear; which induces me to believe that the animal seeks its prey in the night-time. By means of this interior eye-lid it contracts the pupil at pleasure, and it must then see in obscurity, like the cats; but in the latter the pupil is lessened and dilated by contraction; whereas in this animal the same thing is effected without contraction, and, as we may say, by mechanical means.

2d. That the four toes of the fore- as well as hind-feet are connected to each other by a brown membrane without hair, such as that of amphibious animals. I extended its toes and examined this membrane, which is folded backwards, so that when the animal walks it is not seen. This certainly indicates that the animal swims with great facility.

This character proves that it ought to be classed among amphibious animals. Jenson says of the ichneumon:—
 “Amphibium est animal et ad Niloticas ripas commoratur.”
 Aldrovandi also considers it as amphibious: his words are:—
 “Ab ordinis ratione non esse alienum opinamur, si post lutram ichneumonis historiam-recenseamus, quoniam et ipse inter animalia *αμφιβιζαντα*, id est promiscua in aquis et terrâ degentia, reponamur, ideoque a nonnullis lutra Ægypti nuncupatur*.” He quotes also Strabo, who is of the same opinion. “Strabo quoque hanc belluam aquatilem consistere videtur.”

However, though these respectable authors have considered this animal as amphibious †, none of them have mentioned the skin on its feet, which forms a kind of fins. Aristotle, Pliny, and Prosper Alpinus, are equally silent respecting it. Though this character seems very essential in the description of an animal which frequents the banks of rivers; while, on the other hand, they have carefully noticed this peculiarity in the feet of the otter and in those of the castor. After what

* Aldrovandi de quad. dig. p. 298.

† I take the word *amphibious* in the same sense in which it was taken by the ancients: for this term, strictly speaking, can be applied only to the family of the *placa*.

has been here said, will it be asserted that this is not the case? By no means; for there is no opposing facts.

Buffon in his description of this animal exclaims against nomenclators and generic denominations. I know that science will make little progress when people are prejudiced in favour of their systems; but there are certain characters so striking in some animals that no error can be committed in classing them. He reproaches Linnæus with having made the ichneumon at first a badger, then a ferret; yet it certainly belongs to neither of these species.

Had he observed that skin or sort of fins which it has on its feet, he would certainly have classed it among the amphibious quadrupeds after the castors and beavers, which have a similar membrane between their toes. Klein calls it *lutra Aegypti**; but he does not speak of fins. Besides, as the ichneumons frequent the banks of the rivers in Egypt, where they search in the sand for the eggs of the crocodile, of which they are exceedingly fond, or go in quest of those serpents which the Nile leaves among the mud after its inundations, they must be obliged to cross, by swimming, some arms of the river or some canals in order to find their prey. For this reason nature has provided them with fins, and the conformation of the eye induces me to believe that they must also search for their food in the night-time. To this fact I shall add the decided taste which the individual in question has for fish, which seems to prove that the ichneumon in its wild state eats this food.

As this animal will soon be at Paris, you will be enabled to examine it yourself, and to verify my observations. I have no doubt that others will be brought from Egypt: you can examine whether the peculiarities I have described be common to all ichneumons, or belong only to some families.

If this animal should unfortunately die before it arrives at Paris, for it has suffered a great deal by the change of climate, and these animals, besides, do not live to a great age, you will see the beautiful picture of it which M. Aimet caused to be executed by M. Peter, an excellent artist in this department, who has represented it with the greatest exactness possible. Two figures of it are delineated under two points of view. M. Peter kept it at his house for a fortnight, to study its deportment and attitudes, in order that he might be able to give a correct representation of it.

* De quadrup. p. 66.

XXIII. *Of the State of Vapour subsisting in the Atmosphere.*
 By RICHARD KIRWAN, Esq. LL. D. F. R. S. and
 P. R. I. A.*

VAPOUR or moisture in the atmosphere may subsist in dense air, or in air highly rarefied: that it is found in the former is well known, and that it may subsist in the latter appears by the observations of Bouguer; for he saw clouds three or four hundred toises above Chiromboracho, and consequently at the height of twenty-two thousand five hundred and twenty-eight English feet, or 4.3 miles over the level of the sea; a height at which in the temperature of 32° a barometer would stand at 12.7 inches. At such heights, and at much inferior, since evaporation proceeds much more quickly, it is not to be supposed that all the vapour so rapidly produced is dissolved in the ambient air, but part rises uncombined, as it does under an exhausted or half-exhausted receiver, and in this case Mr. De Luc's system is admissible. This emission of pure vapour seems to begin at heights at which the density of the air is 25, (that is, at heights at which the barometer would stand at twenty-five inches, and thus I shall in future express the various densities of air,) at least it is very considerable where the density is twenty. This leads me to treat of the properties and state of pure invisible vapour, namely, its specific heat, elasticity, and specific gravity.

The immortal Doctor Black, the father of all discoveries of this kind, informed me that the vapour of water, boiling at 212° , that is, at 180° above the freezing point, and possessing the same sensible heat as the water, contains nine hundred and forty times more latent heat than an equal weight of water does heated to 212° , or 5.222 times more latent heat than it does sensible heat, counting from the freezing point, for $180 \times 5.222 = 940$ nearly. In this case the pressure or density of the atmosphere is thirty, the barometer standing at the height of thirty inches; and with Doctor Black's account the experiments of Mr. Schmidt of Gießen very nearly agree; for according to him the latent heat of the vapour of water, barometer 29.84 inches, and the heat 212° , is 5.33 times greater than its sensible heat above the freezing point: now $180 \times 5.33 = 959.4$. The difference or excess in his experiment proceeds from the pressure of the at-

* From his paper intitled, "Of the Variations of the Atmosphere," Dublin, 1801.

† Gren's Physical Journal, iv. p. 315.

mosphere being somewhat lower, as Mr. Watt's experiments prove.

Mr. Watt discovered that the latent heat of steam diminished in proportion as its sensible heat increased, Phil. Transf. 1784, p. 335. Now the sensible heat of steam exceeds 180° above the freezing point when the barometer stands above thirty inches, and less than 180° when the barometer stands lower than thirty inches, as Mr. De Luc first discovered, and may be seen in Sir George Schuckburgh's and Mr. De Luc's tables, Phil. Transf. 1779, p. 375. From these I have deduced the following table:

Heat of boiling water.	
Bar.	Heat.
30	212°
29	210°28
28	208°52
27	206°73
26	204°91
25	203°06
24	201°18
23	199°27
22	197°33
21	195°36
20	193°36
19	191°06
18	188°46
17	185°56
16	184°36
15	18°86
14	176°70

The accuracy of this table even in the lower part of the scale is sufficiently apparent by the result of the experiments of Saussure on ebullition on Mount Blanc; for on that enormous mountain, the barometer standing at 16 French inches or 17°05 English, he found water to boil at the heat of $68^{\circ}993$ of Reaumur, a degree which on Geneva thermometers is equal to $185^{\circ}56$ English.—Hence we see that distillation may be more advantageously effected on mountains than on plains, and at low barometrical heights than at the greater, yet within certain limits; for, at heights that surpass 8 or 10 thousand feet, the fuel, by reason of the rarity of the air, is more slowly consumed. Hence also, from the knowledge of the degree of the heat of ebullition to two or more decimal places, the state of the barometer above or below 212° may be inferred to one or more decimal places. The reason of this rapid diminution of the heat of ebullition below 25 inches is evidently the diminution of resistance, from the diminished weight of the atmosphere, which then is very sensible: but as the cold continually produced by evaporation is then also very considerable, the time necessary to procure ebullition is longer, as Saussure remarked on Mount Blanc. Vol. vii. in 8vo, § 2011, p. 328. He found the heat of ebullition barometer 16 to be $68^{\circ}993$ degrees, or in English measures barometer 17°05. $185^{\circ}5$ of Fabr. (counting one of Reaumur at Geneva = $2^{\circ}225$ of Fabr.)

Hence since, according to Mr. Watt, the sensible heats of the vapours of boiling water at different barometrical heights are as the barometrical heights reciprocally, and the specific heats

heats of the vapours of water boiling are as the sensible heats reciprocally, it being known, that the specific heat of the vapour of water heated to 180 degrees above the freezing point is 940. The specific or latent heat of the vapour of boiling water, whose sensible heat is known, (and it may be known by the barometrical height as shown in the above table and the notes) may also be discovered.

Thus the sensible heat of the vapour of boiling water barometer 30 being 180° above the freezing point ($212^{\circ} - 32^{\circ} = 180^{\circ}$) and the specific or latent heat of vapour, whose sensible heat is 208.56 (that is 176.56 above 32°) as it is when the barometer stands at 28 inches, is 958 for $\div 176.56. 180 :: 940.958^*$.

As pure invisible vapour does not in my opinion (of which I have already stated the grounds) exist in the atmosphere when its density is higher than 25, as it is in most of the inhabited parts of the globe, but is always in this case united to air, an inquiry into its latent heat at different temperatures below ebullition were superfluous. But as it does exist in air whose density is 25 or less, since it is found in air whose density is 12.5, it becomes necessary to examine its latent heat in such cases, in all temperatures inferior to that of ebullition. Now, by analogy, I apprehend this latent heat in all inferior temperatures may thus be determined.

As the *sensible* heat of ebullition, when the barometer is at 25 or below 25, is to the *latent* heat of the vapour at ebullition, so is the *sensible* heat of water heated to any inferior degree above 32° to the latent heat of its vapour, multiplied by 5.222. Thus the sensible heat of water in ebullition barometer 25 being 171.4 (= $203.4^{\circ} - 32^{\circ}$) its specific heat is 987 ($= \frac{169206}{171.4}$) the latent heat of the vapour of water at

22° above congelation (that is 52° on Fahr. scale) is 657 for $\div 171.4^{\circ} 987 :: 22^{\circ}. 1.6 \times 5.22 = 657$. The latent heat of vapour in such cases cannot be determined by experiment, on account of the admixture of atmospheric air: we must therefore resort to analogy, which in this case is perfect.

The latent heat of pure vapour at greater heights is more considerable: thus at heights, at which the barometer stands at 20 inches, the latent heat of vapour whose temperature is 22° above 32°, as in the last case, is 730; for the heat of ebullition is 194.8, per table, = 162.8°, above 32: and the latent heat of the vapour at ebullition is 1039. Now $\div 162.8. 1039 :: 22. 140$ and $140 \times 5.22 = 730$.

* Hence 169206, being the product of $110^{\circ} \times 940$, is the common dividend of all sensible heats *below* 180°, when the latent heat of the vapour is to be at barometrical heights below 30 inches.

As air is cooled by the reception of moisture dissolved in it, we must infer that its capacity for containing heat is increased, and hence moist air is more difficultly heated or cooled than dry air of the same temperature. (or the cold proceeds from the absorption and not from the expulsion of caloric.)

The elasticity or expansive force of pure vapour has been examined at every fifth degree of Reaumur above 0 to 110°, by Mr. Betancourt, and may be seen in an excellent work of Prony's, his *Architecture Hydraulique*: he has by a most ingenious calculation interpolated the expansions answering to the intermediate degrees. But Mr. Schmidt seems to have determined this expansive force still more exactly than Betancourt. Hence I here insert this table, adding Fahrenheit's for Reaumur's degrees, and distinguishing the expansions interpolated by calculation from those actually observed by *I*. The forces are measured by the elevation of a mercurial column in inches and hundredths of a French inch*.

Reaum.	Fahren.	Expansive Force.	Reaum.	Fahren.	Expansive Force.
1	34°25'	·01 <i>I</i>	21	79°25'	1·01 <i>I</i>
2	36°5'	·03 <i>I</i>	22	81°5'	1·01
3	38°75'	·05 <i>I</i>	23	83°75'	1·19 <i>I</i>
4	41°	·07 <i>I</i>	24	86°	1·29 <i>I</i>
5	43°25'	·11	25	88°25'	1·32
6	45°5'	·15	26	90°5'	1·38 <i>I</i>
7	47°75'	·16 <i>I</i>	27	92°75'	1·42
8	50°	·20 <i>I</i>	28	95°	1·60 <i>I</i>
9	52°25'	·25 <i>I</i>	29	97°25'	1·80 <i>I</i>
10	54°5'	·28	30	99°5'	1·93
11	56°75'	·34 <i>I</i>	31	101°75'	1·c2 <i>I</i>
12	59°	·38	32	104°	1·12 <i>I</i>
13	61°25'	·44	33	106°25'	2·23
14	63°5'	·50 <i>I</i>	34	108°5'	2·40 <i>I</i>
15	65°75'	·55	35	110°75'	2·68
16	68°	·61	36	113°	2·80 <i>I</i>
17	70°25'	·69 <i>I</i>	37	115°25'	3·20
18	72°5'	·76	38	117°5'	
19	74°75'	·84 <i>I</i>	39	119°75'	3·40
20	77°	·90	40	122°	3·64
			80	212°	28°

* The Paris cubic inch = 1·21 English. Now the English cubic inch of mercury when its specific gravity is 13·6 weighs 3443·2 English grains: therefore the Paris inch weighs 4186 English grains, and 1-10th of this inch = 418·6 grains: and 1-100th of this inch 41·86 grains.

Note.—1°. Most of the interpolations from the 88th degree to the 122nd I have myself inserted, as those calculated by Schmidt erred too widely by his own account.—Gren's *Phys. Jour.* iv. 273.

2do. Mr. Piçet has also made a set of curious experiments on the elasticity of pure vapour in low temperatures. *Essais de Physique*, p. 157. He found that a grain of warm water in *vacuo* evaporates in forty minutes in the temperature of 38° Fahr. under a receiver containing 1452 English cubic inches*, but that it did not diffuse itself equally in less than six hours, and then raised the hygrometer from 17° to 60°, that is 43°; and during this whole time the cold under the receiver was constantly decreasing, though slowly; which decrease undoubtedly contributed to the diffusion of the vapour.

Mr. Schmidt has also made a series of experiments upon the dilatibility of air, made as *dry* as possible by exposure to hot tartarin—an object of great importance, that had never before been examined. This table I here insert, converting Reaumur's degrees into those of Fahr. and adding from his formula the degrees he omitted.

Reau.	Fahren.	Expansion of one inch at 32°.	Reau.	Fahren.	Expansion of one inch at 32°.
1	34°25'	·0044675		79°25'	·0938175
	36°5'	·0089350		81°5'	·0982850
	38°75'	·0134025		83°75'	·1027525
4	41°	·0178700	24	86°	·1072200
	43°25'	·0223375		88°25'	·1116875
	45°5'	·0268050		90°5'	·116155
	47°75'	·0312726		92°75'	·1206225
8	50°	·035740	28	95°	·1250909
	52°25'	·0402075		97°25'	·1295557
	54°5'	·0446750		99°5'	·1340250
	56°75'	·0491425		101°75'	·1384925
12	59°	·0536100	32	104°	·1429600
	61°25'	·0580775		106°25'	·1474275
	63°5'	·0625450		108°5'	·1518950
	65°75'	·0670125		110°75'	·1563625
16	68°	·0714800	36	113°	·1608300
	70°25'	·0759475		115°25'	·1652975
	72°5'	·0804150		117°5'	·1697650
	74°75'	·0848825		119°75'	·1742325
20	77°	·0893500	40	122°	·1787000
				212°	·3574000

* *Ibid.* page 91.

Note —1°. Hence we see that 1000 inches or measures of dry air at 32° would become 1004.4675 at 34.25 Fahr. and at 50° would become 1017.87. Hence 1000 measures of dry air gain .985555, &c. by each degree of Fahr. above 32° (or more compendiously 1.9856, which is true to two decimal places) or nearly two.

2do. We see the source of the discordant results of D'Amontons, De Luc, Lambert, Schuckburgh, Roy, Berthollet, and Monge, &c.; for they all operated upon air more impregnated with various degrees of moisture; besides taking the boiling point at different barometrical heights; in the present experiments it was taken at 29.841 English inches.

3tio. It appears that the expansions are as the differences of heat above 32°, as D'Amontons, Lambert and Schuckburgh also noticed; though their experiments, not being made on perfectly dry air, could not be very exact.

[To be continued.]

XXIV. *Some Conjectures respecting the Origin of Stones which have been observed to fall from the Clouds.* By WILLIAM BEAUFORD, A. M.*

THE falling of stones from the clouds, a natural phenomenon not generally understood, is by no means a novel circumstance in the history of nature. Several stones were observed to fall from the clouds in Yorkshire in 1360, in Bohemia and Saxony in 1480, in Bohemia about 1753, in Sienna in 1794, in Portugal in 1796, in Yorkshire in England in 1795, and near Benares in the East Indies in 1798. From an analysis made of these stones by the French academicians in 1768, and by the Royal Society of London in 1802, they are all found similar in their component parts to each other, but dissimilar to all bodies found in mines and quarries, being composed principally of four kinds of substances: the first being in the form of dark grains, composed of flint, magnesia, iron, and nickel; the second, a kind of pyrites; the third, metallic iron; and the fourth, a gray earthy substance which serves as a cement to the others, and with which they were coated. From these compositions the matter seems to be of volcanic origin; yet it is difficult to conceive how stones of any considerable magnitude could be thrown at such a distance from any volcano as those found in Bohemia, Saxony, and Britain. The nearest volcanos to Britain are those of Vesuvius, Ætna, and Hecla: a stone to be thrown into Bri-

* Communicated by the Author.

tain from any of these, would require an impetus of between 3 and 400 miles; and, if allowance be made for the resistance of the air, 1200 under the greatest range of 2400 miles; a force not known to exist on the earth. It is true, volcanic ashes, when collected in the upper regions, will be carried by the clouds to an amazing distance. But these are small light ashes, not stones. It is evident, therefore, if these substances originate from volcanic ashes, they must be formed in the clouds, where those ashes, meeting with carbonic, sulphuric, and other acids, and mixing with earthy particles drawn from terrestrial objects, are, by the electric fluid in the lightning, precipitated from the aqueous vapours which bore them up, and, becoming united, fall to the earth in the form of stones; as in some measure is evinced from the flashes of light and detonation which accompany their fall.

Substances also of the same nature may be formed in the clouds without the assistance of volcanic matter; for the carbonic, sulphuric, and aqueous vapours, which rise from mines, furnaces, bogs, vegetables, and animals, and the small particles of siliceous and calcareous earths which collect in the clouds, are decomposed or made to assume new arrangements by the electric fire, whereby the minerals are generated and united to the earths, and consequently fall in the form of stones. Thus stones, by means of electricity, are formed in the clouds from the ferriferous principles ascending from volcanos, mines, and furnaces. Britain, indeed, is too far from any volcano to suppose that any quantity of volcanic matter can be wafted by the winds to this island; yet it contains a number of ferruginous mines and furnaces employed in the manufactory of that metal; from which proceeds an immense quantity of gas, containing the ferriferous matter, and such matter as is generally connected with it. Besides, there is a circumstance not generally attended to by mineralogists — that all mines of whatever nature contain a mineralogical atmosphere replete with the generic principles of the metal contained in the respective mines. That Nature, by her slow but regular operations, is daily producing metals from their elements, will hardly be denied; and whether the atmosphere of which I speak be produced by exhalations from the ingredients she employs, or a part of the ingredients themselves, the case will be the same as to the object I have in view. This atmosphere has a strong and visible effect on the stones and vegetables which cover the soil, especially that which covers mines of iron, lead, and copper. Animal and vegetable exuvie, and other decayed mundities, arising from bogs, morasses, and dirt-hills, produce a great quantity of carbonic

and sulphuric gases, containing the generic principles of iron, magnesia, and nickel, &c. : these, uniting with siliceous, argillaceous and calcareous earths, produce in great quantities that species of iron ore termed bog ore, and that in much greater quantities than is generally imagined. These ores are produced in lumps from 40 to 100 lbs. and more in weight, containing from one-fourth to one-half of pure metallic iron, intermixed with pyrites and vitrified substances resembling glass and petrified shells, the inhabitants of fresh-water lakes. Whence it is evident that a number of petrifications and mineralizations are performed by water and air assisted by the electric fluid alone; and a number of the operations of nature have been attributed by philosophers to the effects of fire, and deemed volcanic, which are the effects of the aqueous and pneumatic elements.

In order to ascertain in some respects the truth of this proposition by experiment, I caused a quantity of gas, liberated from water by means of steel filings and vitriolic acid, to be received in a glass vessel, to which was added carbonic acid from the fumes of charcoal and sulphuric gas, with the fine dust of chalk and earth, until the whole appeared a dark thick cloud. The electric spark being then passed through it, a flash of light and a smart detonation ensued. After this operation the cloud became more transparent, leaving at the bottom of the vessel a quantity of water, with a gray powder, evidently metallic, mixed with earth. If the experiment had been performed on a larger scale, and the ingredients varied, the result might have been more decided, and the phenomenon more accurately demonstrated.

This is a subject that merits every philosophic investigation. The magnitude of the stones undoubtedly depends on the quantity of generating matter, and the height from whence it falls; yet, how stones of such a weight as that which fell in Yorkshire could be formed in the air, might be a subject of doubt, if the substance had not been found of the same nature as those which fell in Bohemia and Sienna. But it ought to be considered that these substances are not formed instantaneous in the clouds: the constituting matter, precipitated by the electric shock, is thrown by the explosion to a point, when, from the action of the air in falling, it becomes enveloped in the terra cementum with which the matter is mixed. Whence, the greater the height or range the matter has to pass through from the time of the electric shock, the larger will be the stones. Most if not all the meteors formed in the air even at great heights probably originate from one cause: those which contain the larger
portion

portion of inflammable air take fire at the electric shock, and produce those luminous and fiery meteors so astonishing to mankind; while those which contain less inflammable matter, but a greater quantity of the ferriferous principles, are formed into fire-balls or ferruginous stones of different magnitudes, which descend on the earth; whilst the more light, or those which are composed only of inflammable gases, mount into the upper regions of the atmosphere, where, taking fire, they fly off in luminous vapours. The height to which some of these vapours are carried before they are decomposed is amazing; reaching into regions where we should imagine the atmosphere would not be of sufficient density to sustain them. But the natural history of the terrestrial atmosphere has not yet been fully investigated; nor the power and effects of electricity in the formation of lithological, mineralogical, vegetable, and animal substances;—subjects that demand the attention of the most able chemists and sagacious philosophers.

Dublin,

Sept. 16, 1802.

XXV. *On the Hydrometer.* By WILLIAM SPEER, Esq.
Supervisor and Assayer of Spirits in the Port of Dublin.*

THE hydrometer, or areometer, as it is called, is an instrument which ascertains the density of liquids, weighing unequal masses with the same weight.

This instrument is of great antiquity, and until lately it was supposed to have been invented at the end of the fourth century, by Hypatia, the daughter of Theon, the celebrated mathematician of Alexandria: but M. Uebe Salverte, in a memoir on this subject, in the *Annales de Chimie*, vol. xxii. has demonstrated its having been invented by Archimedes three hundred years before the period in which Hypatia was born; and the very elegant Latin description he gives of this instrument, from an author of great antiquity, shows that, in the form, several of those now in use differ but little from that of the original invention.

This instrument, from the facility and expedition with which it may be applied, has long been in use for ascertaining the specific gravity of various kinds of liquids; but its application to the particular purpose to which it is now used is comparatively of modern date.

* Extracted from his "Enquiry into the Causes of the Errors and Irregularities which take place in ascertaining the Strengths of Spirituous Liquors, &c. London 1802."

Until within a period of about forty years, the strengths of spirituous liquors were mostly ascertained by other modes, both in Great Britain, Ireland, and on the Continent.

Proof by oil, by agitation, by firing gunpowder, by alkaline salts, and by glass bubbles, has been used, but in every case found defective; and the hydrometer was at length resorted to, as an instrument calculated to ascertain these strengths with less trouble and greater accuracy.

To obtain indications of strengths by it correctly, however, depends on circumstances that have not, until lately, been sufficiently understood or ascertained; on which account the instrument has been complicated in various ways, by weights and sliding rules: these, in some cases, have rather increased than diminished its irregularity.

The object of the following inquiry is therefore to bring into one view all the causes of those imperfections and irregularities, and, by so doing, to prepare the way for their removal.

Those irregularities have arisen from several causes. In the first place, when Clarke's hydrometer was constructed (forty years ago), the effects of expansion by heat, and contraction by cold, on the specific gravity of spirituous liquors, had not been accurately ascertained; nor was the diminution of bulk by penetration (or concentration, as it is improperly called,) well understood.

In this state of ignorance of these effects, Clarke's hydrometer was conceived to be a great improvement on that which had been in use before it. Precisely the same kind of advance in improvement had been made in the Irish hydrometer, somewhat nearly about the same period. The duty on spirits in both kingdoms previous to this time was paid only on two denominations, viz. single and double spirits: the former was proof, or under it, and the latter all such as were over proof; and this discrimination of strength was made either by a rude sort of instrument which hardly deserved the name of hydrometer, or by dropping oil into the spirit: if the oil floated, it was called single; if it sunk, it was double.

The present Irish hydrometer was adopted about two or three years after Clarke's hydrometer in England; both of which purporting to discriminate the increase of strength by *per centages**, so as to proportion the additional rate of duty

to

* As this term occurs frequently in the following essays, and may not, perhaps, be clearly understood by all my readers, it may not be amiss to explain it here;—A spirituous liquor is said to be ten per cent. over hydrometer proof when it is so strong that one hundred gallons of it will admit

to the relative increase of overproof, were considered great improvements; and though, from the construction of Clarke's hydrometer, it was evident that the variations occasioned by change of temperature were then *somewhat* known; yet in Ireland the effects of these variations were conceived so immaterial, and the numerous weights attached to this instrument, the difficulty of understanding it, the certain delay and probability of mistake, were considered to be so objectionable, that it was deemed better to use an hydrometer which paid no regard to temperature, than to use one liable to so many other objections. The variations by the ordinary change of temperature being, however, from one to fifteen *per cent.*, this defect in the construction of the Irish hydrometer is so manifest, that it is presumed it would be a waste of time to attempt any demonstration of its incompetency.

Although Clarke's hydrometer has not been constructed without a reference to temperature, yet this has been attended to only in part; and the instrument being otherwise very defective, it will be necessary to exhibit these defects, in order that they may be guarded against in such hydrometer as shall be adopted instead of it.

Till Clarke's hydrometer was adopted, which, from the best information I can obtain, took place about the year 1762, proof spirit was made by mixing equal portions of water and the strongest spirit which could be procured; but it being sometimes difficult to obtain this proof spirit for comparison, such a mixture was made by order of the honourable board of excise; and it was found, that when six gallons of it were mixed with one gallon of water, a wine gallon of the mixture weighed seven pounds thirteen ounces avoirdupoise: the board therefore declared, that the spirituous liquor, of which the gallon weighed seven pounds thirteen ounces, should be reckoned one *to* six, or one *in* seven *under* proof.

This definition of proof was adopted in order to accord with a mode of examination which had been long in use, and sanctioned by the board.

The hydrometer said to be invented by Mr. Clarke * was
at

admit an addition of ten gallons of water to reduce it to the strength of proof; and it is said to be ten per cent. under proof when one hundred gallons contain ten gallons of water more than proof contains.

* In 1772 the States of Languedoc offered a premium for the best memoir on the subject of ascertaining the strength of brandies. This premium was adjudged, by the Royal Society of France, to M. Bories, M. D. whose investigation and experiments on this difficult subject have, I humbly conceive, been surpassed only by those of the Royal Society in this country. Speaking of the various methods he had tried, he says: "J'ous
recours

at this period brought forward, which having a set of weights corresponding to the above-mentioned mixture of water and proof spirit, and the mixture of one to six, or one in seven, being that only which weighed an exact number of pounds and ounces, without a fractional part, per gallon, by the statute of the 2d of George III. this obscure mode of ascertaining proof was adopted. At this time, the effects of heat and cold, on the trial of the strength of spirits by the hydrometer, had not been clearly understood; and though Clarke's hydrometer, which was then adopted, by having, in addition to the weights used for ascertaining the strengths of spirits, another set of weights called weather weights, adapted to several temperatures, is a demonstration that these effects were not altogether unknown; yet they were considered so immaterial as not to require the mention of temperature in the act of parliament. This omission has added considerably to the irregularities of the various hydrometers since in use, as by it the legal standard for proof is rendered very uncertain, and will, by the ordinary change of temperature, vary from five to six per cent.

I here beg leave to quote an observation of sir Charles Blagden, from the Proceedings of the Royal Society in 1790, in his Report on the best Method of proportionating the Excise upon Spirituous Liquors made by Desire of Government:

“By the act of 2d George III. it is ordered, that the gallon of brandy or spirits, of the strength of one to six under proof, shall be taken and reckoned at seven pounds thirteen ounces (which is understood by the trade to mean 55 of heat). Hence taking the weight of a gallon of water at the same heat to be 8 lb. 5 oz. and 66 parts, the specific gravity of this diluted spirit will be found 9335 at 60: this specific gravity indicates a mixture of 107 grains of water with 100 grains of pure spirit; whence, by a computation founded on the tables in this report, the specific gravity of proof spirit will come out 916: but the rules of correction belonging to Ducas and Quin's hydrometer give the specific gravity of proof spirits about 922, at 55, equivalent to 920, at 60. The former, 916, corresponds to a mixture of 100 parts of spirit with 62 by measure, or 75 by weight of water; and the latter, 920, to a mixture of 100 parts of spirit, and 66 by measure
recours à la méthode de Fahrenheit: j'ai vu depuis, qu'elle avoit été mise en usage par M. Brisson. J'entends par cette méthode celle de l'aréomètre inventé par Fahrenheit, et suivi par Clarke et Defaguliers.” He afterwards describes the instrument, and condemns it for its complications, and being improperly graduated: from this it would appear that this instrument was invented by Fahrenheit, and not by Clarke:

fare, or 80 by weight of water. The difference is considerable, but the first is undoubtedly most conformable to the existing acts of parliament: if, therefore, it be thought right to preserve the term *proof spirit* in our excise laws, it may be understood to mean spirit whose specific gravity is 916, and which is composed of 100 parts of rectified spirit at 825, and 62 parts of water, by measure, or 75 by weight; the whole at 60 degrees of heat."

From this extract it appears there are no less than three imperfections in this manner of defining proof spirits. First, the spirit defined is not proof, but another spirit, one *to six*, or one *in seven*, under proof, requiring a subsequent process to make proof: secondly, the difficulty of procuring an exact gallon measure.

The late ingenious Mr. Ramsden, in a publication on this subject, printed in 1792, speaking of the standard of proof, says: "Hydrometer-makers differ on this point $7\frac{1}{2}$ per cent.; and government, to avoid disputes, have been under the necessity of passing an act to constitute Clarke's hydrometer (for a short time) the only legal one, though it is, in all probability, as vague as any of the others, particularly in spirits considerably higher than proof. An obstacle to ascertaining this term (says he) arises from the difficulty of obtaining *practically* the exact capacity of our gallon measure: it is, indeed, stated to contain 231 cubic inches; yet, notwithstanding the great pains taken by a committee of the house of commons, about the year 1758, for that purpose, assisted by several ingenious mechanics, this point was left undetermined. The method they used was making *hollow cubes* of different dimensions, from one inch upwards, which were executed with great care by the late Mr. J. Bird, and are now in the repository of the house of commons: but whoever considers the difficulty of making an exact cube, and that of ascertaining the inside calibre with precision, must be sensible that no great reliance can be had on the exactness of a gallon measure obtained by this method."

Thirdly, that no temperature being mentioned, the strength is doubtful; and though sir Charles, in this part of his Report (which has not, I believe, been contradicted), says the trade considers the temperature to be 55, and that proof spirit should be as he states, by the unerring test of the specific gravity 916, at 60, (and which would be 918, at 55;) yet the specific gravity of proof spirit, by Clarke's hydrometer, is 924, at 55 of temperature.

From this it appears, that even Quin's and Dicus's standards of proof are erroneous to an extent of three per cent.;
and

and that Clarke's is nearly four and a half different from the strength prescribed by the statute: this is supposing the temperature to be what Sir Charles says it is considered by the trade.

In Ireland the standard of proof is still more uncertain, no definition of it whatever appearing on the statute, but resting solely on the practice which prevailed in England prior to the 2d of his present majesty, viz. mixing water with an equal portion of rectified spirits of wine, as it is called, no specific gravity of the spirit mentioned, and the spirit, called rectified spirit of wine, differing materially in point of strength: neither has the temperature been attended to, the hydrometer there having no thermometer attached to it: the standard of proof has consequently become just what the maker of the Irish hydrometer pleased: the generally received opinion, however, supposes it to be nine per cent. over English hydrometer proof.

Two material imperfections appear in Clarke's hydrometer, exclusive of its complexity; namely, that neither variations of temperature, nor the gradations of strengths, have been sufficiently attended to: with respect to the former of these, the same weather-weight (as it is called by the trade) is used, though the temperature should vary four or five degrees.

The inventor, foreseeing that this was liable to weighty objections, conceives he has guarded against it by the direction he gives in a N. B.: but this N. B., so far from removing doubts, only serves to increase them; the words *about* and *near* leaving room for much to be guessed at, and much more to be apprehended, where the important points it alludes to are so loosely and indistinctly defined.

May I be permitted in this place to explain the consequences of this mode of including four or five degrees of temperature to be indicated by the same weight, by stating a case that has frequently occurred?—A merchant in Ireland ships for London a quantity of spirit, and previous to its shipment examines the strength by Clarke's hydrometer: he adjusts the strength to be somewhat less than 10 per cent. (suppose 9') over hydrometer proof, the strength allowed to be importable without an augmentation duty: this spirit is per specific gravity 910, temperature 55. Suppose it to be arrived in London, but the temperature is then 60; notwithstanding this increase of temperature (of 5 degrees) the same weather-weight continues to be used in trying the strength in England which was applied in Ireland: by this increase of temperature, the specific gravity being diminished to 907 lbs, when it comes to be proved in London, by the same hydro-

meter,

meter, it then appears to be full one and a half per cent. stronger than when it was shipped, and will now be found to be 11 per cent. over proof. Should this spirit be a foreign one, viz. brandy or geneva, it must pay the entire augmentation duty of 11 per cent.; whereas, if the temperature was sufficiently discriminated, it should have paid no augmentation duty whatever.

That this case is not merely a supposition, is, I believe, well known to several respectable merchants in London, to whom consignments of foreign spirits have been made from Ireland, and who, in several instances, have been obliged to pay this augmentation duty of 11 per cent. Here, therefore, the instrument proves its own errors; nor can additional weights remedy it.

The principle on which it is constructed supposes that the ratio of expansion by heat is the same in strong as in weak spirits; the same weight for temperature is therefore applied to both: this is totally erroneous, and is demonstrable thus:

Suppose a weak spirit to be tried, the specific gravity of which, at the temperature of 35, is 960.48, let the temperature be increased to 70, the specific gravity will be 948.13; the diminution, consequently, is 12.35.

Suppose next, the spirit under trial to be a strong one, and its per specific gravity at 35, 843.49; increase the temperature, as in the first, to 70, the specific gravity will be only 827.01: diminution in this spirit 16.48; *difference* in the ratio of expansion 4.13; this difference making full three per cent. by the hydrometer, and thus demonstrating a radical defect in the instrument which *cannot be cured by additional weights*.

The spirituous liquors of commerce being mixtures of pure spirit and water, and the value of this, and the duty to be paid on it, depending on the quantities of the former which are contained in the mixture, it becomes necessary to ascertain the proportion in which it enters into every such mixture.

The easiest and most expeditious mode of ascertaining this is by an hydrometer, which acts on the following well-known principles of hydrostatics.

A solid body descends in a liquid, because it is heavier than an equal bulk of the liquid: and it descends with a force or weight equal to the excess of its own weight, over the weight of an equal bulk of the liquid; or, if it be lighter than an equal bulk of the liquid, it ascends with a force proportioned to the difference of weights; but if it be of the same weight as an equal bulk of the liquid, it will remain where it is placed.

Hence

Hence it is evident that every variation of gravity in the liquid will affect the indication on the hydrometer.

This gravity is known by the term *specific gravity*; and as the specific gravity of liquids is not absolute, but relative, this can only be determined by comparison: the first operation, therefore, consists in getting one whose absolute weight is known, in order to serve as a fixed point, and to determine, in its turn, a comparison of the density of the liquid. Pure water having always been considered the best standard for this purpose, the term specific gravity is most readily defined, by saying, that it is as the weight of the liquid is comparatively with pure water: for instance, if a phial, which holds precisely 1000 grains of water, holds only 922 grains of a spirituous liquor, the specific gravity of this spirit is said to be 922.

But as spirits expand by heat, and contract by cold, this specific gravity varies according to the degree of the heat of the liquor, which is called its temperature: therefore it is necessary first to ascertain what that may be, and it is done very accurately by the thermometer. And in the experiment mentioned, supposing the temperature to have been 55, if the spirit be heated to 70, the specific gravity will be diminished to $915\frac{1}{2}$; and, if afterwards it be cooled down to 35 degrees of temperature, it will be found to have increased to $930\frac{1}{4}$.

This is a very convenient manner of trying and expressing what the specific gravity of the liquor may be; and as I shall hereafter have occasion to use the term frequently, I hope I shall be excused for explaining it in this place.

All the variations of the specific gravity of spirituous liquors, and the causes of them, may be comprised under the following heads, viz.

1st, Those arising from heat and cold: 2dly, A difference in the proportions of the spirit and water: and, 3dly, The effects of penetration (or, as it is called, concentration), which takes place on the mixture; all of which, being so clearly defined by sir Charles Blagden, in his Report on this subject, in the second part of the 80th volume of the Transactions of the Royal Society, I shall beg leave to give it in his words, and lament that the proposed limits of this work will not permit me to give the entire Report, every paragraph of which I conceive to be important, and demonstrates the difficulties with which this subject is enveloped, and very clearly points out the way to remove them.

“ Though (says sir Charles) various indications of the
strengths

Strengths of spirituous liquors have been devised, applicable in a gross manner to a general use, it is well known that no method admits of real accuracy but that of the specific gravity. The weights of an equal bulk of water and pure spirit differ from one another by at least a sixth part of the weight of the former; whence it is obvious, that when those two fluids are mixed together, the compound must have some intermediate specific gravity, approaching nearer to that of water or pure spirit, as the former or the latter is the more predominant ingredient.

“ Were it not for a certain effect attending the mixture of water and spirit, which has been called their mutual penetration, the specific gravity of these compositions, in a given degree of heat, would be simply in the arithmetical proportions of the quantity of each of the fluids entering into them.

“ But whenever different substances, which have a strong tendency to unite together, are mixed, the resulting compound is found to occupy less space than the substances forming it held in their separate state; wherefore the specific gravity of such compounds is always greater than would be given by a simple calculation from the volume of their ingredients. Though it be a general fact, that such a decrease of bulk takes place on the mixture of substances which have a chemical attraction for each other; yet the quantity of this diminution is different in them all, and, under our present ignorance of the intimate composition of bodies, can be determined by experiment only. To ascertain, therefore, the quantity and law of the condensation resulting from this mutual penetration of water and spirit, was the first object to which the following experiments were directed.

“ All bodies, in general, expand by heat: but the quantity of this expansion, as well as the law of its progression, are probably not the same in any two substances. In water and spirit they are remarkably different. The whole expansion of pure spirit, from 30° to 100° of Fahrenheit's thermometer, is not less than 1-25th of its whole bulk at 30°; whereas that of water, in the same interval, is only 1-145th of its bulk. The laws of their expansion are still more different than the quantities. If the expansion of quicksilver be, as usual, taken from the standard (our thermometers being constructed with that fluid), the expansion of spirit is, indeed, progressively increasing with respect to that standard, but not much so within the above-mentioned interval; whilst water kept from freezing to 30°, which may easily be done, will absolutely contract as it is heated, for ten or more degrees,

degrees, that is, to 40° or 42° of the thermometer, and will then begin to expand as its heat is augmented, at first slowly, and afterwards gradually more rapidly, so as to observe upon the whole a very increasing progression.

“ Now mixtures of these two substances will, as may be supposed, approach to the less or the greater of those progressions, according as they are compounded of more spirit or more water; whilst their total expansion will be greater according as more spirit enters into their composition: but the exact quantity of the expansion, as well as the law of the progression, in all of them, can be determined only by trials. These were therefore the two other principal objects to be ascertained by experiment.” Sir Charles then proceeds to describe those various experiments, and which are too long to admit an insertion of them here; but from a perusal it will be perceived they were conducted with a degree of patient inquiry, minuteness of attention, and accuracy of investigation, seldom to be met with, and which, with the calculations grounded on them by Mr. Gilpin, clerk of the society, and published in the *Transactions* for 1794, have removed those obscurities with which the subject had heretofore been enveloped.

These celebrated experiments, and the table deduced from them, have been minutely examined by several of the ablest philosophers in France and various other parts of the continent, and they are allowed to be what Mr. Nicholson (who has also minutely examined them), in his *Chemical Dictionary*, says, may be considered as fundamental results; and it is somewhat remarkable that, since their publication in 1794, no person has hitherto availed himself of the important information they contain, as a foundation for putting a period to those irregularities and uncertainties which have been so long and so universally complained of.

That hydrometers should be complicated in their structures, and erroneous in their indications, previous to this period, is not to be wondered at.

The specific gravity of the spirit, which is the foundation of the hydrometer indication, was but little attended to; and those variations which take place in the specific gravity, through the several causes above mentioned, having never before that period been precisely ascertained, hydrometers, instead of being graduated by this unerring test, have been graduated by comparison with another instrument, called a standard, but no means have been pointed out to prove that this standard was correct.

These tables of Mr. Gilpin, however, furnish such elementary

tary information as has enabled me, by the addition of four columns, to remove all doubts and uncertainties on the subject, by demonstrating, from the specific gravity of the spirituous liquor, what the hydrometer indications should be of every gradation of strength.

In the Report, which accompanies these tables, Sir Charles Blagden makes an observation which first suggested to me the utility of these additional columns.

“It may very probably be thought right (says he), for the future use of the revenue, to compute another set of tables, in which the degrees of heat standing at the head of each table, the first column of it shall be even numbers of specific gravity. This would be proper for looking out at once the quantities of spirit and water in a mixture from its heat and specific gravity.”

Sir Charles, by this observation, alludes not to the means of obtaining the hydrometer indication, but to an opinion he had given in his first Report, in 1790, that the simplest and the most equitable way of levying the duty on spirituous liquors would be to consider pure spirit as the true and only exciseable matter, instead of the relation to the standard of proof, and for calculating which one column of the table is a decimal multiplier, to ascertain the proportion of this in any given quantity of a spirituous liquor; an idea which certainly is ingenious, and, at first view, appears to have the recommendation of simplicity: but as every discrimination of strength would require an operation of figures, fractions would unavoidably occur, from which, and the delay and danger of errors in these operations, this mode, I conceived, had been considered practically inconvenient, and therefore was not adopted.

The relation to the standard of proof having been long recognized by the different statutes, and in commerce, I thought it probable it would not be laid aside; nor was it, as I conceived, necessary to do so when a means presented itself of rendering this relation to proof equally correct as that which he pointed out: and the new set of tables, which at first I apprehended he was about to describe as useful for the revenue, were those which would deduce the hydrometer indication of strength from the specific gravity of the spirit at a given temperature. A table for this purpose would, I conceive, be importantly useful on several accounts: 1st, it would afford a mode of graduating an hydrometer on a certain principle; and, 2dly, that as it furnished a standard for every gradation of strength, errors could be discovered in those instruments that have been graduated by the delusive mode of

comparison, many of whose discriminations of strength being, as I had reason to believe, merely conjectural.

Before I proceed to explain Mr. Gilpin's tables, and the columns added to them, it becomes necessary to define what is meant by the term *pure spirit*, and to inquire whether the spirit which Sir Charles describes can with propriety be called such.

“ The first step (says he, in the Report made on this subject in 1790) towards a right performance of the experiments, was to procure the two substances with which they were to be made, as pure as possible. Distilled water is in all cases so nearly alike, that no difficulty occurred with regard to it; but the specific gravity of pure spirit, or alcohol, has been given so very differently by the authors who have treated of it, that a particular set of experiments appeared necessary for determining to what degree of strength rectified spirit could conveniently be brought. The person engaged to make these experiments was Dr. Dollfus, an ingenious Swiss gentleman, then in London, who had distinguished himself by several publications on chemical subjects. Dr. Dollfus, having been furnished by government with spirit for the purpose, rectified it, by repeated and slow distillations, till its specific gravity became stationary in this manner of operating: he then added dry caustic alkali to it, let it stand for a few days, poured off the liquor, and distilled it with a small addition of burnt alum, placing the receiver in ice. By this method he obtained a spirit whose specific gravity was 8188, at 60 of heat. Perceiving, however, that he could not conveniently get the quantity of spirit he wanted lighter than 82527, at 60, he fixed upon that strength as a standard.

Several highly respectable authorities might be produced to prove this specific gravity to be a proper standard for *pure spirit*.

[To be continued.]

XXVI. *A Short Account of the Mammoth.* By Mr. REMBRANDT PEALE*.

THE mammoth is so called from the Russian name, supposed to have been derived from the Hebrew *Behemoth*, Job, chap. xl. It is properly continued, both words being expressive of a large and extraordinary animal.

For a number of years past many large and extraordinary

* Communicated by the Author.

bones

bones and teeth have been discovered both in Siberia and America, which at first were generally attributed to the elephant *, except some very large teeth of the carnivorous kind totally different from those of any animal known.

In Siberia they were attributed to the mammoth, whose fabulous existence they supposed to be under ground, and of which Iibrand Ides pretends to give a description. In North America these large bones and carnivorous grinders have been found in great abundance on the Ohio and its tributary streams, washed from their banks, or discovered by digging in salt morasses in the neighbourhood of Cincinnati; where they are found intermixed with the bones of buffaloes and deer, which a tradition of the Indians states to have been destroyed by a herd of these animals which came upon them from the north. This event happened, the Indians believe, as a punishment for their sins; but they say the good spirit at length interposed to save them, and, seating himself on a neighbouring rock, where they show you the print of his seat and of one foot, hurled his thunderbolts among them. All were killed except one male, who, presenting his forehead to the shafts, shook them off, until, at length wounded, he sprung over the Wabash, the Illenois, and the Great Lake, where he still lives.

These bones were forwarded with great eagerness to all parts of Europe, and deposited in museums, where they attracted the curiosity of all naturalists, whose conjectures and theories on them were very various, until Dr. Hunter, by a more accurate comparison between them and the bones of other animals, determined that they must have belonged to a large non-descript animal of the carnivorous kind, somewhat resembling the hippopotamus and the elephant, yet essentially different from both.

The subject is now completely elucidated. Not long since some farmers in the State of New York, in America, digging marble from their morasses in the neighbourhood of New-Windsor, accidentally discovered several of these bones, which were preserved by physicians in the neighbourhood. In the autumn of 1801, my father Charles W. Peale and myself, having obtained possession of these bones, persevered for nearly three months, at the expense of much time, labour, and money, in a search for the remainder of the animal; and were fortun-

* Naturalists were led to this idea in consequence of finding, in a few instances in America, but frequently in Siberia, some large graminivorous teeth, which probably belonged to an animal of the elephant kind, though certainly of different species from any known: these teeth are remarkable for size, and in the number of lamellated veins of enamel which pervade them.

nate enough to obtain two skeletons, found in two distinct situations, and unmixed with bones of any other individual whatever: one of these is preserved in the Museum at Philadelphia, and the other is now exhibiting in the Old Academy-room, Pall-Mall, previously to its being taken to Paris.

The skeleton of the mammoth bears some general resemblance to that of the elephant, yet on examination even the general figure is found to be considerably different; principally in the effect of the tusks, structure of the head, prominence and pointedness of the back over the shoulders, its great descent thence to the hips, together with the comparative smallness of the body and the necessarily detached effect of the hind-legs—proofs of greater activity than in the elephant. On a closer examination, the characteristic features are greatly multiplied; and with respect to the hind-legs, the idea of activity is confirmed from the structure of the thigh-bones, which are extremely broad and flat, and well adapted for great exertions of strength, beyond that of the elephant, whose thigh-bones are not flat, but round. This effect of strength likewise prevails in the ribs, which are of a very unusual structure, being bent edgewise and having their greatest thickness at top, gradually becoming smaller towards their junction with the cartilage; whereas in the elephant they are bent flatwise, like those of the ox, and are narrow at top and broad at the lower ends. This peculiarity in the ribs of the mammoth is worthy of particular notice, not only on account of the unusual position of strength, but because, from their distance between each other, they show the animal to have had considerable flexibility in its body; to which the breadth and proximity in the ribs of the elephant, as well as the ox, are a certain impediment. Besides, as I observed before, the body is comparatively smaller, in consequence of the small length of the ribs.

The spines of the back over the shoulders are of an unusual magnitude, which gives the appearance of a hump, like the bison, and are calculated to give power and motion to the head. Those in the elephant are not so large over the shoulders, but much more so all the way to the sacrum: consequently his back is more arched. The proportionate length of the processes from the spine of the scapula differs essentially from all other animals. And, independently of any other variation in form, all the bones, of the limbs in particular, are astonishingly thick and strong.

We now come to the head, where the most striking features of this animal are to be found; and since between the corresponding parts of all animals there is a general analogy, it is
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the province of comparative anatomy not only to trace out the points of distinction, but, since they originate from certain fixed principles, in the discrimination of variations, to confirm their propriety by an examination of the principles on which they are founded.

Although it is sufficiently evident to those who are accustomed to this kind of investigation, from the observation of a few facts, that this animal must have been carnivorous; yet to others it is necessary to introduce every proof and conclusive evidence. Many persons, from a false impression, believe that teeth are determined to be carnivorous merely from their having a rugged surface: with this opinion they very properly ask, "May not the vegetable food be of a coarser quality?" It is true that the surface is roughest on those graminivorous teeth which are employed in the mastication of the coarsest vegetable substances, not only because such roughness is requisite, but because the teeth are rendered so from the quality of the food, the bony interstices wearing down more easily than the ridges of enamel, which operate as the roughness in a mill-stone. It is not therefore from this species of roughness that we presume on so important a determination: the roughness existing on the surface of carnivorous teeth is of another nature, much more strongly marked, and far from being rendered so by usage: the more they are used, the more even do they become. The tooth of a graminivorous animal is composed of *alternate veins* of enamel and bone, which thus pervade the whole mass: those of carnivorous animals are covered with a shell or crust of enamel, which is merely external, and exists as well in the cavities as on the ridges; which is not the case with other teeth. This enamel is required in the cavities, because the teeth interlock with each other, the prominences striking into the cavities.

An uniform composition of tooth, as it respects the intermixture of enamel and bone, is observed to prevail in those of the elephant, horse, ox, &c. principally differing from each other in the *figure* which those veins of enamel assume, and by which alone they may be discriminated among themselves. On the other hand, carnivorous teeth, incased with enamel as far as the gums, yet vary in the form and number of their protuberances, so as generally to designate their species: yet among them there is a very proper distinction to be observed, which is, that those carnivorous animals, the form of whose teeth and the attachment of whose jaws allow them the side or grinding motion, are always of the mixt kind. Man, the monkey, hog, &c. are carnivorous ani-

mals, because their teeth are incrufted with enamel, and because they do eat flefh; yet they are adapted for other food, by the rotatory motion of their jaws and the form of their teeth: this rotatory motion does not exift in the jaws of thofe animals which live entirely upon flefh; for they are attached by an oblong head or procefs inferted into a tranfverfe groove, and confequently have no other motion than up and down. In graminivorous animals the under jaw is attached by means of a confiderably round head (condyloid procefs) to a prominence or flat furface, fo that they *rotate*; and, to favour this motion, the coronoid procefs is generally thicker and not fo long as the condyloid; whereas in carnivorous animals the coronoid procefs is extremely flat and long, being never acted on except lengthwife.

But it muft not even be fupposed that an animal may be of the mixt kind, unlefs we obferve a capacity for maffication; without which we muft declare it excluſively carnivorous.

Some object to the carnivorous nature of the mammoth from its not having cutting or canine teeth. To this it may be replied, that if we form our rule of judgment, as to what conſtitutes a graminivorous animal, from the conſtruction of an ox's jaw, the elephant would certainly be excluded, becauſe it has not *incifores* at leaſt in the lower jaw: the fact is, that all carnivorous as well as graminivorous animals differ among themſelves with reſpect to the number and ſituation of their teeth; and hence they afforded to the ſagacious and celebrated Linnæus the moſt infallible method of claſſification, which has ſince been adopted, either wholly or partially, by all naturaliſts. The probofcis of the elephant answers the purpoſe of *incifores*: he therefore requires no others than grinders, which entirely fill his jaws: hence he is completely graminivorous. And although the mammoth is deficient in cutting teeth, and has no other canine teeth than his enormous tuſks, the deficiencies of which may have been ſupplied by a pair of large and powerful lips, indicated by the uncommon ſinuofity on the front of the lower jaw; yet I am decidedly of opinion, ſince it cannot be contradicted by a ſingle proof or fact, that the mammoth was excluſively carnivorous; by which I mean, that he made no uſe of vegetable food, but either lived entirely on fleſh or fiſh; and not improbably upon ſhell-fiſh, if, as there are many reaſons to ſuppoſe, he was of an amphibious nature. I therefore only require aſſent to theſe facts: 1ſt, The teeth are certainly of the carnivorous kind: 2dly, They are not of the mixt kind, becauſe they have not the leaſt rotatory motion,
and

and so completely lock together: 3dly, Since, therefore, they are not graminivorous, since they cannot be of the mixt kind, from a defect in motion, they must be exclusively and positively carnivorous.

Independently of the teeth, the under jaw of the mammoth differs most essentially from that of the elephant, which in its outline is semi-circular, from the condyle to the chin; whereas in the mammoth the outline is distinctly angular, and is much greater in the length than it is in the height, which is the reverse in the elephant: besides several other striking distinctions in both jaws.

When the skeleton was first erected, I was much at a loss how to dispose of the tusks; their sockets showed that they grew out forwards, but did not indicate whether they were curved up or down. I chose, therefore, first to turn them upwards, not because they produced the same effect as in the elephant, for it is evident they could not in any position, owing to two circumstances. In the elephant, taking the level of the teeth for a horizontal base line, the condyle of the neck is at right angles with it; and the perpendicular, one third longer than the base line: hence they are useful on every occasion, the tusks themselves being nearly straight, and pointing downwards; whereas in the mammoth, taking the level of the teeth for a base line, the condyle of the neck is situated but a few inches above it: consequently the sockets for the tusks and the condyle of the neck are in a horizontal direction: this circumstance, together with the extraordinary curve of the tusks, would raise the points in the air, directed in some degree backward over the head, twelve feet from the ground, and never could have been brought lower than six or seven feet from it. This position was evidently absurd: I therefore resolved on reversing them; in which position, in consequence of their twist or double curve, they appear infinitely more serviceable.

Six miles from the spot where this skeleton was discovered we found two entire tusks, in form exactly like those in the skeleton, but very much worn at the extremities (the point of one I have with me), and worn in so peculiar a manner, considering their form, as could not have happened in an elevated position; unless on the absurd supposition, that the animal amused himself with wearing and rendering them blunt, by rubbing them against high and perpendicular rocks: this in a state of nature can never be supposed, whatever habits may be acquired when in a narrow confinement. There can be no doubt, then, of their having been used against the ground, and not improbably in tearing up

shell-fish, if, as we have many reasons to suppose, he was of an amphibious nature: for this species of food his teeth seem admirably adapted. All animals of similar habits have similar teeth: this animal has teeth unlike any other with which we are acquainted: there is much reason, therefore, in supposing his food to have been different; especially when we consider the thickness of enamel which covers the teeth, the peculiar manner in which they are worn, and the small opening for the throat. But, whether amphibious or not, in the inverted position of the tusks he could have torn an animal to pieces held beneath his foot, and could have struck down an animal of common size, without having his sight obstructed, as it certainly would have been in the other position.

The tusks themselves are composed of two very distinct substances: the internal bony or ivory part, which we find in the greatest state of decay; and a thick, distinct coating, doubtless having undergone some decay, yet at present absolutely heavier and harder than the freshest ivory. No part of the skeleton is petrified, but all in their present state of preservation from having been surrounded by a calcareous soil, composed principally of decayed shells, and covered with water even in the driest seasons.

How long since these animals have existed, we shall perhaps ever remain in ignorance; as no judgment can be formed from the quantity of vegetable soil which has accumulated over their bones. Certain we are, that they existed in great abundance, from the number of their remains which are found in America: we are likewise sure that they must have been destroyed by some sudden and powerful cause; and nothing appears more probable than one of those deluges or sudden irruptions of the sea, which have left their traces in every part of the globe, and which are in amazing abundance on the very spot where these bones are found: they consist of petrifications of sea productions, shells, corals, &c. It is extremely probable that, whenever and by whatever means the extirpation of this tremendous race of animals was effected, the same cause must have operated in the destruction of all those inhabitants from whom we might have received some satisfactory account of them.

Dimensions of the Skeleton.

				Ft.	In.
Height over the shoulders	-	-	-	11	0
Ditto over the hips	-	-	-	9	0
Length from the chin to the rump	-	-	-	15	0

From

			Ft.	In.
From the point of the tusks to the end of the tail, following the curve	-	-	31	0
Length in a straight line	-	-	17	0
Width of the hips and body	-	-	5	8
Length of the under jaw	-	-	2	10
Weight of the same	-	63½ pounds		
Width of the head	-	-	3	2
Length of the thigh-bone	-	-	3	7
Smallest circumference of the same	-	-	1	6
Length of the tibia	-	-	2	0
Length of the humerus, or large bone of the fore-leg	-	-	2	10
Largest circumference of the same	-	-	3	2½
Smallest ditto ditto	-	-	1	5
Length of the radius	-	-	2	5½
Circumference round the elbow	-	-	3	8
Length of the scapula, or shoulder-blade	-	-	3	1
Length of the longest vertebra, or back-bone	-	-	2	3
Longest rib, without cartilage	-	-	4	7
Length of the first rib	-	-	2	0
Ditto of the breast-bone	-	-	4	0
Length of the tusks, defences, or horns	-	-	10	7
Circumference of one tooth or grinder	-	-	1	6½
Weight of the same, 4 pounds 10 ounces				
The whole skeleton weighs about 1000 pounds.				

XXVII. *New Theory of the Constitution of mixed Gases elucidated.* By J. DALTON, Esq.*

IN an essay, published in the *Memoirs of the Literary and Philosophical Society of Manchester*, vol. v. part 2, I gave a new theory of the constitution of mixed gases, and particularly of the atmosphere, and endeavoured to illustrate my meaning by a plate, &c. Notwithstanding this, I am informed by some of my chemical friends that they do not clearly understand the hypothesis itself, and consequently are not able to judge of its merits or defects: and a late writer (Dr. Thomson) in his *System of Chemistry*, vol. iii. p. 270, speaking of the uniform diffusion of the different gases of the atmosphere, makes the following observation:—"Even Mr. Dalton's ingenious supposition, that they neither attract nor repel each other, would not account for this equal distribution; for, undoubtedly on that supposition they would arrange

* Communicated by the Author.

themselves

themselves according to their specific gravity." Now, as I am persuaded that no one acquainted with the principles of mechanical philosophy could have written the above if he had understood my hypothesis, it seems to call from me a further explanation. I propose therefore, 1st, To state, in as clear a point of view as the subject will admit, the principles which I assume: 2d, To show that the consequences which I have deduced from them are legitimate; and, particularly, that mixed elastic fluids ought *not* to arrange themselves according to their specific gravity: and, 3d, To demonstrate that the supposition of the gases constituting the atmosphere being held in a state of equal diffusion by chemical affinity, is not only inconsistent with the phenomena, but is completely absurd.

I. Principles assumed.

1. I take for granted, that the particles of simple [unmixed] elastic fluids repel one another with forces inversely as the distance of their centres, the temperature being given. This is a mathematical deduction from the allowed fact, that the space occupied by any gas is inversely as the compressing force. (See Newton's *Principia*, b. ii. prop. 23.) The *absolute* distances of the centres of such particles must vary according to circumstances, and cannot easily be determined; their *relative* distances in a liquid and aerial state sometimes may. Mr. Watt has shown that steam of 212°, and pressure 28 inches, is 1800 times lighter than water; consequently the distances of the particles of steam are to the distances of the said particles in a liquid state as 12 to 1, nearly, in that particular case. Vapour in the vacuum of an air-pump, at common temperature, will have its particles about four times the distance, or 48 to 1.

2. I suppose that in mixed elastic fluids the heterogeneous particles do not repel one another at all at such distances as they repel those of their own kind; but that such particles, when brought into actual contact (to use the common language), resist each other in all respects like inelastic bodies. This is the peculiarity of the hypothesis, and what appears not to be generally understood. If I may explain by analogy, the most striking will be found in magnetism. Two like poles of magnets repel one another with the same force, whether any other bodies intervene or not, and do not affect those other bodies: in the same way I conceive two particles of any one gas repel one another with the same force, whether particles of other gases intervene or not, and do not affect those other particles. A magnet is amenable to the common laws

of motion in its collision with other bodies, and when it is brought into seeming contact with them; so is a particle of one gas when it is brought into seeming contact with a particle of another species; and in this case the bodies may be said to have a repulsive power: but this power is essentially different from the other, in that it extends to no definite distance. Further, conceive a very fine capillary tube placed perpendicular to the horizon, into which let a number of correspondent small magnetic wires, or particles, be inserted, with their poles of the same denomination together, or, more strictly, as near as their repulsive power would admit, one particle above another, the air having intercourse amongst them. Then, as the magnetic particles would not actually touch one another by reason of their repulsion, they would *seem* to be supported by the intervening air; whereas in reality they are supported and kept at certain distances entirely by the repulsion inherent in themselves and their own gravitation: and thus, I conceive, particles of gas support those of their own kind above them, though, were they visible, they might seem to rest upon others immediately under them; and the ground, or lowest solid or liquid surface, by supporting the lowest particle of each kind, has the weight of the whole to sustain. These observations, together with a view of the plate above alluded to, must, I think, be sufficient to satisfy any one what the hypothesis is. And it may be proper to add, there is something much resembling polarity observable in the ultimate particles of bodies at the instant of transition from the liquid to the solid state: witness the congelation of water.

II. Consequences.

It is plain from the above account that I conceive any one gas to be constituted of perhaps *one* part solid matter, and *one thousand* or more parts vacuity or pore, if it may be so called; and that into this vacuity we may throw as many other gases as we please without materially disturbing the first, provided we do not absolutely fill the vacuity with solid matter (for so I denominate common liquids or solids). Thus, we might have had a dozen gases in our atmosphere instead of three or four, all in the same compass, and each retaining the same density it would have had alone. The heavier gas has no more tendency to raise the lighter than a quantity of shot has to expel the air from its interstices. If therefore Dr. Thomson, or any other, can show how one fluid, which is not displaced nor any way acted on by another, should by its *reaction* cause that other to move into a higher or lower station, then the mathematical world will be obliged to reconsider their

their doctrine of statics. Till then I must take the negative of the proposition, and conclude that elastic fluids of the greatest and least specific gravity imaginable, on the supposition I hold, will alike take the lowest and the highest stations, regardless of each other; or, in other words, they will arrange themselves in the same order as if thrown into a complete vacuum. The great difficulty respecting the uniform diffusion of the gases being removed, I think on my hypothesis the other phenomena can require no explanation to any person conversant in pneumatics. I will take one instance: it may be asked, How does sulphuret of potash abstract oxygenous gas out of any mixture; lime water, carbonic acid gas, &c. &c.? The answer is obvious: Exactly in the same way as if the gas in question was the only one in the vessel, and the operation going on in a close vessel.

III. *Gases held together by chemical Affinity absurd.*

On this head it will be proper to premise certain facts:

1st, When two gases of different specific gravity, such as oxygenous and hydrogenous, are put into the same vessel and agitated; then, after standing some time, they still continue uniformly mixed.

2. They occupy the same space before and after mixture; that is, *one* measure of each put together occupy *two* measures, the temperature and pressure being the same. Mr. Davy seems to think this principle not strictly true in regard to a mixture of azotic and oxygenous gas; but the deviation from it, if any, is extremely small.

3. The compound is subject to the same laws of rarefaction and condensation as the simples.

There are but *three* suppositions we can make essentially different respecting the mutual action of heterogeneous particles of gas. 1st, When two gases are mixed, their particles may reciprocally *repel* one another, just as they act on their own kind in an unmixed state: 2d, They may be neutral, or have neither attraction nor repulsion for each other: 3d, They may have a chemical affinity or *attraction* for each other. The advocates for the chemical adhesion of gases will agree with me in exploding the *first*, because, where nothing but *repulsion* is manifest, we can ascribe no effect to attraction: the *second*, which is the one I adopt, is obviously inconsistent with their hypothesis: and as for the *third*, I can conceive no other explanation than the following: 1st, Two or more heterogeneous particles may unite, and become a new centre for the caloric to adhere to; but in this case the gases are no

longer *two* but *one*, and oxygenous gas and hydrogenous will become aqueous vapour: this, therefore, would not be a case of two *gases* held together by affinity. 2. Two gases may separately retain their caloric, and still be held by chemical affinity; that is, there may be an equilibrium between the powers of attraction and repulsion: but this is evidently inconsistent with the third law of condensation and rarefaction, observed in such compounds.

Manchester, Nov. 20. J. DALTON.

Note. I have lately read a paper to the Literary and Philosophical Society of Manchester, in which I have shown that the quantity of carbonic acid gas found in a given volume of atmospheric air is not more than $\frac{1}{1000}$ th part of the whole; and that the said gas is held in water, not by chemical affinity, but merely by the pressure of the gas, abstractedly considered, on the surface, forcing it into the pores of the water.

XXVIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THIS learned body has recommenced its labours by bestowing on count Rumford the first medal awarded from the fund provided by the count himself for discoveries on the nature and properties of heat.

The Copley medal has been adjudged to Dr. Woolaston.

On the first night of meeting, which was on the 11th of November, the Bakerian lecture was delivered by Dr. Woolaston. The subject, horizontal refraction.

On the 18th was read a paper, by Mr. Chenevix, on the chemical properties of the humours of the eye; and one by Mr. Smithson on calamines or ores of zinc.

On the 25th, a paper, by M. Aldini, on the galvo-electricity of hot-blooded as well as cold-blooded animals. The experiments detailed in this curious paper are similar to those of which we gave an account in our last, and to some detailed in a subsequent page of our present number.

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Clafs of the Mathematical and Physical Sciences during the 3d quarter of the year 10. —The mathematical part by Lacroix secretary.

ASTRONOMY.

Calculation of Observations of two Occultations of the Spica Virginis by the Moon, which took place in the Year 9—Discovery of a new Comet—Observations of the Planet discovered by Dr. Olbers.

Occultations of the stars by the moon are so useful for improving geography, by determining the longitude, that they have been ranked among the most important of the celestial phænomena; and in this class those easiest to be observed, and which give the surest results, are occultations of stars of the first magnitude.

The moon, by the position of its orbit, can eclipse only four; namely, Aldebaran, Regulus, Centares, and the Virgin's Spike; but the passage of the latter behind the moon's disk rarely takes place. C. Lalande knows only four epochs in the space between 1623 and 1790; and the year 9 having exhibited two, he took care to unite and calculate the observations which reached him of this phænomenon.

For the first occultation, which took place on the 30th of March, these observations are in number sixteen, of which the city of Paris alone furnished six, carefully made by the most distinguished astronomers. It was from an observation made by C. Ciccolini, at Florence, that Lalande determined the longitude of that city, which he published some time ago, expressing his astonishment that the position of a city of so much importance should have hitherto been so inaccurately fixed.

The longitude of the moon, deduced from observations at the time of the conjunction of these two bodies, is less by 13'' than that given in the tables lately transmitted to the board of longitude by M. Burg.

Fourteen observations of the second occultation, which took place on the 24th of May, were examined and calculated with the same care as the preceding. On this occasion there was an observation also at Florence, the result of which gave 6'' more in time in the difference of meridians between that city and Paris, as deduced from the first occultation.

The error of the tables of M. de Burg was,

In longitude	-	-	+ 4''
In latitude	-	-	+ 3

On the 1st of September C. Mechain read in the same sitting a notice on the new comet which he discovered at the national observatory on the evening of the 28th of August in Serpentarius. It was not visible by the naked eye: it resembled two nebulous stars which are in the same constellation a little below the equator, and from which it was distant only some degrees towards the south. The centre of the nebulo-
sity

ity seemed a little more luminous than the rest; but no sensible nucleus was distinguished, nor any trace of a tail. After that period the light of the comet always decreased, because it was removing from the earth. Its apparent motion in declination, which was at first $2\frac{1}{2}$ degrees towards the north, in 24 hours, was not more the last day than 30 minutes. The motion in right ascension amounted towards the end to no more than 17 minutes in 24 hours. The successive decrease of the light of the comet, and the brightness of the light of the moon, did not allow of its being observed any longer. It traversed the constellations of Serpentarius and Hercules.

During the 36 days it was visible he determined its position on 23 different days; and from his own observations he calculated the elements of its orbit as follows: they have no resemblance to those of any of the preceding comets:

Perihelion distance 1.0942046; the mean distance of the earth from the sun being supposed 1.0.

Passage of the perihelion Sept. 9, 1802, at 20 h. $43\frac{1}{2}'$ mean time at Paris.

Place of the perihelion in the orbit	-	11 ^s 2° 7 $\frac{3}{4}$ '
Longitude of the ascending node	-	10 10 16 $\frac{1}{4}$ '
Inclination of the orbit	-	57 0 $\frac{1}{2}$ '

Motion—direct.

This comet is the 94th with the elements of the orbits of which we are acquainted, and the thirteenth discovered by C. Mechain. It was observed on the 26th of August, or two days before, by C. Pons of Marseilles; but on these two days the sky at Paris was overcast. Dr. Olbers discovered it also at Bremen on the 2d of September. C. Messier, our fellow-labourer, and C. Bouvard, adjunct of the board of longitude, observed it with great assiduity after the appearance of it had been announced by C. Mechain.

We shall give here only four positions determined by C. Mechain; the first, the last, and the two intermediate ones: all the rest will be published in detail in the next volume of our memoirs.

Date.	Mean Time at Paris.	Apparent right Ascension.	Apparent Declination.
Aug. 28, 1802	9 ^h 44' 30"	249° 19' 68"	6° 8' 52" S.
Sept. 5	10 2 14	251 47' 11"	9 41 17 N
Sept. 17	8 31 42	255 3 5	24 18 50
October 3	10 27 5	259 22 57	35 23 39
Apparent motion in 36 day	0 42 35	10 2 59 Towards the East	41 32 31 Towards the North

The planet which we announced in the account of the labours of the last quarter, discovered by Dr. Olbers, of Bremen, has also engaged the attention of all astronomers.

It was observed by C. Mechain till the 28th of August, and a sufficient number of its positions was obtained to determine the elements of its orbit in such a manner as to enable us to find it again some months hence, when it will appear in the morning after issuing from the rays of the sun. C. Burckhardt, adjunct of the board of longitude, presented some to the class, which he calculated, taking into account even the perturbations which this planet experiences from the principal part of the rest. These elements represent very well all the observations hitherto made. C. Vidal, director of the observatory of Toulouse, placed under a sky so favourable to astronomy, followed the planet of Olbers with the same attention and constancy which he employed in the observations of Mercury, which are so difficult; and he sent to the class forty, with a table containing twenty-three select determinations of its right ascension and declination, and a chart of its apparent route from the 19th of May to the 23d of August.

In this period of time it passed over about 17 degrees in right ascension and 5 in declination.

It appeared to C. Vidal as a star of the ninth magnitude, and exhibited no trace of that nebulosity with which comets are always accompanied.

NATURAL PHILOSOPHY.

Observation of a remarkable Phænomenon of Terrestrial Refraction.

The most remarkable of the physical phænomena next to those which inspire most men with terror, are those singular appearances which are produced sometimes by the reflection or refraction of parts of the atmosphere, and towards which the attention of philosophers has been directed by the observations of C. Monge.

This circumstance reminded C. Dangos of an effect of terrestrial refraction which he witnessed at Malta in 1784.

On the 20th of March, about one in the afternoon, he learned, by loud shouts, which resounded from all the streets of the town, that a new island had arisen in the channel of Malta. Having ascended to one of the terraces of the observatory, he indeed observed a very white tract of land in the middle of the water, the form of which was nearly that of a right cone irregularly truncated. The illusion was so complete, that some of the sailors had resolved to go and re-

to go and re-

connoitre this island in order to take possession of it. Its figure, colour, and particularly its situation, in the line which joins Malta and Mount *Ætna*, made C. Dangos soon perceive that it was nothing else than the appearance of the summit of that mountain, always covered with snow, which some extraordinary cause had brought considerably nearer, lowering it at the same time very much below the level of the water.

The publicity of this phænomenon did not permit C. Dangos to observe it with more precision. A multitude of curious spectators, whom he could not get rid of, crowded the terrace. But this astonishing spectacle appeared again on the 17th of April 1785, at six in the morning; a time when the indolent, not being awake, could not interrupt the diligent philosopher in his retreat.

On this occasion, the apparent island, which was better defined than that of 1784, seemed to be 15' 17'' below the horizon, which corresponds to a distance of about 18000 yards: it seemed then to recede and to rise up; after which it became confused for a moment, and *Ætna* re-appeared in its real place. The coasts of Sicily, which had been hitherto concealed, were fully seen, and remained visible during the rest of the day.

C. Dangos, without attempting to explain this phænomenon, thinks that the humidity of the atmosphere, of which he that day perceived very sensible signs, had a great share in it; and that observations of the hygrometer ought not only to be added to those of the thermometer and barometer to determine the refragent force of the atmosphere, but some day may supply the place of each other.

Going back to the beginning of the last century, we find, in the memoirs of the Academy of Sciences, "that the mountains of Corsica, seen from the coasts of Genoa and Provence, seem at certain hours to plunge into the sea." The author of the memoir which we here analyse, saw the same appearance when at the Isles d'Heyeres in 1778: but this phænomenon was not so well defined as that which he relates.

[To be continued.]

ACADEMY OF DIJON.

In the public sitting on the 6th of September last, this society, after adopting the plan of its labour and fixing the nature of its occupations, thought proper to change its title into that of *Academy of the Sciences, Arts, and Belles-Lettres*. It was of opinion that this denomination, more general and

more expressive, would preserve much better the remembrance of that illustrious association to which it has succeeded, and in whose steps it proposes to tread.

C. Lefchevin read a report on the discovery of the phenomenon of scintillation by the collision of charred wood. Three successive explosions took place in the course of four months in the powder manufactory of Vonges, notwithstanding all the precautions employed to avoid them. The frequent return of these events induced government to send to the spot C. Lemaître, inspector-general, to inquire into the cause of these accidents. Having assured himself that no part of the machinery was deranged, and that no foreign substance had been introduced into the mortars, he endeavoured to verify the suspicions entertained in regard to the employment of charcoal in sticks. He recollected, that under certain circumstances he had obtained sparks by the collision of charred wood: he therefore made a trial, and, after three or four strokes, excited three strong sparks. This fact serves to account for the explosions; it explains why they do not happen more frequently, and points out in what manner explosions may be totally prevented, by adding one caution more to those already employed, namely, to pulverize the charcoal used in the manufactory of gunpowder*. C. Lefchevin terminates his memoir with the following reflection:—
 “Heat and light disengaged from a combustible body being the more abundant as the combination of oxygen with the body is stronger in a given space of time, it seems to result from the different circumstances of the phenomenon I have described, that a very slight degree of heat only is required to effect the combination of oxygen with charcoal, and the combustion of the latter.”

C. Potel, in a memoir on bleaching, communicated to the society interesting details respecting the new method substituted for the old one for bleaching linen, &c. He examined the different agents which have been recommended for some years past; gave an account of the result of the experiments he tried to ascertain the value of each of them; and concluded his memoir by pointing out the most advantageous; such as *odorous oxygenated muriatic acid* and *caustic alkali in vapour*, which are those employed in his establishment. He showed that the use of *sulphuret of lime* without any mixture is absolutely improper for bleaching; and how ill-founded is the fear of those who reject the new

* In most of the gunpowder manufactories in England, if not in all of them, the practice, we believe, has long been to pulverize the charcoal alone: yet explosions still take place.—EDITOR.

processes because they say it *burns the cloth*. He proved that if the operation is performed by an intelligent and careful artist, the cloth gains instead of losing. The author acknowledges that in these different processes the agent is always the same, namely, *oxygen*, which combining with the colouring principle renders it soluble in the leys employed, which then become much more effectual.

The use which C. Potel made of *oxygenated muriatic acid gas* conducted him by accident to many trials and experiments which are of the utmost importance. He has discovered that this substance may be employed with the greatest advantage in all cases of *asphyxia*. Several rats which had been found drowned, were placed on a table on which some of this gas was deposited: soon after the rats disappeared, and concealed themselves in a corner of the room, except one which remained in the neighbourhood of the apparatus: it had been restored to life, but, having sustained some injury in its feet, it was not able to follow the rest. C. Potel caught these animals, reduced them again to a state of *asphyxia*, and, having subjected them to the action of the gas, saw them resuscitated before him. He repeated the experiment with the same success in cats: in the last place, in imitation of Dr. Storch, who tried on himself the action of hemlock, this young chemist was induced to try on himself the efficacy of his new method, and his boldness was crowned with success. The academy has appointed commissioners to ascertain in a certain manner the property of this gas in cases of *asphyxia*.

C. Degouvenain gave the result of a great number of experiments he made on acetous fermentation, and which led to the demonstration of two points in theory not before proved by any positive fact; one of which, when the author publishes his processes, will serve as a guide to those desirous of making good vinegar. In the mean time he has applied his discovery to the advantage of domestic economy; and being convinced that the efficacy of aromatic vinegar depends much more on its acid nature than the aromatic substances with which it is accompanied, he made some which to be saturated required from 130 to 150 parts of potash in a thousand, whereas the strongest before known (that of Maille) absorbs only 114.

Good wine combined with oxygen by a series of ingenious processes peculiar to himself, is the only substance he employs for making vinegar; and the result, according to the report of the commissioners of the academy appointed to examine it, is, that it is in every respect superior in quality to the most

celebrated hitherto known. This vinegar may be carried to any country, and will keep any time without fear of alteration. It possesses also another advantage, which is, that it costs only half as much as that known under the name of Maille.

XXIX. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

Dr. Pearson's second and last Evidence.

Mercurii, 14 Aprilis, 1802.

Admiral BERKELEY in the Chair.

DR. PEARSON was called in and examined, and stated, that Dr. Heberden * authorized him to state, on the authority of Dr. Lind, and Mr. Battiscombe of Windsor, that there is now living near Windsor a person (the son of an apothecary,) who many years ago was inoculated for the cow-pox.

Did Dr. Heberden inform you whether this inoculation was performed from one human being to another, or from the virus taken immediately from the cow?

A. This is a question I cannot answer.

What further facts do you know affecting Dr. Jenner's claim of being the promulgator, or inventor of vaccine inoculation?

A. I have admitted Dr. Jenner was the gentleman who first set on foot the inquiry into the advantages of the vaccine inoculation; but I apprehend that the practice of vaccine inoculation, which was first promulgated by Dr. Jenner, has been established almost entirely by other practitioners, and that his new facts, or what I consider to be new, have been, in my opinion, disproved by subsequent observers; and that in consequence of those facts being disproved, together with the very extensive experience of other persons, we owe the present practice of the vaccine inoculation.

Will you inform the committee who those practitioners and persons were to whom you refer?

A. The cow-pock inoculation, after Dr. Jenner's book was published in May or June 1798, which contained seven or eight cases, (the whole result of his experience,) was not practised by any person, that I know of, till January 1799; neither Dr. Jenner, nor any other person that I could find, being in possession of matter: but in January 1799, in con-

* See Dr. Heberden's Evidence, annexed to this of Dr. Pearson.

sequence of a general inquiry, which I had instituted immediately after Dr. Jenner's publication, information was given of the cow-pock disease breaking out in two of the cow stables near London; and from these sources Dr. Woodville and myself collected matter, by which, in the course of about three months, not fewer, I think, than about 300 persons were inoculated, in addition to the seven or eight cases of Dr. Jenner, then the whole stock of facts of inoculation before the public. Besides carrying on the inoculation ourselves in this manner, we disseminated the matter throughout the country, in particular to Dr. Jenner* himself; and particularly also, I within that time issued a printed letter, directed to upwards of 200 practitioners in different parts of the kingdom, containing thread impregnated with cow-pock matter. In the course of this practice we already learnt that young infants might be inoculated with safety; which I considered to be then a new fact, Dr. Jenner not having had the experience, and being apprehensive of serious † consequences from inoculating them.

Secondly, That the inoculated arms, so far from requiring caustic or escharotic, or other topical applications, according to Dr. J., were sooner cured than in the inoculated small-pox: That Dr. Woodville's publication, in June 1799, appeared, containing the cases of upwards of 400 inoculated, up to that time: and in August 1799 I published a statement of inoculation, referring to many practitioners who had furnished me with reports of inoculation with matter which I myself had furnished: among these I beg leave to mention Mr. Relfon, of Seven Oaks; Dr. Mitchel, of Chatham; and Dr. Harrison's cases; as communicated to me by the right honourable sir Joseph Banks: and by that time I had also introduced it into the army, through the hands of the surgeon-general, Mr. Keate; and reports frequently came into my hands, by his direction, from the army. I had also by that time introduced the vaccine inoculation into many parts of the continent, and received reports of the successful practice of it; in particular, from Dr. De Carro, of Vienna. In addition to these testimonies contained in the paper above alluded to, is the result of my own practice in three parishes of poor people inoculated under my superintendance; so that in that paper, I be-

* See Dr. Jenner's Letter in Dr. Pearson's Inquiry 1798, in which he says no matter can be had. Dr. Jenner, both in letters to Dr. Woodville and Dr. Pearson, owns this matter excited the genuine cow-pock.—*Note of the Evidence.*

† This is also acknowledged in Dr. Jenner's Letter to the Evidence in February 1799.

lieve, it will be found that 2000 cases had by that time been afforded for the public by Dr. Woodville and myself, and the persons with whom I was in correspondence, and who are mentioned in the papers alluded to. By this time, too, some difficulties appear to have been removed which had been occasioned, in a great measure, by some facts stated to the public by Dr. Jenner. In particular, I published experiments of inoculation in the paper alluded to:—1st, Of inoculating persons with the cow-pock who had undergone the small-pox, to show that they could not take the cow-pock after the small-pox, contrary to Dr. Jenner: 2dly, Experiments to show that persons could not take the cow-pock both locally and constitutionally who had already gone through the cow-pock, also contrary to Dr. Jenner: 3dly, Many persons had by this time made experiments to show that the cow-pock did not originate in the grease of horses' heels, as Dr. Jenner had asserted. These sentiments will be found in a printed statement, which I beg to deliver in as published by me.

In the spring of the year 1799, whilst the above-stated evidence was collecting, a second publication appeared from Dr. Jenner, adding nothing but a few cases of inoculation further of the cow-pock, but recommending caustic or escharotic applications to the inoculated parts in the cow-pock, not found necessary by myself or the medical persons alluded to in my evidence: and I consider that the distinctive characters of the cow-pock were understood better by some of the above alluded to persons than by Dr. Jenner.

The vaccine inoculation was next considerably established by the Cow-pock Institution, of which I was one of the founders, the arrangement for which commenced at the very close of the year 1799; which Institution has been the principal office, I apprehend, for supplying the world in general, and the army and navy in particular, with matter; and where a regular register is kept of each of the cases inoculated, more fully and accurately than had been done any where before or since that time; where the authenticity of the cases, from the nature of the institution, is established in a manner that, I apprehend, will be considered as unexceptionable. This appears from a register of above 700 cases already entered, and open to the inspection of the subscribers. By this time, namely, the close of the year 1799, I think I can make it appear that about 4000 persons have been inoculated by Dr. Woodville, myself, and correspondents, which can be referred to. I here close my evidence, as I consider it of very small importance, comparatively, what was done by others after this

this time, all the facts that I recollect of use in practice being by this time established, as they have been since confirmed.

Did you never hear of inoculation having been performed by Mr. Cline*, with matter furnished by Dr. Jenner, previous to the time you began to practise vaccine inoculation?

A. I cannot recollect distinctly.

Were not seven or eight cases of Dr. Jenner alluded to by you, cases of inoculation from one human being to another?

A. Some of them were; some were not.

Had not many, or a large majority of your first cases, variolous-like eruptions?

A. The matter, which had never been in the Small-pox hospital, and which I myself took from the cows at the two cow stables above alluded to, scarcely ever afforded any eruptions like the small-pox; but when I obtained matter to supply my correspondents in the country, not having enough of my own, but obtaining it from the Small-pox hospital, it frequently, according to the reports of my correspondents, and in a few cases where I used it myself, did produce such eruptions.

Was not the matter, or virus, which you distributed, found great fault with on account of the eruptions it produced?

A. No, it was not found fault with; but many people were disappointed, as they expected that one of the advantages attending the inoculation was to be exempt from the eruptions.

Did not these eruptions, which were produced by your matter, very much discourage practitioners and the public, and very much retard the progress of the new inoculation?

A. I should think it did not.

Do you not know there is a case in Dr. Jenner's first publication of his having inoculated a child of eleven months old?

A. I believe there is one case.

Did not Dr. Woodville and yourself take the vaccine matter in Gray's-inn Lane, for the purpose of commencing your experiments, from a person fully marked with the small-pox?

A. No such case is in my recollection.

Have these facts stated by you to militate against Dr. Jenner's declared opinions remained uncontradicted by him? Does he still maintain them, or has he publicly retracted them?

A. I think he has not retracted them. [Withdraw.

* The Evidence afterwards found there had been a single case, but from which no one had any benefit by matter, nor was it published till the following year.

† See note, p. 181, on the inoculation of infants.

Dr. Heberden's Evidence.

Dr. Heberden, being called to speak to the statement made as above written, said, "That all he knew upon the subject was, about three years ago Dr. Lind, of Windsor, mentioned to him, in conversation, there was living, near Windsor, a young man, apprentice to an apothecary, who, when a child, was inoculated with vaccine matter by his father, who was an apothecary in the west of England. With respect to Mr. Battiscombe he could not speak, having heard nothing of it." — On this extract, from the minutes of the committee of the house of commons, the following remarks have been published: "In his (Dr. Pearson's) examination of the 14th (April) the authority of Dr. Heberden is made use of to prove what on that gentleman's examination *was found completely erroneous, for he could not speak to what Dr. Pearson asserted he could; and of Mr. Battiscombe he had no knowledge.* On this it is unnecessary to make any comment; the conclusion must be obvious."

These assertions, made from the words of Dr. Heberden's evidence, must appear unwarrantable by merely publishing this gentleman's explanation subjoined, obligingly communicated at the request of Dr. Pearson, who is conscious that he had been sufficiently correct in the statement above given on the authority of Dr. Heberden.

"Dr. Heberden acquiesces in the correctness of his printed evidence, with the addition of only two words, viz. "having heard nothing of it *from him.*" In fact, Dr. Heberden was acquainted with Mr. Battiscombe, but received his information respecting the vaccine inoculation from another quarter. Still it is true, that when Dr. Heberden mentioned the circumstance to Dr. Pearson upon Dr. Lind's authority, he corroborated his statement by adding, that Dr. Gisborne had been made acquainted with the same account through Mr. Battiscombe. So that Dr. Heberden may, in effect, be said to have related the circumstance to Dr. Pearson upon the united testimony of Dr. Lind and Mr. Battiscombe; though, his information in the latter case not having been derived *immediately* from that gentleman, he could not, with propriety, produce to the committee the authority of Mr. Battiscombe for what he had heard upon the subject."

How to inoculate several hundred Persons with the Matter of a single ordinary Vaccine Pock.

A member of the Vaccine Institution mixed the fluid of a single cow-pock with a drachm measure of water of about
the

the temperature of 70° of Fahrenheit. Of *three* subjects inoculated with this diluted matter, two took the disease in the usual way. The remaining third was inoculated in each arm with one puncture with this diluted matter, and also in each arm, in like manner, with undiluted cow-pock matter; but all these four punctures failed to produce the vaccine disease, the subject being an adult, and probably had had the small-pox.

Letters from Bassora of the 17th of June, from S. Mairesty, the British consul at that place, and Dr. Milne, physician to the factory, addressed to Dr. De Carro, of Vienna, confirm the happy result of the vaccine inoculation, which has been introduced into several parts of the East by the zeal of Dr. Carro. This beneficial practice has been introduced not only at Bagdad but also at Bassora. At the latter the consul set the first example by causing his own son to be inoculated; and from the end of April to the 17th of June the operation had been performed on forty subjects with the best success. Dr. Milne inoculated not only the sailors on board some ships destined for Bombay, but supplied a merchant who was travelling to Mascate with vaccine matter for that district.

THE PLANET OF OLBERS.

Circumstances have been much more favourable for determining the orbit of this planet than for that of *Piazz*, an are four times as large. A great number of observations made during six months, with great exactness, notwithstanding the difficulty of observing so faint an object, and an inclination of orbit much more considerable, give more precision to the results of calculation.

C. Mechain and Messier observed this planet till the middle of the month of August; the former, with a telescope which was not even mounted on a parallactic machine, which greatly increases the difficulty of observation. The comet which C. Mechain then discovered having obliged him to interrupt his observations, C. Messier continued to observe it alone till the 24th of September: he even tried to observe it on the 6th of October; but the vicinity of the horizon, and particularly the smoke of the chimneys which surrounded the observatory, rendered the observation too uncertain to be turned to any use. All these observations agree with an uncommon precision, and far superior to what could have been expected from an equatorial sector; C. Lalande having found the difference of $35''$ in two consecutive observations of Mercury made with a large equatorial sector by an able astronomer: it appears also that this planet has not where been observed so long as at Paris.

I have again carefully calculated the perturbations of the new planet. They are exceedingly numerous; nevertheless I have obtained only an approximation very far distant from that perfection to which astronomers aspire. The application of so many equations to calculation is attended with several difficulties, and requires many trials, principally on account of the great inequality. I have not yet finished them, but I hope it will be a gratification to astronomers to be made acquainted with the primitive orbit which I had calculated without employing perturbations, and corrected according to the latest observations; a labour which was interrupted only for two days by the researches. I began employing the perturbations—

Node $172^{\circ} 27' 35''$ — inclination $34^{\circ} 38' 0''$ — longitude of the perihelium $121^{\circ} 12' 19''$: on the 4th of April 1802, its motion $+ 2' 3''$ per day.

Mean anomaly, April 4th, at 10h. $51' 17''$, $42^{\circ} 21' 9''$.

Great semi-axis 2.769915 ; eccentricity 0.2463 .

Sidereal revolution 1683 days 20 hours.

These elements represent the five observations in the following manner:

Errors	Apr. 4.	May 20.	July 3.	Aug. 5.	Sep. 20.
Helioc. in long.	$+ 1' 4''$	$+ 1' 0''$	$- 1' 6''$	$- 0' 6''$	$- 6' 0''$
———— in lat.	0' 0''	$- 2' 7''$	$- 3' 5''$	$+ 13' 5''$	$- 18' 3''$
Geoc. in lat.	-	-	-	$+ 11' 0''$	$- 12' 0''$

Observers—Von Zach, Lefrançois-Mechain, Mechain, Messier, and Burekhardt.

With these elements it is found that the planet on the 4th of Feb. 1803, at midnight, will have $267^{\circ} 4'$ right ascension, and $5^{\circ} 38'$ north declination; which differs only a few minutes from the position which Dr. Gauss deduced from his elements. That able astronomer could employ observations only to the 8th of July, and still proposes to rectify his elements by later observations.

I hope this result will be confirmed when I have determined an ellipse by employing the perturbations.

BURCKHARDT,
of the Bureau of Longitude.

Nov. 13, 1802.

TRANSIT OF MERCURY OVER THE SUN.

The weather on the 9th of November was favourable to the wishes of astronomers, who had an excellent opportunity of observing this phenomenon. For the information of our philosophical readers we present them with those observations of the transit which have reached us. In a future number we shall give other details respecting it.

Utrecht,

Utrecht, Nov. 10.—M. van Utenhoven observed yesterday at the observatory of this academy, the ingress of Mercury at 12 hours 17 minutes 53 seconds, and the egress or the end of the transit of the planet over the sun's disk at 12 hours 19 minutes 28 seconds true time. M. Timmers of Rotterdam, a student here, observed the passage of Mercury over the meridian to be 15 seconds after the sun's limb. He observed also several times the contact of the Sun and Mercury on the horizontal and vertical threads of a quadrant by Bird, in order to calculate the time of the conjunction according to the method of L'Isle le Cadet. This phenomenon, which will not be visible again in this republic till the 4th of May 1832, was rendered much more important by the appearance of a great many solar spots; a collection of such spots, one or two of which seemed to be larger than Mercury.

Leyden, Nov. 10.—Yesterday morning I had the satisfaction, with M. Bisdon, M. van der Meer, and several of my pupils, to observe at the observatory of our university the passage of Mercury over the sun's disk. Mercury it appears must have been on the sun's disk before sun-rise, as the clouds prevented us from seeing that luminary till half after nine. The sun having then broke through the clouds for some time, the planet was plainly seen on the sun's disk as a black, round, sharply defined body, and could be easily distinguished from the solar spots, a great many of which were then visible on the sun's disk. The planet took its course under a great many of the principal spots, and, when it approached the sun's limb, seemed to have a somewhat elongated form. I observed the contact at the time of ingress to be at 12 hours 15 minutes 6 seconds, and at the time of egress at 12 hours 16 minutes 40 seconds, and therefore that of the planet's was 12 hours 15 minutes 53 seconds, true civil time. The planet employed 97 seconds from the time of ingress to that of its egress, which agrees very well with calculation if the diameter be taken at 41 seconds. I previously observed the planet's passage of the meridian with our meridian circle on the 8th of November, 23 hours 43 minutes 8 seconds mean time. I have no doubt that this transit will enable astronomers to improve or confirm the tables of Mercury.

VAN BEECK CALKOEN.

Enschede, Nov. 13.—Observation of the transit of Mercury over the sun's disk at Enschede on the 4th of November 1802, with the day telescope and an achromatic telescope, which magnifies the diameter 50 times, the clock being brought to true time by a meridian line; but there

was

was no opportunity for taking corresponding altitudes of the sun.

Enschede lies $50^{\circ} 16'$ north latitude and $7^{\circ} 30''$ in time east from Amsterdam. At sun-rise I saw the planet a good way from the eastern limb on the sun's disk. There were a great many spots on the sun's disk, and particularly on the west side, about 10 in the morning. The sky was clearer, though it was cloudy in the west. We were, however, able to follow the planet in its passage. About 11 the sky became clear in the south; but about 10 minutes after noon a very thick cloud proceeded from the north, which threatened to deprive us of all hope of seeing the egress. A few minutes before the planet came in contact with the sun's limb, I took the smoked glass from the telescope, and saw clearly the interior contact of the sun's limb, at 12 hours 22 minutes 10 seconds true time; but in a few minutes the western limb of the sun was covered by a thick cloud, so that no observation could be made of the exterior contact of Mercury with the sun's limb.

The planet when on the disk seemed to be surrounded by a small luminous circle. The sun's limb also at the time of interior contact seemed to quiver, and, as it were, to swell up a little.

L. NIEUWENHUIS.

Paris, Nov. 9.—The passage of Mercury over the sun's disk was observed this morning, for the 19th time. The weather was exceedingly favourable, and astronomers enjoyed, in the completest manner, the sight of this curious phenomenon. I was the more anxious to have a view of it, as I shall never see it more, since the next will not take place till the 5th of May 1832; for I do not reckon those which will be invisible in Europe. I had the satisfaction of observing it in the same place where it was observed for the first time, Nov. 7th, 1631, by Gassendi, one of my most illustrious predecessors in the *Collège de France*. Mercury emerged from the sun at 8 minutes past noon, which agrees to a minute with my tables of Mercury, on which I have been employed for forty years. That day, remarkable to astronomers, is much more so on account of the regeneration of France.

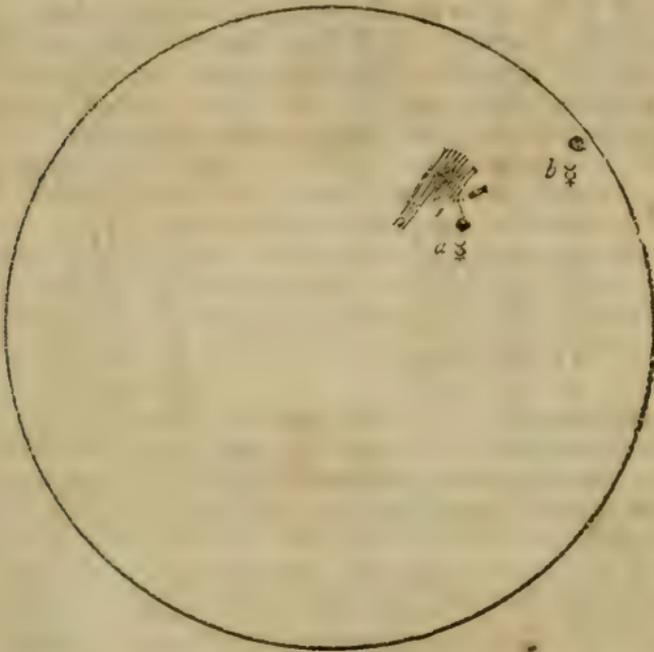
LALANDE.

From a Correspondent.

SIR,

If the subjoined sketch and account of Mercury's transit on the 9th instant, and his contact with the penumbra, or light part of the largest spot on the sun that day, be worth inserting in your valuable Magazine, the insertion may perhaps

lead to further disquisition, and will much oblige a lover of astronomy, who is a constant reader of your Philosophical Magazine*.



Apparent Time.

First contact with the light part at <i>a</i>	-	11 ^h	2 ^m	50 ^s
Central contact	-	11	4	24
End of contact	-	11	5	22
First contact of Mercury with the sun's limb		11	57	13
Central contact	-	11	57	54
End of contact	-	11	58	17

Mr. Tilloch.

From another Correspondent.

Nov. 8, 1802.—At 20h. 15' apparent time, having fitted a prismatic dark glass to an achromatic telescope of Dollond's, magnifying about 65 or 70 times, I saw Mercury upon the sun's disk, extremely distinct, and well defined. As Mercury was then approaching very fast towards the sun's centre,

* This correspondent is requested to furnish us with the longitude and latitude of his observatory, the method by which he ascertained his time, and the nature and power of the telescope he made use of.

and

and the body of the sun appearing pretty steady, I began to take some distances with a micrometer I had previously applied to the telescope for that purpose. Upon trial, however, I found the sun's limb so very tremulous, that I could take but few measures so satisfactorily as I wished: those which I can chiefly depend upon, I have here selected and reduced, by which it appears the nearest approach of Mercury to the sun's centre, was at 21h. 13' 38" apparent time, when Mercury's centre was 59.8" north of the sun's centre.

Apparent Time.	Dist. Centres. ☉ & ☿
20 ^h 56' 2.6"	1' 58.6"
21 6 10.9	1 11.1
21 8 25.5	1 4.9
21 39 50.2	2 40.7
21 45 29.2	3 15.2
21 46 16.3	3 19.0
21 50 3.5	3 40.4
Internal contact - at 23 ^h 56' 58"	} apparent time.
External contact - at 23 58 35.1	

The above times and observed distances are reduced to the meridian of St. Paul's church, latitude 51° 30' 49", long. 23.1" west.

The internal contact was also observed in long. 19.24", west lat. 51° 31' 7" at 23h. 57' 18.8", which reduced to the time of my observation gives 23h. 57' 12.9" apparent time. The gentleman who made this observation informs me that the house in which he was situated was in such a continual shake from carriages passing by, that he could not be certain of the contact to less than a few seconds; also that the method by which he got his time was by equal altitudes taken under the like disagreeable circumstances.

TO THE EDITOR.

Respected Friend,

I must beg room for a few lines to obviate any offence to a respectable body by the erroneous addition of F. L. S. to my name, which I meet with in p. 55 of last Magazine. I am neither fellow nor associate of the Linnæan Society, and, notwithstanding the insertion of a little piece, which has been favourably received by that body in their last volume of Transactions, am not, nor have been, a candidate for a place therein. Thy sincere Friend,

L. HOWARD.

We are sorry to have made the mistake alluded to by Mr. Howard. It arose from a very natural association of ideas,

ideas, which might easily mislead.—His partner in business Mr. Allan, is a worthy member, and himself a meritorious contributor to the labours of the Linnæan Society.

GALVANISM.

Paris, Oct. 14.

C. Aldini, a native of Italy, and nephew of the celebrated Galvani, to whom we are indebted for the discovery of that electricity called the Galvanic, repeated, a few days ago, in presence of the commissioners of the National Institute, and yesterday at the Oratoire, in presence of the Galvanic Society, the principal experiments; in consequence of which he asserts, with justice, that the ideas of his uncle respecting animal electricity ought not to be entirely rejected, to adopt exclusively those of Volta respecting metallic electricity. It results, indeed, from the experiments of C. Aldini, that there is an animal pile and an animal circle, as there is a metallic pile and metallic circle.

The experiments of which we were witnesses, and which prove his opinion in a rigorous manner, are as follow :

1st, The sciatic nerves of a frog being laid bare, as is usually done, for subjecting them to the action of the arming and metallic circle, he contented himself with bringing together and putting in contact the muscular parts of the thighs and paws of the frog with the uncovered nerves, and contractions of the animal took place as in the usual Galvanic experiment.

2d, He took the frog by the paws, holding it with one hand by the muscular parts, making the nerves hang down : he touched with a finger of the other hand the nerves thus suspended ; and the contractions took place as by the metallic circle and Galvanic apparatus.

3d, For the third experiment, he made his assistant hold the frog by the paws or by the muscular parts ; applied his finger to the nerves, without giving his hand to the assistant ; and the contractions did not take place. He then gave his hand to the assistant ; and, having applied a finger of the other hand to the nerves, the contractions took place as in the other experiments. These experiments were repeated on several frogs.

In the last place, several experiments were made on the head of a large dog separated from the trunk, which had no relation either to the animal circle or pile ; but afterwards they took one of the above frogs, and, by putting a finger into the spinal marrow of the dog, presenting with the other hand the nerves of the frog to one of the muscles of the trunk

of the dog, the contractions of the frog took place as with the Galvanic apparatus; which, according to the observations of the author, leaves no doubt respecting the existence of the animal circle and pile. These ingenious experiments will doubtless furnish to their modest and learned author a multitude of other ideas on the animal economy, particularly respecting the nervous fluid, &c., which leave him the care and glory to explain.

For my part, I came out from these experiments charmed and transported with admiration at the simplicity of the means which nature employs in its phenomena that seem to us the most complex. It appears to me proved, that to perform a prodigious number of its operations it contents itself with one electric fluid, which it puts in motion at the surface and in the interior of the earth by a kind of Galvanic piles, which produce, as I have explained in my lectures, a great number of the phenomena of the animal and vegetable kingdom; and that it has employed the same agent in the animal kingdom, by organizing the nerves and muscles as Galvanic piles to execute most of the operations of animal life by the same agent, and by means of these substances the nerves and the muscles, which it has organized in such a manner, that they discharge, in regard to each other, the same functions as the different metals the contact of which excites a permanent current of the electric fluid; which is the most valuable discovery for which we are indebted to the pile of Volta.

It had hitherto been tried, without success, to excite a permanent electric current without friction; and the machine of Hierne did not accomplish this end in a satisfactory manner.

This permanence of the electric fluid, for which we are indebted to the Voltaic pile, is a discovery, then, no less admirable perhaps than that of C. Aldini; and both have given to the natural sciences a stimulus which will astonish future ages, if the results be followed, as there is no reason to doubt.

MASSEYER-DIN, Professor in the
Special School of Medicine at Strasburgh.

XXX. *On Capillary Action.* By JOHN LESLIE, Esq.*

THE principle of universal attraction, having finally subdued every species of opposition, is now fixed on a base never to be shaken. Many are the fruitless attempts to explain its operation by the impulsive energy of some invisible impalpable fluid: but these owe their birth to metaphysical prejudice, and are justly discarded by all sober and reflecting inquirers. Nor is the supposition of such mechanical *intermedia* merely repugnant to the spirit of true philosophy; it is directly contradicted by recent discoveries. When an impulse is communicated to any mass or system of particles, it is transferred along the chain by a series of pulsations, each particle in succession feeling the action and suffering a momentary derangement. Motion is therefore propagated in the same manner as sound, and the celerity of its transmission must depend on the mutual distance of the affected particles and the relative force with which they are connected together. In most cases, indeed, that come under observation, it is impossible to distinguish the interval between the origin and the termination of an impulse, which is thence very generally imagined to act simultaneously through the whole line of its communication. But, though the rapidity of transit outstrips the quickness of our sensations, it still requires a certain lapse of time. Nay, on the just estimate of this principle,—on the duration of effect,—(refined as it may appear,) depends the theory of the tools and manipulations used in most of the mechanic arts. Nor is the existence of such a small yet finite moment a mere abstraction; it is the necessary result of the known properties of matter. Were we to suppose that the sun acts on the planets by the intervention of some subtle medium diffused through the celestial spaces and endowed with the most powerful elasticity, a very considerable measure of time would be required to propagate the impression. If we ascribed to that fluid, for example, the relative density and elasticity of hydrogenous gas, almost five years would be spent in conveying the impulsive energy to the earth. But it is proved, by some late and very nice researches of M. Laplace on the irregularities of the planetary motions, that the attractive force of the sun is exerted simultaneously at all distances. The notion of an intermediate fluid is thus entirely precluded.

The principle of *action at a distance* is therefore a primary

* Communicated by the Author.

and essential law of nature. Gravitation itself is only a branch of that law, from which are derived the various constitution and all the diversified properties, of bodies. The mutual action exerted between two elementary portions of matter is, in the language of modern algebraists, always some *function* of their distance. At proximate distances, this function must change repeatedly, and with different degrees of intensity, from positive to negative, or from attraction to repulsion. Hence the varied structure and composition of bodies. It is indifferent whether we consider the elementary portions of matter as points, atoms, particles, or molecules. Their magnitude, if they have any, never enters into the estimate. When the distance is considerable, the law of action becomes confounded with that of gravitation, and is of such remarkable simplicity as to qualify it for the happiest application ever made of the mathematical sciences. Could we ascertain the gradations at near distances, we might determine the structure, affinities, and mutual operations of bodies, with the same certainty as we compute the revolutions of the planets. But such a discovery seems placed beyond the reach of the human faculties. However, by a scrupulous attention, we may discern certain instances of the approximation and transition of corpuscular forces. And I hold those facts to be the more valuable, as they form the intermediate link between the mechanical and the chemical phænomena.

Of this kind I consider the *ascension of water and other liquids in capillary tubes*. This fact is so familiar that I need not stop to describe it. It was first noticed by the Academy *del Cimento*, at Florence, early in the 17th century; but seems not to have been much regarded in the sequel. After the promulgation, however, of the Newtonian system, the subject was revived with ardour. It was justly considered as affording intuitive evidence of the reality of attraction. About the beginning of the 18th century, Hawksbee, in England, made some excellent experiments on capillary action; and Musschenbroeck pursued the same course in Holland. Similar experiments were performed in France; but in that country the Cartesian philosophy was then in the height of its career, and no deliberate attention could be paid to facts which appeared to countenance an opposite system. About the same period Dr. Jurin published, at London, an elaborate dissertation on the cause of capillary action; and his explication of that curious fact seems, either from conviction or supine acquiescence, to be almost universally adopted. It is repeated in all the elementary books of natural philosophy. It continues to maintain the same credit: no suspicion is ever started
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of its solidity, and scarce an attempt is made to establish another theory. The celebrated Clairaut, indeed, has casually touched on the subject of capillary action in his Treatise on the Figure of the Earth; but his investigation of that phenomenon is lost in a chaos of calculation. M. Lalande, who is so active a writer, has tried to unravel it: the astronomer does not appear, however, to have succeeded. I content myself with this general notice of his little tract; for to refute it is much easier than to render it distinctly intelligible.

But, when we coolly consider Jurin's account of capillary action, we are surpris'd that it could obtain such success. It is in appearance simple indeed, and plausible; but it will not bear the slightest examination. The water is conceived to be kept suspended in the tube by the attraction of the small ring of glass immediately *above* the interior surface. But I ask, Ought not the ring *below* to exert an equal force in a contrary direction, and consequently destroy the effect of the former? This argument it seems impossible to elude, and to expand it would be superfluous. We must therefore regard the common account of capillary action as entirely without foundation.

It may well furnish matter for surpris'e and mortification to remark such a glaring oversight committed in the very porch of the physical sciences. But if we extend our observations we shall soon be convinced that the popular branches of philosophy, with all their supposed improvement, are in general still very defective and erroneous. Those flowery departments have been left to the culture of a secondary order of men, whose imagination was commonly more powerful than their judgment. In every age the vigour of genius has been directed to the sublimer parts, and those united efforts have reared a stupendous monument of the penetration and resources of the human mind.

In attempting to explain the mode of capillary action, the chief difficulty seems to arise from the prejudice that a *vertical* attraction is necessary to account for the elevation of liquor in the tube: yet this is assuredly not the primary direction of the force; for, the action of glass being evidently confined within very narrow limits, that virtue must be diffused over the internal surface of the tube, and consequently must exert itself *laterally*, or at right angles to the sides. Nor is it difficult to conceive how a lateral action may cause an ascent. We know that in fluids a force impressed in *one* direction is capable of propagating itself in *all* directions. The tendency of the liquor to approach the glass, must occasion it

to spread over the internal cavity of the tube, and, consequently, to mount upwards.

But let us view the subject a little more closely. Suppose I put a drop of water upon a horizontal plate of glass: it will quit its globular form, adhere to the glass, and spread out till it has covered the plate with a thin aqueous film. What then is the cause of this phenomenon? It is surely not the mere incumbent weight of the water; for that would not have been sufficient even to surmount the mutual adhesion of the particles of the fluid, or their natural tendency to agglomulate. Besides, the same precise effect will take place if the drop be applied to the under side of the plate. The water therefore diffuses itself on the glass in the same manner as if it were urged by the pressure of a column acting against that surface. Its attraction to the glass is equivalent to this supposed pressure, and is productive of the same consequences. But why should the mere tendency of the water to the surface of the glass occasion a dispersive motion? The reason is, that the external particles could not approach without spreading themselves and extending the film: and analogy will instruct us, that the attraction of water to glass must increase in proportion to the proximity of its approach, till it has reached the term of closest union.

If the plate be held vertically the aqueous film will still adhere, but only to a certain limited elevation, depending on its thickness. I reckon the force of suspension corresponding to each inch of width, or of the extent of the horizontal linear boundary, as equal to the weight of about the 100th part of a cubic inch of water. Hence, if the film was only the 1000th part of an inch in thickness, it would maintain a height of ten inches; but if its thickness amounted to the 100th of an inch, it would subside to an elevation of one inch.

Suppose I now dip the plate perpendicularly in a basin of water, the film will suffer a very considerable modification. A new portion of water greedily attaches itself to the film, and depresses it by the load of additional weight. The curve of protuberance seems nearly an inverted parabola, and consequently the pressure to be sustained is only the third part of what would obtain if the column had been of uniform thickness. The relative force of attraction is therefore $= \frac{1}{100} \pi$; and if we conceive the height to be equal to the breadth, which appears nearly the case, either of them will be denoted by $\sqrt{\frac{1}{100} \pi}$, or a little more than the sixth part of an inch: a conclusion which corresponds sufficiently with observation.

If two glass plates, held near each other and parallel, be dipped in water, the water will mount in the included space. The aqueous protuberance is now confined, and the ascent of the column is therefore greater; besides that the effect is doubled by the united action of both opposite surfaces. Each surface acts only upon a thin film; but, since the force is spent in supporting the particles which adhere to this, the height of the column must evidently be inversely as the weight suspended, or the distance between the glass plates. Imagine the interval between those plates to be the 100th part of an inch: then each surface may be considered as acting against a column of the thickness of the 200th part of an inch; and since the force of attraction is equivalent to the weight of the 100th part of a cubic inch, the corresponding ascent must be two inches. In like manner, if the interval were only the 200th part of an inch, the height of the column must be four inches. In general, put d = the distance between the plates, and $\frac{1}{50d}$ = the height of the column.

The same reasoning is applicable in the case of capillary tubes. The attraction of the internal surface is exerted on a thin circular lining; but this force is diluted and attenuated by the pressure of the water which adheres to the film and occupies the cavity of the tube. A circle, it is well known, is equal to a rectangle which has the circumference for its base and half the radius for its altitude: consequently the attractive power of the glass will produce the same effect as if it acted simply against a column whose thickness is one-fourth part of the bore of the tube. But we have already seen that the measure of force is expressed by $\frac{1}{100}$; and hence, if d denote the width of the bore, the height at which the water

will be suspended in the tube will be $= \frac{1}{100 \times \frac{1}{4}d} = \frac{1}{25d}$.

Thus the altitude of suspension in capillary tubes is the double of what obtains with parallel plates whose mutual distance is the diameter of the bore.

The suspension of water in capillary tubes must depend entirely on the smallness of the superior orifice. Nor will the effect be in any degree altered, however much the lower part of the tube be enlarged: for, by the laws of fluids, the pressure is proportional merely to the altitude of the column; and this pressure is balanced at the upper extremity by the adhesive force of the film, which attaches itself to the inside of the tube.

If a capillary tube be inserted through another tube, and both dipped in water, it will rise not only in the capillary bore, but in the interstice between the two tubes. Even though the diameter of the outer tube be considerable, the water must form a sensible elevation in the intermediate ring; and this elevation will be determined by comparing the extent of the opposite surfaces of glass with the intercluded space on which their action is spent. The absolute ascent in the capillary bore continues the same; but, if we estimate it from the external protuberant ring of water, it will appear evidently diminished. Conceive the outer tube to be fitted with a bottom, and the whole to be removed from the basin: the effect will still remain the same, and consequently the apparent altitude of the fluid in the capillary bore will be diminished. Let d denote this bore, d'' the diameter of the tube, and d' the width of the outer tube, or rather that of the cistern in which the capillary is plunged: then it may be easily investigated, from the principles already explained, that the height to which the water will rise is $= \frac{1}{25} \left(\frac{1}{d} - \frac{1}{d'' - d'} \right)$ in inches.

If the tube has its lower orifice not too wide, on removing it from the cistern in which it was immersed, a drop of water will adhere, and the column in the capillary bore will remain at the same height. Its suspension, we have seen, is produced by the lateral adhesion of the internal film, to which a cylinder of water attaches itself. If the drop at the extremity be diminished by any cause, such as the contact of bibulous paper, the column will subside; for the tendency of the water to agglobulate then counteracts, in some degree, its capillary extension in the tube. Cover a horizontal piece of glass with a fine film of water, and bring the tube with its charge to touch it, the water will immediately desert the cylindrical cavity and spread over the film. The attraction which the vertical column of water, joined to its weight, bears to the expansive horizontal film, overcomes its adhesion to the narrow film that lines the inside of the tube. We here contemplate the extreme case; but it should be remarked in general that the mutual attraction of the particles of water or other fluids must, to a certain degree, diminish their ascent in capillary tubes, since that force tends to agglomerate the parts, and consequently opposes any ramifications or filamentous prolongations of the fluid. This resistance, it might be

be shown, is, like the capillary action itself, inversely as the width of the bore. The two opposite effects, being thus proportional, are confounded, and their difference only is observed. In the case of glass, the capillary action greatly preponderates: one consequence of this is the concavity remarked at the top of the column; a clear proof that the lateral exceeds the central adhesion. If the upper surface were perfectly flat, those two forces would be in exact equilibrium. But the convexity of the top of the column proves that the fluid has a greater attraction to its own particles than to glass. Such is the case with quicksilver, which, instead of ascending in capillary tubes, suffers a depression according to the same law. This remarkable fact has been ascribed to some repulsion existing between quicksilver and glass. But I regard such a supposition as equally unnecessary and improbable. The same consequence would, no doubt, take place with water in polished tubes of steel or brass. If I place a drop of water on a smooth surface of metal, or a globule of quicksilver on a plate of glass, neither of them will seem at all affected by the contact, but will obey the attraction of their own particles, and therefore affect the spherical form.

Hence the mercury in a barometer can never mount to its true height; and the error will be the more considerable in proportion as the tube is narrow. If two tubes of different diameters be carefully filled and planted in the same basin, the mercurial column will stand visibly higher in the wider tube. This aberration has been generally neglected, though it must evidently affect the barometric calculation of the altitudes of mountains*.

On the same principle I would explain the familiar experiment of a needle swimming on the surface of water. It is superfluous to have recourse to any supposed repulsion. The internal cohesion of the water opposes its division; a gentle cavity is formed, which, pressing upwards, supports the needle.

Above twenty years ago, that able chemist M. Guyton-Morveau, examining into the nature of chemical affinities, attempted to determine the relative attraction of a variety of substances, from the force required to detach small plates of glass or metal from their contact with water or quicksilver. The

* Suppose the mercurial column at the bottom of the mountain to be 30 inches, at the summit 15; and let the depression be equal to the 20th of an inch, which corresponds to ordinary tubes. Then the corrected columns are 30.05 and 15.05; but the ratio of these numbers is different from that of 30 to 15, and consequently it will give a different altitude. The common calculation will represent the mountain above 90 feet higher than it ought to be.

idea, though not logically accurate, was ingenious, and had a certain degree of success. It is evident that the force measured was not strictly that of mutual attraction, but only the weight of the protuberant mass of fluid the moment before its separation. Nor does the height of this column depend on its mere adhesion; for it can never exceed the cohesive force of the fluid molecules to each other. When the plate, whatever may be its attractive power, is raised above a certain limit, the attached column breaks, and part of it adheres to the plate, while the rest falls back into the body of the fluid. Thus, those experiments can ascertain the adhesion of the plate only when it is comparatively very small; in other cases they measure simply the integrant attraction of the particles of the fluid. If capillary action be regarded as approximate to chemical affinity, this may be always determined, with facility and with sufficient accuracy, by observing the ascent in two parallel plates fixed at some minute but known distance from each other.

The elevation of a liquid in a capillary bore is produced by its specific attraction to the matter of the tube. With different substances the effects are considerably diversified: alcohol, for example, rises little more than a third part of the height to which water reaches. But the slightest alteration in the constitution of the substance will sometimes occasion a very material difference of effect. Thus I find that, on diluting the alcohol, the ascent of the liquor is scarcely at all augmented; but, if I reverse the process, and add a few drops of alcohol to the water, the capillary column will suffer a remarkable depression. On this principle might be constructed a very simple hydrometer for measuring the strength of weak liquors. And I would invite chemists to try capillary action with different saline and metallic solutions, as I am confident that many curious facts would thus be discovered. Nothing could exceed the simplicity of such an instrument. It is only necessary to choose a fine calibred tube, and to have it divided on the outside into equal parts by the point of a diamond, or marked with enamel colours. On plunging it into the liquid and then removing it, the precise effect would be indicated by the suspended column. I have no doubt but that such an instrument, in the hands of a skilful operator, would be brought to mark, with sufficient exactness, the proportion of ingredients contained in a compound fluid, and might in some cases supersede the trouble of analysis itself.

The ascent of water through pounded glass, sand, and other powdery substances, is justly explained by capillary action,

action. The effect is produced by the attraction of the numerous proximate facets; and it is the more notable, as the aggregate surface is very large in comparison with the interstices to be filled up with humidity. But the absorption of water by bibulous paper, linen, or flannel, though commonly referred to the same cause, is of a very different nature. From close observation I am convinced that in those instances there occurs a real though not a permanent change of constitution: the solid begins to assimilate itself to the qualities of the combined fluid, and becomes softer and more translucent. By means of an instrument, contrived to measure the smallest alteration of volume, I have proved decisively that the union of water or oil with paper or linen is accompanied with a general contraction or concentration of the mass. Nay, applying a delicate thermometer, I perceived a very sensible extrication of heat invariably to take place during such combinations. And this effect was the greater in proportion to the previous dryness of the solid. Thus I have sometimes produced a heat of ten degrees by moistening saw-dust which had been parched before the fire. An absorption of this kind is strictly a chemical process: the internal structure of the solid is altered, and a force is developed very distinct in quality and degree from what obtains in capillary action. The contemplation of such facts may serve to extend our ideas of chemical agency. The state of fluidity is essential to its operation; but that quality is required only in one of the ingredients, and the result of the combination may be indifferently a fluid or a solid. Copper will imbibe quicksilver and become only more brittle; and, on the other hand, quicksilver will dissolve a small portion of copper without relinquishing its fluid character. Nay, if the one species of combination can be produced, we may safely infer the existence of the other. Thus all stones are found to contain water incorporated in their substance, altogether distinct from what may insinuate itself in their accidental crevices. If we reverse the combination, therefore, and suppose the fluid to predominate, we shall conclude that water is to a certain degree capable of dissolving all sorts of stones. And if, disregarding the authority of disputed systems, we candidly examine the numerous facts that occur in geology, we cannot hesitate to admit the justness of the proposition. I would not venture, however, to maintain that water is singly capable of dissolving the hardest stone; for the cohesion of the integrant molecules will, in some cases, oppose a force superior to the attraction of the water. But the process may be

be assisted by the concurrence of other agents that tend to disunite the solid. In general, the action of chemical affinities admits of comparison with the application of mechanical force. There are some obvious facts which at once illustrate and confirm this principle. For example, carbonic gas, combined with water, enters into the composition of marble; but neither of those fugitive substances, however concealed or disguised, yet abandons its specific character. On the application of intense heat their elasticity becomes developed with irresistible force, and they make their escape, leaving the stony basis in the dry caustic state of quicklime. I shall mention one other fact which exhibits the play of chemical affinities. Charcoal, it is well known, has the property of imbibing air; and I have proved from experiment that this imprisoned air exists in a compressed or condensed state. But water, being applied to the charcoal, will be immediately absorbed by superior attraction, and will dislodge the air, which now recovers its usual expansion.

Sulphuric acid, potash, and in general all the deliquescent salts, have the power of attracting moisture from the atmosphere. They exert a real chemical action which overcomes the adhesion of humidity to the air. But I have remarked the same property to obtain more or less in a great variety of substances; in paper, linen, flannel, wood; nay, in stones and earths. The water, thus abstracted from the atmosphere, penetrates into their substance and disappears. The surface of glass shows, in a limited degree, a similar power. I have observed that, on the approach of evening, bits of glass became covered over with minute globules long before the surrounding air was absolutely damp. About the temperature of freezing I have noticed this dew to appear on the surface of the glass, when my hygrometer still indicated a dryness of five degrees. But in higher temperatures the effect was even more striking; and I have seen the sides of a tumbler covered with dew when the ambient air possessed 15 degrees of dryness. In those cases, however, the humidity is merely detached from the air by the action of the glass, and it remains adhering to the surface without being absorbed into the vitreous mass. The effect cannot, with any appearance of probability, be imputed to a supposed alkaline efflorescence; for it was observed with fine flint glass, and the dew collected was always perfectly tasteless. When polished metals were exposed, they never received any dew till the atmosphere was absolutely damp. They seem therefore to be entirely passive.

This singular property of glass is certainly a modification
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of capillary action: it must therefore obtain in other kindred substances. I am inclined to refer it to the same cause, however apparently subtle, which has so forcibly struck me in some other researches. It is well understood that physical is different from mathematical, contact. In the former there is a finite interval whose extent is various, depending on the mutual relation of the bounding surfaces. The degree of approach is greater in some cases than in others, or the contact is of a more perfect kind. I have proved lately, I think to demonstration, that air is separated from the polished surface of metal by a much wider interval than from glass or other substances. The air therefore, charged with its humidity, approaches so close to the glass, that the latter exerts most powerfully its specific attraction, and detaches the minute globules of water. Paper and other vegetable substances, though saturated with moisture, and therefore capable only of displaying capillary action, seem to possess the same property as glass.

I consider the power of abstracting humidity from the atmosphere as of important consequence in the vegetable economy. Plants may thus inhale liquid nutriment, when the ambient air is still far from being disposed to part with its watery store. And we have seen that heat promotes the effect. Hence certain vegetable tribes, without feeling the beneficial influence of rain or dews, are yet capable of existing in the sultry arid plains of Arabia. They extract a scanty supply of moisture from the air by a sort of chemical process. Perhaps the organic structure of the plant may conpire with its physical quality in augmenting the effect.

The celerity of the flow of liquids in capillary syphons depends chiefly on a circumstance which, I believe, has not hitherto been noticed. If we consider with a little degree of attention the motion of water through a narrow passage, we shall soon be convinced that it is not regular and uniform. The obstruction at first experienced occasions a certain accumulation, which at length overpowers resistance and causes a partial acceleration. In this manner, a sort of continual reciprocating tide is produced in a series of pulses more or less intricate. This curious effect is distinctly visible in artificial *jets-d'eau*. But the same thing may be perceived in every current of water. Hence the varying dimpled surface and the gentle murmur, of brooks. The volume of water continues the same; but its contours and flexures are incessantly changing, and soothe the fancy by exhibiting a picture of animation. After performing a certain cycle, however, the same irregularities are again repeated; and hence the musical cadence

dence of rivulets, so closely associated in our minds with luxurious ease and the calm pleasures of pastoral life.

If we examine carefully the ascent of mercury in a fine thermometer, we shall find that it mounts by a succession of starts. It seems to force itself along by a sort of vermicular motion. Nor does the resistance depend much on the friction experienced against the sides of the tube; it is owing chiefly to the waste of force in impressing a narrow thread of liquid with those concatenated contractions and dilatations indispensable to progressive motion. I must observe that the term *fluidity* itself is merely of relative import. A solid body may soften by insensible gradations, and pass into the state of a fluid. In this new condition the particles are indifferent to position, and therefore easily admit of intestine motion. But such a property implies an extension of the sphere of mutual connection. In a large system of molecules, the slightest alteration in the situation of each is sufficient to produce a total change of arrangement. It is otherwise when the group is very limited. The composition of a fluid may thus be conceived to resemble a long spring, which bends easily and without risk under the smallest pressure; while the structure of a solid may be compared to a short spring, which yields only to the application of a great force, and is then liable to break. But the action of heat extends this imaginary spring, and promotes softness and fluidity. Thus a bit of sealing-wax, held near the flame of a candle, gradually loses its angles and protuberances; an evident proof that the sphere of mutual cohesion is enlarged. And every person must have remarked that oil, during the heat of summer, becomes apparently thin, and flows with facility. Nay, water itself undergoes a similar change of constitution, though it eludes ordinary observation. I bend a thermometer tube, with rather a wide bore, into a siphon, which I insert into a tumbler of cold water, and count how many drops fall in a minute. I then empty the tumbler, and fill it to the same height with hot water; and, replacing the siphon, I find that the drops, which are still of the same size, succeed each other much more rapidly than before, inasmuch as sometimes to form a continual streamlet. I conclude, from several trials, that the velocity of the flow is at least six times greater near the boiling point than on the verge of congelation. But the difference may be rendered much more striking in another way. The height to which liquids are projected is proportional to the square of their initial velocity. Provide, therefore, a glass tube three or four feet long and more than half an inch wide: by the help of a blow-pipe, draw

out the end into a tapering capillary bore, and, a little above this, bend the shoulder back parallel to the tube. Then, holding the tube perpendicular, fill it with cold water, and break off by degrees the slender stem till the water begins to spirt up perhaps half an inch. Now plunge the lower end of the tube, for the space of a minute or two, in boiling water, and, on removing it, the jet will appear to dart almost to the height of three feet, but will gradually subside as the heated portion of water is expended.

The same experiment will succeed, though in different proportions, with alcohol and even mercury. Yet all these are commonly deemed perfect fluids; nor can we doubt that the application of heat will in every case increase the tenuity of the liquid substance, and heighten its degree of fluidity. If water thus experiences such a change, the effect must be proportionally greater on the dilute solution of mucilaginous and saccharine matter which constitutes the sap of plants. The return of spring, by the mere physical influence of its warmth, will promote the flow of the juices destined for the nourishment of the vegetable tribes. That genial season, therefore, not only reanimates the principle of life, and stimulates the organs of secretion to elaborate their fluids, but quickens the circulation of those fluids through the fine ramifications of the sap-vessels. Hence the rapid growth of plants in the hot climates. Hence, likewise, the quick vegetation remarked within the polar circle, where, for the space of weeks or months, the slanting rays of the sun play without intermission.

Versailles,
October 9, 1802.*

* This paper was drawn up in great haste for a particular occasion. It is now printed without alteration, although the author is conscious of its defects in point of unity and arrangement.

XXXI. *Observations on the Salt of Bitumen; the Bit-Noben of the Hindoos.* By JOHN HENDERSON, Esq. Surgeon on the Bengal Establishment*.

Sal Indus vel subniger, vel subrufus, obscurus omnibus fortior.

Messue, c. xvi.

Et alius est Indus, qui est niger, non nigredine napticitatis.

Avicenna, lib. ii. c. 624.

THE saline substance which has lately been imported into Britain under the name of *sali of bitumen*, is not, as might be inferred from the title, a natural production, but an artificial preparation of great antiquity invented by the Hindûs. It is known in India by various appellations †; but the trivial name, by which it is familiar to those who have resided any time in that country, is *khala nimuc*, or black salt. It is met with in every village in large irregular lumps, for the most part of a dark brown colour.

It has a strong saline taste, with a peculiar sensation diffused over the mouth, which is not easily described. At first, the taste is disagreeable: but I have been told by those who were in the habit of using it, that it not only becomes pleasant, but is often taken to remove a disagreeable taste in the mouth. When the salt is perfectly dry, it has scarcely any perceptible smell, but when moistened it sends forth a strong sulphureous fœtor.

It dissolves readily in a small portion of water, forming a solution of a greenish colour, which emits a strong sulphurous smell, resembling bilge water, or the foulest gun-scurings. By exposure to the air, the smell gradually abates, and the greenish tint disappears, the liquor becoming as clear as the purest water: when this has taken place, if the solu-

* Communicated by the Author.—This presents a curious specimen of the Hindoo physic; and further, it may suggest to British practitioners the trial of hydro-sulphurets alone or in combustion, as in the case of the present salt, in many untried diseases.

† By the Hindoos it is called *bit-noben*, *padnoon*, and *soncherloon*; in Arabic and Persian MSS. *melk*, *melk-nust*, *melk-afwed*, *nimuci-nust*, *nimucifed*, and *nimuci-bin li*. It is the *sal-naphthicus Indus vel Indicus* of the Latin versions of the Arabian and Persian authors; the *pharma opcia angustana* of the earlier editions of the *Pharmacopœia Londinensis*, &c. It must be observed, that all the formulæ of which it is an ingredient in the different pharmacopœias, are copied from the Arabian authors; and therefore I doubt much whether it was ever imported into this country before, or even into Europe in any considerable quantity, for I find no particular account of it in any of these books. It is, perhaps, the *sal-asphaltites* and *sociemenus* of Pliny and Galen.

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tion has been pretty strong, on pouring out the water, the inside of the vessel in which it was contained is found lined with a crust of a dark brown colour; a phænomenon observed in most sulphur wells: this will be best discovered if the experiment is made in a glass vessel.

A silver spoon laid over a fresh solution of the salt became discoloured in the course of a few hours; and a little sugar of lead put upon the shank of the spoon, and kept over the solution during the night, was found in the morning considerably blackened. A few drops of the nitric acid added to the fresh solution caused a milky appearance, and a little acetate of lead poured into a glass of it caused a precipitate that filled nearly one-third of the glass. The hepatic gas is in such abundance, that, by exposing a strong solution in a tumbler to the air, the sulphur becomes at once evident, in the crust with which the glass is uniformly found to be lined.

After a solution of the salt had been exposed to the air till it became perfectly clear, a quantity of it was poured into a china plate, and gradually evaporated by the heat of the sun: there remained in the plate a number of cubical crystals, evidently pure common salt, without any other residuum. The salt, from the taste, and some curious phænomena attending it, appeared to be of an uncommon degree of purity.

From these experiments it appears that salt of bitumen is chiefly composed of common salt and hepatic air, or, in the language of modern chemistry, of muriate of soda and sulphureous hydrogen gas, the two principal ingredients that impregnate the mineral waters of Aix la Chapelle, Baden, Harrowgate, Moffat, and most of the celebrated sulphureous springs in Europe.

There are very few sulphurated springs, either hot or cold, in Hindoostan: I only heard of one, "in the province of Burdwan," in all the country from Hurdwar to Point Palmyras. How far the Hindoos have succeeded in discovering the desideratum for preparing them artificially appears from the above analysis, and will be confirmed by comparing a solution of the salt with the sulphurated waters at their sources. All the European processes and machinery for imitating these waters have been directed to the impregnation of water with gas disengaged from *hepar sulphuris*, which produces an imitation of the sulphurated waters mentioned by Dr. Coggan in his Travels on the Rhine, but not of Moffat or Harrowgate: it may perhaps be found that air disengaged from common salt is different from that of *hepar sulphuris*, and in sulphur springs the salt seems to be a very universal ingredient. Not only the waters already mentioned, but those of Gosforth, St.

St. Bernard's Well, Broughton, Deddington, Crickle Spa, Durham, Rippon, Shipton, Keddlestone, Sutton Bog, &c. &c., have all common salt for their basis. This discovery of the Hindoos is upwards of two thousand years old, and far surpasses all the attempts of modern chemists to make artificial sulphurated waters*: they have perhaps discovered the very process employed by nature in the formation of them.

The Arabians and Persians, and even the Mussulmans in India, have generally considered salt of bitumen a natural production; and those who allow that it is made in the country insist upon two kinds, the one natural and the other artificial, and that the latter is only an imitation of the natural. The Mahummedans have such a contemptible opinion of the Hindoos, that they are much more disposed to believe it dug out of the earth, or formed from the water of the Mare Mortuum, than that it is a production of Hindoo chemistry. Some of the chemists to whom I showed it in this country were also inclined to consider it as a natural production. That it is an artificial preparation I am perfectly convinced, from the information of the natives, from having seen a mass of the salt in the form of the earthen vessel in which it had been made, and from having succeeded, in a great measure, in making it: finally, Mr. Robertson, the gentleman who collected and sent it from India, writes, that the salt is manufactured in the neighbourhood of the city of Agra, where it may be had in any quantity. Although I was at considerable expense with the native chemists and alchemists, yet I must confess that I never prepared any salt equal to what was to be got in the bazar or market-place. I shall therefore not describe the different processes performed by my operators. I shall only remark one part, in which they all agreed, and that was, the igneous fusion of common salt with a very celebrated Hindoo medicine called *turp'balla* †, or the three fruits, a name given by way of

* Even in the gaseous part, the present artificial sulphurated waters are said to be different. In the report made to the National Institute of France by citizens Fourcroy, Chaptal, &c. respecting the artificial mineral waters of Messrs. Paul and Co., they observe, 9thly, finally, "the sulphurated appeared to the committee not sufficiently impregnated with sulphurated hydrogen gas."

† *Turp'balla* is the *artifal* of the Arabians and Persians, and the true and genuine origin of those celebrated compositions, long retained in the pharmacopias of Europe under the title of *nypbera*; a word which seems to have exhausted the ingenuity of our lexicographers, who, I find, are fast expelling it from their lexicons and dictionaries. It never had any connection with the Greek word *τροφη*, nor the *nypbera* of Scribonius Largus.

distinction to the Chebul, Belleric and Emblic myrabolans. I must here observe, that there is not a particle of sulphur, alkali, or calcareous earth, used in the process. I have often tried solutions of the salt with infusions of flowers, that afforded very delicate tests of the presence of acids and alkalies, but never discovered the smallest appearance of either.

As a medicine for man and beast, salt of bitumen is more extensively used in Hindoostan than any article of the materia medica that I know of; and, except common culinary salt, I know no medicine the consumption of which comes near it. It forms the basis of those compositions called *missilus*, which the natives in charge of horses, elephants, camels, and other cattle, are in the habit of demanding, once a month, or oftener, as essentially necessary to keep them in proper condition. The Hindoos themselves also use great quantities of it, and have frequent recourse to it to improve their appetite and digestion. They consider it a specific for obstructions of the liver and spleen, particularly for that affection of the spleen called in England the *ague cake**; which is a very frequent disease in India, and well known there by the trivial names *peely* and *bose*. It is a most obstinate disorder, often continuing for years, and resisting the most powerful remedies: after every other has failed, it has been frequently known to give way to a course of the *bit-noben*.

It is in high estimation as a remedy in paralytic disorders, particularly for that species of palsy where the organs of speech are affected. It is much used for different cutaneous affections, worms, old rheumatisms, indigestion, want of appetite; in short, it is considered the grand restorative for man and beast in all chronic disorders. Great quantities of the salt are used by the *salitras*, or native farriers, who seem perfectly to understand the principle on which its efficacy depends; for, after giving a horse a dose of the salt, which is done by mixing it with his food, they always give him water to extricate the gas.

* This affection is, I believe, a rare disease in England, and seldom treated of in medical books. In the East, it is not only often brought on by long-continued fevers, but is a frequent primary disease, and under the titles *zourn el tebul* and *amasi sepuz* is particularly described in almost every Persian and Arabic MS. on the practice of physic.

There is a remedy for the enlargement of the spleen, now very popular in Bengal, called *Lynd's pill for the bse*, which, from the heterogeneous ingredients of which it is composed, has generally been considered by the practitioners there as an useless farrago: however, its efficacy has been such as to bring it into high repute. It was in analysing this pill that I became acquainted with the virtues of salt of bitumen.

Mr. Lynd was a head surgeon of eminence on the Bengal establishment.

XXXII. *Memoir on the Refining of Lead; with some Reflections on the Inconvenience of Ash Cupells; and the Description of a new and economical Method of constructing Cupells or Refining Vessels: read in the French National Institute. By C. DUHAMEL, Member of the Institute and Inspector of Mines &c.*

IT is well known, that to separate silver from lead, a metallurgic process called refining or cupellation, performed in a vessel called a cupell, has been employed: it is known also that this vessel is composed either of the ashes of the bones of animals, or of those of vegetables, after they have been lixiviated, to free them from the saline matters which they may contain.

The great quantity of wood-ashes which must be employed in the construction of cupells, and the difficulty of obtaining them, long ago induced me to endeavour to discover a simpler and less expensive method of constructing the vessels in question. The old chemists having observed that lead becomes oxidated, or reduced into what is called *litharge*, when exposed to heat, or the contact of the atmospheric air, while the silver united to it retains its metallic form, nothing seemed necessary but to find the means of separating these two metals. They were conducted to the method of accomplishing this by observing that the oxide of lead, in its state of liquefaction, easily penetrates the substances which are in contact with it, and especially bone-ashes, without deforming the vessels which are formed of them. No matter, indeed, is more proper than the latter for constructing small refining cupells.

The difficulty, and often even the impossibility, of obtaining about 160 English gallons of ashes for each operation of refining on a large scale in the German furnaces, made the proprietors have recourse to wood-ashes; but, besides that these ashes are expensive, it often happens that they cannot be procured in sufficient quantity. They are even attended with one inconvenience, which is, that they come off, and float on the fused lead; the refining then fails: and this takes place every time that the ashes are badly prepared, that the cupell is insufficiently or not uniformly beat, or when the canals destined for the evaporation of the moisture are neither in sufficient number, nor properly arranged, nor covered with a stratum of scoriæ, on which is established the bottom, that receives the ashes, and which ought to be con-

• From the *Journal des Mines*, No. 64.

structed of the most porous bricks, in order that the water, with which it is necessary to moisten the ashes, may penetrate them in evaporating, may proceed to the bed of scoriæ, and escape by the spiracles which are at the base of the furnace.

To ascertain the proportion of lead in silver, it is sufficient to put some pennyweights into a small cupell of bone-ashes placed under the muffle of an assaying furnace. In proportion as the lead becomes oxidated, it insinuates itself into the cupell, and the silver at last assumes that vivid appearance which announces that the whole lead is dissipated, that the silver it contained is refined, and has attained to its *maximum* of purity.

In refining on a large scale, the object also is to separate the silver from the lead, but not to make the whole of the latter penetrate into the cupell, which is even impossible; for in that case it would be necessary to have a much larger quantity of ashes for the total absorption of the metal: besides, the operation would require a period ten times as long as that used in general for refining, and would occasion ten times the expense in fuel, and a much greater loss of the metals than by the usual process, where the greater part of the lead is obtained in litharge, while a portion penetrates into the cupell for about two inches of its thickness, which must be fused to revive the lead. This reduction is also more expensive, and experiences a greater loss than the litharge, which is easily fused, and which, without passing through the furnace, may be employed as an article in commerce.

Lead ore and litharge may be fused as in England, and the department of the ci-devant Brittany, in a reverberating furnace the soles or basons of which are formed of pounded and moistened clay. These soles can stand the action of heat and of the oxide of lead for six or eight months of uninterrupted labour.

The durability of these earthen soles gave me the first idea of the method, which I shall hereafter propose, for refining-furnaces, where the only thing required is to oxidate the lead to obtain it in litharge, and not to cause the cupells to imbibe the whole of it, as is done when the object is to assay the metal in order to know whether it contains silver. In operating on a large scale, the cupell, though of ashes, absorbs only a part of the lead, as I have already said, observing at the same time that it would be much more advantageous to obtain the whole transformed into litharge, the reduction of which into lead is much easier than that of the

oxide contained in the ashes, which oppose fusion, and the scoriæ of which always carry with them some of the metal.

In a cupell of ashes beat into an oval circle of iron, the greater diameter of which is only five or six feet and the less one yard, the English refine from a ton to 23 cwt. of lead, which is converted into beautiful litharge, except the small portion which penetrates into the cupell, the thickness of which is only about $2\frac{1}{4}$ inches, and which is supported under the arch of the furnace by two bars of iron. A pair of leather bellows drive the litharge towards the anterior part of the furnace, from which it falls, without interruption, on the floor of the foundry, while, to fill up the vacuity left by the oxide running off, an ingot of lead placed close to the base of the bellows is made to advance gradually into the interior part of the furnace. This lead, by fusing, keeps the cupell full till towards the end of the operation.

If I have here given a short view of the process of the English, it is only to show that it is possible to perform operations of refining by employing only a small quantity of ashes for the construction of cupells. Those in question do not absorb 90 pounds of oxide in the large quantity of lead which is refined.

It is then proved that metallurgists have always endeavoured to obtain the greatest quantity possible of litharge, and little ashes impregnated with oxide; but as they thought that they ought not to deviate from the docimastic process, they have always constructed their cupells of ashes.

It has been seen that in cupellation on a small scale, lead, in proportion to its oxidation, penetrates the ashes. When no more is left, the small button of silver remains pure at the bottom of the basin under a spherical form. This operation takes place with the more celerity, as the surface of the mass is always convex in these small vessels; which allows the oxide to flow as on an inclined plane, towards the edges of the cupell, where it is immediately imbibed.

The case is not the same with cupells on a large scale, which are several yards in diameter: bellows must be applied, the wind of which serves not only for accelerating the oxidation, but also for driving the litharge towards the gutter formed for its escape.

We have remarked the inconveniences and even the impossibility of making the whole lead penetrate into the ashes of large cupells: oxidation, indeed, is not effected but in the parts of the mass exposed to the contact of the air or to the wind of the bellows; but as litharge, towards the middle of the basin, could not reach its edges, it would remain there

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in a state of stagnation, and would necessarily oppose the formation of a new stratum of oxide. This has induced metallurgists to expel the litharge by the wind of a pair of bellows in proportion as it is formed, and to make it flow from the furnace.

Oxidation then takes place only at the surface of the mass, and not at its lower part: if the case were otherwise, the ashes of cupells would be penetrated by the oxide to a thickness the more unequal, as the operation is longer; but I have always remarked, that the *test*, or the part of the ashes impregnated with litharge, in refining on a large scale, is not thicker in the centre of the basin than towards its circumference, though the lead remains thirty or forty times as long in the bottom as on the edges; since the mass continually decreases till the whole lead is reduced to litharge, and till nothing remains but a cake of silver at the bottom of the cupell.

If the whole lead is imbibed by the assaying cupell, it is because this small vessel is exposed to a heat uniform in all its parts. As the cupell, in operations on a large scale, presents to the action of the caloric only its upper surface, the oxide imbibed ceases to penetrate it at the place where the temperature is no longer high enough to keep that oxide in a state of fusion. For this reason, the thickness impregnated is equal throughout the whole extent of the cupell; and this prevents the possibility of making the whole lead penetrate into the ashes.

From the above observations it may easily be conceived, that if the assaying of lead ought to be performed in small cupells of bone-ashes, in order that the oxidated metal may penetrate them, and be in part evaporated, the case is different with refining on a large scale, where it is necessary to accelerate the operation, and to obtain as much litharge as possible.

I have already said, that the wood-ashes of which cupells are made for refining on a large scale are expensive; that very often a sufficient quantity cannot be procured; and that besides this, part of the ashes, and sometimes the whole, separate themselves entirely from the sole; which occasion a considerable loss. I shall add, that to give more weight and consistence to the cupells, it is often necessary to mix with the ashes a large quantity of sand; especially if the lead contains foreign substances, such as arsenic, cobalt, antimony, tin, &c. If the lead be only arsenical, after having separated the first scum, a quarter of a hundred weight of iron filings or cast iron turnings are now and then thrown over the whole

surface of the mass. This iron, being lighter than lead, floats over it and absorbs the arsenic, after which the mass must be scummed: soon after, the litharge is formed without any obstacle. This method is employed in Saxony.

The necessity of adding sand to the ashes of cupells must have conducted to the discovery of the following means, which I shall here propose.

New Method of constructing Basons for Refining.

Without making any change in the mason-work of the refining furnace, called the German, care only must be taken to form at the bottom a sufficient number of canals for the evaporation of the moisture, and to arrange them in the manner best calculated to produce that effect. These canals or spiracles must be covered with a bed of scoriae, over which a pavement is to be made of one layer of the most porous bricks.

On this area, which must be concave like the sole on which the ashes of common cupells are beat, place founders' sand a little moistened; to which may be added a fifteenth part of argil, if it is not sufficiently earthy, in order to give it the requisite solidity; and the whole must be carefully mixed. This sand must be rammed in the same manner as for consolidating ashes; and a refining bason is to be formed in like manner, uniformly beat in all its parts. The thickness of this cupell must be six or seven inches: it may be formed of two strata, as will be seen hereafter.

After the bason has been uniformly beat in every part, about a gallon of lixiviated wood-ashes may be sifted over its whole surface, and rendered adherent with beaters.

When the cupell is thus prepared, let down the head on the furnace and make a moderate fire in the fire-hole; which must be maintained for several hours, in order to cause a part of the water, with which the sand has been moistened, to evaporate. The surplus will be dissipated during the operation, without any inconvenience, by canals of evaporation.

After a sufficient desiccation, raise the head and suffer the cupell to cool a little; spread out straw or hay over it, and arrange the ingots of lead, placing them gently on it that their weight may not derange the sand: it is to prevent such derangement that straw is employed, as is done in regard to cupells of bone-ashes*. When the quantity of lead necessary for filling the cupell is arranged in the furnace, let down

* Instead of prismatic ingots it will be better to cast the lead in hemispherical iron moulds. Pieces of that form are less liable to damage the cupell.

the head, and, having luted it round with soft clay, make fire in the fire-hole as for the common operations of refining.

When the lead is in complete fusion, and the mass is covered with scum and charred straw, make the scum or dross run off by the gutter for the litharge with a bit of board about a foot in length, in the middle of which is fastened a rod of iron of sufficient length to traverse the furnace and about a yard more.

When the lead has been well scummed several times, and begins to be red, make the bellows act, but at first gently; arrange the nozzles of them in such a manner, that the wind issuing from both may be directed to the centre of the cupell; and in order that the wind may be always reverberated on the mass, adapt to the extremity of each nozzle a small round piece of iron plate. This kind of valves, which the French refiners call *papillons*, is employed for refining according to the German method. They are suspended by hinges at their upper part: at each stroke of the bellows they are half raised, and they reverberate the wind on the lead, which accelerates its oxidation.

After all the dross or scum is removed, and when the lead has become exceedingly red, and covered with a stratum of litharge, form, with a small iron hook destined for that purpose, a small gutter in the sand of the cupell, which must be dug deeper, gradually and with caution, until the bottom of it be on a level with the mass. The litharge then, driven by the wind of the bellows towards the anterior part of the furnace, will run by this gutter and fall on the floor of the foundry, as is the case in the common operations of refining.

When the refiner observes that no more litharge remains in the neighbourhood of the gutter, he will stop the flowing off with a small quantity of moistened ashes: but as soon as the lead again becomes covered with oxide, the gutter must be opened, and must be dug in proportion to the diminution of the mass, taking care that no lead escapes, and particularly towards the end of the operation; for it would carry with it a great deal of silver, which would be lost. You must proceed in this manner till the silver has acquired its vivid colour; taking care to increase the fire in proportion to the diminution of the mass; especially when the operation is nearly terminated, because the silver then is collected together: and, as it is much more difficult to be kept in fusion than the small quantity of lead which remains united with it, it could be refined only in an imperfect manner at an insufficient temperature; and instead of about a twentieth of lead, which the silver generally contains in the German refining-

houses, it would remain charged with a great deal more, which would render it more difficult to proceed to a second operation, called the *refining of silver*, by which it is carried to the required degree of purity. The Germans call this second process *silber brennen*, burning silver.

Those accustomed to the refining of lead according to the German method, will be able to perform that which I here propose; for, though the cupell be of sand instead of ashes, the operation must be conducted in the same manner.

It has been seen that the English refine a large quantity of lead in a small cupell: in the like manner, a great deal of metal may be made to pass by that which I propose, if care be taken to add more metal as that which is oxidated escapes. If we suppose that the cupell is capable of containing four or five tons of lead, above sixteen may be refined at one operation; which will not be attended with the inconveniences of the English process.

I have reason to think that a cupell of sand well constructed may serve for several operations without the necessity of re-constructing it each time, as is the case with those of ashes; but in this case, and before the lead is introduced, you must fill up the gutter which has been made for the litharge to run off, after having removed with a chisel the kind of varnish which the oxide of lead has left on the sides of it, in order that the new sand, somewhat moistened, may form an intimate connection with the old sand, which must also be watered in that part before the new sand is deposited.

The long duration of earthen soles in reverberating furnaces, where lead ore and even litharge are fused, as I have already mentioned, leaves no room for apprehension in regard to the action of the oxide of lead, which will act only at the surface of the cupell, and will penetrate only a very small part of its thickness.

After one or more operations of refining, this crust must be removed, and fused in a furnace in contact with fuel, in order to obtain the lead. This process will be as easy as the reduction of that metal contained in the ashes of common cupells, and in a much smaller quantity. More litharge then will be obtained by the new method than the old; which is an advantage, as I have already observed. I shall here add, that as the sole of sand does not absorb so much oxide of lead as that of ashes, it will not carry with it so much silver; for it is well known that lead revived from its ashes always contains more than that which arises from the reduction of litharge.

Instead of sand, argillaceous earth might be employed for
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the construction of cupells, as is the case in regard to the soles of the reverberating furnaces in the ci-devant Brittany; but it would be necessary to ram this earth repeatedly for several days; otherwise it would split, and these cracks would increase by the shrinking which must result from the heat, and lead would insinuate itself into these fissures: an inconvenience which cannot take place with sand even a little earthy. I shall observe also, that a sole of earth would harden too much to allow a gutter to be dug for the passage of the litharge: in this case it would be necessary that the place destined for the oxide to run off should be constructed with sand or lixiviated ashes.

I shall add also, that it will be advantageous to employ two kinds of sand in the formation of the basin of the cupell; one kind fine like that used by founders, and the other coarser and not earthy: the latter will form the first stratum, which, after being beat with rammers destined for that purpose, ought to be about three inches and a half in thickness. The fine sand, a little earthy, must then be applied over this first stratum to form a second, which is to be rammed like the former. Both these kinds of sand must be somewhat moistened before they are introduced into the furnace, in order that they may be better heaped up, and be consolidated by the rammers.

The sand of the lower stratum, being coarser than that of the upper, will absorb the moisture of the latter in proportion as it evaporates; and it will pass without any obstacle through the canals disposed for that purpose.

The lower stratum of sand may remain in its place when a new cupell is to be constructed with fine sand, and the part of the latter, which has not been impregnated with oxide, must be mixed with new sand to form a cupell. Care must be taken in raising this sand not to touch the lower stratum; for the sand of the latter, which is coarse, must not be mixed with the other. This inconvenience may be avoided by beating over the bed of coarse sand a thin stratum of ashes, at which you must stop in removing the fine sand of the upper stratum.

It has been said that the founders' sand must be somewhat earthy, and that, if it is not, a little argil must be added to give it cohesion; but, as it is necessary that this argil should be uniformly diffused through all the parts of the sand, it must be diluted in the water with which the sand is moistened, and the whole must be carefully mixed.

It may be objected, that as cupells of sand do not absorb so much litharge as those of ashes, more time will be required to terminate the operation of refining; since, in the new pro-
cess,

cess, the oxide, instead of being absorbed, ought to flow from the furnace. This circumstance needs excite no uneasiness; for the wind of the bellows, if well directed, will make the litharge flow along the gutter more abundantly than if there had been an absorption.

I have seen refiners in Germany, who, in constructing their cupells of ashes, formed in the middle of it a small circular depression the diameter of which was proportioned to the quantity of the silver which they knew to be contained in the lead subjected to the operation. By this excellent disposition no grains of that valuable metal remain insulated from the cake; the whole runs into the central basin, and forms a cake perfectly round. I would recommend this practice.

I am certain that the cupells here proposed, if carefully and properly constructed, will be attended with complete success; will be free from the inconveniences of those of ashes, and at the same time will be economical. I am desirous, for the benefit of metallurgy, that the method here pointed out may be put in practice: it will prove that we ought not to be too tenacious in adhering servilely to ancient usages or to the common routine of workmen.

XXXIII. *On Painting.* By Mr. E. DAYES, Painter*.

I THINK it right again to repeat, that I have not observed any order in the production of these Essays. They were written as the subjects arose in my mind, and the present paper should be considered rather as an introductory address than otherwise. My motive in writing the present essay was to endeavour to remove the prejudice of those who consider the arts as a useless study, and their produce as things merely ornamental. But who, in a state of civil society, would be content with the useful or necessary? Who is he whose soul seeks not after perfection?

The motions of his spirit are dull as night,
And his affections dark as Erebus:
Let no such man be trued.

The subject of the following essay had long engaged my attention; but I had dropped the idea of writing on it, in consequence of some intelligent friends observing it would be useless, as no one could be so stupid as not to see the usefulness and influence of the arts on society. Experience,

* Communicated by the Author.

however,

however, has taught the contrary; and I have been further strengthened in my resolution by observing, that the French National Institute, in their public sitting of April 5, had thought the inquiry of sufficient importance to offer it as a subject for the premium of a gold medal *.

Francis-street, Bedford-square,
November 30, 1802.

EDWARD DAYES.

ESSAY VII.

On the Power and Usefulness of Drawing.

I am persuaded that to be a virtuoso (so far as befits a gentleman) is a higher step towards becoming a man of virtue and good sense, than the being what in this age we call a scholar. *Lord Shaftesbury.*

IN this essay we have two objects in view: to show the connection of drawing with painting; and to exhibit, in as clear a manner as we possibly can, its usefulness and influence on society.

But before we proceed it may be necessary to observe, that those who would question the utility of the arts, would be equally disposed to question the utility of these essays that treat about them. Of their usefulness we hope to be able to offer numberless proofs; but they rise superior to the merely useful. For that which is necessary is neither ornamented nor elegant, because necessity implies poverty, while ornament implies abundance. Hence architecture, as an art, does not apply to mere house-building.

In defence of these essays, they are serviceable by exhibiting the usefulness of truth; and so far they become an object to all those who wish to be acquainted with the subject handled, and to obtain a knowledge therein. But to those who never think or inquire, or concern themselves with matters of speculation, or who take up with speculations without examining them, or read only to confirm themselves in such as they have received, not any thing can become an object of concern, or any book be useful.

That man was not intended by nature for purposes base and ignoble, none will deny; and, if arguments were wanted, they might be drawn from that eternal inquiry after whatever is grand, dignified, or exalted; and, finally, after a state superior to our present terrestrial one. For it is not too much

* We cannot help thinking that Mr. Dayes has judged well in taking up this part of the subject. It is of great importance, and he has rendered an essential service not only to the art itself, but to its liberal professors, by removing, as his arguments effectually do, ill-grounded prejudices against its indispensable utility in civilized society; prejudices which could only originate in, and be fostered by, ignorance and stupidity.—EDITOR

to assert, that we approach the Divinity in nothing so much as in wisdom. Hence, as the arts are connected with wisdom, as men become careless of their culture, they become equally incapable of fulfilling the duties of social beings. For knowledge is what humanizes mankind; reason inclines them to mildness, but ignorance generates prejudice, which eradicates every tender feeling.

By *drawing* is meant the exact imitation of all the forms and manners which present themselves to our sight; and in knowing how to give every thing its proper and corresponding character agreeably to the subject consists the excellence of what the artist terms *a good draftsman*.

Drawing, as far as it is connected with mere imitation, is a mechanical operation, and may be acquired by a person of very moderate talents. So may a knowledge of bodies, properties, facts, events, and fables, by reading. But the powers of invention, the *vis poetica*, which distinguishes the bard from the mere versifier or journalist, the genius from the mere imitator and copyist, must be a gift from heaven bestowed at the formation of the being. Neither this poetic energy nor the inventive powers of the artist can be taught in schools or academies; but they both may be buried in rust and inaction, if proper objects are not presented to call them into motion. So the inventive powers of genius will be futile if unaccompanied by a skill in drawing. Without this, the learning of the painter or sculptor cannot be shown to advantage: it is the *sine qua non* by which all the other accomplishments are displayed.

From what has been already stated, the dependence of painting on drawing must be obvious.

Genius has been compared to fire from flint, which can only be produced by collision: if so, success must follow where nature directs and perseverance attends. Activity is a necessary ingredient to enable us to obtain a knowledge in art; and should we find others out-step us, let us redouble our diligence, and comfort ourselves with the recollection, that a late spring produces the greatest plenty.

No one can possibly judge of his powers from mere speculation; the test must be applied before the value of the gold can be known. Nor will inactivity ever discover how far our fortitude will enable us to overcome difficulties, our patience to bear disappointment, or our industry enable us to range the wide field of art. For, were the arts of easy attainment, they would be unworthy the notice of a great mind. This should induce us to increase our exertions in proportion to our disappointments, remembering that to strive

with difficulties is noble, but to conquer is one of the highest points of human felicity. It is in painting as in writing: where difficulties occur, they arise from not clearly understanding the subject. Hence, to be able to represent an object justly we must understand its fabrication; for it would be in vain to think of drawing the arch of a bridge correctly without knowing how it was keyed or put together, or even a basket if we did not know how it was wove.

We shall now proceed to consider the power of drawing in a point of view merely useful.

How limited must their ideas be who consider it as "the foundation of painting" only! We know it is such: for without drawing it would be in vain to think of producing an effect; as mere colour without form must remain a crude and undistinguishable mass.

Drawing is not only an accomplishment the most elegant, agreeable, and ornamental, but, at the same time that it is the foundation of painting, is of the utmost utility to the sculptor, the civil and naval architect, the engraver, the engineer, the mathematician, and navigator. It also assists the gardener, the cabinet-maker, the weaver, &c. In short, there is scarcely a branch of civil society that is not indebted to it, from the maker of the iron rails before our house to the tea-urn on our table. To it we are indebted for representations of those elegant remains of antiquity that have contributed so much to the advancement of our knowledge of fine form. Volumes of verbal description will never convey so true an idea of a thing as the most slight sketch. Hence the source of much of our knowledge in antiquity, of which language could convey no adequate idea.

To be able on the spot to make a sketch of a fine building, beautiful prospect, or any curious production of nature or of art, is not only a very desirable and elegant accomplishment, but in the highest degree entertaining. To treasure up whatever may occur in our travels, either for future use or to illustrate conversation, to represent the deeds of the great of former ages, to preserve the features of our most valued friends, has made this art not only one of the highest embellishments of our nature, but the delight of all ages. The greatest writers have united to praise, and empires to encourage it. It has been in the highest degree morally useful; and, where it has flourished, conferred honour on the country. In fact, society could not sustain a more severe loss than in being deprived of it; as many comforts, and all those elegancies that adorn the present state of our being, must depart with it.

What

What has been the fate of those people whose lawgivers forbid the practice of one part of the elegant arts? It appears they well knew, that where art resides, wisdom will ever be of the party; and dreaded the downfall of opinions built on a false base.

Wisdom is power, and power is what preserves a nation: hence those who shut the door against knowledge are wilfully seeking their own destruction: such is precisely the present state of the Turkish empire.

Ye gods! what justice rules the ball!
Freedom and arts together fall:
Fools grant whate'er ambition craves;
And men once ignorant are slaves.

POPE.

What was the fate of Crete, that was so renowned for her wisdom, valour, and laws? How did she sink under the tyranny and oppression of Rome? With their freedom departed their arts, their sciences, their valour, and their virtues. With the loss of liberty we lose all the ardour nature has furnished us with to strengthen and support the flame of genius and the ardent glow of valour: without it we become destitute of vigorous resolution, and sink below the natural virtue and dignity of our species.

Drawing may be said to possess a divine virtue in its creative power, and to be a perpetual miracle, as it preserves the images of distant objects, and the likeness of those we love.

Without risking our lives on the boisterous ocean, we may enjoy at home, in a small book, representations of the finest productions of nature and art situated in the remotest regions of the world.

The wealth of a state, and the degree of civilization of its inhabitants, are shown in the perfection of the elegant arts: no country ever flourished without them.

To speak of the power of drawing in a very limited point of view: without it we could not have maps and charts; without them we could not navigate; and without navigation we could not possess the advantages of commerce. Its application to ship-building must be obvious, as every part is made to a scale. As a mere power of imitation, it unquestionably sets man at the head of creation, no other animal having made even the attempt.

The arts have not only an influence on our manners but passions, and, taken in a national point of view, are highly useful. The pictures representing gallant actions or noble achievements rouse and stimulate to acts of heroism and

public spirit; while those of a more elegant turn exhibit examples of graceful address, and incline the mind to acts of beneficence and virtue.

However much we may lament that historical painting is not sufficiently encouraged, yet we must dissent from those who support the old but erroneous opinion, that our love of portrait-painting arises from a national vanity. This ridiculous idea has been bandied about, both by foreigner and native, till many who take up with opinions without examining them have believed it true. We boldly assert, on the contrary, that it is national virtue that gives it birth, and a desire the most rational, that of preserving the images of those we love and delight in, constantly before our eyes. It argues great national beneficence and goodness of heart. We may in some measure judge of the disposition of the master of a house from the number of portraits he possesses: they cannot be likenesses of his enemies. Hence his choice must be founded on love, and not, as the ancients' was, on pride and vanity. The portrait-painter therefore becomes morally useful by increasing that social tie that binds society together, in keeping before our eyes the images of departed worth or existing merit. It is only those who neither love nor are beloved, that have no need of the portrait-painter.

Among the number of our own national advantages, and which some may think superior to all others, we may observe that the excellence of our artists has turned the balance of trade in our favour. For whereas we formerly imported vast quantities of prints, we now supply all Europe, and import very few. Even for the decoration of our books we were formerly obliged to apply to strangers: but Heath has added a taste to that department of art unknown to former engravers in the historical line. Among the topographical publications, those prints that accompany the "Beauties of England and Wales" must be highly interesting for taste and beauty.

In the beginning of the last century, the writers on the continent amused themselves in endeavouring to assign a cause for the dulness of us islanders in not having produced one historical painter. Our northern latitude, being involved in fogs, was among the reasons assigned: but the cause of such absurd inquiries has ceased, and the mental capacity of Britons no one will now dare to question.

The consequence of our nation and the arts appear to have advanced together. The first is evinced in our colonial possessions; and if we go back to the time of Henry VIII., we shall easily discover the state of commerce and the comfortable situation of society compared with the present. Hollin-
shed

shed observes that chimneys were a novelty, as were pewter ornaments for the table. Straw formed the bed, and a good hard block of wood the pillow. Then was the dawn of the arts. Since which time they have been advancing, and are now, thank God! matured into a glorious mid-day, under the auspices of his present majesty.

It is impossible to speak of the arts without expressing our gratitude towards their great patron; and were his name to flourish in no other way, that of George III. will be sacred to posterity with those of Leo, Julius, and all such as have a claim on eternity, as their protectors. His majesty has done for the arts what no monarch of this nation ever did before: he has given, by his patronage, a turn to the national taste highly beneficial to the profession, which the public are bound to support by a liberal and fair encouragement. With respect to the mere act of buying, we are bound to consider his majesty in the light of a private gentleman, who regulates his expenditure according to his income: and we ought to thank God it is so.

Holbein had not taste enough to change the grotesque fashions of the court of Henry VIII. He brought about a revolution in architecture; but he introduced a mungrel style, inferior to the Gothic of that period. Zuccaro was in England in the time of Elizabeth; and during that long reign we find little improvement in architecture, dress, or in the general circle of elegancies. It was a court of intrigue and vanity. In the reign of James I. Van Somer and Cornelius Janson paved the way for Van Dyck—an epoch of taste: but this appears to have been confined to the court and a few noble collectors; and the troubles of Charles his successor prevented his giving them a more general influence. His reign stands high in the history of architecture, from having produced Inigo Jones. Under Lely taste sunk into Indian gowns and flowing perukes; till fashion became a monster in the time of Kneller, and appeared in buckram coats, square-toed shoes, and disproportioned head-dresses in the ladies. This style of dress prevailed till within these few years, when good sense and a more just taste broke through the buckram and whalebone, and produced the present easy and elegant mode of attire; which may be said to mark a point of national excellence. Reynolds contributed much to this change; his whole life was a struggle with the hydra fashion, as his works evince.

The above statement will be found not to apply only to the article of dress, but to extend to every department. Let us, for instance, from the period of Henry VIII. examine
ship-

ship-building, civil architecture, our furniture, plate, &c. &c., and we shall find them to have nearly improved together, or to have fluctuated as the taste for *dessin* prevailed, till the patronage bestowed by his present majesty, by exciting a general love for the arts, improved the national taste to its present great and highly respectable state.

Before we dismiss the present essay we shall endeavour to point out some of the advantages that result from the practice of drawing, to those who do not make a profession of it. Many must be obvious from the former part of this paper. To every gentleman who travels, it is absolutely necessary; for, independently of its teaching him to see accurately, the curious and ever-reflecting eye of the artist comprehends more at one view than the common observer will notice in an age. The volume of nature is laid open to him; his attention is directed to the vast and minute; men and manners are not concealed from his view, and his imagination clings to perfection with ineffable delight.

It is not too much to say, that drawing opens the mind more than years devoted to the acquiring of languages, or the mere learning of words: it teaches to think. The artist is a true logician: not content with producing effects, he is ever inquiring after causes founded on a visible demonstration, to exhibit them in his works.

We must not rank it among the least of the advantages resulting from the practice of the arts, that it enures the reflecting mind to the most enticing sort of logic. The practice of reasoning upon objects in themselves agreeable tends to produce such a habit, and habit strengthens the reasoning faculties. Besides, while the mind is engaged in obtaining knowledge, we escape the insipidity and indifference connected with the tediousness of inactivity. Hope attends labour; a blessing unknown to those who live lazily on the toil of others. The sensualist imagines he enjoys the world because he eats and drinks, and runs about upon it; but to enjoy it truly, is to be sensible of its greatness and beauty.

Independently of keeping the mind employed, the arts contribute to harmonize the temper; and the power of drawing brings with it so much mental enjoyment, that youth, in order to be occupied, is not tempted to precipitate into the ruinous and destructive vices of gaming and drinking. It defends us in the meridian of life from the wild schemes of ambition, and in old age it becomes a sure shield against avarice. Shenstone observes, "Wherever there is a want of taste, we generally observe a love of money and cunning."

The influence it has on our moral conduct is, perhaps, one of the greatest recommendations for the study of the arts. No one can meditate on the order observable in nature, and not reduce his conduct to a similar standard of regularity. To have a just relish for what is elegant and proper in painting, sculpture, or architecture, must be a fine preparation for true notions relative to character and behaviour. Should such a one be overpowered by passion, or swerve from his duty, we need not fear but he will return on the first reflection, and with a redoubled resolution not to err a second time: for he cannot but observe, that the well-being of nature, as well as of the individual, depends on regularity and order; and that a disregard of the social virtues will ever be accompanied with shame and remorse. Passion is a whirlwind, that shakes the human frame, as the convulsions of an earthquake disorder that of nature.

Every Briton that travels should propose to himself pleasure and advantage, and his inquiry should enable him to add to the national stock of knowledge; for it cannot be said that he travels to enjoy the advantage of a better government, or because other nations have a greater commerce. Hence, then, it must be for arts and learning. And how is he to become acquainted with the former without a knowledge in painting, sculpture, and architecture, any more than he could with the latter, without a knowledge in the languages of the countries he may have occasion to pass through? Lord Bacon says: "Travel, in the younger sort, is a part of education; in the elder, a part of experience. He that travelleth into a country before he hath some entrance into the language, goeth to school and not to travel." The same may be said of those who travel before they have obtained a knowledge in the polite arts. How many noble works of architecture did lord Burlington bequeath to his country! They remain monuments of national taste, highly honourable to his memory. Let us be permitted to mention the honour the arts at present derive from the masterly productions of the earl of Aylesford, sir G. Beaumont, sir R. Hoare, W. Scope, esq. of Castlecomb; captain Lewis, of the royal navy; capt. Mordaunt, and many others, whose works will ever rank among the first productions of the pencil. Lord Warwick is said to possess the true poetic spirit for composing heroic landscape. While we are recommending to gentlemen to learn to draw, it must not be understood that we wish to deprive the ladies of the pleasure and advantage that must result from their practising an art that stands, perhaps, before all others for

improving

improving our taste, particularly in such things as are connected with decoration.

Though we recommend learning to draw thus generally, we must say it requires the utmost caution in the choice of a master; for, should his abilities be confined, or his taste depraved, there is great danger of the poison being conveyed to the pupil: and if, in the end, his better understanding rise superior to the evil, he will, unfortunately, have much to unlearn. Above all, if he be arrived at an age to discriminate, objects worthy attention should be set as examples of imitation; he should not be amused and his time wasted with gew-gaws and trash beneath the dignity and attention of rational beings.

Every one is acquainted with the progress of what may be termed common or school education. The masters begin teaching the letters, and then proceed to syllables, which are joined into sentences: but the ultimate end is, composing themes to call forth the power of invention, and convey a more exquisite idea of the language. Exactly so should be the progress in teaching drawing. If the knowledge to be obtained be the human figure, we begin with parts; as eyes, noses, heads, hands, &c., which is the A B C. This, of course, leads to the whole figure, which may be compared to spelling; that naturally conducts to the round, or drawing from plaster casts; then from the life; and ultimately to composition. Should landscape be the pursuit, the progress is precisely the same. We begin with parts or single objects; as trees, bridges, cottages, castles, &c. Here again is the alphabet. This we too quit to copy wholes, or a combination of objects; and in the end we apply to nature, which sets us free from our master. Then we must improve by our own activity; and, like the bee, cull the honey from every flower. As much of our success depends on the abilities of the master, the greatest care should be observed in the choice. He is but as a crutch to the lame; but we ought to make ourselves sure it is sound, and without flaw or shake; that is, as far as our judgment will permit, or the opinion of friends direct.

He who aspires to a knowledge in the fine arts can only hope to succeed by turning his attention to the sensitive part of nature, particularly by an inquiry after such objects as are naturally agreeable, or the contrary: also such as are grand or mean, proper or improper. This is the only foundation of a just and rational taste, and, like morals, may be cultivated to a high degree of refinement. The fine arts, where the feelings only are concerned, will please, from their novelty,

velty, in the prime of life; but the delight will cease in a more advanced period, when the fervour of the imagination goes off. On the contrary, where we are governed by just principles and a thorough knowledge, they will afford scope for fancy as well as judgment, they will grow into a favourite entertainment, and their vigour will prevail as strong in the evening as in the morning of life. This only can make the arts truly delightful. It is not a few technical phrases, picked up from professional men, which may enable one to babble like a parrot, that can at any time please or be pleasing. Science is a coy lady, and will not grant her favours without being long courted. But, should we aspire to no higher character than that of the mere critic, a small stock of information will suffice; and practice will increase confidence where there is nothing to lose. Criticism is a lady of easy access: the want of meaning she supplies with words; and the want of knowledge is recompensed with cunning. She flatters all; and those whom nature has made weak, or idleness keeps ignorant, may feed their vanity at her shrine.

XXXIV. *On the Differences which exist between the Heads of the Mammoth and Elephant.* By REMBRANDT PEALE, Esq.*

THE drawings which accompany this (see Plate V.) are intended to explain the differences between the head of the mammoth and that of the elephant. The teeth form the most striking character: those of the elephant are exclusively graminivorous, and consequently distinguished from those of the mammoth, which were intended for animal food of some kind, and not improbably shell-fish, on the supposition that the animal was amphibious †: and this may account for the peculiar form and position of the tusks. On examining the head of the elephant, it will appear that the sockets for the tusks at A are situated, with respect to the condyle of the neck at B, nearly in an angle of 45 degrees; so that the tusks, which have but little curve, are directed downwards and forwards, and may be with ease employed offensively and defensively. On the other hand, it will be observed that in the mammoth the socket A is nearly on a horizontal line with the condyle B; and therefore the tusks, which are semi-circular, could never have been elevated in the air, pointing

* Communicated by the Author.

† See the former number, p. 162—169 of the present volume.

backwards, but must have been as represented in the figure, the points thrown out by the spiral twist on each side:—in this position they might have answered in striking down small animals, or in detaching shell-fish from the bottoms of rivers, or even in ascending the banks.

In the elephant the orbit of the eye is situated at C, whereas in the corresponding part at C in the mammoth is a large mass of bone, so that the eye must have been elsewhere: to ascertain where, we must wait until we receive the cranium lately discovered on the Ohio. The cheek of the elephant is formed of two bones; but in the mammoth, besides other variations, there is but one bone. The whole figure of the under-jaw differs most remarkably; first in the length of the condyles or arms from E to B: in the mammoth it is short and angular; but in the elephant DEB forms a semi-circular line, and at D it is long and pointed.

This short reference is sufficient to direct the attention of those who wish to examine them more critically; when they may remark several other characters sufficiently interesting.

XXXV. *On the Hydrometer.* By WILLIAM SPEER, Esq.
Supervisor and Assayer of Spirits in the Port of Dublin.

[Concluded from p. 162.]

I SHALL now proceed to explain Mr. Gilpin's tables, in order to demonstrate their use, and the use of my additional columns. The first I cannot do better than in the words of Sir Charles Blagden himself:

“Tables for reducing the quantities by weight, in any mixture of pure spirit and water, to those by measure; and for determining the proportion, by measure, of each of the two substances in such mixtures, by Mr. George Gilpin, clerk to the Royal Society, communicated by Sir Charles Blagden:

“These tables are founded on the experiments, of which the results were given in the Report and Supplementary Report on the best Method of proportioning the Excise on Spirituous Liquors. They are computed for every degree of heat, from 30° to 80°, and for the addition or subtraction of every one part in a hundred of water or spirit; but as the experiments themselves were made only to every fifth degree of heat, and every five in the hundred of water or spirit, the intermediate places are filled up by interpolation in the usual manner, with allowance for second differences.

“ Every table consists of eight columns, and there are two tables for every degree of heat. In the first column of the *first* of the two tables are given the proportions of spirit and water by weight, 100 parts of spirit being taken as the constant number, to which additions are made successively of one part of water, from 1 to 99 inclusively: the first column in the second table has 100 parts of water for the constant number, with the parts of spirit decreasing successively by unity, from 100 to 1 inclusively.

“ It must be observed, that each of these tables, occupying one page, is divided in the middle for adapting it more conveniently to the size of the paper; but the whole of each page is to be considered as one continued table. The second column of all the tables gives the specific gravities of the corresponding mixtures of spirit and water in the first column, taken from the table of specific gravities in the Supplementary Report, the intermediate spaces being filled up by interpolation. In the third column, 100 parts by measure of pure spirit, at the temperature marked at the top of every separate table, is assumed as the constant standard number, to which the respective quantities of water by measure, at the same temperature, are to be proportioned in the next column.

“ The fourth column, therefore, contains the proportion of water, by measure, to 100 measures of spirit, answering to the proportions by weight in the same horizontal line of the first column. The fifth column shows the number of parts which the quantities of spirit and water, contained in the third and fourth columns, would measure when the mixture has been completed; that is, the bulk of the whole mixture after the concentration or mutual penetration has fully taken place. The sixth column, deduced from the three preceding ones, gives the effects of that concentration, or how much smaller the volume of the whole mixture is, than it would be if there was no such principle as the mutual penetration. The seventh column shows the quantity of pure spirit by measure, at the temperature in the table, contained in an hundred measures of the mixture laid down in the fifth column.”

From this account it will be seen, that every mixture of pure spirit and water possible to be made, is analysed so clearly at every temperature, as to render it a matter of no great difficulty to demonstrate, at a given temperature, all the gradations of strength which the hydrometer should indicate. The mode in which this has been done I shall now explain.

The table which Mr. Gilpin has calculated for the temperature of 55, is that which I have chosen, conceiving it,

for several reasons, to be the most convenient. And as a reference to it becomes necessary, I have annexed this, with the additional columns to it, by which the hydrometer indications of strength are regularly deduced from the specific gravity of the spirit at this temperature*.

In order to explain the manner in which I have calculated these additional columns, I conceive the easiest mode will be by an example.

It being understood by the trade that the specific gravity of proof spirit at this temperature (55) is 922, I look at the table for this specific gravity, and I find that it is a mixture of pure spirit and water, in the following proportions, viz. 100 parts of the former to 81 of the latter (both by weight), but that by measure it is made by mixing 100 gallons of pure spirit with 66 gallons 99 parts of water. I then find that the diminution of bulk, by penetration, on the mixture by measure, (that by weight being unnecessary to attend to in bringing out the result,) is 4 gallons 57 parts, as, instead of producing 166 gallons 99 parts, there will be only 162 gallons 42 parts. I find next, that this mixture contains per cent. of pure spirit 61 gallons 57 parts.

These being the proportions in the standard of proof, to which every other gradation of strength is relative, the Rule of Three demonstrates this relation in a manner requiring to be explained by another example. Suppose a spirituous liquor is produced to ascertain the hydrometer indication: on weighing it in a phial adapted to this purpose, I find that at the temperature of 55, its specific gravity is 848; by looking into the table I perceive that this contains per cent. 93.18 of pure spirit. I then try how much more than proof this is by subtracting 61.57 (the quantity which proof contains), and I find that this has a redundance of pure spirit, amounting to 31.61.

Therefore, as 100 gallons of pure spirit require 66 gallons 99 parts of water to reduce it to proof, the redundant 31.61 will require 21.17. Add these, and from the amount 52.78 the diminution of bulk by penetration is to be deducted, which, by the ratio in proof spirit being 1.44, the result finally comes out that this spirit is 51 gallons and 34 parts (about one-third) over hydrometer proof. The under proofs require less calculation, the excess of water per cent. over the proportion which proof contains being all that is required.

* It may perhaps be necessary to observe here, that a reference to this table is not required in the use of the hydrometer I have constructed, further than to try whether it be correct.

These examples are, I hope, sufficient to explain this table. The uses to which it is applicable, are, that *as it affords first an unequivocal standard for every gradation of strength*, an hydrometer can be graduated on a certain principle; and, secondly, the errors of those that are graduated otherwise may be discovered by it, and we shall no longer be obliged to rely on a mere assertion, that the instrument is correct, nothing more being required than to compare the specific gravity of the spirit with the indication of strength which it has demonstrated.

On considering how far it might be practicable to simplify the hydrometer, I perceived that the makers of these instruments had fallen into two errors, which had very considerably increased the necessity for those complex additions with which they are incumbered.

First, conceiving that the instrument was to be valued in proportion as it was capable of making *minute* discriminations, (or of its sensibility as it is called,) they have, by attempts to increase this beyond those limits required either in revenue or in commerce, destroyed its simplicity.

In the construction of this instrument, the proportion of the stem to the ball is an important consideration: if the former be too large, the instrument will not be sufficiently sensible; and should it, on the contrary, be too small, the number of gradations of strength it is capable of indicating will proportionably be diminished.

Those who have constructed most of the hydrometers now in use, have run into the latter error; the stem being diminished to a size which rendered it necessary to have recourse to complex additions to supply the place of this injudicious and unnecessary waste of the simple and proper power of the instrument.

From a great variety of experiments to ascertain the proper proportion between the ball and stem, I was finally satisfied that the latter would admit of such enlargement as to be rendered capable of measuring upwards of 66 gradations or percentages of strength, without any weight; and this so clearly and distinctly, as to convince me that its sensibility and accuracy were still fully sufficient.

The second error alluded to has arisen from an attempt to extend the power of the instrument beyond those limits, which, with propriety, and consistently with its simplicity, could be effected.

An hydrometer being a counterpoise to ascertain the weight of a spirituous liquor, may, with propriety, be compared to a

pair of scales*, of which there are various *fixes* and *descriptions*, to answer *different purposes*, by which means their simplicity is uniformly preserved.

On the contrary, it has erroneously been conceived, that an hydrometer would be imperfect that did not, *by one means or another*, ascertain the specific gravity of all liquids at their various temperatures: the simple power of every instrument of this kind being confined within certain limits, this could not be effected without additional complications of various kinds to those which were added, to increase its sensibility, some of which are certainly ingenious, but, I conceive, highly unfit for the purpose of revenue.

Should this ingenuity be exercised on a pair of scales, which it would be proper to use in weighing a portion of eight or ten pounds, and by complex additions render them sufficiently sensible to ascertain a few grains or fraction of a grain, or so extended in their power as to weigh 100 pounds, is it not evident that the simplicity of the balance, which is its great recommendation, would be destroyed?

That which led to the construction which I finally fixed on, was first a *quadrangular stem*, from which I had four temperatures, viz. 35, 45, 55, and 65; and the intermediate degrees I managed with four small weights on the top of the stem, each serving for two degrees of temperature. The instrument having been graduated with these on, if the temperature should be *two* degrees higher than the scale, I removed one weight, in order to lighten the instrument equal to the decrease of specific gravity; if *four* degrees, I removed two weights; if *six* degrees, I removed three weights; and if *eight* degrees, I removed the fourth; and two degrees more brought me to a new scale, or side of the stem: by this means the instrument would accord with the variations arising from temperature, so far as at most to be but one degree different from it. It was adjusted at every tenth degree of temperature.

This was evidently a considerable progress towards the object I was in pursuit of, as it not only remedied the great defect of inattention to temperature which took place in the Irish hydrometer, but, in a great measure, the various defects of the English revenue hydrometer, as, notwithstanding the weights were reduced from 36 to 4, it accorded nearly with

* The name of the instrument, which in strictness should be *arometer*, (*hydrometer* being an instrument for weighing water), demonstrates this to be the principle on which it acts; therefore in France it is called *peste liqueur*, and by some English writers, a water-poise.

the various temperatures, and indicated 66 gradations of strength. I perceived, therefore, that the principle would answer, but that it could be improved still further; and after various efforts I at length fixed on that construction, of which I shall now beg leave to give a description.

This new hydrometer is made of hard brass: the ball is shaped in the form of a pear, being nearly two inches in diameter at its greatest dimension, and two inches and a quarter in length: the lower stem measures one inch and a half, and is in shape a prism, each side measuring one-eighth of an inch: to the lower end of this a round weight is fixed, the diameter of which is seven-eighths of an inch. The upper stem is in length five inches and a half, and is an octagon, each side being somewhat less than an eighth of an inch wide: each of these sides is graduated for a temperature engraved on the top, the lowest being 35, the second 40, and so increasing by five until it reaches 70. The zero, or proof point, is marked \ominus , and the gradations of strength (numbered at every fourth) amount to sixty-six, and those so clearly distinct, that at the over-proofs they will admit of a sub-division, and by that means indicate a half per cent. These divisions are not at equal distances; an error which takes place in the present Irish and several of the old hydrometers, but widens in proportion as the specific gravity of the spirit diminishes; and, being graduated with spirits of known strengths at every four per cent., the intermediate per centages are adjusted by interpolation.

To prevent any error which might arise from taking the indication of strength from the wrong side of the stem, an index is applied on the top of it, with an opening to show the figures which point out the temperature. This index, which applies *merely* to the purpose here mentioned, may be removed lower to any part of the stem, but above the surface of the liquor, without affecting the accuracy of the instrument, as neither its weight nor dimension is changed; and being of a different colour from the stem (sanguined steel) it forms a contrast with it, and, as it were, points to the indication sought for, by which every danger of error in this respect is removed.

Although this is the only use of the index, when the temperature shall be found one of those eight marked on the stem, yet it is necessary that the instrument shall accord with the four intermediate degrees between each of the adjoining sides: for this purpose one of two other indexes of different weights are occasionally substituted for the first one, in order to lighten the

the instrument so as to accord with the decrease of gravity which takes place in the spirit by the increase of temperature. Therefore the manner of using the instrument is as follows:

Supposing the temperature to be 50, nothing further is required but to place the index No. 1 (each being marked so as easily to be distinguished) on the side marked 50, and immerse the instrument, which at once shows the strength. Should the temperature be 51 or 52, instead of index No. 1, use that marked No. 2: should it be 53 or 54, use index No. 3: the instrument having been adjusted with these two auxiliary indexes, in the one case at a temperature of $51\frac{1}{2}$, and in the other $53\frac{1}{2}$, these four intermediate temperatures are so accorded to, as to be either the actual one, or within *half a degree* of it. And they apply in all cases, to the four intermediate degrees of temperature, and no other appendage required to enable the instrument, in this plain and simple manner, to measure sixty-six gradations of strength with an accuracy which, it is presumed, is fully sufficient for either revenue or commerce*. No weight requiring different immersions to find out that which is the proper one; no temperature omitted to create doubts, or false indications of strength; no fraction in the per centage to operate either against the revenue or the merchant; no gradation of strength left unascertained or determined by conjecture; no doubt remaining as to the correct strength of all the various gradations; and no second inspection and subsequent combination to be made, requiring the aid of, and liable to the errors of, a sliding rule.

The following is a table for graduating hydrometers on a certain and invariable principle, showing from the specific gravity of the spirit at the temperature 55, what the hydrometer indication of strength should be of every possible mixture of pure spirit (or alcohol) and water, from the former down to proof spirit.—N. B. This table is calculated on the *supposition* that the standard of proof is 922, temperature 55.

* Even this half degree of temperature may be obtained by holding the jar containing the spirit for a few moments in the hand.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Spirit & water by weight.	Specific gra- vity at 55°.	Spirit by measure	Water by measure	Bulk of mixture	Diminution of bulk, or con- centration.	Quantity of pure spirit, per cent.	Pure spirit per cent. redundant.	Water to re- duce redund. spirit to proof	Diminution of bulk on red. spirit & water	Per Cent over Hydrometer proof.
Sp. + W.										
100 + 0	,82736	100		100,00		100,00	38,43	25,74	1,75	02,42
1	,82967		0,83	100,72	0,11	99,29	37,72	25,26	1,72	01,26
2	,83192		1,65	101,44	0,21	98,58	37,01	24,79	1,69	00,11
3	,83412		2,48	102,16	0,32	97,88	36,31	24,32	1,65	58,98
4	,83626		3,31	102,88	0,42	97,19	35,62	23,86	1,62	57,86
100 + 5	,83834		4,03	103,62	0,51	96,50	34,93	23,39	1,59	56,73
6	,84037		4,16	104,36	0,60	95,82	34,25	22,94	1,56	55,63
7	,84235		5,79	105,10	0,69	95,15	33,58	22,49	1,53	54,54
8	,84429		6,62	105,84	0,78	94,49	32,92	22,05	1,50	53,47
9	,84618		7,44	106,58	0,86	93,83	32,26	21,61	1,47	52,40
100 + 10	,84802		8,27	107,32	0,95	93,18	31,61	21,17	1,44	51,34
11	,84982		9,10	108,07	1,03	92,54	30,97	20,74	1,41	50,30
12	,85158		9,92	108,81	1,11	91,90	30,33	20,31	1,38	49,26
13	,85330		10,75	109,56	1,19	91,27	29,70	19,89	1,35	48,26
14	,85499		11,58	110,32	1,26	90,65	29,08	19,47	1,32	47,23
100 + 15	,85664		12,41	111,07	1,34	90,03	28,46	19,06	1,30	46,22
16	,85825		13,25	111,82	1,41	89,43	27,86	18,66	1,27	45,25
17	,85984		14,08	112,58	1,48	88,83	27,26	18,26	1,24	44,28
18	,86139		14,89	113,34	1,55	88,23	26,66	17,85	1,21	43,30
19	,86292		15,71	114,09	1,62	87,64	26,07	17,46	1,19	42,34
100 + 20	,86441		16,54	114,86	1,68	87,06	25,49	17,07	1,16	41,40
21	,86588		17,37	115,62	1,75	86,49	24,92	16,69	1,13	40,48
22	,86732		18,19	116,38	1,81	85,93	24,36	16,31	1,11	39,56
23	,86874		19,02	117,14	1,88	85,37	23,80	15,94	1,08	38,66
24	,87013		19,85	117,90	1,95	84,82	23,25	15,57	1,06	37,76
100 + 25	,87150		20,68	118,67	2,01	84,27	22,70	15,20	1,03	36,87
26	,87284		21,50	119,43	2,07	83,73	22,16	14,84	1,01	35,99
27	,87415		22,33	120,20	2,13	83,19	21,62	14,48	1,98	35,12
28	,87544	100	23,16	120,97	2,19	82,66	21,09	14,12	0,96	34,25
29	,87671		23,98	121,74	2,24	82,14	20,57	13,77	0,93	33,41
100 + 30	,87796		24,81	122,51	2,30	81,63	20,06	13,43	0,91	32,58
31	,87919		25,64	123,28	2,36	81,12	19,55	13,09	0,89	31,75
32	,88040		26,46	124,05	2,41	80,62	19,06	12,76	0,87	30,94
33	,88160		27,29	124,82	2,47	80,12	18,55	12,42	0,84	30,13
34	,88277		28,12	125,59	2,53	79,63	18,06	12,09	0,82	29,33
100 + 35	,88393		28,95	126,36	2,59	79,14	17,57	11,77	0,80	28,54
36	,88507		29,77	127,13	2,64	78,66	17,09	11,44	0,78	27,75
37	,88619		30,60	127,90	2,70	78,18	16,61	11,12	0,76	26,97
38	,88729		31,43	128,68	2,75	77,71	16,14	10,81	0,74	26,21
39	,88838		32,25	129,45	2,80	77,25	15,68	10,50	0,71	25,47
100 + 40	,88945		33,08	130,23	2,85	76,79	15,22	10,19	0,69	24,72
41	,89051		33,91	131,00	2,91	76,33	14,76	9,88	0,67	23,97
42	,89155		34,74	131,77	2,97	75,88	14,31	9,58	0,65	23,24
43	,89258		35,56	132,55	3,01	75,44	13,88	9,29	0,63	22,54
44	,89359		36,39	133,33	3,06	75,00	13,43	8,99	0,61	21,81

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Spirit & water by weight.	Specific gravity at 55.	Spirit by measure.	Water by measure.	Bulk of mixture.	Diminution of bulk or concentration.	Quantity of pure spirit per cent.	Pure spirit per cent. redundant.	Water to reduce redund. spirit to proof.	Diminution of bulk on red. spirit & water.	Per cent. over Hydrometer proof.
Sp. + W.										
100 + 45	,99458		37,22	134,11	3,11	74,57	13,00	8,70	0,59	21,11
40	,99556		38,04	134,88	3,16	74,14	12,57	8,42	0,57	20,42
45	,99652		38,87	135,66	3,21	73,71	12,14	8,13	0,55	19,72
48	,99748		39,70	136,44	3,26	73,29	11,72	7,85	0,53	19,04
49	,99841		40,52	137,22	3,30	72,86	11,31	7,57	0,51	18,37
100 + 50	,99933		41,35	138,00	3,35	72,47	10,90	7,30	0,49	17,71
51	,99923		42,18	138,78	3,40	72,06	10,49	7,02	0,47	17,04
52	,99911		43,01	139,56	3,45	71,65	10,08	6,75	0,46	16,37
53	,99900		43,83	140,34	3,49	71,25	9,68	6,48	0,44	15,72
54	,99883		44,66	141,13	3,55	70,86	9,29	6,22	0,42	15,09
100 + 55	,99975	100	45,49	141,91	3,58	70,47	8,90	5,96	0,40	14,46
56	,99950		46,31	142,70	3,61	70,08	8,51	5,70	0,38	13,83
57	,99931		47,14	143,48	3,66	69,69	8,12	5,43	0,37	13,18
58	,99911		47,97	144,27	3,70	69,31	7,74	5,18	0,35	12,57
59	,99890		48,79	145,05	3,74	68,94	7,37	4,93	0,33	11,97
100 + 60	,99978		49,62	145,84	3,78	68,57	7,00	4,68	0,31	11,37
61	,99945		50,45	146,63	3,82	68,20	6,63	4,44	0,30	10,77
62	,99921		51,28	147,42	3,86	67,83	6,26	4,19	0,28	10,17
63	,99895		52,10	148,20	3,90	67,46	5,91	3,95	0,26	9,60
64	,99870		52,93	148,99	3,94	67,12	5,55	3,71	0,25	9,01
100 + 65	,999144		53,76	149,78	3,98	66,77	5,20	3,48	0,23	8,45
66	,998217		54,58	150,57	4,01	66,42	4,85	3,24	0,22	7,77
67	,99729		55,41	151,35	4,06	66,07	4,50	3,01	0,20	7,31
68	,99631		56,24	152,14	4,10	65,73	4,16	2,78	0,18	6,76
69	,99432		57,07	152,93	4,14	65,39	3,82	2,55	0,17	6,20
100 + 70	,99502		57,89	153,71	4,18	65,06	3,49	2,33	0,15	5,67
71	,99371		58,72	154,50	4,22	64,73	3,16	2,11	0,14	5,13
72	,99169		59,55	155,29	4,26	64,40	2,83	1,89	0,12	4,60
73	,99000		60,37	156,08	4,29	64,07	2,50	1,67	0,11	4,06
74	,98772		61,20	156,87	4,33	63,75	2,18	1,45	0,08	3,55
100 + 75	,98837		62,03	157,66	4,37	63,44	1,86	1,24	0,08	3,02
76	,98901		62,85	158,45	4,40	63,11	1,54	1,03	0,07	2,50
77	,98963		63,68	159,24	4,44	62,78	1,23	0,82	0,05	2,00
78	,92024		64,51	160,04	4,47	62,46	0,92	0,61	0,04	1,49
79	,92085		65,34	160,83	4,51	62,16	0,61	0,40	0,02	0,99
100 + 80	,92145		66,16	161,62	4,54	61,87	0,24	0,16	0,01	0,39
81	,92205		66,99	162,42	4,57	61,57	0,00	0,00	0,00	Proof

N. B. When this Table shall be finally calculated, the fractions in the second and last column are to be rendered into whole numbers.

XXXVI. *Memoir on the Supply and Application of the Blow-pipe.* By Mr. ROBERT HARE *jun.* Member of the *Chemical Society of Philadelphia* *.

THE blow-pipe is, on many occasions, an useful instrument to the artist and philosopher. By the former it is used, for the purpose of enamelling, to soften or solder small pieces of metal, and for the fabrication of glass instruments: while the latter can, by means of it, in a few minutes, subject small portions of any substance to intense heat; and is thereby enabled to judge of the advantage to be gained, and the method to be pursued, in operations on a larger scale. The celebrated Bergman has amply displayed the utility of this instrument in docimastic operations; and with the perfection of the docimastic art the improvement of metallurgy is intimately connected. It is by means of the blow-pipe that glass tubes are most conveniently exposed to the heat necessary to mould them into the many forms occasionally required for philosophical purposes; and by the various application of tubes thus moulded, ingenuity is often enabled to surmount the want of apparatus, which is the greatest obstacle to the attainment of skill in experimental philosophy.

To all the purposes which I have mentioned the blow-pipe is fully adequate, when properly supplied with air, and applied to a proper flame: but it appears that the means which have hitherto been employed to accomplish those ends are all faulty.

The most general method is that of supplying this instrument with the breath. In addition to the well-known difficulty of keeping up a constant emission of air during respiration, and its injurious effect on the lungs †; it may be remarked, that as the breath is deprived of part of its pure air, is mixed with carbonic acid gas, and loaded with moisture, it is not the most fit for combustion; and the obvious impossibility of supporting a flame with oxygen gas, by this method, is also worthy of consideration.

Another way of supplying the blow-pipe with air, is that of affixing to it a small pair of double bellows. A contrivance of this kind possesses obvious advantages over the mouth blow-pipe; but, owing to the pervious nature of the materials of which bellows are constructed, and the difficulty of

* Published by order of the Society.

† In consequence of this, some artists have abandoned the use of the instrument.

making their valves air-tight, upwards of nine-tenths of the air drawn into them escapes at other places than the proper aperture. A pair of bellows of this kind, belonging to an artist of this city, which were considered as unusually air-tight, were found to discharge the complement of their upper compartment in six-fourths of a minute, when the orifice of the pipe was open; and in seven-fourths of a minute when it was closed. Hence it appears, that six-sevenths of the air injected into the upper compartment escaped at other places than the proper aperture; and if to this loss were added that sustained by the lower compartment, the waste would be found much greater. As in operating with these machines, it is necessary constantly to move the foot, the operator cannot leave his seat; and, in nice operations, the motion of his body is an inconvenience, if not a source of failure. Bellows of this kind cannot be used for supplying combustion with oxygen gas; because, as this air is only to be obtained by a chemical process, the smallest waste of it is of serious consequence; and as there is always a portion of air remaining in them, even when the boards are pressed as near to each other as the folding of the leather will permit, any small quantity of oxygen gas which might be drawn into them would be thereby contaminated.

It seems that the only instrument hitherto used for the supply of combustion with oxygen gas, is the gasometer of the celebrated Lavoisier: but this machine, although admirably calculated for the purposes of that great philosopher, is too unwieldy and expensive for ordinary uses.

Being sensible of the advantage which would result from the invention of a more perfect method of supplying the blow-pipe with pure or atmospheric air, I was induced to search for means of accomplishing this object. Having observed the cheapness, strength, and tightness, of coopers' vessels, I became desirous of forming an apparatus for my purpose, by means of hydrostatic pressure exerted within them. I soon found that this could not be effected conveniently without the use of leather. Obligated to resort for assistance to this material, I endeavoured to apply it in such manner, as to remedy the evils resulting from the use of it in the common kinds of bellows. The causes of these evils appeared to be, the opening of the pores and joints of these instruments by dryness, and the tension to which they are so frequently subjected. I therefore determined to subject the leather which I should use, to moisture and compression. In this I succeeded, and derived the expected advantage from success. The result of

my attention to this subject is the production of a machine, of which there follows an engraving and description.

When it was first shown to the gentlemen of the Chemical Society, some of them bestowed on it the appellation of *gaso-meter*; but, as etymology does not authorize this name, it has been changed for that of *hydrostatic blow-pipe*.

Fig. 1. (see plate VI.) is a perspective engraving of the hydrostatic blow-pipe. Part of this figure is made transparent, that the internal construction of the machine may be understood with the greater facility.

It consists of a cask A, whose length is thirty-two, and whose least diameter is eighteen inches. It is divided, by the partition B, into two apartments. The upper and external apartment BA, is in depth fourteen inches. The lower and internal apartment BC, is in depth sixteen inches; and contains a sheet and pipe of copper EE, D, which descend into it nine inches, forming two equal compartments of that depth. The sheet and pipe of copper are foldered together and inserted into the partition B, as may be observed at fig. 2; where B represents the partition, EE the sheet of copper, and D the pipe. The edges EE of the sheet were slid down into corresponding joints in the staves of the cask until the partition attained its proper situation. Coopers' flags were then passed into the joints; and the hoops were driven on the cask.

CF, fig. 1. is a pair of circular bellows. The bottom of the cask serves as a bottom for these bellows. In the centre of this bottom there is a hole, round which, at the distance of one inch from its centre, is a circular rim of wood. On this is nailed a valve opening upwards, which may be observed at B, fig. 3, where there is a transparent engraving of the bellows. Under the valve B may be observed the hole, and circular rim of wood, over which it is nailed. C the top of the bellows, is a circular piece of wood, seven inches in diameter and two in thickness. In its centre there is a hole one inch and a half in diameter. Around this hole there is a circular rabbet, in which is nailed a valve, opening upwards. This valve, and the rabbet in which it is fastened, may be seen under the letter D, at the end of the rod. There is also in this top, at the distance of one inch from its perimeter, a circular dove-tailed furrow filled with lead, E. The body of the bellows FF, is composed of strong hose-leather so as to be water-tight. Before it was fixed to the other parts of the bellows its form was that of a hollow frustum of a cone, of which the perpendicular and greatest diameter were each

each eight inches, and whose least diameter was six inches and a half. It was more easily fastened to its appendages when of this conical form than if it had been cylindrical. At the protuberances FF, it is distended by two iron rings, to which it is sewed fast.

FG, fig. 1, is an iron rod, by means of which the top of the bellows may be raised or depressed. It passes up through the pipe D to the handle G, which is worked by the hand or with the foot by means of the pendent stirrup. An enlarged view of this rod, and of the contrivance by which it is annexed to the top, may be seen at fig. 3; where GD represents the rod, and H, H, H, H, flat pieces of iron branching from it. These are fixed to the circular rim KK in such a manner as to include the rim II, of the same metal, which is screwed fast to the top of the bellows. Sufficient room is left to allow the pieces H, H, H, H, and the rim KK, to move round without rubbing against the included rim II, or the top of the bellows.

A copper hood, with an opening in one side, may be observed at L, fig. 3. The rod GD is passed through the centre of this hood, until the flat pieces of iron H, H, H, H, come in contact with the flat part of it. The hole in the centre is then luted. The hood may be seen in its proper situation, at F, fig. 1.

HI, fig. 1, is a suction-pipe half an inch in diameter. It passes under the cask in the direction of the dotted lines at C, and turns up into the hole in the bottom of the bellows. This hole, which is of such a size as to fit the tapering end of the pipe, is seen at fig. 3, and has already been mentioned, together with a circular rim of wood, which, being nailed round it, prevents the end of the pipe from touching the valve. The suction-pipe has a conical mouth at I, into which is inserted occasionally the pipe J, fastened to the hose and syphon K, L. The hose is made of leather, distended by hollow cylinders of tin half an inch in diameter and one inch in length. These were coated with tar, after which the leather was sewed over them*.

Fig. 1, MNO, m n o, are pipes of delivery, furnished with cocks at N, n, and conical mouths at O, o. Each of these pipes communicates with one of the compartments on each side of the sheet and pipe EE, D.

In the partition B, may be observed the pipe Y, furnished

* This hose may be made very perfect by tarring, and covering it with leather a second time; the seams of the first and second coverings being placed on opposite sides. Flexible pipes thus prepared will be found useful for many other purposes besides that here mentioned.

with a cock. Each end of this pipe communicates with one of the compartments above mentioned.

P is a table affixed to the cask by means of irons, which are at pleasure slid into or out of staples. One of these irons, and its staples, may be seen near the letter Q. They are fastened to pieces of wood which run lengthwise under the table, and which are so grooved as to support a block of wood which slides between them. Through this block passes the screw S, which slides backward and forward in the opening TRV. The stand TV, which may be observed under the lamp, is loosely put on this screw, as a wheel is placed on its axletree. It rises and falls with the screw; but is prevented from turning round with it, by the upright strip of wood T.

Having described the construction of the hydrostatic blow-pipe, I proceed to an explanation of the principle and manner of its action, and to a detail of the uses to which it may be applied.

Suppose that as much water were poured into the cask A, fig. 1, as would fill the lower apartment, and rise above the partition B; one or two inches. Let fig. 4 be a representation of the cask when supplied with this necessary quantity of water. When the machine is at rest, the top of the bellows, being loaded with lead, is depressed as low as the folding of the leather will permit, and the small space which remains in consequence of this folding, between the top of the bellows and the bottom of the cask, becomes filled with water, which leaks through the upper valve. Let the bellows be extended by depressing the handle at *a*. The upper valve will shut tight; and a quantity of water equal to the bulk, which the bellows will gain by extension, will rise through the pipe D, to the external apartment; and the weight of the atmosphere being removed from the top of the valve in the bottom of the cask, the air will press through the suction-pipe I H, lift this valve, and occupy the vacant space within the bellows. If the hand be then removed from the handle, the lead in the top of the bellows will again depress it, and the air drawn into them, being thereby compressed, will force open the upper valve, and ascend. During its ascent it will receive a strong lateral tendency from the hood, which will make it pass out at the open side of the hood, into that compartment which is immediately over this opening; and as by turning the rod, this part of the hood may be brought under either compartment, so the air may be thrown into either of them; and one of them being filled with one species of gas, the other may be filled with another species: nor can there be any danger of mixture; because, as the pipe D is shorter than

than the sheet E E, any superabundant quantity of air which may be thrown into either compartment will pass up the pipe and escape.

In fig. 4, the bellows are represented as nearly depressed, and the air issuing from the open side of the hood into the compartment immediately over it, which is about half filled with air. The other compartment is represented as being completely full of that fluid. The water is represented in commotion, that the action of the machine may be strongly marked; but the motion of this fluid is in reality so gentle, that the regularity of a blast is not thereby perceptibly affected.

If it be desired to fill both compartments with one kind of air, without the trouble of turning the hood, by opening the cock of communication in the pipe Y, any air which may be thrown into either compartment will divide itself equally between both of them.

It must be obvious that the air in the compartments on each side of the sheet and pipe of copper E E, D, fig. 4, is subject to hydrostatic pressure, and that of course it will pass out at the pipes of delivery, unless stopt by the cocks. These pipes are omitted in fig. 4, but have been already described, together with their cocks, at M N O, m n o, fig. 1.

The leather and joints of the bellows are evidently subjected to the weight of a considerable column of water; but this pressure, being external, tends to tighten them, and renders this part of the machine so perfect, that if the orifice of the suction-pipe be closed, it will be found impossible to raise the top of the bellows, without the immense force which would be necessary to produce a vacuum within them. This would not be the case if the smallest leakage took place.

It is now time to give an account of the purposes to which the hydrostatic blow-pipe may be applied, and the manner of applying it to them.

This instrument may be employed to supply with atmospheric air a small flame for the various purposes of the mouth blow-pipe. To effect this, it is only necessary to place a lamp or candle on the stand T V, which is upheld by the screw S, fig. 1. By raising or lowering this screw, or by sliding backward or forward the block through which it passes, the stand may be so adjusted, as that the straight mouth-piece X will just enter the flame. The handle must then be worked until the blast obtains the proper strength. This generally happens when the water has risen above the partition B three or four inches. If it should be raised higher,

the blast may be regulated by turning the cock more or less at N.

When an operation is to be performed on a subject which cannot be held over the table; by fixing the small hose and blow-pipe *ab*, fig. 7, into one of the conical mouths *O, o*, of the pipes of delivery, and, by placing a lamp or candle on the edge of the table, an operator may, with the subject in his hand, expose the proper spot to the flame. In this way glass matrasses filled with liquors have been hermetically sealed.

Nothing can be more steady than the stream of air emitted by this instrument. The falling off in pressure, arising from the descent of the water, does not perceptibly affect the flame in a blast of six minutes duration; and, in the mean time, the hand'e may be depressed so gently, that the most strict observation will not discover the least unsteadiness to be produced by it. Or, if the machine be filled with air, by opening the cock more or less, an equable blast may be supported for more than the space of an hour.

In order to supply the enamellers' lamp with air by means of the hydrostatic blow-pipe, it is only necessary to substitute this instrument for the bellows commonly used for this purpose. There will then be nothing novel in the manner of operating, excepting, 1st, That the relative situation of the flame and the pipe is to be regulated by turning the screw *S*, or by sliding backward or forward the block through which it passes; and, 2dly, That in lieu of the frequent movement of the foot, necessary with the common bellows, in the space of one minute, and with fifteen strokes of the handle, as much air may be drawn into the hydrostatic blow-pipe as will blow for one hour: and as the cask and pipes are completely air-tight, the blast may be stopped, or its strength increased or diminished at pleasure, by turning more or less the cock of the pipe delivering the air.

The flame of the enamellers' lamp is not used exclusively for the purposes of the artist from whom it takes its name. It is this modification of the principle of the blow-pipe which is applied to the moulding of glass instruments. But in heating glass with this flame, an inconvenience arises from the impossibility of exposing both sides of any subject to the same heat, unless it be constantly turned round; for, if only one side of a large glass tube be applied to the flame, the part exposed to its action will be fused before the other will be softened, and if it be turned round constantly a much longer time will be required to melt it. Indeed some large tubes of
refractory

refractory glass, which are not to be melted while undergoing this rotatory motion, may be readily fused in any spot constantly exposed to the action of the flame.

In order to produce a flame which should be free from the inconveniences just described, I procured the oblong lamp with two wicks W, X, Fig. 1. It may be observed, that these wicks are fixed on two plates, which slide in a groove, in the direction of the length of the lamp. They may therefore be made to approach to, or recede from each other. This lamp being as represented in the engraving placed on the little stand T V, so as that one of the wicks was before the orifice of the straight mouth-piece, above A; the bent blow-pipe at W was so adjusted to the other wick, that when they were both lighted, and a blast passed over them, their flames met each other as represented in the plate. The result of this was, that a much larger tube could be fused by the united action of two flames, than could be melted with one of them; and the parts being more equally heated, a bend could be made more regularly, and with less danger of collapsing.

It may be proper to observe that the machine represented in the plate is much more complex and expensive, than is requisite for the purposes of the mouth blow-pipe, or enamellers' lamp, simply. But it is expected that artists, availing themselves of the principles of the machine, will reject those appurtenances which are unnecessary to their peculiar purposes *.

[To be continued.]

XXXVII. *Memoir on the Fabrication of Charcoal in the Forest de Benon, near Rochelle. Addressed to the French Council of Mines, Nivose 30, Year 10. By C. FIEURIAU-BELLEVEUE †.*

FUEL of every kind is so scarce in the neighbourhood of Rochelle, that there are few manufactories in that quarter, and none of those which consume a large quantity of that article can be established. Wood is sold exceedingly dear, and there is scarcely a quantity sufficient for distilling the wines of the country.

* The cost of the machine represented in the plate was about twenty dollars; but a machine fully equal to the purposes of the mouth blow-pipe, or enamellers' lamp, may be made for one fifth of that sum.

† From the *Journal des Mines*, No. 65.

It is no doubt to this high price of wood, and the necessity of deriving as much advantage as possible from the few forests in the neighbourhood, that we are indebted for a method of fabricating charcoal which seems to be practised no where else. At any rate, from the silence respecting it in the *Collection des Arts et des Métiers*, and in *La Nouvelle Encyclopédie*, and from the surprise expressed by several persons on seeing, in the market of Rochelle, pieces of charcoal of such a size and length that they could be tied up and transported in the form of faggots, there is reason to presume that it is not known.

The Council of Mines, desirous to collect every thing that can contribute to the success of the different establishments of the republic, requested me to make known the process. What I have been able to collect on the subject is as follows: —

The charcoal of the forest of Benon is sold at Rochelle 25 or 30 per cent. above the price of every other charcoal fabricated from the same kind of oak brought from the neighbouring departments. The wood of this forest may have some superiority over that of others: it grows slowly, is hard and heavy; but, as it appears that the same means of fabrication are not employed in other places, a small part only of the great difference in the prices of charcoal can be ascribed to this superiority of the wood.

The care taken to place the furnace in the centre of surrounding walls, which, by checking the current of the inferior air, renders the operation of charring more uniform and more perfect, with some other circumstances which will be mentioned hereafter, seem to contribute in a special manner to the advantage in question.

The heaps of wood which are to be converted into charcoal, are everywhere almost dispersed throughout the forests, and remain exposed to the action of the air in every direction; but at Benon the charcoal is fabricated in chambers.

These chambers are 20 feet square: the walls, built of rough stones, united by means of earth, are 15 feet in height, and are covered with planks and tiles, arranged in such a manner, that between the planks a space of two inches is left, to afford a free passage to the smoke.

The floor of the chamber is convex: a mass of argillaceous earth rises in the centre about six or seven inches, having between it and the wall a circular space two feet and a half in breadth, and the four corners free for the service of the furnace.

The only wood employed is oak, known under the name
of

of black oak, and very rarely white oak *. That cut within the current year is used, and never that of the preceding.

The wood is ten, twelve, or fifteen years old, and the lower part of the tree is never separated. It however, in general, does not exceed six inches in diameter. It is cut into pieces from three feet eight inches to four feet in length, called *billets*.

They are placed upright, without being split, resting, with the side cut into a slope like the mouth of a flute, on the mass of earth, and in such a manner that they all touch each other; those at the circumference only being a little inclined; and, contrary to the general practice of those who char wood, one story only is formed. Care is taken to mix these billets with small branches; but twigs are never introduced, except in the centre of the furnace, merely to kindle it. Two cords of wood are sometimes employed at one time †.

When the furnace is constructed, and is very round, stakes, a foot in height, are planted round it, at the distance of half a foot: it is then covered with dry grass, ferns ‡, or *palmeines* §, to the thickness of four inches in every direction; and over these is placed coal earth (*terre de charboniere*) to the same height on the sides, and to the height of 15 inches on the summit. In this state, there remains around this focus, called the *furnace*, the circular space before mentioned of about a foot and a half in breadth.

The earth employed is an argil mixed with calcareous earth: it is never removed from this inclosure, where it is baked to such a degree that it might be taken for ashes, with which it is mixed. It is then called *terre de charboniere*. In other countries, it is known by the name of *frasin* or *frasil*.

Fire is applied in the centre by means of a light placed at the end of a stick, introduced by a passage formed at the lower part of the furnace. The crevices are stopped as soon as they appear, and the usual practice is followed in this respect, that the fire may be perfectly regular.

When the wood is charred, half a barrel of water is thrown over it, and then it is covered to the height of five or six

* These are varieties of the *quercus robur*. In this species are distinguished the *robite*, *red*, and *black*.

† A cord is eight feet in length, four feet in height, and nearly four in breadth.

‡ *Pteris aquilina*.

§ A kind of grass of the genus *bromus* or *triticum*.

inches with earth: it is then suffered to cool for a day, and the charcoal is taken out. This operation lasts eight days in winter, and only four in summer. At the latter period the furnace is watched day and night.

The pieces of charcoal extracted are often three inches and more in diameter, and sufficiently long to be made up into bundles, which are transported on the backs of mules to the distance of five or six leagues: the smaller fragments are put into sacks.

This charcoal, which is very black, exceedingly brilliant, and sonorous, has two qualities which cause it to be much sought for in preference to all others; it possesses more activity, and lasts longer. It is attended with the inconvenience of emitting an odour, but it is well known that this is one of the characters of the best charcoal.

It is preferred for the kitchen, and for ironing linen. For the latter use it is put into iron boxes, called at Rochelle *flafques*. It is employed also by blacksmiths when they have no common coals. That in large pieces is most esteemed.

The latter is sold at seven or eight francs per cwt. delivered at Rochelle; but if the forest of Benon were taken proper care of, this price might be diminished*.

This method of making charcoal differs from that described in the *Collection des Arts et des Miers*, those of Brie and Burgundy mentioned in the *Encyclopedie*, and those in the departments around Paris.

1st. By the inclosure of walls, which must secure the furnace much better than the hurdles employed in those countries, and which the workman places when he thinks proper on the side from which the wind proceeds, this inclosure must render the charring more uniform and more economical.

2d. By the care taken not to reserve for firewood, as is done in several places, the lower part of the wood, which, being more compact than the branches, ought necessarily to furnish better charcoal.

3d. Because the pieces of wood are longer, and twice as large as those employed in the other methods, and because they are put into the furnace without being split.

4th. Because, instead of raising, as usual, four or five stories, disposed in the form of a cone or pyramid, one only is

* There are reckoned to be eighteen furnace chambers in the village of Benon, and one at Lalaigne. The forest was so much destroyed during the revolution, that at present no more than seven or eight chambers are occupied. It scarcely supplies enough of firewood. No more than 20,000 weight of charcoal is fabricated on it. About thirty or forty years ago it furnished ten times as much.

constructed,

constructed, which renders the action of the current of air much more moderate, and prevents the consumption of the wood, and perhaps of a part of the hydrogen, which it is essentially necessary to preserve in the charcoal.

5th. By the practice followed at Benon of throwing a certain quantity of water over the furnace when the wood is charred. This practice is not mentioned in the works already alluded to.

The forests of Chizai and Aunai, which, except that of Benon, are nearest to Rochelle, furnish charcoal, which is fabricated also from pieces of wood of the same size, which are put into the furnace in like manner without being split; but the difference in the choice of the wood, and particularly in the fabrication, which takes place in the open air, makes a difference of 25 or 30 per cent. in the price of the charcoal. This difference is sometimes greater when compared with that of other forests.

In the process therefore here described, there is a saving of wood, and at the same time the product acquires a greater value.

XXXVIII. *On the Northern Magnetic Pole of the Earth.*
By JEROME LALANDE *.

IT has been known for more than two centuries, that the magnetic needle does not point exactly north, and that its declination from that direction is different in different places. Researches therefore have been made to determine the point of the earth towards which the magnetic needle turns; and this object engaged the attention of Dr. Halley in 1683, of Euler in 1745, of Lemonnier in 1776, and of Buffon in 1788. About five years ago Mr. Churchman, a native of America, came to Paris to induce government to set on foot a voyage to the north pole, for the purpose of determining the position of the magnetic pole in the north. In the year 1794 he published a work, in which he proposes a theory by which the declination of the magnetic needle can be determined for different periods and different places. I endeavoured to compare it with the latest observations. Those of which I have already spoken in the *Connoissance des Temps* † were made at Nootka Sound in 48° 36' north lat. and 129° long. west from Paris, in the year 1778; and the declina-

* From the *Connoissance des Temps pour l'an. xii.*

† An. iv. p. 215.

tion there was $19^{\circ} 44'$ west. In the supposition that the lines of direction lie in the planes of great circles, and meet in one point, I found it to be in $77^{\circ} 4'$ north lat. Euler in the Memoirs of the Academy of Berlin places it in 75° ; Lemonnier, in the *Lois du Magnetisme*, in 73° ; and Buffon, in 71° ; which makes the differences to be very small. Euler conceived two magnetic poles, which are not diametrically opposite to each other. The two observations which form the ground of my calculation were made, however, near enough to the north pole to enable us to determine it independently of the south pole. Churchman places the north pole in the lat. of 60° ; a difference which would be too great.

The two observations here alluded to would give the longitude of the magnetic pole in too doubtful a manner, as the angle at the pole is too obtuse. I endeavoured, therefore, to obtain an intermediate observation, and found that, in the year 1770, at Norreton, in lat. $40^{\circ} 10'$ north, and long. $77^{\circ} 36'$ west from Paris, the declination was $3^{\circ} 8'$ *. From this it would follow, that the longitude of the magnetic pole is $110^{\circ} 35'$ west from Paris. The year, however, of the last observation does not correspond with that of the two former ones: but the difference on this account cannot be of much importance.

At the time of the transit of Venus over the sun's disk in 1779, observed at Hudson's Bay, in lat. $58^{\circ} 48'$ north, and long. $96^{\circ} 30'$ west from Paris, the declination of the magnetic needle was found to be, in that place, $9^{\circ} 41'$ west †. This gave me for the longitude of the magnetic pole only 86° west from Paris. The mean of the two observations, therefore, would be 98° . Euler makes the longitude 115° , and Buffon 100° west from Paris: Lemonnier makes it only 50° . But, as the parallel at so high a northern latitude is only of small extent, a more considerable difference in longitude would have no great influence on the previous determination of the true position of the magnetic pole.

We can therefore admit the given data till a series of more accurate observations of the declination of the magnetic needle, and its variations, collected for different determinate places, shall enable us to deduce from them the variations of the magnetic pole. The variations of the magnetic declination have been observed at Paris for 140 years; but as this has not been the case in America, we still want the proper data for calculating the motion of the magnetic

* American Transactions, p. 117.

† Phil. Transactions 1769, p. 483.

pole: it seems only to appear that Churchman's hypothesis corresponds very little with the observations which I have calculated, and that the northern magnetic pole lies on the north-west coast of Bassin's Bay, nearly where the entrance of Alderman Jones is to be sought for on Buache's chart of 1782, and where Ferrer Maldonado touched in 1598, according to a Spanish memoir read some years ago in the Academy of Sciences; which, however, seems to deserve very little credit.

XXXIX. *Of the State of Vapour subsisting in the Atmosphere.*

By RICHARD KIRWAN, Esq. F.R.S. and P.R.I.A.

[Concluded from p. 143.]

THE dilatation of the moisture contained in the air has been separately examined by Mr. Schmidt, and he has shown how from it the volume of air saturated with moisture, saturated, I say, at every degree of Reaumur, may be discovered: the results of his experiments appear in the following table of the volume which 1000 measures at 32° of air would acquire if saturated with moisture at each degree of Reaumur above 32°, expressed on Fahrenheit's scale*.

Reaum.	Fahren.	Expansive Force.	Reaum.	Fahren.	Expansive Force.
1°	34°25'	1010·56		70°25'	1122·68
	36·5	1010·78		72·5	1132·25
	38·75	1016·45		74·75	1142·53
	41·	1022·21	20	77·	1152·83
5	43·25	1028·58		79·25	1164·02
	45·5	1034·97		81·5	1175·23
8	47·75	1040·41		83·75	1186·52
	50·	1048·52	24	86·	1198·59
	52·25	1056·26	25	88·25	1211·44
10	54·5	1064·72		90·5	1223·65
	56·75	1071·28		92·75	1279·62
12	59·	1078·52	28	95·	1377·09
	61·25	1087·11		97·25	1494·02
	63·5	1095·76	30	99·5	1610·02
15	65·75	1104·46		101·75	1725·49
16	68·	1113·21	32	104·	1849·96
			33	106·25	1983·42

* To prevent mistakes, it must be noted that this table is not meant to express the dilatations of air saturated at any particular degree of heat it would acquire at other superior degrees, but only the bulk that 1000 parts dry air at 32° would acquire by saturation at each higher degree.

Note.

Note.—1mo. Hence we see that air saturated with moisture at high heats is much more expanded than dry air of the same temperature, as De Luc and general Roy have also observed; but in temperatures below $36\cdot5^{\circ}$ dry air is more dilatible; which probably induced Saussure to conclude it was so at higher temperatures. At $54\cdot5$ the difference is very perceptible; for 1000 parts *dry* air at 32° are expanded at $54\cdot5^{\circ}$, that is, by $22\cdot5^{\circ}$ above the freezing point to 1044 \cdot 67; whereas 1000 parts of air saturated with moisture are extended to 1064 \cdot 72, and in higher heats, the differences of expansion are incomparably greater.

2do. Hence it is plain why moist air, such as that of the West Indies, is much more suffocating than dry air of the same temperature: for 1000 cubic inches of air, saturated with moisture at 86° of Fahrenheit, contain nearly 76 inches of moisture which is useless to respiration.

3tio. These experiments agree with those of general Roy in which steam was introduced at hazard; for the general found that from 32° to 52° each degree gave at a mean 2 \cdot 588, and consequently these 20° would expand 1000 inches to 1051 \cdot 76; and by Schmidt's experiments, much more accurately made, we have 1050 \cdot 33.

4to. Schmidt also observed a peculiarity in the expansion of moist air, previously noticed by Roy; for Schmidt found that the expansibility of air, saturated with moisture, was smaller than the expansibility of pure vapour until the 167th degree of Fahrenheit; but in higher degrees they constantly approached nearer to each other. And the general observed that the mean rate of expansion, which from 152° to 172° of Fahr. was 12 for each degree, did, from the 172° to the 192° , increase to 17 \cdot 88 for each degree, and increased still more after the 192d to the boiling point. The sluggishness of expansion of air, saturated with moisture at about 32° , was also noticed by the general; and he hence concludes the mean rate of expansion from 0 to 32° of Fahr. to be 2 \cdot 27 for each degree, which is smaller than that of drier air.

These variations of the rates of expansibility of moist air, saturated at different temperatures, Schmidt very justly attributes to the variation of the degrees of affinity or adherence of air and vapour to each other at different temperatures. At 32° Fahr. it is very strong, and also below that degree; and hence the strong solvent power of air colder than the water it acts upon, remarked by Richman: but if both are equally cold, very little moisture will be taken up by the air, as already mentioned: and hence I have said that air dissolves vapour

vapour when this is in a nascent state. But in heats above 167° or 170° air and vapour are disposed to separate.

5to. Hence we may deduce the impossibility of discovering a co-efficient universally applicable to express the rate of expansion of air in every state of moisture, as Tremley has well noticed. (See *Saufure Voy. aux Alpes*, ii. 4to.) This must vary with the mean state of hygrometers above and below the heights to be measured: and experiments of this kind have not yet been made. De Luc's co-efficient answers tolerably well for very dry air, that is, whose saturability is greatest; sir George Schuckburgh's, for air much moister; and general Roy's, for air still moist, that is, whose saturability is smallest. Hence each succeeds in certain cases, and fails in others. The dilatation or contraction which air saturated with moisture at any one given degree of temperature receives without the addition of any more moisture, at any higher or lower degree of temperature, has not as yet been discovered: for Schmidt, who alone has attempted it, is justly diffident of the correctness of the table he has given of it; and, in fact, it is not grounded on the indication of any known hygrometer, and improperly supposes the 50th degree to indicate the mean betwixt the lowest and saturation: whereas the 65th degree on Sauffure's indicates that mean; and 98, and not 100, indicates saturation.

According to Mr. Watt (as stated by De Luc, *Meteorology*, iii. p. 145), the specific gravity of pure vapour is to that of air as 4 to 9. I suppose he compares it with air at the usual density of 30 or 29, and at some particular temperature which is not mentioned; for at high temperatures the difference must be much greater, as appears by the foregoing tables.

M. Sauffure (*Hygrometer*, p. 284,) has given us the specific gravity, not indeed of pure vapour, but of vapour dissolved in air, with more precision; for he tells us, *imo.* That a cubic foot of perfectly dry air has its volume augmented by $\frac{1}{3}$ th, when saturated with ten grains of moisture at about 65° Fahr. of heat, and barometer 28.77 inches (English).

2do. That a cubic foot of *pure* or perfectly dry air of that density and at that temperature weighs 751 grains (French); and after dissolving 10 grains of moisture, by which it is dilated $\frac{1}{3}$ th, this new volume weighs $751 + 10 = 761$ grains: but a cubic foot of *pure* air, augmented by an accession of $\frac{1}{3}$ th of its bulk of pure air, would weigh $751 + \frac{1}{3}751 = 765$ grains, that is 14 grains more. Hence he infers that, in this case, the specific gravity of the dissolved moisture is to that of dry air as 10 to 14; for $\frac{1}{3}$ th of a cubic foot in the one case weighs 10 grains, and in the other 14 grains nearly.

But I strongly suspect that the original experiment, on which this calculation is founded, is erroneous, chiefly by reason of the strong adherence of moisture to cold glass, as will hereafter be seen in treating of dew. From Schmidt's experiments it may be inferred that the specific gravity of vapour, dissolved in air at this temperature, is much lower with respect to that of pure air than Saussure has stated; for he tells us that about 1066 measures of dry air in temperature 65° , would, if saturated with moisture at that temperature, occupy the space of about 1100 measures, and consequently receive an augmentation amounting to about $\frac{1}{3}$ d of their bulk: now, transferring this ratio to the cubic foot in Saussure's experiment, it appears that $\frac{1}{3}$ d of a cubic foot thus added to the cubic foot of dry air weighs 10 grains; but a cubic foot of dry air, augmented by an accession of $\frac{1}{3}$ d of similar air, would weigh $751 + 23.46$ grains, which approaches nearly to Mr. Watt's ratio: therefore the specific gravity of vapour dissolved in air at this temperature is to that of perfectly dry air as 10 to 23.5 nearly. It should however be recollected that M. Saussure found that a cubic foot of dry air in reality took up 11.069 grains of moisture when saturated at this temperature, and that it was only by way of concession to those against whom he argued, that he stated the weight taken up at 10 grains; then we should have of 11.069 to 21.195, or, in round numbers, as 11 to 21, or 10 to 19. And it should further be remarked that the temperature is given very loosely, for it is stated to be from 14 to 15° or 16° of Reaumur. See Hygrometer, p. 104 and 284.

Saussure has given us a table, by the help of which the absolute quantity of vapour at any barometrical height, in a cubic foot of air, being known, the proportion and absolute quantity in a cubic foot, at another barometrical height 3.6 inches lower, may be known from the mercurial height 28.77 to that of three inches and one-half nearly.

This table I here give, adapting it to our measures.

Barometer	Ratio.
28.77	1.0000
25.17	0.9528
21.57	0.8899
17.97	0.8264
14.37	0.7629
10.77	0.6887
7.17	0.6230
3.57	0.4311

$\times .6230 = 6.23$.

But still it is supposed that at those great heights,

Thus, supposing the absolute quantity of dissolved vapour at any temperature, and barometer 28.77 to be 10 grains per cubic foot; then the quantity of vapour at a height at which a barometer would stand at 25.17 inches would be $10 \times 0.9528 = 9.528$, and at the height at which a barometer would stand at seven inches, the quantity in a cubic foot would be only 10

heights, at which barometers would stand so low, that the air is of the same temperature as the original experiment is made at, namely in this case, as it is found at barometer 28.77 inches; but since in reality air at great heights is generally much colder than below, to ascertain the real proportion of vapour at those heights it will be necessary to find the quantity of vapour which a cubic foot of air is capable of holding at that temperature barometer 28.77, and the ratio which the quantity or weight of vapour actually found, bears to the complement at that temperature. Then, 2do. to find the complement of a cubic foot of air at the temperature which prevails at the given barometrical height, and diminish it in the same ratio in which it was found diminished below; and finally, diminish it still further in the ratio which that barometrical height demands. An example will fully explain this rule.

Thus Saussure found, barometer 28.77 and thermometer 82° of Fahr., a cubic foot of air contained about 10 grains of moisture at Geneva. Now the complement of 82° is nearly 15 grains, and the ratio of 10 to 15 is $\frac{2}{3}$. Then at Mount Blanc, on the same hour, the barometer stood at 16° and the thermometer at 26.8 : the complement of a cubic foot of air at this temperature is 5.3 grains, which diminished in the ratio of 2 to 3 becomes 3.5; and this, further diminished by the ratio which the barometrical height of 16 inches demands, namely $.78 = 3.5 \times .78 = 2.7$ grains, by observation it was found to be 1.7 : the difference is only one grain. *Voy. aux Alpes*, § 2007. How the temperature which prevails at those great heights may be found, will be shown in the sequel.

The celebrated Lambert of Berlin (Mem. Berlin 1772,) has also given an estimate of the proportion of vapour which prevails in the atmosphere at different barometrical heights, deduced from calculations founded on many fictions—such as that of a homogeneous atmosphere, of pure air distinct from common air, and an erroneous system of the ascent of heat; yet, as it is much easier in its application, and in the instance just quoted approaches very near the truth, I have calculated the results of his system, which is nothing more than that the quantity of vapour at different barometrical heights above the earth is in the ratios of the squares of those heights. By a homogeneous atmosphere it is probable he meant such a state of the atmosphere as prevails in serene unclouded weather; and it is certainly only in such an atmosphere that any calculation can be instituted.

Table of the Ratios of the Quantities of Vapour at different barometrical Heights, the Quantity at the Surface of the Earth being given.

Barometer.	Ratio of Vapour.	Barometer.	Ratio of Vapour.	Barometer.	Ratio of Vapour.
30°	900	24°	576	12	144
29°5	870	23°	529	11	121
29.	841	22	484	10	100
28°5	812	21	441	9	81
28°	784	20	400	8	64
27°5	756	19	361	7	49
27°	729	18	324	6	36
26°5	702	17	289	5	25
26°	676	16	256	4	16
25°5	650	15	225	3	9
25°	625	14	196	2	4
24°5	600	13	169	1	1

Thus, in the example last quoted, the quantity of vapour in a cubic foot at Geneva being 10 grains, barometer 28°77, the quantity on Mount Blanc, barometer 16, should be .309; for as 827.7 ($= 28.77$) is to 256 ($= 16$), so is 10 to 0.309, which differs from the truth by only 0.391 of a grain.

As vapours unite to air, partly through the agency of heat, and partly through that of affinity and of electricity, so they separate from it, sometimes from a diminution of that degree of heat which they possessed in their nascent state, sometimes from a diminution of affinity, and sometimes from an alteration in their electrical state.

In their first degree of coalescence when separated from air, they form aggregates of exceeding minute particles, separated from air by the diminution of affinity, and also from each other by electrical atmospheres: these aggregates are of equal and often lower specific gravity than the air in which they are formed, and yet are visible by reason of their opacity; when near the earth, they are called *fogs, mists, or haze*, (which differ only in density,) and when at greater heights, *clouds*.

Vapours issuing from water or moisture warmer than the air to which they unite, are soon cooled by it, and thence in great measure dismissed: hence the morning mists observed in summer and the winter mists of the colder regions: evening mists, on the contrary, proceed from the supersaturation of air with vapours previously dissolved, arising from the super-

pervening

pervening decreased temperature. The inferior strata of the atmosphere are scarce ever supersaturated by vapours arising from water or moisture warmer than the air into which they ascend; for, before the point of saturation can be attained, their affinity to the portion of air to which they are united is weakened, and thence exceeded by the unincumbered affinity of the superior strata: and this happens successively on to the higher regions; but with diminished activity, by reason of the diminished density of the higher strata, until their ulterior progress is checked by saturation; but as they are still continually recruited from below, their quantity is at last so far increased that they coalesce into clouds. Here the process recommences; for from the surface of these clouds a fresh evaporation often takes place, which, after some progress, is again checked in its turn, and clouds are formed at a superior height: these again give room to a further evaporation, and a new stage of clouds is formed, until the process is at last arrested by the intense cold of the superior regions. But the mere cold of congelation is not sufficient to arrest it; for Bouguer informs us that clouds are formed 2500 feet above the lower line of congelation, and that ice itself evaporates, though cooled, several degrees below the freezing point, is well known. The distance of the particles, both of air and vapour, from each other, when so far rarefied as they must be in the superior regions of the atmosphere, prevents their coalescence in any but the extreme degrees of cold.

Hence we see that in the warmer latitudes and seasons various strata of clouds may be formed one above the other: Muschenbroek attests that even in Holland, in August 1748, he distinctly discerned three. These distinct strata, variously electrified and otherwise circumstanced, give occasion to various phenomena, the detail of which would here be misplaced.

The clouds which commonly crown the summits even of low mountains, and often announce rain, are caused by the near approach to saturation at those elevations, and its actual attainment through the evaporation from those summits. But the summits of the loftiest mountains ever crowned with snow, are generally shrouded in clouds, from the cold they impart to the air in contact with them, and the loss of electricity conducted away from the vapours contained in that air by the mountain.

The heights at which the lowest clouds are formed, are various in various latitudes and seasons; greater in the warmer, and smaller in the colder. In latitude 54° in Cum-

berland, Mr. Crosswaite observed none lower than 2700 feet, and none higher than 3150, in the course of several years*. But this country being mountainous, they are probably lower than in others under the same parallel. Lambert, in Berlin, latitude $52^{\circ} 32'$, in the month of July 1773, found their height 7792 feet; thermometer 65° , and the barometer somewhat below its mean height †. Schueckburgh also remarks that clouds frequently rest below the summit of Saleve, whose height is 2831 feet. Phil. Trans. 1777, p. 538; and Gentil, at Pondicherry, latitude 12° , observed some at the height of 10240 feet. ii. Voy. p. 79.

The weight of clouds Saussure estimates at one-third or one-fourth of that of the cubic foot of air in which they subsist. Hygrometer, p. 270. When the barometer rises, clouds are partly dissolved, as dense air is a better solvent than rarer air, and partly rise higher in consequence of the increased specific gravity of the inferior air; when the barometer falls, the contrary takes place.

XL. Report, read before the Conference of Mines, on the Specific Gravity of the Coals of several Mines of France; and on the Difference in the increase of Volume which they acquire by Humectation. By C. BLAVIER, Engineer ‡.

THE conference of mines had long been sensible of the necessity of determining, with rigorous precision, the specific gravity of coals in masses or in large fragments, in order that it might be compared with that of the same article as sold by the coal merchants. This object was at the same time of more importance, as it would make known what difference humectation would produce on the volume which coals occupy in their state of dryness.

C. Duhamel and Blavier proposed to accomplish this object in the execution of a labour with which they were charged, in order to confirm the different assertions already established by one of them, in a memoir delivered to the conference on the 12th Pluviose, year 7.

These commissioners wished to take as a fixed and invariable base, the solid coal, or such as it is when extracted from the mine, that they might afterwards proceed progressively to that reduced to different degrees of attenuation, and particu-

* D'Alton's Meteorological Observations, p. 41.

† Mem. Berlin 1773, p. 44.

‡ From the *Journal des Mines*, No. 65.—We have inserted this paper as it may furnish useful hints for similar experiments on the varieties of coal in Britain, which are so numerous.

larly to those which it experiences till the moment when it passes into the hands of the consumer: but they were obliged to confine their experiments to each of those kinds of coal placed at their disposal by the council, and which were transmitted to them directly by the workers of the mines of Creusiot, St. Etienne, Lataupe, Labarthe, Lacomballe, and Decise.

The method by which they were able to ascertain the specific gravity was as follows:

After bringing the different kinds of coal above mentioned to the uniform size of pease or beans, by sifting them, and having carefully picked out all the earthy or schistous particles, the commissioners filled a decalitre with each of them, taking care to choose those in the highest state of dryness, and to pour them in without any shock, as merchants do who measure them on the ground or in their barges. The weight of each decalitre being ascertained, the dry coal contained in the vessel was then watered in succession without shaking or displacing it; and this was continued till the water floated over the surface. The coals thus moistened were again weighed, and the difference of weight indicated the specific gravity required, since this article is impermeable to water, which only fills up the vacuities left between the grains of the bruised coal by their uniting under a greater or less obtuse angle.

In regard to the increase of weight arising from humectation, it will be sufficient to decant the supernatant liquor; and the difference of the two, weighed as above, expressed this second result.

They then moistened successively, and in different proportions, each kind of coal; suffered the superfluous water to drain off for a quarter of an hour; and, comparing the volume of the dry matter with that which it occupied at different degrees of humectation, were able to discover the progressive increase or diminution by employing for this purpose a wire placed exactly level with the surface of the vessel.

The table annexed exhibits the series of the comparative experiments: indicating for each hectolitre of the kinds of coal before mentioned the weight of that article in its state of dryness; that of the water introduced, which may be considered as solid; the increase of weight in the moistened coals; the augmentation of its volume arising from greater or less humectation; the number of parts of solid coal in a hundred parts of dry coal, and the specific gravity of the latter.

It follows, from the labour of C. Duhamel and Blavier, 1st, That the increase of weight is always in the direct ratio of the quantity of water added, which itself increases accord-

ing to the degree of the trituration of the coal, and in the inverse ratio of the specific gravity of the article. 2d, That the latter also is in the inverse ratio of the weight of the liquid which the dry coal retains after decantation. 3d, That the increase of volume is the more sensible as a greater quantity of humectation has been produced; and that there exists a term at which the addition of water occasions no change, and beyond which the volume decreases in determinate proportions. 4th, In the last place, that all these results vary not only in regard to the different kinds of coal, but even in the same kind of coal, according to its nature, its mixture with parts more or less earthy, and particularly its size or degree of trituration.

The most natural conclusion to be deduced from these experiments is, that in the sale of coals there may be introduced abuses, which it will be of more importance to reform, as in 100 parts of dry coal there are scarcely 70 parts of solid coal; and besides, it is proved, that from humectation carried to a certain degree, there may result an augmentation or diminution of volume to the loss of the consumer or even of the merchant himself.

In consequence of these considerations, C. Duhamel and C. Blavier, in a report dated Pluviose 8, year 10, have concluded that the sale of coals by weight is attended with the same inconveniences as those which take place in a determinate measure of capacity. They persist in believing that the combinations of the two methods could not be employed but on the supposition of coal entirely dry, and yet by expressing a wish that an accurate table of the specific gravities of all the coals in France, comparing them with each other in different degrees of size and humectation, might be drawn out. The result would at least be approximative data, by help of which it would be possible to expose the shameful traffic of some coal-merchants, who alter the nature of their commodity by mixtures more or less earthy. This labour would be particularly important were it accompanied with experiments proper for determining the real value of coal in regard to the use for which it is best fitted. It is thus, for example, that C. Blavier has already found, by repeated trials, that the *pera* of Decise must be selected to heat reverberating and evaporating furnaces in preference to the small coal of St. Etienne; while the latter, which is sold in general for at least a fourth more, may be employed with advantage in forges and in all circumstances where a strong concentrated heat is required. The mixture of these two kinds of coal, in the proportion of four to three, gave him an article of fuel the more valuable, as, by furnishing a more ardent
and

and longer maintained flame, there arises to the consumer a saving of more than a fifth, compared with the use of either of these taken separately. It was with this view that the reporter proposes to subject the different kinds of coals in the republic to experiences, capable of fixing, in an invariable manner, not only their peculiar use in commerce and in the arts, but also the advantages which would result from mixing them in certain proportions.

Table of Experiments on the Specific Gravity of different Kinds of Coal, and on the Increase of Weight and Volume which they acquire by Humectation.

NAMES OF THE COALS.	Weight of the dry coals per hectolitre. Kilogr.	Weight of the water introduced per hectolitre of dry coal. Kilogr.	Increase of weight in the moistened coal per hectolitre. Kilogr.	Increase of volume of the moistened coals per hectolitre. Decalitres	Number of parts of coal in 100 parts of dry coal.	WEIGHT OF THE DRY COAL.	
						Per hectolitre. Kilogr.	Per cubic foot. Pounds.
Mine of Labarthe.	88.50	36.10	9.50	1.67	63.9	145.32	97
Mine of Combelle.	86.07	41.53	17.50	2.50	58.5	136.42	95
Mine of Lataupe.	85.50	42.00	19.50	2.50	58.0	135.09	94
Mine of St. Etienne.	84.20	47.10	26.80	1.67	52.9	128.74	90
Mine of Decise.	82.75	50.75	29.95	2.50	49.3	125.55	88
Mine of Creusot.	79.50	52.75	47.90	2.50	47.25	117.75	85

XLI. *Memoir on the Wax-Tree of Louisiana and Pennsylvania.* By CHARLES LOUIS CADET, of the College of Pharmacy*.

A NUMBER of plants, such as the *Croton sebiferum*, the *Tomax sebifera* of Loureiro, the poplar, the alder, the pine, and some *labiati*, give by decoction a concrete inflammable matter, similar, in a greater or less degree, to tallow or wax; that is to say, a fixed oil saturated with oxygen. The light down, called the bloom of fruits, and which gives a silvery appearance to the surface of plums and other stone fruits, is wax, as has been proved by M. Prevost. But the tree which furnishes this matter in the greatest abundance, and which in many respects deserves the attention of agriculturists, chemists, physicians, and commercial men, is the *Myrica cerifera*, or wax-tree.

We read in the History of the Academy of Sciences for the years 1722 and 1725, that M. Alexandre, a surgeon and correspondent of M. Mairan, observed in Louisiana, a tree of the size of the cherry-tree, having the appearance of the myrtle and nearly the same odour, and bearing a seed of the size of coriander. These seeds, of an ash-gray colour, contain a small ossaceous stone, pretty round, covered with shining wax, which is obtained by boiling the seeds in water. This wax is drier and more friable than ours. The inhabitants of the country make tapers of it. M. Alexandre adds: "This seed has commonly a beautiful lake colour, and on being bruised with the fingers they acquire the same tint; but this takes place only at a certain season."

The liquor in which the seeds have been boiled, and from which the wax has been taken, when evaporated to the consistence of an extract, was found by M. Alexandre to be an effectual remedy for checking the most obstinate dysenteries.

The advantageous properties exhibited by this tree could not but induce scientific men to make researches for the purpose of ascertaining the varieties of this vegetable production, and what care was required in its culture. It was long considered as a mere object of curiosity.

Linnaeus, in his Vegetable System, speaks only of the wax-tree of Virginia (*Myrica cerifera*), with leaves lanceolated as if indented, stem arborescent.

Having requested C. Ventenat to inform me how many species there are of it, he replied that Ayton has distinguished two, viz.

* From the *Annales de Chimie*, No. 131.

1st, *Myrica cerifera angustifolia*, which grows in Louisiana. This tree is delicate, flowers with difficulty in our green-houses: its seeds are smaller than those of the following.

2d, *Myrica cerifera latifolia*, which grows in Pennsylvania, Carolina, and Virginia. It does not rise to such a height as the former, and is perfectly naturalized in France. These two *Myricæ* are of the family of the *diœci*.

They are both cultivated at the *Museum des Plantes* and in the gardens of C. Cels and Lemonier.

C. Michault admits a third species of *Myrica cerifera*, which he calls the dwarf wax-tree. C. Ventenat thinks that wax may be extracted from all the *Myricæ*.

The authors who have spoken of these trees with some details are C. Marchal, translated by Lesferme, Lepage-Duprat, and Toscan, librarian of the Museum of Natural History. A memoir inserted by the latter in his work intitled *L'Ami de la Nature*, makes known the manner in which vegetable wax is collected in the colonies.

“Towards the end of Autumn,” says he, “when the berries are ripe, a man quits his home, with his family, to proceed to some island, or some bank near the sea, where the wax-trees grow in abundance. He carries with him vessels for boiling the berries, and an axe to build a hut to shelter him during his residence in that place, which is generally three or four weeks. While he is cutting down the trees and constructing the hut, his children collect the berries: a fruitful shrub can furnish about seven pounds. When the berries are collected, the whole family employ themselves in extracting the wax. A certain quantity of the seeds are thrown into the kettles, and water is poured over them in sufficient quantity to rise to the height of half a foot above them. The whole is then boiled, stirring the seeds from time to time and pressing them against the sides of the vessels, that the wax may more easily be detached. A little after, the wax is seen floating in the form of fat, which is collected with a spoon and strained through a piece of coarse cloth to separate the impurities mixed with it. When no more wax detaches itself, the berries are taken out by means of a skimmer, and new ones are put into the water; taking care to renew it the second or third time, and even to add more *boiling* water in proportion as it is consumed, that the operation may not be retarded. When a certain quantity of wax has been collected in this manner, it is placed on a piece of linen cloth to drain, and to separate the water with which it is still mixed. It is then dried, and melted a second time

for the purpose of purifying it, and is moulded into the form of cakes. Four pounds of the seeds give about a pound of wax. That which detaches itself first, is generally yellow, but in the last boilings it assumes a green colour, in consequence of the tint communicated to it by the pellicle with which the nucleus of the seed is covered."

Kalm, the traveller, speaking of the vegetable wax, says that in countries where the wax-tree grows, it is employed for making excellent soap, with which linen can be perfectly washed.

Such was the knowledge naturalists had of the myrica, or at least no other observations, as far as I know, had been published, respecting it, when a naturalist gave me half a kilogramme of the vegetable wax of Louisiana. I was desirous to analyse it, and compare it with the wax made by our bees, but before I undertook this labour, I wished to be acquainted with the nature of the shrub, and of the seeds of the myrica. I saw this valuable production in the *Jardin des Plantes*, and wrote to C. Deshayes, a zealous botanist, who superintends at Rambouillet the cultivation of the *Myrica pennsylvanica*, to beg he would give me a few details on that subject. He was so kind as to return an answer, accompanied with some of the seeds, which I took the earliest opportunity of examining.

This seed is a kind of berry, of the size of a pepper-corn; its surface, when it is ripe and fresh is white, interspersed with small black asperities, which give it the appearance of shagreen. When rubbed between the hands, it renders them unctuous and greasy.

If one of these small berries be strongly pressed, it divests itself of a matter in appearance amylaceous, mixed with small round grains like gunpowder. The nucleus, which remains bare, has a very thick ligneous covering, and contains a discotyledon kernel. By rubbing a handful of the berries on a hair sieve, I obtained a gray dust, in which I could distinguish, by the help of a magnifying glass, the small brown grains already mentioned, in the middle of a white powder.

I put this powder into alcohol, which by the help of a gentle heat, dissolved all the white part, and left the black powder, which I collected a-part. Water poured over this alcoholic solution, disengaged a substance which floated on the surface of the liquid. I melted this substance, and obtained a yellow wax, similar to that brought me from Louisiana. This experiment was sufficient to prove that the wax of the myrica is the white rough matter which envelopes the seeds.

The black powder which I separated appeared to me to contain

contain a colouring principle, and I did not despair that I should find in it the beautiful lake, mentioned by M. Alexandre. With this view, I bruised strongly the powder, and boiled it in a solution of acid sulphate of alumine. I was much astonished to obtain nothing but a liquor scarcely coloured, and the alumine precipitated by an alkali, was only slightly stained.

I took another part of this black bruised powder, and put it to infuse in alcohol. I soon obtained a tincture of the colour of wine lees: on heating this tincture, it became as red as a strong tincture of cinchona or cachou. This result induced me to believe that the colouring principle was resinous, but by adding water I saw no precipitate formed.

I poured into this tincture water charged with sulphate of alumine; a slight precipitate was produced: a solution of sulphate of iron formed it immediately into an ink.

What is the astringent colouring principle which is not soluble in alcohol, which forms no precipitate with water, and which has so little attraction for alumine? To find it a series of experiments, which the few substances I had in my possession did not permit me to make, would have been necessary. The astringent matter mentioned by M. Alexandre, must be found in the decoction of the unbruised seeds. To ascertain this fact, I boiled the seeds in a silver vessel. The decoction on which a little wax floated, was of a greenish colour, with a taste somewhat styptic: it precipitated ferruginous solutions black. Having heated it in a very clean iron vessel, it speedily became black. To know whether this property arose from the gallic acid alone, or from tannin, I mixed a little of the concentrated decoction with a solution of gelatin, but no precipitate was formed.

It is therefore to the pretty considerable quantity of gallic acid contained in the seeds of the myrica, that the virtue of its extract in checking dysenteries ought to be ascribed. In this respect, I am of opinion that the leaves and bark of the tree would furnish an extract still more astringent than the berries.

The following are the most interesting results of an examination of the wax:

When extracted either by decoction from the seeds, or by solution of the white powder in alcohol precipitated by water, this melted wax is always of a yellow colour, inclining to green. Its consistence is stronger than that of the wax made by bees; it is dry and friable enough to be reduced to powder; in a word, it is manifestly more oxygenated than wax prepared by these insects. Tapers made with the wax of the

myrica

myrica give a white flame and a beautiful light, without smoke, do not run, and when new emit a balsamic odour which the inhabitants of Louisiana consider as very beneficial to the sick: when distilled in a retort, it passes in a great part to the state of butter. This portion is whiter than it was before, but it loses its consistence, and acquires that of tallow. Another portion is decomposed, furnishes a little water, sebatic acid, and empyrenematic oil. A great deal of carbonated hydrogen gas and carbonic acid gas are disengaged, and there remains in the retort a black carbonaceous bitumen. Common wax when distilled, exhibits the same phenomena.

I have already said that alcohol dissolves the wax of the myrica, but ether dissolves it much better, and, by the evaporation of the liquid, it separates in the form of stalagmites. Neither of these liquids destroy its colour. If this wax be boiled with dilute sulphuric acid, it becomes a little whiter, but there is no sensible combination of the acid with it. The yellow wax of bees, treated in the same manner, did not change its colour.

Oxygenated muriatic acid bleaches both kinds of wax perfectly. The vegetable wax, however, loses its colour with more difficulty.

The vegetable wax dissolves in ammonia. The solution assumes a brown colour: a part of the wax becomes saponaceous. The volatile alkali has much less action on the wax of bees.

These two kinds of wax, when strongly agitated in a boiling solution of caustic potash, wash and form a real soap, as observed by Kalm the traveller. The whiteness which wax acquires by this saponification is not a new phenomenon. C. Chaptal, in his process for bleaching by the steam of alkaline lees, has proved that the colouring principle of vegetables yields to the action of alkalies. Some chemists ascribe this effect to the direct combination of soda or potash with the coloured extractive part, and a combination which brings it to a state almost saponaceous and renders it soluble.

According to my opinion, the alkali, in this operation, exercises over the oil or wax a double attraction, first direct with the constituent principles of the oil, then predisposing and favouring the combination of the oxygen of the atmosphere with oil or wax. I do not know whether any one before me ever entertained this idea; but it was suggested by observing what takes place when soap is decomposed by an acid. The oil is always concrete and more oxygenated than it was before.

It would be of importance for the theory of chemistry to make soap, if possible, in a close vessel, and to examine the air afterwards, or in different gases containing no oxygen.

By decomposing soap of the myrica, very white wax is obtained; but in a particular state, which does not admit of its being employed for our purposes.

Litharge, or semi-vitreous oxide of lead, dissolves very well in the melted wax of Louisiana. It forms a very hard mass, the consistence of which may be diminished at pleasure by the addition of a little oil. If the wax of the myrica, as there is reason to think, retains a portion of the astringent principle given by a decoction of the berries, the physicians, perhaps, will find useful properties in topics made with this wax.

By taking a general view of what has been here said, it is seen that the myrica may be of very great service in the arts. The wax which it furnishes is sufficiently abundant to prove an ample indemnification for the care and expense of cultivation, since a shrub in full bearing gives six or seven pounds of berries, from which a fourth of wax may be extracted. This wax is of a quality superior to that of bees.

The astringent principle of the myrica, extracted on a large scale, may be very useful either in medicine or in the arts. In certain respects it may be substituted for the gall-nut in dyeing, hat-making, and perhaps in the tanning some kinds of leather. The colouring principle seems to be sufficiently fixed to deserve some attention; and, if it be true that in Louisiana beautiful lakes are made from it, why is it not rendered useful in painting?

In a word, when this wax becomes sufficiently common to be sold at a low price, great advantage might be derived from it in making soap.

The art of bleaching this wax requires also some researches, when it is to be performed on a large scale with œconomy. Two re-agents present themselves to manufacturers—the sulphuric acid and the oxygenated muriatic. But as wax does not sink in these liquids, means must be found to multiply the contact, either by cutting the wax into slices and besprinkling it with oxygenated muriatic acid, or shutting it up when cut in this manner, in casks, into which oxygenated muriatic acid is introduced.

I shall propose a third method, which seems to promise a speedier effect. Place the wax, cut into small pieces, in alternate strata with hyper-oxygenated muriate of lime: when arranged in this manner, leave it for some time dry and in contact. The salt and acidulous water are then to be decomposed by
the

the sulphuric acid, taking care to pour in water gradually, at different periods, till there is no longer a sensible disengagement of muriatic gas. A large quantity of water is then to be added, and the mixture must be stirred with a rod. By rest, the insoluble sulphate of lime is precipitated, and the bleached wax will float at the surface.

I shall terminate this memoir with some observations on the culture of the myrica.

C. Deshayes, to whom I am indebted for the trials I made, has observed, for several years, the wax-trees of Rambouillet. What he wrote to me on this subject is as follows:

“The *Myrica latifolia* (Ayton) is here absolutely in its native country: it is in the soil proper for it; that is to say, in sandy and blackish turf. We have sixteen wax-trees in full vigour. They are four, five, and six feet in height: one male is seven feet. The seeds are abundant almost every year: I say almost, because in some years they fail. The fruit in general is in that part of the English garden assigned to it.

“The culture requires no care. Every year a great number of shoots, which proceed from the roots of the large trees, are pulled up. These are so many new shrubs, which are then planted at the distance of a yard from each other.

“The seeds may be sown in beds in the spring, and then transplanted: but this method is tedious. The myrica will succeed wherever it finds a light soil, somewhat moist. How many provinces are there where the cultivation of this shrub would be useful, and employ land almost neglected!

“What advantages may not agriculture hope for from such an acquisition, since Prussia has so long seen the myrica flourish in its dry, sandy plains!”

C. Thiebault, of the Academy of Berlin, gave me the following interesting note on this subject:

“The late M. Sulzer, author of a general dictionary of the fine arts, had obtained from Frederic the Great a pretty extensive piece of waste land on the banks of the Spree, at the distance of half a league from Berlin, in a place called the Moabites. However barren this ground, which presented only a very thin, poor turf, above fine light sand, might be, M. Sulzer converted it into a very agreeable garden, worthy of a philosopher. Among other remarkable things he formed a plantation of foreign trees, consisting of five pretty long alleys running east and west. In these alleys there were not two trees of the same kind following each other. In the alleys most exposed to the north he planted none but the highest trees, capable of withstanding the severity of the climate.

Hence,

Hence, in proceeding from the north to the south, the first alley exhibited trees of about seventy feet in height, the second trees of from twenty-five to thirty, and so on, in the form of an amphitheatre; so that all these trees had the sun at least in part, and the weaker were sheltered by the stronger.

“ In the most southern alley I observed a sort of shrub which rose only to the height of two or three feet, and which M. Sulzer called the wax-tree. Every person visited this alley in preference to the rest, on account of the delicious perfume emitted by the leaves, which they retained a very long time.

C. Thiebault then speaks of the method of extracting the wax. This operation is the same as that described by M. Alexandre.

“ I have seen,” adds he, “ one taper of this wax perfume three chambers which composed M. Sulzer’s private apartments, not only during the time it was lighted, but even for the rest of the evening.”

The myrica cultivated at Berlin was, no doubt, more odoriferous than that which we possess, the wax of which does not emit the same perfume.

M. Sulzer intended to make tapers of this wax not bleached, covered with a coating of our finest wax. The heirs of this academician sold the garden, but the wax-trees still remain. They were planted in 1770.

• If it has been found possible to naturalize the *myrica cerifera* in the north, why should we neglect a vegetable production so valuable, which would certainly thrive in our southern departments, and which requires less care than bee-hives. The successful trials which have been made must excite the zeal of our agriculturists.

The government has already encouraged this branch of industry by ordering plantations of the wax-tree. There are nurseries at Orleans and Rambouillet which contain more than 400 shrubs. Results so satisfactory cannot be made too public. Useful plants are always propagated slowly: a barren but picturesque tree, an agreeable shrub, are soon adopted through fashion: they ornament the parterres of our modern Luculluses and the flower-pots of our Phrynes, while our indefatigable agriculturists exhaust themselves in vain efforts to enrich our meadows with a new grass, or to fill our granaries with a new nourishing grain. The vulgar, through prejudice, long rejected maiz and potatoes, which have been of so much service to our soldiers and to the poor. The oak, which fed our ancestors, is no longer found in our forests. Let us, however, hope that our agriculturists will

at length open their eyes to their real interests; and that, laying aside their old prejudices, they will not disdain the presents which learned societies are desirous to give them, and which will conduce as much to their advantage as to the glory and prosperity of France.

XLII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON:

ON the 30th of November, being St. Andrew's day, the Royal Society held their anniversary meeting at their apartments in Somerset-place, when the gold medal (called Sir Godfrey Copley's) was presented to William Hyde Wollaston, M.D. for his various papers printed in the Philosophical Transactions.

Afterwards the Society proceeded to the choice of the council and officers for the ensuing year, when, on examining the ballots, it appeared that the following gentlemen were elected of the council:

Of the old council—The right hon. sir Joseph Banks, bart. K. B.; sir Charles Blagden, knt.; Henry Cavendish, esq.; Edward Whitaker Gray, M. D.; right hon. Charles Greville; right hon. sir William Hamilton, K. B.; Rev. Nevil Maskelyne, D. D.; George earl of Morton, K. T.; Joseph Planta, esq.; Benjamin count Rumford; Samuel Wegg, esq.

Of the new council—Mark Beaufoy, esq.; Andrew Douglas, esq.; sir Martin Browne Folkes, bart.; Charles Hatchett, esq.; Everard Home, esq.; Thomas Barnard, lord bishop of Limerick; William Marsden, esq.; Joseph de Mendoza Rios, esq.; Francis earl of Moira; William Hyde Wollaston, M. D.

And the officers were—Sir Joseph Banks, bart. president; William Marsden, esq. treasurer; Joseph Planta, esq., Edward Whitaker Gray, M. D., secretaries.

Afterwards the members of the Society dined together, as usual, at the Crown and Anchor tavern, in the Strand.

The Transactions of the Society for 1802 contain the following papers:

1. The Croonian Lecture. On the Power of the Eye to adjust itself to different Distances, when deprived of the Crystalline Lens. By Everard Home, Esq. F. R. S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M. D. F. R. S. Professor of Natural Philosophy in the Royal Institution.—3. An Analysis of a mineral

mineral Substance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Esq. F. R. S.—4. A Description of the Anatomy of the *Ornithorhynchus paradoxus*. By Everard Home, Esq. F. R. S.—5. On the Independence of the analytical and geometrical Methods of Investigation; and on the Advantages to be derived from their Separation. By Robert Woodhouse, A. M. Fellow of Caius College, Cambridge.—6. Observations and Experiments upon oxygenized and hyper-oxygenized muriatic Acid; and upon some Combinations of the muriatic Acid in its three States. By Richard Chenevix, Esq. F. R. S. and M. R. I. A.—7. Experiments and Observations on certain stony and metalline Substances, which at different Times are said to have fallen on the Earth; also on various Kinds of native Iron. By Edward Howard, Esq. F. R. S.—8. Observations on the two lately discovered celestial Bodies. By William Herschel, L. L. D. F. R. S.—9. Description of the Corundum Stone, and its Varieties, commonly known by the Names of Oriental Ruby, Sapphire, &c.; with Observations on some other mineral Substances. By the Count de Bournon, F. R. S.—10. Analysis of Corundum, and of some of the Substances which accompany it; with Observations on the Affinities which the Earths have been supposed to have for each other, in the humid Way. By Richard Chenevix, Esq. F. R. S. and M. R. I. A.—11. Description of the Anatomy of the *Ornithorhynchus Hystrix*. By Everard Home, Esq. F. R. S.—12. A Method of examining refractive and dispersive Powers, by prismatic Reflection. By William Hyde Wollaston, M. D. F. R. S.—13. On the oblique Refraction of Iceland Crystal. By William Hyde Wollaston, M. D. F. R. S.—14. An Account of some Cases of the Production of Colours, not hitherto described. By Thomas Young, M. D. F. R. S. F. L. S. Professor of Natural Philosophy in the Royal Institution.—15. On the Composition of Emery. By Smithson Tennant, Esq. F. R. S.—16. Quelques Remarques sur la Chaleur, et sur l'Action des Corps qui l'interceptent. Par P. Prevost, Professeur de Philosophie à Genève, &c.—17. Of the Rectification of the Conic Sections. By the Rev. John Hellins, B. D. F. R. S. and Vicar of Potter's Pury, in Northamptonshire.—18. Catalogue of 500 new Nebulæ, nebulous Stars, planetary Nebulæ, and Clusters of Stars; with Remarks on the Construction of the Heavens. By William Herschel, LL. D. F. R. S.

APPENDIX.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

FRENCH NATIONAL INSTITUTE.

Proceedings during the last quarter of the year 10, continued from our last Number.

NATURAL PHILOSOPHY.

Of Meteors supposed to fall under the form of Stones.

A great deal has been said of stones which have fallen from the clouds; it was long believed that this was one of the forms assumed by thunder in its fall; they were then considered as the product of the explosion of certain luminous balls, which are sometimes observed. The rarity of these phenomena, however, which has not allowed of their being seen at a short distance by observers possessed of intelligence, and at the same time worthy of credit, and which seems hitherto to have reserved them for the eyes of the vulgar, so much inclined to exaggeration, has prevented the learned from believing in the existence of these stones.

However, most mineralogical collections, contain a great number of stones, to which this origin has been ascribed. They exhibit exterior uniform characters: a specific gravity nearly equal, and by analysis, give the same component parts, among which is nickel, a substance rarely found at the surface of the earth; and iron in a metallic state, which is never met with in volcanic productions, to which these stones in other respects seem to be very analogous.

These remarks have induced Mr. Howard, and Count de Bournon, to think that, however doubtful the fall of stones from the atmospheric regions may be, it ought to be subjected to accurate examination. They have collected the different testimonies in a paper read before the Royal Society of London, and C. Pictet thought it proper to present it to the class, that the attention of philosophers may be directed to this subject, in order that the phenomenon, if true, may be confirmed; or, if only an illusion supported by popular error, may be confined for ever to the class of errors.

CHEMISTRY.

On the Prussiates of Barytes and Lime.

After the bases of a theory have been established on important facts well confirmed, and when by a methodical arrangement of the science they have been distributed, as we may say, into regions, the communications between which are known, it remains to review them in detail, in order that
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all the parts may be carefully described, and that these parts may be assigned to the regions which they compose. Such, it appears is the idea which may be formed of the present state of the chemical knowledge of salts. Their general formation seems to be well known, the great divisions are well established, and the principal facts have been exactly observed and classed; but notwithstanding these satisfactory labours, many details are still unknown or imperfect. Hence the researches of the chemists of the institute during this quarter have been particularly directed towards this object, and it will be seen that they have not been fruitless.

The liquor charged with the colouring matter of Prussian blue, having manifested the property of taking metals from their solvents, without producing a decomposition of the salts with an alkaline or earthy base, the phenomenon of the precipitation of barytes had been considered as an indication of the metallic nature of that substance, which could not be reduced to a metallic state, because it had a greater affinity for oxygen than carbon. The most celebrated chemists had adopted this opinion, others had announced that precipitation did not take place. Mr. William Henry thus maintaining that prussiates perfectly purified did not produce any precipitation, confirmed himself the first observations of Bergman and Lavoisier, and announced that there was formed by double affinity a real prussiate of barytes. C. Guyton, having long observed that prussiate of lime was decomposed by carbonate of potash, made use of this experiment, and those of Mr. Henry, to fix the theory of these phenomena; and, instead of concluding, like the English chemist, that barytes differs in this respect from other earths, and approaches the nature of metals, he shows that the same effect takes place with lime, strontian, magnesia, potash, soda, and even ammonia, and consequently that, in all these cases, there is nothing but the necessary result of the concurrence of several divellent forces.

On Mercurial Salts.

After treating different oxides of mercury, as already mentioned in his memoir, C. Fourcroy continued to read an account of his labour during the last quarter. In this second part he employed himself on the sulphates and nitrates of mercury; a very complex kind of compounds, exceedingly variable, the characters and properties of which have been examined by many chemists, without their being able to determine the real differences between them, and particularly the cause of these differences. The author had already made

this kind of combination the subject of his researches, and in 1791 communicated to the academy of sciences a pretty long paper on these salts. He established three kinds of them, distinguished by the proportions of acid and oxide, and he showed a difference between them, founded on the different states of oxidation of the metal.

Different sulphates are made not only by exposing mercury with sulphuric acid to a greater or less heat, and for a longer or shorter time, but also by mixing this acid or a soluble sulphate with a nitric solution of mercury, more or less oxidated. If the latter is little oxidated, a white precipitate of sulphate little oxidated is obtained; if it be much oxidated a yellow precipitate highly oxidated will be obtained; sulphuric acid united to two or three parts of water does not form sulphate of mercury much oxidated, unless it be concentrated by long and strong ebullition; without this, the water added for washing does not render the mixture yellow, and will not make turbith mineral. The author gives the proportions of the component parts, acid, oxygen and mercury, of the different neutral or acid sulphates, little or very much oxidated. These results are a supplement to his labour of 1791 on this kind of mercurial salts.

Nitrates of mercury furnished him with observations still newer and more important for science than the sulphates. There are two kinds of nitrates, one much oxidated, and the other little oxidated. The former is precipitated, of a gray colour, and almost black by alkalies, and white by sulphates; with muriatic acid it forms mercurius dulcis. The nitrate much oxidated, results from long and strong ebullition, gives no precipitate by muriatic acid, it gives a yellow one with sulphates, a white one with ammonia, and an orange yellow one with fixed alkalies. Nitric solutions of mercury, are often mixtures of the two salts. That which precipitates by water is a solution of oxide much oxidated, or red, in concentrated acid. When a nitric solution of mercury, little oxidated, is precipitated by a fixed alkali, the first portion of the white precipitate, a little coloured, which is obtained, is a nitrate of mercury insoluble and neutral, formed by the union of the separated portion of oxide with the remainder of the solution which is not decomposed. What is new in this labour is, the comparison of the properties of the nitrite of mercury with those of the nitrate. Almost all solutions contain more or less of the former of these salts. It is prepared by making nitrous gas pass into nitric solutions, which greedily absorb it. Super-oxidated nitrate absorbs much more of it than the nitrate little oxidated. The latter, nitrite of mercury,

cury, disengages a great deal of rutilating vapour by the sulphuric and nitric acids. It tinges the skin of a dark purple colour: while nitrate very much oxidated dyes it black, and nitrate little oxidated, like the nitrite of the same nature, does not change the colour of animal matters. It retains longer in the open air its nature of nitrite than the alkaline nitrites, which speedily resume the nature of nitrates. Alkaline nitrites, and particularly deliquescent nitrites, may be prepared without difficulty by impregnating the solutions of nitrates, &c. with nitrous gas, which easily condenses in them.

The author, to terminate his labour, is to occupy himself with the muriates of mercury, of which he has discovered a new kind, and with the sulphurets of the same metal. It would be a pity that the important and numerous functions entrusted to him, should oblige him to discontinue these useful researches; but, happily for the interest of science, people seldom abandon a career which they have long pursued with success.

On Aluminous Sulphates.

S. Seguin, having been employed in continued researches on the different states of the sulphates of alumine, read on that subject a memoir, in which he proves That the acid sulphate of alumine pure, that is to say when free from those substances which it is necessary to add to it in order to make it crystallize, does not, in any case, decompose the muriate of soda—That alum, the cause of the crystallization of which is the sulphate of potash, does not experience decomposition from the muriate—That alum, the cause of the crystallization of which is the sulphate of ammonia, receives no alteration from the muriate of soda, when it contains only the quantity of sulphate of ammonia indispensably necessary for its crystallization—Finally, that alum, containing more sulphate of ammonia than the quantity necessary for its crystallization, is the only salt which experiences alteration by the muriate of soda; and that this alteration is confined merely to the decomposition of the sulphate of ammonia which it contains in excess.

A New Triple Salt.

There results from the decomposition above mentioned, on the one hand muriate of ammonia, and, on the other, a triple salt, composed of sulphuric acid, soda and ammonia, and which had not been before remarked.

A mixture either of the sulphate of ammonia and muriate of soda, or of sulphate of soda and sulphate of ammonia,

produces this triple salt in its full purity. In the first of these two cases, the affinity of the sulphate of ammonia for the sulphate of soda opposes the total and generally admitted decomposition of the sulphate of ammonia by the muriate of soda. This triple salt acts a distinguished part in the fabrication of sal ammoniac: it crystallizes regularly; does not effloresce in the air; has a flavour, at first pungent, then slightly bitter; is decomposed by soda, which transforms it wholly into sulphate of soda; decrepitates in the fire, swells up in it, and suffers to be disengaged, first ammonia, and then acid sulphate of ammonia, while pure sulphate of soda remains at the bottom of the vessel.

A New Polishing Rouge.

Chemistry, which can contribute in so effectual a manner to the improvement of the arts, does not lose this important direction, and, in this respect, descends to the minutest details. In consequence of a report presented to the Class, on a *rouge* for polishing, C. Guyton communicated some observations on ochry reds similar to those of Almagra in Spain, and which, in many cases, might be substituted for red oxide of iron or colcothar. He mentioned as a very economical process, and proper for giving the last polish to the hardest matters, the use of bits of old hat, which, as is well known, are dyed with iron. By immersing these pieces of hat for some minutes in sulphuric acid, the iron which they contain passes to the state of red oxide, and they then become excellent pieces for polishing, and may be used in the stead of the finest rouge.

Analysis of an Ore of Uranium.

C. Sage communicated to the Class the analysis he made of a sulphurous ore of uranium, of a blackish brown colour, without a regular form, and brought from Erbenstloch in Saxony.

This ore, which has some external relation to that generally known under the name of *pechblende*, is however different in its colour, which is brownish and dull, and in exhibiting some pyritous points. It contains iron, the presence of which was manifested by the magnet, after the torrifaction necessary to disengage the sulphur.

It results from the different trials to which this substance was subjected by C. Sage, that 100 parts of it contain 78 of uranium, 20 of iron, and 2 of sulphur.

Thinking, like all those who possess any elevation of mind, and a philosophical spirit in cultivating the sciences,
that

that it is more proper to consecrate the names of men who have enriched them by their discoveries, than those of the fabulous deities, and great men who resemble these deities in a great many points, C. Sage wished that the name of *uranium* given to this metal by the Germans, who call the planet discovered by Herschel *Uranus*, might be changed. In applauding these motives, it will perhaps be found that the names of celebrated men ought to be assigned to those things which have been the particular objects of their attention, and that Klaproth, who discovered this metal, has a greater right than any other to distinguish it by his name. The French seem constantly to agree in giving the name of Herschel to the planet which he brought from that obscurity under which it had been concealed for so many ages; and, by the effect of the same sentiment of justice, the names of Piazzi and Olbers will undoubtedly remain to those discovered by these astronomers.

Zoologists and botanists now consecrate to their masters and friends the genera or species which they discover; and mineralogists no doubt will soon follow their example. The name of *Scheele*, so justly celebrated, has already been substituted for that of *tungsten*.

ANATOMY.

Artificial Preparations in Wax.

The art of imitating anatomical preparations with wax, of little use when applied to objects easy to be obtained by dissection, and which may be daily procured, such as those of the most visible parts of the human body, becomes important when applied to the representation of things rare or difficult to be obtained, such as the different objects of comparative anatomy, or of things accidental and transient, as monstrosities and uncommon diseases. In the last place, it is almost indispensable to make known to pupils certain parts of such a complex nature, that the demonstrator cannot develop the whole in one dissection.

It is to this last class that we must refer the lymphatic vessels. The success of injecting them is so variable; the quicksilver employed for that purpose is so inconvenient, in consequence of the fluidity it retains; in a word, it is so rare that it can be made to penetrate to the last ramifications of these vessels, even in one limb, that it is only by repeating these operations for a long time, and on a great number of subjects, that it has been possible to become acquainted with the whole of this vascular system. Natural pieces, prepared

with the greatest care and success, soon alter, because the mercury abandons their upper parts to accumulate itself in the lower, the vessels of which it dilates and ruptures. Young anatomists then cannot, without the assistance of the arts of imitation, acquire elementary notions on this object. The case is the same in regard to preparations of the nervous system, though less difficult to be made from bodies, but which, by desiccation, are soon rendered indistinct, and almost useless.

It has long been found that anatomical preparations, executed in wax, are those which exhibit, in the clearest manner, the qualities of such objects, namely, all their dimensions and all their colours; while other imitations, such as common sculpture, engraving, and even painting, besides that they are not of a nature so delicate as those of wax, cannot express, at the same time, these two orders of qualities. Hence this method has been exclusively preferred to all others, and has been employed to form collections already celebrated. But several of them, while they give us reason to admire the hand of the artist, leave room sometimes for regretting that it was not directed by the anatomist familiarised with all the details of dissection.

The union of these two kinds of talents in the person of C. Laumonier, associate of the Institute, has given great merit to three pieces which he submitted to the inspection of the Class; namely, a lower extremity, in which he has represented the muscles, the superficial veins, the extremities of the arteries, and the lymphatic vessels; a head, exhibiting the cranium open, and the brain covered on the one side by the dura and pia mater, and uncovered on the other. The face and neck are prepared in such a manner, as to show chiefly the facial nerve, the eighth pair, and the cervical branches. Another head, open at the height of the orbits, presents a section of the posterior lobe of the brain, and a portion of the cerebellum, cut above its tentorium. It was prepared with a design to exhibit the origin of the great sympathetic nerve, and more particularly the cavernous ganglion, discovered by the author, and described with all its communicating branches in the *Journal de Physique*.

These pieces, executed by the order of government for the School of Medicine, form a continuation of others which have been deposited there for some years, and which are not inferior in point of merit.

MEDICINE.

Chemical and Medical Experiments on the Diabetes Mellitus.

Life, that physical, mechanical, and chemical process, so complex, exhibits in its aberrations, as in its perfect accomplishment, phenomena which are as much interesting to the philosopher as the physician. It is under this double point of view that C. Nicolas, associate member of the Institute, and professor of chemistry in the central school of Calvados, and Dr. Guédeville, have considered the *diabetes mellitus*, or the *ptysisuria saccharina*.

The presence of the saccharine matter, which, for a long time, was found only in the sugar cane (*Arundo saccharifera*, Linn.), has, by the labours of modern chemists, been discovered not only in many other vegetable substances, such as the mallow, the juice of the maple, beet-root, &c. but also in the mineral kingdom, where C. Vauquelin has proved its existence by his analysis of the emerald and aigue-marine. Some products of the analysis of milk had shown an analogy between it and sugar. Dr. Willis remarked, that, in the morbid affection in question, the first symptom of which is a superabundant evacuation of urine, this fluid assumed a sweet saccharine quality, instead of the acrid and pungent flavour which it has in general.

C. Nicolas and Dr. Guédeville, in the course of their practice, having met with patients attacked by diabetes, undertook a comparative analysis of the urine voided in the diabetic state and in that of health. They ascertained, by careful experiments, the existence of the mucous saccharine matter in the former: they extracted from it acetic acid and alcohol, while in the second it is not susceptible of fermentation, either vinous or acid.

The memoir of C. Nicolas and Dr. Guédeville, which may be considered as a complete treatise on the diabetes mellitus, contains a history of the causes ascribed to this disease, and the means employed to combat it since the days of Hippocrates to the present time; and an exact description of the symptoms it exhibits at its different stages; the principal results of their important labour on this disease, observations of which would be less rare were it not for the negligence of many physicians, who commit into the hands of quacks and *urine doctors* the unfortunate patients attacked by it.

The principal cause of the diabetes mellitus, which seems to be most frequent in countries where cyder, or liquors of that kind, is drunk, is a spasmodic and continual deviation

of the unanimalized nutritive juices to the urinary organ, which alters also the gastric, pancreatic, biliary, &c. juices. It seems to be peculiar to muscular temperaments. Its seat is placed in the system of digestion; and the urinary organ, by the excess of its evacuations, supplies the want of other excretions and secretions which are suspended.

The urine which passes, as already said, has the vinous and acetous fermentation, gives alcohol of a disagreeable odour, a crystallized sugar, the nature of which is not yet well known, instead of *uric*, uric and benzoic acid, which it ought to contain. Ammoniacal and phosphoric salts show themselves in it only in very small quantity; the blood of ptyphuric patients is exceedingly ferous, and contains scarcely any ammoniacal and phosphoric salts. These phenomena furnish the following indications:—

1st. To remove the spasmodic state.

2d. To restore to the nutritive juices the principles of animalization.

And, to accomplish these ends, to select the food and remedies from substances which contain azot and phosphoric salts..

From these indications C. Nicolas and Dr. Guedeville have prescribed to the subjects of their different observations, an animal regimen, composed of fat meat and milky beverages, in which phosphate of soda is dissolved. As medicines, they employed boles formed with an aqueous extract of opium and cinchona; sometimes also musk. This treatment was attended with complete success*.

GEOLOGY.

Observations made on the Summit of Mont-Perdu.

The beauty of sites exhibited by mountains, and in particular the hope of reading on those awful masses the history of the revolutions which they seem to have witnessed, or at least of their results, continually attract towards their summits those who have once experienced the charm of these meditations, which might be called antediluvian.

C. Ramond, whose particular study it has been to make us acquainted with the Pyrenees, and particularly Mont-Perdu, has confirmed by a new tour, that this mountain overlooks all the surrounding peaks.

* Those who have seen Dr. Rollo's and Mr. Cruickshank's valuable works on the Diabetes Mellitus, will be not a little surprised to find them not even quoted in the preceding notice, though they present every one of the facts that have been noticed in it as new! ——— EDIT.

The ridge of it consists of beds of black marble, filled with siliceous nodules, which here and there contain heaps of shells, the summit seems to have none of them, but they are found a little further down. These beds or banks, which are generally parallel, follow the principle direction of the chain, and are subject to flexions more or less considerable on each side of this direction. They are almost all vertical, their mean inclination being about 80° to the south.

The cap of snow which covers the peak is only about six feet in thickness, because the steepness of the lateral declivities does not admit of its accumulation; but, in parts where the ground is less steep, the thickness of the snow is 40 or 50 feet, and it is more considerable in the valleys, which catch the snow as it rolls down from the surrounding declivities.

The summit of Mont-Perdu presented to C. Ramond two plants of the phanerogamia kind, the *Aretia alpina*, Linn., and the *Saxifraga retusas*, Gorian. Lower down he found the *Cerastium alpinum*, the *Saxifraga grœnlandica*, and the *Ranunculus pamassifolius*. He is of opinion that it is not the height of the peak, but the want of earth proper for vegetation, that renders plants so rare on the summit. He saw scarcely any thing but a few remains blasted by lightning and buffeted by the winds; and if, amidst this destruction, occasioned by the combined action of the most powerful meteors, a rock still in its place offered vegetables a firm support, it was covered by turf and plants in such a state of vigour, as proves that it is neither the want of air, nor the lowness of temperature, that banishes them from these regions.

The revolutions which this part of the globe has experienced appeared evidently to C. Ramond, to have been occasioned by the rending of the primitive mass, the salient and re-entering angles of which are still so entire and so sharp, that he thinks if the cause which disjoined them should operate exactly in a contrary direction, they would unite in such a manner, that the joining would be imperceptible.

These characters, peculiar to the mass of Mont-Perdu, "make it, says Ramond, like an island of a few leagues in extent, raised by some revolution on the back of the Pyreneés."

GALVANIC SOCIETY, PARIS.

Dr. Nauche, president of the society, with the senators Aboville and Lelpinasse, has made a curious observation, which is of some importance on account of the inferences that may be deduced from it. He has found that it is possible to make a blind person, however great the degree of blindness, to perceive very lively and numerous flashes of light,

light, by bringing one extremity of the voltaic pile into communication with the hand or the foot, and the other with the face, the skin, of the head covered with hair, and even the neck. There exists a line of demarcation, beyond which no flashes take place.

Dr. Nauche has also confirmed with his fellow labourers, Tourlet, Legallois, Bonnet, Douffin-Dubreuil and Pajot-Laforêt;

1st. That reiterated applications of galvanism, when they comprehend the half of the trunk, produce in the person subjected to them great agitation, many reveries, involuntary tears, increased secretion of saliva, an acid or alkaline taste, a great secretion of urine, an increase of heat and transpiration, abundant sweat in the galvanized parts, great disturbance in the state of the pulse, which is accelerated, and often imperceptible at the moment of the commotions.

2d. That the action of the galvanic fluid may be increased by drawing it off by a sharp point, which does not appear to act at the moment of contact.

He has been able also to stimulate the organs separately, by directing to the nervous trunks, which distribute themselves to these organs, or which communicate with them, the two extremities of the pile, of the circle of cups or of the galvanic trough. He remarked that, by making the application a bath charged with a saline solution, a strong *galvanic bath* may be obtained, the effects of which are mild, and sometimes more advantageous than those obtained by other processes.

Paris, Dec. 17th.

In the last sitting of the Galvanic society, M. Robertson repeated experiments on the combustion of phosphorus and metals, by means of a very large pile composed of plates of copper and zinc. M. Gantherot announced that platina is a worse conductor of the galvanic fluid than iron. Medical applications were not neglected, and among the useful results the following were mentioned: The cure of a gutta serena, with which a domestic of M. Gillet-Laumont, member of the council of the mines, had been affected, by M. Nauche, the president: of a sciatica, on the coachman of the second, by M. Dudanjeon; and of a palsy in the right arm, by M. Pajot-Laforêt. The society appointed M. Laplace, Aboville, Lespinasse, Suc, Dubreuil, Paroisse and Judelot, to make experiments at the national establishment of the *Quinze-Vingts* on persons born blind.

THE BATAVIAN SOCIETY OF THE SCIENCES AT
ROTTERDAM.

On the 21st of August, the society proposed the following new prize questions.

1st. What are the phenomena observed in regard to the origin and progress of waves, in laying the foundations of piers, at greater or less distances? What means have from time to time been discovered, and tried with more or less advantage to restrain or to lessen the destructive consequences of the course of the waves? What can be deduced from these phenomena, for explaining the cause of waves; and what use can be made of this knowledge, to improve the means already adopted for subduing the waves, or to render them more powerful?—To be answered before the 1st of March, 1804.

2d. What is the reason that the experiments in regard to the conducting power of bodies for caloric, are so uncertain and often contradictory? and what is the surest and properest method to ascertain the quantity of this conducting power both in solid and fluid bodies?—To be answered before the 1st of March, 1803.

The prize for each question is a gold medal of the value of 30 ducats. The papers must be transmitted, post paid, under the usual conditions, to the director and first secretary of the society, Oliver Christian Eickma.

THE JABLOWSKY SOCIETY OF THE SCIENCES AT
LEIPSIK.

This society has proposed the following prize questions for the year 1803.

History.—An account of the connection which subsisted between the kingdom of Poland and the grand Duchy of Lithuania, before and after the union established by the assembly of the States at Lublin in 1569.

Natural Philosophy.—Historical account of the theory of attraction, and the application made of it from the time of Newton to that of Laplace.

Economy.—What foreign trees and shrubs, useful on account of their speedy growth, their duration, and their fitness for fire-wood; or applicable to the purposes of dyeing, tanning, or making furniture, can be cultivated and naturalized in the German pleasure-grounds?

The prize for each will be a gold medal of the value of 24 ducats; and the papers must be transmitted, under the usual conditions, to professor Wieland at Leipzig, before the end of February, 1803.

ELECTORAL ACADEMY OF MENTZ.

This society have published a new volume of their transactions, 1799-1802, large octavo, with plates. The contents are, 1st. Chemical examination of some fossils, by Tromsdorf. 2d, Experiments on a proper method of preparing cinnabar in the dry way, by Buchenholzen. 3d. A view of the principles of the Derivation Calculus of the two French analysts, Lagrange and Arbogart, with a comparison between it and the Differential Calculus. 4th and 5th. Homeyer's essay, which obtained the academical prize. 6th. Observation on some rare kinds of fern, with three plates by Wildenow. 7th. On the *Asplenium*, and some plants of the same family, by Bernhardt. 8th. Observations on stripping off the bark of fruit trees as the means of increasing their produce. 9th. On the action of common saltpetre and common salt on animal bodies, by Thilow. 10th. Examination of the origin of harmony, and its progressive formation, with three plates. 11th. *Stuffo*, no deity of the Thuringians, by Wolf. 12th. Eloge of M. A. H. Frank, by Bellerman.

ROYAL ACADEMY OF SCIENCES AT BERLIN.

The following papers have been read before the Society since the commencement of the present year:—

Jan. 7. A continued account of the new planets, by professor Bode. 14. On the noble pride of men of letters, by the director de Castillon. 21. A paper on the question, To what extent were the antients acquainted with the art of painting? by counsellor Hirt. 28. A public sitting. M. Merian read the eloge of Mr. Selle; M. Teller, the eloge of M. von Wöllner; professor Bode, a history of the discovery of the new planets; professor Klaproth, an examination of the last experiments on galvanism.

Feb. 4. A chemical examination of the calculi found in the stomachs of horses. 11. On the certainty of the mathematical sciences, by professor Burja. 18th. A continuation of moral and philosophical thoughts, by M. Ancillon. 25. On the means of promoting mental culture in the ci-devant Poland, by M. Gedike.

March 4. A succinct account of the manner in which the vaccine has been introduced, brought into repute, and propagated at Vienna, by Dr. De Carena; read by M. Walter, junior. 11. Observations on the developement of the functions which contain multiple sines and co-sines of arcs. 18. On the oldest evidences of geology and physiology, and particularly men; by M. Trembley. 25. On some words of number, and their etymology; by M. Bafide.

April

April 1. Some observations on the cow-pock; by Dr. Hufeland. 8. On some elementary theorems of philosophy; by M. Gruson. 29. On the influence of the will; by M. Klein.

May 6. On the genealogy of the house of Prussia, 4th period; by M. Verdy. 13. An examination of the question, What is manuring? by M. Hermbstadt. 20. Experiments towards ascertaining the nature of some vegetable alkalies; by M. Bernoulli. 17. On improving the regulations in regard to criminals; by M. Zollner. 24. On the art of dressing; by count de Guyon.

July 1. A second memoir on artificial meadows; by M. Basside. 8. Astronomical intelligence; by professor Bode. 15. Reflections and general principles in regard to manufactures and exclusive privileges; by M. de Castillon. 22. On synonyms, and the richness and elegance of languages; by the abbé Denina. 24. On the black gum of the elm-tree; by professor Klaproth.

Aug. 5. A public sitting. The eloge of M. de Carmer, and the eloge of M. de Moulines; by Dr. Merian. On the antiquity and riches of the German language; by the abbé Denina. On the organs of smell in man and in animals; by M. Walter, junior.

Sept. 16. Some remarks on the soul of man; by M. Prevost, of Geneva. Account of the new planet of Olbers; by professor Bode. 23. A fourth memoir on historical problems; by M. de Chambrier. 30. Geographical observations on the county of Hohenstein; by M. Gerhard.

XLIII. *Intelligence and Miscellaneous Articles.*

MEDICINE.

WE copy the following article from an Edinburgh paper; it is an extract of a letter signed Civis:

“While I was at Smyrna there was a girl afflicted with a cancer in her lips, and the gum was affected. The European physicians consulted on the measure to be taken, and agreed that they saw no other method than to cut it out; and the girl had already submitted herself to that decision. By an accident of that nature which men cannot account for, an old Armenian came to them just in time to prevent the application of the knife. “Do nothing,” said the Armenian, “I will cure her;” and when he had pledged himself strongly, the physicians consented. He procured a copper
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vessel newly tinned in the inside (an essential circumstance), and having poured a certain quantity of olive oil into it, he made it boil over a small fire, sufficient to keep it gently agitated; and so for three times in twenty-four hours. With this the oil resolved itself to the consistency of an ointment, and, by constantly rubbing the part affected, he cured her in fourteen days.—Nothing else was done.

The physicians supposed that the oil received its virtue from the tin, and that it was communicated by its long boiling over the fire."

ON THE WEAVIL IN SEA BREAD.

The fatal effects of the weavil in sea bread have long been severely felt by seamen employed on long voyages: rewards have been humanely offered by the legislature for a cure or preventative, but hitherto without success. The following fact was discovered by accident, and is now offered to the public as a hint worthy the attention of those who may be employed in supplying ships with provisions, or to captains and the owners of vessels, and may, in all probability, lessen, if not wholly remove, an inconvenience so injurious to our invaluable navigation:—A bag belonging to a powder-mill fell into a cauldron of liquid nitre; it was immediately taken out, plunged into cold water, and hung up to dry: several days after this circumstance the bag was filled with sea-biscuit and sent on board a West Indianman, where it was stowed away amongst the captain's stock. The vessel was nine months out of England before she proceeded on her passage home, when she got becalmed, and remained so long in that situation, that her crew were forced to be put on half allowance, more particularly so, as their bread was much destroyed by the weavils, and was hourly consuming. The captain at this time wishing to make use of the bag above mentioned, which had not been opened since the ship left England, ordered it to be examined, when, greatly to his surprise, the whole contents were found to be perfectly sound, without any appearance of having been injured by any insect whatever; a circumstance solely to be attributed to the quality of the bag.

ANTIQUITIES, &c.

A number of rare manuscripts and other valuable articles have been brought to this country by Mr. Cripps, of Suffex, and the Rev. Mr. Clarke, which we understand are principally intended to enrich the library of Jesus college, Cambridge. The whole collection made by these gentlemen, illustrating

illustrating the natural and moral history of the various people they visited, in a journey from the 69th degree of north latitude to the territories of Circassia and the shores of the Nile, fills 183 cases. The botanic part contains the herbarium of the celebrated Pallas, enriched by the contributions of Linnæus, and his numerous literary friends. With the minerals are several new substances, and the rarest productions of the Siberian mines. Among the antiquities are various inscriptions and bas-reliefs, relative to observations made in the plain of Troy, and which were announced by M. Chevalier, in France, in the last edition of his work. The medallion series contains several coins of Greece, and of the kings of Parthia, hitherto unknown. The manuscripts are in Hebrew, Coptic, Arabic, Abyssinian, Persian, Turkish, and the language of Thibet Tartary: and in the Greek and Latin languages are several manuscripts of the classics, of the gospels, and the writings of the earliest fathers of the church. In addition to these, the collection contains Greek vases, gems, sculptures, and many remarkable Egyptian monuments, from the ruins of the city of Sais, discovered by these travellers in the Delta after the evacuation of Egypt by the French: also numerous original drawings, maps, charts, plans, models, and seeds of many rare and useful plants; the habits, utensils, idols, of the inhabitants of the Aleutan isles, brought by Billings to Russia after his expedition to the countries lying between Kamtschatka and the north-west coast of America, with many geographical observations, the publication of which was so long withheld by order of the Russian government.

ON THE APPARENT ATTRACTION OF FLOATING BODIES. By a Friend to Physical Inquiries.

It is a well known fact, that when bodies which are afloat upon water come within a small distance of each other, they will suddenly rush together: this sudden approach has usually been attributed to a mutual attraction of the floating bodies; and it is common to float two cork balls in a vessel of water, for the purpose of demonstrating this supposed attraction. A few years ago the following experiments were made, with a strong persuasion that the abovementioned circumstance was not owing to the attraction of the cork balls; and if any one who is now of opinion that it is owing to a mutual attraction of the balls, will make the experiments themselves, it is probable that they will have doubts on the subject, or totally alter their opinion.

1. June 1797. Two cork balls (one larger than the other considerably) were floated on water: when brought near

each other, they approached in the usual manner, as if by some mutual influence. This was expected.

2. The larger ball was stuck on a piece of wire, and was holden near the smaller one, which was floating whilst this (the larger one) was entirely out of the water. There was, under these circumstances, not any apparent attraction whatever.

3. The larger ball on the wire was then totally immersed in the water, and, though near the other ball, there was not any apparent attraction.

4. The ball on the wire was then raised *partly* above the surface of the water near the floating ball; then the small ball approached, and the usual appearance of attraction took place.

The following is offered as an explanation of the above facts; and is supposed to be the chief, if not entire cause, of those effects:

Round each cork ball, when floating on water, may be seen an elevated circular mass of water, raised probably from the same cause (whatever that may be) by which water rises in bread, sugar, &c.: now it appears that when these two circular masses or rings of water touch each other they unite, and, by endeavouring to form one mass, carry the two cork balls with them until they touch.

London, Nov. 2, 1802.

GALVANISM.

On the 20th of November professor Aldini repeated, in two courses, at Mr. Wilson's anatomical theatre, Great Windmill-street, formerly that of the celebrated Dr. Hunter, the galvanic experiments which he performed before the French National Institute, and lately at Oxford. The first course, destined for the medical students, was opened by Mr. Wilson, who presented professor Aldini to his pupils, with some observations on his interesting discoveries. The second course, which commenced immediately after, was honoured by the presence of his excellency general Andreossi, ambassador of the French republic, accompanied by several gentlemen of his suite; M. Argyropoli, charge d'affaires of the Ottoman Porte, Sir William Hamilton, Dr. George Pearson, Dr. Lettsome, and a great many other gentlemen. Mr. Cuthbertson assisted the professor in arranging the apparatus, and Mr. Hutchins, a medical pupil, provided the anatomical preparations. The experiments were performed with neatness and precision, and gave much satisfaction to the spectators, who testified their approbation by loud and repeated applauses.

XLIV. *Analysis of the Schieferspath from Cornwall; to which is prefixed an Analysis of Carbonated Lime, and Remarks on the Means which have been employed to ascertain the Quantity of Carbonic Acid contained in it.* By Mr. RICHARD PHILLIPS, Member of the British Mineralogical Society*.

FROM some experiments made upon the schieferspath, I was induced to believe that it consisted of lime combined with a much greater quantity of carbonic acid than, according to the analysis of Bergman (Eng. edit. vol. i. p. 32.) is contained in carbonated lime. I refer to his analysis of this substance, supposing it to be the last, and perhaps the only one ever made of it, since it is quoted by Haüy, *Traité de Mineralogie*, tome ii. p. 128; and by Brochant, tome i. p. 548, as well as by other late writers on the subject. By the analysis of Bergman, pure carbonated lime consists of

Carbonic acid	-	34
Lime	-	55
Water	-	11

100

In order to ascertain the quantity of water, which, as above stated, is very considerable, the following experiments were made:

Exp. I. 100 grains of pure carbonated lime (double refracting spar) were exposed, in a silver crucible, to a red heat for about twenty minutes. On weighing them when cold they were found to have diminished 1·8 grain. It will hereafter be shown that a part of this loss was probably water: yet a portion of it is to be attributed to the disengagement of carbonic acid; for, upon putting the remaining carbonated lime into water coloured blue by syrup of violets, the solution instantly assumed a deep green colour. Hence it appears that this method is not to be relied upon in order to dissipate water only.

Exp. II. 400 grains of carbonated lime were introduced into a coated glass retort, having a receiver adapted to it. Soon after the application of heat, a very minute quantity of water appeared in the neck of the retort; but it was entirely dissipated before it had reached the mouth of it. Owing to this, and the extreme smallness of the quantity, it was entirely impossible to ascertain or even to estimate its weight. No more water appeared upon the application of a much stronger

* Communicated by the Author.

heat to the retort. This experiment was repeated with similar results.

Exp. III. To find the quantity of carbonic acid contained in carbonated lime, I made use of a vessel nearly similar to that described in *page 365 of the 12th volume of the Philosophical Magazine.

Into this vessel was put a sufficient quantity of nitric acid of the specific gravity 1.40, noting at the same time the aggregate weight of the vial, tube, and acid; and 100 grains of fragments of carbonated lime were gradually added to the nitric acid. When the last portions of it were decomposed, on weighing the vial, &c. it had received an addition of 56 grains. Hence 44 grains, which were carbonic acid, were expelled. On repeating this experiment with quantities of carbonated lime greater than 100 grains, proportional results were afforded.

Exp. IV. To determine the quantity of lime, 100 grains of carbonated lime reduced to powder were put into a platina crucible, and strongly heated in a wind-furnace for about two hours: the residuum was pure lime; it weighed 55.9 grains. Upon repeating this experiment I obtained a residuum weighing 55.05 grains. These results differ but little: their mean, 55.475, is therefore assumed as the quantity of lime contained in 100 parts of the carbonate.

According to the above experiments, carbonated lime contains

Carbonic acid	-	44
Lime	-	55.475
Water and loss		.525

—————
100.000

In comparing the above with the analysis by Bergman there appears a difference of 10 of carbonic acid and nearly 10.5 of water. Kirwan, (*Mineralogy*, vol. i. p. 87.) on remarking the difference of the quantities of carbonic acid obtained by himself and Bergman, supposes the latter employed sulphuric acid to disengage the carbonic: and this conjecture seems well founded; for, if carbonated lime be put into sulphuric acid, the sulphate of lime formed, and falling down insoluble, so envelops a part of the carbonated lime that the complete action of the sulphuric acid is prevented: and as it does not appear that Bergman obtained the water by direct experiment, he seems to have assumed its quantity

* The experiments there related upon the fatin spar were repeated; but it did not appear to contain more than the usual proportion of carbonic acid.

from the deficiency occasioned by the incomplete action of the sulphuric acid.

Still apprehending that results so dissimilar might arise from inaccuracy in the method I had employed, more minute attention was paid to the disengagement of the carbonic by the stronger acids. The following experiment was instituted to determine the quantity of muriatic acid carried over by the effervescence it excited. This acid was preferred to the nitric for two reasons: being very dilute, and its action consequently increased, the error is shown in its greatest degree; and small quantities of it are much more readily detected than of nitric acid.

Exp. V. 200 grains of fragments of carbonated lime were put into muriatic acid of specific gravity 1.17 in the vial already mentioned, having a Woulfe's apparatus so adapted that the carbonic acid disengaged might pass through water. After the effervescence had ceased, the vial containing the muriate of lime was heated in water for nearly an hour, in order to expel the carbonic acid, which, although disengaged from the lime, was held in solution by the water of the dilute muriatic acid. By these means the loss was .6 more than when nitric acid of 1.40 was used, occasioned by the more rapid effervescence.

To the water through which the carbonic acid had passed nitrate of silver was added, which occasioned the formation of such a quantity of muriate of silver as, from comparing the degree of turbidness, was nearly equalled by .6 of muriatic acid. The slight dissimilarity evidently resulted from the evaporation of the water of the muriate of lime by the heat employed to extricate the last portions of carbonic acid.

The stronger effervescence which a dilute acid excites, is not the only inconvenience attending it; the water is capable of combining with a quantity of carbonic acid, which renders it necessary to employ heat, as in the above-mentioned experiment, which is totally unnecessary when a concentrate acid is made use of.

Analysis of the Schieferspath.

Some fragments of schieferspath being put into muriatic acid, strong effervescence took place, and nearly the whole was soon dissolved: the solution was colourless; a very minute quantity of a finely divided white substance remained undissolved. The solution, divided into parts, exhibited with reagents the following appearances:

Prussiate of potash, a blue precipitate.

Tincture of galls, a dark brown precipitate.

Ammonia, a small quantity of reddish brown precipitate.

Oxalate of ammonia, a copious white precipitate.

Sulphuric acid and sulphate of soda both produced plentiful white precipitates; the latter not immediately: the solution, therefore, contained neither strontia nor barytes.

Carbonate of potash also occasioned a plentiful white precipitate: upon heating the solution after filtration no further deposition took place, as would have done had the solution contained magnesia.

The insoluble white residuum was boiled in sulphuric and nitric acids, but neither of them dissolved any part of it: potash dissolved it entirely: had it been alumina, its state of extreme division would have admitted of its easy solution in acids: it therefore appears to be silica. The same appearance took place with solution of the schieferspath from Germany.

From these preliminary experiments it appears that the schieferspath is a carbonated lime intermixed with oxide of iron and a very small quantity of silica; so small, indeed, that, had it not always appeared in every solution which was made of the foreign as well as the English, I should have been induced to suspect that its presence was rather accidental, than necessarily entering into the composition of the mineral.

Employing the method which has already been mentioned, 200 grains lost by solution in nitric acid of 1.40 specific gravity 86.8 grs. of carbonic acid, equal to 43.4 per cent. Now, according to the analysis just given of carbonated lime, 44 parts of carbonic acid are united to 55.475 of lime: hence 43.4 of carbonic acid must be combined with 54.718 of lime, forming together 98.118 of carbonated lime.

The nitric solution was considerably diluted with water, in order to effect more readily the subsidence of the silica; which being carefully collected, after repeated washing, and dried in a glass vessel by the heat of an Argand's lamp, weighed .1 of a grain, equal to .05 per cent.

The oxide of iron precipitated by ammonia was submitted to a red heat, and treated with carbonaceous matter so as to render it magnetic: on weighing, it was found equal to .8 per cent. 100 parts consist of

Carbonate of lime	-	98.118
Silica	-	.05
Oxide of iron	-	.8

		98.968
Loss	-	1.032

100.000

XLV. *Description of the Schieferspath.* By ARTHUR AIKIN, Esq. Member of the British Mineralogical Society.

SCHIEFERSPATH: Calcareus spathum schistofum: *Werner.* Argentine: *Kirwan.* Spath schisteux: *Brochant.*

Colour: very dilute yellowish white; by being kept for a few minutes in a red heat, it becomes slightly reddish white.

Lustre, internal; shining pearly.

Fracture: waved-lamellar.

Fragments: for the most part blunt-edged, wedge-shaped: it is translucent even when in mass, and at the edges is occasionally transparent. It is brittle; may be scratched by the nail, and has a slightly unctuous feel: specific gravity 2.740.

This mineral differs from common calcareous spar in its superior brilliancy; and especially in the total absence of the rhomboidal figure in its fragments. The specimen analysed*, and from which the above description was taken, differs from the general account of this mineral by Widenman, Emmerling, Brochant, &c. in being more transparent: it is probably from Polgorth tin-mine, and is covered in various parts with crystallized oxide of tin and chlorite: on breaking the specimen, a small quantity of fluor spar was found. It may be well to remark, that Cornwall, and probably the same mine, has produced a calcareous spar of the usual rhomboidal fracture and of a brilliant pearly lustre: it contains no silica, and appears to be lime combined with the usual quantity of carbonic acid and a little oxide of iron: specific gravity 2.723.

XLVI. *A short Account of Mr. SMITH's Air-pump Vapour-bath.* By Mr. HENRY JAMES.

To Mr. Tilloch.

PERMIT me, Sir, to lay before the readers of your Magazine such an account of a *Philosophical Apparatus* (not less useful than ingenious) as may in some measure correspond with the general intention of so valuable a publication.

The *Air-pump Vapour-bath*, after fifteen years almost constant attention, and at a very considerable expense, has at length been brought to such a degree of perfection as to be applicable, with good effects, in some of the most distressing complaints to which suffering humanity is liable. The application of this apparatus is now at length committed to the direction of medical men, so that, I trust, its good properties will not, as heretofore, be overlooked; or, what amounts to

* See the preceding article.

the same thing, will not, from want of professional discrimination, be suffered to sink into oblivion. With this part of the business, not being a medical man, I have nothing to do: leaving it, therefore, in better hands, I shall attempt, 1st, Some account of its origin; 2dly, What, *à priori*, might have been expected from it in a philosophical point of view; and, lastly, Such an explanation of its principles as, I hope, may prove that it has a fair claim to its daily increasing popularity.

1st. Mr. Smith, of Brighton, my father-in-law, from the story of king Edward, at the crusades, having had the poison of an arrow sucked from a wound by the mouth of his fair queen, long ago conceived the idea of this Apparatus. His first attempts at putting it in execution were rude, and almost laughable: but the great engine of his mind, on this as on other occasions, rose superior to all difficulties; and at length the accomplishment of his object rewarded his perseverance: for what will not perseverance achieve!

With every possible respect for the faculty, may we not here take the liberty to express our surprise that they should have left this extension of the powers of the cupping-glass to be discovered by an individual altogether unacquainted with the principles of their science? For the intelligent reader will presently be informed, that the Air-pump Vapour-bath acts upon the same principle as the cupping-glass; and, to use the inventor's own words, "is neither more nor less than a cupping-glass on a large scale." This description is accurate as far as it goes; but Mr. Smith did not at the time take into account, that by means of his apparatus, fomentation can be applied, and its temperature regulated, with a degree of certainty and accuracy which, I apprehend, were never attained, or so much as expected, before this happy discovery. For I think it requires little sagacity to observe, that in fomenting with flannels the temperature can never be for a minute equably preserved; but the limb must be exposed to various degrees of heat and cold during the application.

2dly, To those of your readers who have visited the tops of high mountains, it is unnecessary to describe the effects of the diminution of atmospheric pressure. M. de Saussure, who has published an interesting account of his journey up Mount Blanc, states it most forcibly. He found that the mercury in his barometer sunk to 16 inches and a line (17.145 inches English), and that the air had consequently little more than half the pressure of that on the plains. In such situations, the arteries on the surface of the body, deprived of their accus-

tomed pressure, do not, as usual, resist the impetus given to the blood by the contraction of the heart, which has been found to occasion difficulty of respiration, violent retching, and even vomiting of blood.

I need not tell you, that the pressure of the atmosphere in its mean state is equivalent to a weight of 15 pounds to every square inch. It has thence been computed, that the pressure of the circumambient fluid upon the surface of the whole earth is equivalent to the weight of a globe of lead 60 miles in diameter. If every square inch of the human body, therefore, sustains a pressure of 15 pounds, every square foot must sustain that of 2160 pounds; and according to this calculation, every ordinary sized man has to support a weight of between 15 and 16 tons for his common load. Such an enormous pressure, if not counterbalanced by the elasticity of the air within our bodies, would crush us in a moment. If a portion of this pressure be removed from any part of the body, as is the case, for instance, when a leg or arm is enclosed in the cylinder of this Apparatus, and the air partially extracted, the effect of this unequal pressure soon becomes perceptible to the patient. Should the exhaustion be carried to its utmost extent, it requires no stretch of imagination to conceive the effects that would be produced!

The quantity of atmospheric pressure on the human body sometimes varies near a whole ton, from natural causes. When it is diminished so much, many people, particularly the nervous, find themselves inactive and irritable. It is somewhat surprising that the spring of the internal fluid, mentioned above, as counterpoising atmospheric pressure, should exactly balance it when artificially augmented, and even when naturally diminished, but not when *artificially* diminished. Thus, though we perceive no evident distension of the blood-vessels on the surface of the body from the natural diminution of atmospheric pressure; yet the case is widely different when the diminution is artificially produced, as can be effected to any extent within the cylinder of this Apparatus. Thus animals in the receiver of an air-pump become immediately uneasy, and can live but a very short time in air artificially deprived of no more of its pressure, than by the barometer, appeared to take place on the top of Mount Blanc. I am aware that this phenomenon may be accounted for on other principles; namely, that a certain quantity of oxygen gas diffused through a given space, will not sustain animal life half so long as twice the quantity diffused through the same space. There may be something in this; but, I humbly think, it is not sufficient alone to account for

the immediate uneasiness and early death of the enclosed animal.

What proportion of these consequences is to be attributed to retarding the impetus of the blood returning to the heart, and consequently producing an earlier collapse of that organ, I leave to anatomists and physiologists to determine.

It was once the fashion among physicians to explain the functions of the human body by mechanical principles alone; to consider it as an hydraulic machine, and its fluids as ascending and descending by the ordinary powers of such engines. From having applied the laws of dead matter to the functions of the living body too extensively, they bewildered themselves, and contradicted each other. Nevertheless, in this age of perfected anatomy and improved physiology, we find Dr. Darwin, who is said to have done as much for the latter science as sir Isaac Newton did for natural philosophy, proposing "to still the action of the heart and arteries by mechanical means." This, he supposes, may be effected by suspending a bed so as to whirl the patient round, with his head nearest the centre of motion. For this purpose, a perpendicular shaft might have one end pass into the floor, and the other into a beam in the ceiling, with a horizontal arm, to which a small bed might be attached. The effects of whirling a patient in this situation, so as by the centrifugal force to propel the blood from the superior into the inferior parts of the body, would certainly be considerable, and, he observes, might probably add to the means of curing fevers.

Be this as it may, the relief which many persons have experienced from the use of the *Air-pump Vapour-bath*, authorizes me to affirm, that it is capable of producing, with ease and safety to the patient, all the good effects which Dr. Darwin could possibly expect from his centrifugal machine.

It would neither be compatible with my attainments, nor your plan, to describe the medical uses of the *Air-pump Vapour-bath*. I shall therefore barely mention, that it has been found extremely beneficial in a variety of diseases specified in a treatise lately published, intitled, "Facts and Observations respecting the Use of Smith's Air-pump Vapour-bath in Gout, Rheumatism, Palsy, &c. &c."

Lastly, it only remains that I offer you some explanation of the mechanical principles of the Apparatus, according to the references on the annexed plate.

Explanation of the Plate.

Fig. 1. (Plate VII.) a view of that end of the machine to which the exhauster, &c. are affixed. A, the body of the machine.

machine. B the boiler containing the fluid, the fumes of which are thrown into the cylinder, through the stop-cock H, and heated by means of a spirit lamp C, which ought always to be withdrawn immediately on turning the stop-cock G, hereafter mentioned. D a thermometer, showing the temperature of the fumigation. E the exhauster for producing a partial vacuum within the cylinder, after the fumigation has continued a proper time. F the escape-valve of the exhauster, to which a flexible pipe is adapted to convey the air from the chamber, if vitiated by the nature of the affection for which the application is made. G the stop-cock of the boiler. H another stop-cock to prevent the valves of the exhauster from being injured by the hot fumes, as they enter the machine during the fumigation.

Fig. 2. a perspective view of the machine from the other end, where the limb is admitted. I the body of the machine, made of strong copper tinned in the inside, ordinary tinned iron itself not being sufficient, in all cases, to resist the pressure of the atmosphere. K the mouth of the machine, to which is attached a strong bladder, cut so that one end of it may go over, and be firmly secured to it by means of a ligature; the other so that it may be drawn over the limb, when passed through it into the machine, and secured upon it by means of a roller.

The construction of the machine just described, is adapted to the leg or arm only. Its principle, however, may be extended, and one might be made to include a greater portion of the body. Such an attempt is making. One of the most obvious consequences of its application must be, a temporary expansion of the vessels of the part from whence so great a pressure is removed. This must powerfully assist nature in removing obstructions formed in them, which often speedily produce inflammation, and terminate in suppuration and abscesses.

Dr. Hamilton, of the London Dispensary, has observed, that the mode in which it must act is agreeable to sound theory, and that the more it is applied to practice, the oftener will facts occur to recommend it. That eminent physician "not only views it as valuable to remove local affections of the extremities, but also to afford relief in other parts of the body, where obstructions may have taken place." In the same letter he observes, that "the machine, by having a condensing pump fixed to it, may be used as a bracer, and that with beneficial and powerful effects." This may be done merely by reversing the valves in the pump.

These

These considerations, however, I shall leave to your medical readers, to whom I wish to submit this important query—*Is the application of the principle just alluded to, ever likely to be of use in relieving the ruptured?*

No. 5, Cumberland Place,
New Road, Marylebone,
January 8, 1803.

I am, Sir, yours, &c.

HENRY JAMES.

XLVII. *Memoir on the Supply and Application of the Blow-pipe.* By Mr. ROBERT HARE jun. Member of the *Chemical Society of Philadelphia.*

[Concluded from p. 245.]

THE hydrostatic blow-pipe may be filled with any of the gases, by exhausting them from the inverted jars of the pneumato-chemical apparatus: and if it be desired to confine different species of gas, by closing the cock of communication between the compartments, one of them may be filled with one kind of gas, and afterwards, by turning the hood, the other compartment may be filled with another kind. To make this understood, let *a*, fig. 5, be a pneumato-chemical tub, with a shelf *c*, and an inverted glass jar *b*. Suppose that the tub were filled with water, and the jar with gas. Lute the pipe *J*, fig. 1, to the mouth of the suction-pipe at *I*; pass the syphon *L* under the jar, as may be observed in fig. 5, and then extend the bellows. The bellows will become filled with the air of the jar; and this being discharged into that compartment of the cask which is over the open side of the hood, the bellows will be ready for another extension; the repetition of which would soon exhaust the jar of its air, although it should be of the largest size.

This method of filling the machine is very convenient in a laboratory well supplied with pneumato-chemical apparatus. But it is a principal convenience of the hydrostatic blow-pipe, that it may be filled with any gas, immediately from the retort, bottle, or matrafs, made use of in obtaining it. Let *D*, fig. 6, be a separate representation of the pipe *D*, fig. 1. Let *B* be a matrafs containing the substance from which the air is to be obtained, and let *C* be a syphon luted to the neck of the matrafs. The air issuing from the matrafs must be emitted from the mouth of the syphon at the lower end of the pipe *D*. Suppose that this pipe were in its proper situation at *D*, fig. 1, the air issuing from the matrafs would be discharged

discharged into that compartment of the cask under which the mouth of the syphon should be placed, and if the cock at Y should be closed, this compartment alone would become filled; but if this cock should be open, the air would divide itself equally between both compartments. It must be obvious, that while one matras and syphon are employed in filling one compartment with one species of air, the bellows, or another matras and syphon filled with different substances, may be employed in filling the other compartment with another species of air; and thus the oxygen, and hydrogen gases or oxygen gas, and atmospheric air, may at the same time be confined in the same vessel without their mixing with each other.

Those who desire to experiment largely with oxygen gas will find it advantageous to make use of a cast iron matras, with a short and large neck narrowing inwards, and about fifteen inches of a gun barrel. The neck of the matras being made large and short, it will not only be easily filled, but will be readily freed from any caput mortuum which may be left in it. The gun-barrel must be ground to fit the neck of the matras.

The syphon for conveying the gas into the cask may be fitted to the gun-barrel with a cork.

The philosophical world has been for some time acquainted with the intense heat produced by combustion supported with oxygen gas. By means of the hydrostatic blow-pipe, every artist may, with little trouble and expense, avail himself of the intense heat produced by this combustion*.

Probably there are not at present many operations in the arts which require greater heat than may be produced by the ordinary means; but it is certain that the knowledge of a process cannot precede an acquaintance with the heat necessary to effect it; and this most intense fire being placed within the reach of the artist, it is highly probable that cases may be discovered in which it may be applied with convenience and utility.

The most convenient way of making use of oxygen gas for small operations, is to supply one of the compartments of the hydrostatic blow-pipe with that gas; to retain the gas thus confined for those moments when the greatest heat is required; and, by means of the other compartment, to make

* In a former page I mentioned the gasometer of Lavoisier as being too complicated for ordinary application to the supply of oxygen gas. I should also have noticed the apparatus of Sadler and the palometer of Seguin; but, if I am not mistaken, these, although very ingenious inventions, are liable to the same objection.

use of atmospheric air when the heat produced by it is sufficiently intense. It must be obvious, if the conical mouths, O, o, of the pipes M, N, O, m, n, o, fig. 1, be furnished with straight mouth-pieces, that any lamp or candle placed on the stand TV may be readily shifted from one mouth-piece to the other, when it shall be desired to expose any subject successively to the heat produced by atmospheric air and oxygen gas.

If it be wished to make use of the heat produced in the combustion of charcoal with oxygen gas; after having confined a sufficient quantity of this gas, it will be necessary to fix in the conical mouth of the pipe, communicating with the compartment containing the gas, the larger end of a common brass blow-pipe, the orifice being directed downwards. Under this orifice the body to be acted on must be placed, supported by a piece of charcoal, in the form of a parallelopiped, the charcoal being ignited in the part contiguous to the body. Things being thus arranged, by turning more or less the cock of the pipe in which the blow-pipe shall be fixed, a stream of oxygen may be precipitated on the burning spot, with the proper degree of rapidity*.

This method of supporting the combustion of carbon with oxygen gas is nearly the same as that by which the celebrated Lavoisier performed his experiments; excepting that in the place of the hydrostatic blow-pipe he made use of his gascometer.

In the introduction to this paper it was mentioned that some experiments had been performed which seemed to invalidate the opinion that the employment of larger quantities of oxygen gas would be the only means of increasing the power of caloric. I shall proceed to give an account of these experiments, but will first retrace the ideas which led to them.

In operating with the combustion of carbon and oxygen gas, great evils were observed to result from the difficulty of placing the subject of the operation in the focus of the heat, without interrupting the stream of air by which this heat was supported. Not only was the focus widened by this interruption, and the intenseness of the heat thereby lessened; but the stream of air oxidated those substances which were combustible, and cooled those which were otherwise, in the places where it impinged previously to its union with the charcoal.

* In detailing the uses of the hydrostatic blow-pipe, it may be proper to mention the facility which it gives to the employment of the gases for medical purposes. When this machine is filled with any gas, the bag to be made use of in respiring it may be inflated by fixing it to the mouth of the pipe of delivery communicating with the gas.

Added to this, the charcoal was so rapidly consumed, that the substance acted on became so much buried, that it was difficult to follow it with the eye, or the orifice of the pipe: and some substances were observed to run into the pores of the coal, and elude examination.

To avoid these evils, it was thought desirable that means might be discovered of clothing the upper surface of any body which might be subjected to this species of operation with some burning matter, of which the heat might be equal to that of the incandescent carbon, with which the lower surface might be in contact; or by which bodies might be exposed on solid supports to a temperature equal or superior to that of the porous charcoal uniting with oxygen.

It soon occurred that these desiderata might be attained by means of flame supported by the hydrogen and oxygen gases; for it was conceived that, according to the admirable theory of the French chemists, more caloric ought to be extricated by this than by any other combustion.

By the union of the bases of the hydrogen and oxygen gases, not only is all the caloric of the oxygen gas evolved, but also a much larger quantity, which must be necessary to give the particles of the hydrogen their superior power of repulsion. The product of this combustion is water in the state of steam, which retains heat so slightly, that it acts merely as a vehicle to deliver it to other bodies. What is necessary to preserve to water its form of fluidity, is the only portion of the caloric extricated in this combustion, which is permanently abstracted.

The combustion of carbon with oxygen gas has been hitherto considered as the hottest of all fires. The caloric evolved in this case proceeds from the oxygen gas alone, while the product of this combustion is carbonic acid gas, which abstracts the large quantity of caloric, necessary to give it the form of permanent air, but which adds nothing to the heat of the combustion. Hence it is evident, that more caloric is evolved, and less abstracted, in combustion supported by the hydrogen and oxygen gases, than in that supported by oxygen gas and carbon.

However, the intenseness of the heat of combustion is not only dependent on the quantity of caloric extricated, but also on the comparative smallness of the time and space in which the extrication is accomplished. But in this respect the æriform combustible has obviously the advantage over those which are solid, as its fluid and elastic properties render it susceptible of being rapidly precipitated into the focus of combustion,

combustion, and of the most speedy mixture with the oxidating principle when arrived there.

The opinion of the intenseness of the heat produced by the hydrogen and oxygen gases thus upheld by theory, derives additional support from the practical observation of the great heat of a flame supported by hydrogen gas while issuing from a pipe; and also of the violent explosion which takes place when it is mixed with oxygen gas and ignited; for it appears that this explosion can only be attributed to the combination of an immense quantity of caloric with the water which is either held in solution by these gases, or formed by the union of their bases.

Such was the reasoning which originated the desire of employing the flame of the hydrogen and oxygen gases. But before this could be accomplished it was necessary to overcome the difficulty of igniting a mixture of these aëriform substances without the danger of an explosion. It was for the purpose of surmounting this difficulty that the hydrostatic blow-pipe was furnished with two compartments, by means of which the machine might be at the same time charged with different species of air, without any possibility of mixture. One of these compartments being supplied with oxygen and the other with hydrogen gas, two common brass blow-pipes *a, b*, fig. 8, were joined at their orifices to two tubular holes in the conical frustum of pure silver *c*, of which the mean diameter is one-third, and the length is three-fourths of an inch. The diameter of one of these holes is large enough for the admission of a common brass pin. The other hole is a third less. They commence separately on the upper surface of the silver frustum near the circumference, and converge so as to meet in a point at the distance of a line and a half from the lower surface. In the space between the lower surface and the point of meeting, there is a perforation of the same diameter as the larger hole. The manner in which this perforation and the tubular holes communicate one with the other, may be understood from the lines in the form of the letter *Y*, in the transparent representation of the silver conical frustum at *d*. The pipes *a b* were then fitted into the mouths *O, o*, of the pipes of delivery, fig. 1; so that the blow-pipe inserted into the larger hole of the frustum should communicate with the compartment containing the hydrogen gas, and that the other should communicate with that which contained the oxygen gas. The cock of the pipe communicating with the hydrogen gas was then turned until as much was emitted from the orifice of the cylinder

as when lighted formed a flame smaller in size than that of a candle. Under this flame was placed the body to be acted on, supported either by charcoal or by some more solid and incombustible substance. The cock retaining the oxygen gas was then turned, until the light and heat appeared to have attained the greatest intensity. When this took place, the eyes could scarcely sustain the one, nor could the most refractory substances resist the other.

However, it is worthy of notice that the light and heat of this combustion do not become evident until some body is exposed to it, from which the light may be reflected, or on which the effect of the heat may be visible. This is not the case with combustion supported by oxygen and carbon; for no sooner is a stream of oxygen gas directed on ignited carbon, than an effulgence is produced, which impresses the mind of the beholder with an idea of the greatest heat being produced by it.

It is in this different appearance of these different species of combustion that we may discover the reason why philosophers have neglected the one, while they have bestowed much attention on the other*.

In lieu of the conical frustum represented at c d, that at d e may be used. The tubular holes of this last-mentioned frustum do not meet, but deliver their air, at separate orifices, into an excavation in the lower part of the frustum. The dotted lines represent the tubular holes, and the arched line the excavation. This is about three lines in diameter, and enters into the silver about the same distance.

At f are represented pipes which are used for the fusion of platina, or subjects of the larger kind. They consist of a large and a small pipe, the orifice of the one being inserted into that of the other, as may be understood from the dotted lines near f.

The purity of gases contained in the hydrostatic blow-pipe may be at any time examined by charging eudiometers from the syphon and leathern pipes hanging to the cocks ZZ, fig. 1. These cocks are soldered to curved pipes, one of which is represented in the figure. By turning the cocks round, the

* The inferiority of the light emitted by the flame of the hydrogen and oxygen gases, to that which irradiates from bodies exposed to its action, adds one to the many instances in combustion in which the quantity and colour of the light extricated do not seem to be so much dependent on the quantity of oxygen gas consumed, as on the nature of the substances heated or burned. In this, therefore, we may find support for the idea, that the light extricated by fire, or emitted by heated bodies, proceeds not only from the decomposition of pure air, but from that of the combustible, or the heated bodies themselves.

mouths of the curved pipes may be brought down to the surface of the water; this gives a facility to the discovery of any heavier gas which may be mixed with one which is more light, as the fluid, whose specific gravity is greater, will be found on the surface of the water:

I shall now describe the changes effected on the most fixed and refractory substances by the flame of the hydrogen and oxygen gases.

In order to avoid a tedious recurrence to an awkward phrase, I shall generally, in the subsequent part of this paper, distinguish the flame of the hydrogen and oxygen gases by the appellation of *gaseous flame*.

By exposure to the gaseous flame, either on supports of silver or of carbon, barytes, alumine, and silex, were completely fused.

The products of the fusion of alumine and silex were substances very similar to each other, and much resembling white enamel.

The result of the fusion of barytes was a substance of an ash-coloured cast, which after long exposure sometimes exhibited brilliant yellow specks. If it be certain that barytes is an earth, these specks must have been discoloured particles of the silver support, or of the pipes from which the flame issued.

Lime and magnesia are extremely difficult to fuse, not only because they are the most refractory substances in nature, but from the difficulty of preventing them from being blown on one side by the flame: nevertheless, in some instances by exposure on carbon to the gaseous flame, small portions of these earths were converted into black vitreous masses. Possibly the black colour of these products of fusion may have been caused by iron contained in the coal; for in the high temperature of the gaseous flame, a powerful attraction is reciprocally exerted by iron and the earths.

Platina was fused, by exposure on carbon, to the combustion of hydrogen gas and atmospheric air. But the fusion of this metal was rapidly accomplished by the gaseous flame, either when exposed to it on carbon or upon metallic supports.

A small quantity of this metal in its native granular form, being strewed in a silver spoon, and passed under the gaseous flame, the track of the flame became marked by the conglutination of the metal; and, when the heat was for some time continued on a small space, a lump of fused platina became immediately formed.

About two penny-weights of the native grains of platina, when

when subjected to the gaseous flame on carbon, became quickly fused into an oblate spheroid as fluid as mercury. This spheroid, after being cooled, was exposed as before. It became fluid in less than the fourth of a minute.

Had I sufficient confidence in my own judgment, I should declare, that gold, silver, and platina, were thrown into a state of ebullition by exposure on carbon to the gaseous flame; for the pieces of charcoal on which they were exposed became washed or gilt with detached particles of metal in the parts adjoining the spots where the exposure took place. Some of the particles of the metal thus detached exhibited symptoms of oxidation.

As the fusion of lime and magnesia by exposure on carbon was accomplished with great difficulty and uncertainty, it became desirable that means might be discovered of effecting this fusion with greater ease.

By the union of the base of oxygen with iron, the whole of the caloric of this elastic fluid is supposed to be extricated. This consideration, together with some practical remarks on the heat of burning iron, induced me to employ the combustion of this metal in conjunction with that of the hydrogen and oxygen gases.

Some pieces of iron wire, each of about half an inch in length, were quickly thrown into fusion and rapid combustion by exposure on carbon to the gaseous flame. When either lime, magnesia, barytes, alumine, or silice, were thrown on the iron in this state, they became instantly melted and incorporated with the metal. It remains a question whether in this case the earths were fused or dissolved, and whether the substances which resulted from their union with the iron were mixtures or combinations. If they were combinations, according to the present nomenclature, they should be denominated *ferrurets*.

The difficulty of igniting some substances which are only susceptible of combustion at very high degrees of heat, has hitherto excluded them from the laboratory. By means of the gaseous flame, such substances may be employed with the greatest facility in small analytical operations.

Of the nature of the substances above described are the carburets of iron and some peculiar species of native coal.

Among the carburets of iron, the English plumbago is esteemed the best. Some pieces of this substance, obtained from the best English black-lead pencils, were readily thrown into combustion by exposure to the gaseous flame, either on carbon or on some larger pieces of American plumbago. It was found that either lime or magnesia was fusible when

exposed to the fire thus produced. This, however, may have been caused by the iron contained in the carburet; for the fused earths and plumbago generally adhered to each other.

There is a peculiar species of native coal found on the banks of the Lehigh in this state, which it is extremely difficult to ignite; but when exposed to a high degree of heat, and a copious blast of air, it burns, yielding an intense heat without either smoke or flame, and leaving little residue. By exposure to the gaseous flame on this coal, both magnesia and lime exhibited strong symptoms of fusion. The former assumed a glazed and somewhat globular appearance. The latter became converted into a brownish semivitreous mass.

The heat of the gaseous flame is very much dependent on the proportional quantities of the gases emitted. On this account, the perforations in the keys of the cocks N, n, fig. 1st, should be narrow and oblong, to admit of a more gradual increase or diminution in the quantity of gas emitted.

I have now concluded my communications on the subject of this paper, and shall be happy if they have been found worthy of the time and attention bestowed on them by the society.

XLVIII. *On the double Refraction of Rock Crystal, and another dioptric Property of that Mineral Substance.* By C. P. TORELLI DE NARCI, attached to the Council of Mines*.

DDOUBLE refraction, that singular property of rock crystal †, and of several other minerals, has long engaged the attention of mineralogists and philosophers, though they employed it in no other manner than as a distinguishing character. C. Haüy says ‡: “It would be difficult to find a more striking character than that deduced from double refraction, since it depends on the essence of the minerals in which it exists.”

C. Rochon is the first philosopher who employed this property of rock crystal to measure small angles; and he read on the 26th of January and 9th of April 1777, to the Academy of Sciences, two memoirs on the application he made of it, and the exact results he obtained. This discovery must be of the greatest utility, if means should be found to construct the instrument he invented at so moderate a price as to bring

* From the *Journal des Mines*, No. 66.

† Limpid hyalin quartz. Haüy *Traité de Mineralogie*, vol. ii. p. 427.

‡ Vol. i. of his *Traité*, p. 254.

it within the reach of those who might have occasion to measure angles with it.

A desire to accomplish this object induced me to undertake some researches in regard to the cutting of rock crystal, and experiments on its double refraction, founded on those made by Beccaria and Rochon. With rock crystal alone I formed *mediums doubly* refringent. This is the name which Rochon gives to these instruments cut cylindrically and composed of two or three prisms of this substance, which are perfectly achromatic, and produce very strong double refraction. I constructed one with three prisms, in which the angle of double refraction is one degree eight minutes: and I find that larger may still be obtained.

I shall not here indicate the direction in which I cut my different prisms of rock crystal in order to obtain the *maximum* of double refraction, because I have still some experiments to terminate before I can acquire a thorough knowledge of them. Among those which I cut for my experiments, there is one which produces effects so singular that I think it my duty to describe it.

This prism, the section of which is an isosceles triangle, has one of its angles obtuse, and of more than 100 degrees. When one looks through the two faces which form the obtuse angle, and in a direction parallel to the face opposite to it, the object appears neither displaced nor sensibly coloured, but only inverted in such a manner, that what is on the right appears on the left; and *vice versa*. If a capital L, for example, cut out and applied to the pane of a window, be looked at, the horizontal line of that letter, instead of being on the right below the vertical one, appears to be situated on the left. By continuing to look at this letter, if the prism be turned on itself, and in such a manner as if it were traversed by an axis parallel to the direction in which the letter is viewed, the image of the letter turns at the same time as the prism; but it moves twice as quick—so that, if the prism makes one turn, the image of the letter makes two. I made other very singular experiments with this prism; but as it would be too tedious to detail them here, I shall reserve them for a memoir, in which I shall explain the means I employed to ascertain the rules which must be followed to cut rock crystal in the direction that produces the *maximum* of its double refraction, and to be able to construct, without repeated trials, the instrument invented by Rochon, to measure, with very great precision, distances of every kind. I shall treat of its application to mines; and shall describe the

method I pursued to measure the deepest wells and the longest galleries.

I shall conclude this note with a succinct account of some experiments which I made with the isosceles prism of rock crystal already mentioned. By applying it to a simple *camera obscura*, the objects painted in an inverted position, when this prism is not used, are made to appear in their proper situation. By adapting it to astronomical telescopes, the same effect will be produced in regard to objects, which, when seen through the two convex glasses that compose it, appear inverted.

This prism supplies the means of shortening telescopes destined to view terrestrial objects, because, by employing it with a convex eye-glass only, and an object-glass simple or achromatic, instead of three, four, or five eye-glasses, objects which without its interposition would have appeared inverted, will be seen in their proper position. By these means, one, two, three, or even four eye-glasses would be saved, and the telescope might be shortened by nearly the whole length occupied by these eye-glasses. Light also will be gained; for this prism occasions no loss in this respect, the matter of which it is formed being exceedingly transparent; nor will any thing be lost in regard to distinctness; for, as the prism is very near the eye, the faults which might arise from any inexactness in the polishing of its two surfaces will not be sensible.

In employing this telescope it must be remembered, that at the same time that it inverts objects by turning them upside down, it turns them from right to left, and what appears on the right in the field of the telescope is really on the left: for example, if a man going from right to left be viewed with it, he will appear in the telescope as if going from left to right, but in his natural situation: whereas, if viewed with the same telescope, taking from it the prism of rock crystal and leaving only the eye-glass which inverts the objects, the man would appear not only to be proceeding in a direction contrary to that in which he really is advancing, but he would appear also inverted—the common effect of telescopes which have only a convex eye-glass.

Experience alone can show whether this method of shortening land telescopes can be as useful as it appears curious, and whether it will be possible to construct one at such a moderate price as to maintain a competition with common telescopes, without which this instrument would remain among the number of those discoveries which are rather curious than useful.

XLIX. *Preparation of the Phosphuret of Lime.* By
J. B. VAN MONS*.

PHOSPHURET of lime affords to the amateurs of amusing chemistry a curious compound, on account of the property it has of disengaging, when a few bits of it are thrown into water, a quantity of gaseous bubbles, which, on reaching the surface of that liquid, inflame spontaneously with a beautiful white flame, and give rise to successive detonations, which may be compared to a running fire of musketry. But the preparation of this phosphuret is often unattended with success on account of the air, which, by following the usual process, cannot be excluded from the vessels, and which oxidates and even acidifies the phosphorus; in which case, the combustible losing its action on the water, no detonating gas is engendered; and the correction, by which the inconvenience of oxidation is avoided, by putting the phosphorus at the bottom of the vessel, and the lime at the top, does not give a homogeneous product, but a saturated phosphuret, by the vaporization of the phosphuret, which brings it to a state improper for uniting itself with the lime. These different obstacles may be avoided by proceeding in the following manner:

Fill a small glass matras, with a flat bottom and a long narrow neck, two-thirds, with one part of carbonated lime (white marble, washed chalk, or prepared oyster-shells). Place the matras in a sand-bath, and apply a heat capable of expelling the carbonic acid from the lime. When you think that the decarbonization is near an end, introduce in portions a third part of phosphorus, at very small intervals, and constantly maintaining the matter at a dark red heat. The phosphorus fuses, and prevented from burning by a remainder of carbonic acid gas which is disengaged from the lime, diffuses itself throughout the whole mass of the matter, contracts an union with the lime, loses its volatility, and forms phosphuret. After the whole phosphorus is introduced, let the fire be suddenly slackened, and stop the matras with a stopper having a pneumatic valve to prevent access of the air, and to suffer to escape the gas which the matter that remains some time puffed up continues to disengage. When the matter is sufficiently cooled, take it from the matras, and put it, taking care not to touch it with the

* From *Journal de Chimie et de Physique*, par J. B. Van Mons, No. 7.

fingers or other moist bodies, into heated glass flasks which can be hermetically closed.

The phosphuret of lime, when well prepared, is a compact mass of a pale reddish brown colour inclining to chocolate. It inflames by the least humidity, and emits in the air an odour of garlic mixed with that of phosphorated hydrogen gas.

The same phosphuret may also be prepared directly from lime, by directing, by means of a gasometer with a column of water, through a hole formed in the belly of the matras, on the red matter, at the moment of adding the phosphorus, a delicate current of carbonic acid gas.

L. *Chemical Analysis of an uncommon Species of Zeolite.* By ROBERT KENNEDY, M.D. F. R. S. F. A. S., and Member of the Royal College of Physicians, Edinburgh*.

THE zeolite subjected to the following experiments possesses some of the distinguishing properties common to other stones of the same class, but differs in certain respects from any variety with which I am acquainted. I found it, more than three years ago, in the basaltic rock on which the castle of Edinburgh is built; and it was inclosed within a mass of prehnite.

The colour of this zeolite is in some parts nearly white, in others grayish white. It is composed entirely of straight fibres arranged in bundles or masses of different sizes, all the fibres of each mass converging towards a common point. The whole specimen is an aggregate of these masses, the bases of which are in contact with the prehnite, and are impressed with the form of its surface, which is rounded or botryoidal. The cross fracture presents the irregular and ragged ends of the broken fibres, termed the *hackly* fracture by Mr. Kirwan.

Although the shape and arrangement of the fibres appear plainly to be the effects of crystallization, yet I have not been able to trace a perfectly regular, determinate form in any of them. However, when the stone is broken, some of them can be readily separated longitudinally, in a pretty entire state, and seem in most instances to be four-sided and rectangular. Their length is from half an inch to two inches; but their thickness does not exceed 1-4th or 1-50th part of an inch. None of these fibres can be broken across, so as to

* From the Edinburgh Transactions, vol. v.

present an even surface; for they break irregularly, and become divided at the point of fracture into very minute spiculæ, which also assume a somewhat rectangular shape.

The small spiculæ or fibres are transparent and colourless, with a considerable degree of lustre; but the unbroken part of the stone possesses less lustre than the separate spiculæ, and much less transparency, from a want of compactness, and from the effect of many minute cracks.

Its hardness is not easily determined, on account of brittleness; but when a piece of it is rubbed against glass, though the fibres crumble down very quickly, yet the glass is slightly scratched at the same time. Small fragments of it can be broken with the fingers, or crushed by pressure, into very slender spiculæ, which are sharp, and apt to penetrate the hands when touched. Although the cohesion of its component parts be so weak, yet it bends, and yields in some measure before it breaks, and is not easily ground to powder in a mortar.

I found the specific gravity of different pieces of the specimen, taken in distilled water at the temperature of 60°, to vary from 2.643 to 2.740.

This stone has the property of appearing luminous in a dark place, both by friction and by heat. A very slight degree of friction produces this effect; for a person can easily distinguish a phosphoric light, even if he draws his finger across it. When struck with a hammer in such a manner that small fragments are driven off, they appear luminous in passing through the air, and continue to shine for a moment after falling on the ground; and a hard body drawn over it leaves a track of light, which remains a second or two visible. When a piece of the stone is pounded quickly in a mortar, a strong light is emitted; but after being wholly reduced to powder, it no longer shines.

The light which it gives by slight friction, is fully equal to that produced by two quartz pebbles rubbed or struck against each other strongly.

Small fragments of this zeolite placed on a piece of hot iron or of clay, also become luminous, and shine with nearly as much brightness as common blue fluor does, when heated in the same manner. By being made red-hot, however, it is deprived of the property of giving light afterwards by heat, though it still appears faintly luminous by friction. In all these experiments it is a reddish white light which it emits, accompanied at times with reddish momentary kind of flashes.

It can be melted without difficulty into glass. When a

small piece of it is heated gradually with the blow-pipe, it first becomes white and opaque; a number of fissures are then formed, by which its bulk appears somewhat increased; and after the flame is made sufficiently intense, it melts into a globe of colourless glass, the transparency of which is imperfect on account of many minute air-bubbles. Although thus fusible by strong heat, yet a very low degree of ignition scarcely affects it. A piece of the stone, after having been put into a crucible, and exposed for a short time to a fire which made it just visibly red-hot, was not altered in appearance, and had not lost more than $\frac{1}{20}$ th part of its weight. In a temperature, however, about 20° of Wedgwood, I found that a fragment of this zeolite became opaque, and more easy to pulverize than in its natural state; at 90° it did not melt, but was glazed on the surface, adhered to the crucible, and had begun to sink down; and at 120° melted into an imperfect glass of a light greenish yellow colour, deficient in transparency, which acted strongly on the crucible.

In temperatures sufficiently high, it loses from $4\frac{1}{2}$ to 5 per cent. of its weight; but to produce this effect, the heat must be equal at least to 20° or 25° of Wedgwood. Part of the volatile matter thus driven off, is carbonic acid; for the zeolite, when reduced to powder, and mixed with acids, produces a slight effervescence. I found, by three different experiments, that the loss of weight after the effervescence was about 3 per cent.; consequently, the remaining 2 or $2\frac{1}{2}$ parts may be presumed to consist of moisture.

This substance produces a jelly, as most other zeolites do, with the stronger acids. When ground to powder, and mixed with the sulphuric, nitric, or muriatic acid, the mixture becomes a firm jelly in a few minutes, provided the acids are not much diluted, or used in too great quantity. That which is formed by the action of the nitric or the muriatic acid, is nearly transparent; but the stone contains so much lime, as will presently be shown, that with the sulphuric the jelly is white and opaque, on account of the sulphate of lime which is generated.

The prehnite in which it was inclosed, as already mentioned, is of a light green colour, with some lustre, and a considerable degree of transparency. It gives fire with steel, can be readily melted with the blow-pipe, and froths up much before fusion.

Having made these preliminary experiments respecting the general properties of the zeolite, I subjected a portion of it, in the next place, to analysis, to ascertain of what earths it was composed,

composed, and found that it consisted almost wholly of silice and lime, with a certain proportion of soda. The following were the methods by which it was analysed :

1. One hundred grains, reduced to fine powder in a mortar of flint, were mixed with 500 grains of muriatic acid and 1000 grains of distilled water. The powder was immediately attacked by the acid; some heat and momentary effervescence were produced, and in a few minutes the silice appeared floating in a loose and very divided state. The mixture being heated on a sand-bath, became in a short time a thin transparent jelly. I exposed this jelly to a gentle heat (less than 200° of Fahrenheit) till it became nearly dry. Water was then poured on it, and the mixture, after being digested for some time, was filtered. The undissolved part collected on the filter, when sufficiently washed, was dried and heated red-hot for a quarter of an hour. It weighed 51½ grains, was perfectly white, and proved on examination to be pure silice, unmixed with any other earth.

2. The filtered solution, which was transparent and nearly colourless, after being saturated with caustic ammonia, deposited a small quantity of a brownish white precipitate. Having collected this precipitate on a filter, and washed it, I exposed it for a few minutes to a red heat. It then weighed one grain, and had become brown, and was found to consist of half a grain of oxide of iron, and half a grain of argil.

3. In the next place I added a few drops of sulphuric acid to the solution, to discover if it contained any barytes or strontian. The acid produced no precipitate. The solution was then evaporated to a small quantity, and boiled with carbonate of ammonia. Some carbonate of lime was thrown down, which, after being washed, and exposed for a few minutes to a very low red heat, weighed 57 grains. To drive off the carbonic acid, and ascertain the real quantity of lime which this precipitate contained, I put it into a small crucible of Cornish clay, which was inclosed within a Hessian crucible, and heated it for three hours. The fire was raised slowly at first, but was afterwards increased to 80° of Wedgwood. The lime adhered slightly, and weighed 31½ grains. By treating it with sulphuric acid I detected some slight traces of magnesia, the rest being wholly converted into sulphate of lime.

4. The different earths having been thus separated from the solution, it was evaporated to dryness for the purpose of obtaining the soda, which I had learned by previous experiments would be wholly taken up with the other soluble parts of the zeolite, when decomposed by acids. After the evaporation

poration a white salt remained, which was heated gradually in a crucible to volatilize the muriate of ammonia formed in the course of the analysis. When white vapours ceased to rise, the heat was increased to redness, and a salt was left which weighed 17 grains. On redissolving it in a small quantity of water, and boiling the solution with carbonate of ammonia, a minute portion of carbonate of lime was precipitated, which weighed one grain; equal to about half a grain of pure lime. I obtained the salt by a second evaporation; and after it had been exposed again to a very low red heat, it weighed 16 grains, and consisted wholly of muriate of soda.

According to Mr. Kirwan's experiments, 16 parts of muriate of soda in crystals contain 8.5 parts of soda; but the 16 parts above mentioned, by having been dried in a red heat, and consequently freed from water of crystallization, would contain somewhat more than 8.5 parts of soda. However, the proportion of soda in 100 parts of the zeolite may be stated at 8.5 parts, which, though probably rather less than the real quantity, must be very nearly correct.

Having finished the experiments just described, I analysed the zeolite a second time; and made use of nitric acid, for the purpose of ascertaining whether any muriatic acid entered into its composition. By the test of nitrate of silver, I found that some traces of the muriatic acid could be distinguished, although the quantity was very small. With regard to the proportion of the earths, the results of the second analysis corresponded almost exactly with the former.

I also exposed some of the zeolite to the action of the sulphuric acid in the following manner, with the view of obtaining the soda only, the earths being disregarded. One hundred grains*, reduced to fine powder in the flint mortar, were mixed with 250 grains of sulphuric acid, diluted with twice its weight of water. Some heat and very slight effervescence were produced, and the mixture soon became thick and gelatinous. It was then evaporated slowly to dryness in a sand-bath in a cup of Chinese porcelain; and the dry mass was pulverized and boiled for half an hour with water, and filtered. Having washed the undissolved residuum sufficiently, I boiled the filtered solution with carbonate of ammonia, which precipitated some earthy matter. After this had been separated by filtration, the solution was evaporated to dryness

* I made use of small quantities only of the zeolite in all these experiments; because, as the specimen appears to be the only one of the kind which has been found, I wished to preserve as much of it entire as possible.

by a gentle heat; and the saline mass left was put into a crucible, and heated slowly to redness. A white salt remained in the crucible, which weighed 19 grains. To free this salt from any remains of earthy salts which might be mixed with it, I dissolved it in a small quantity of water, added some carbonate of ammonia, and boiled the mixture for a few minutes, by which means a slight earthy precipitate was thrown down. This being separated as before, the salt was again collected by evaporation, and heated to redness. It now weighed $17\frac{1}{2}$ grains, and was found on examination to be pure sulphate of soda*.

By Mr. Kirwan's estimation, $17\frac{1}{2}$ parts of dry sulphate of soda contain nearly eight parts of alkali; consequently, from 100 parts of the zeolite there have been obtained by the process last described eight parts of soda. This result corresponds with the former, in which the alkali was collected in the state of muriate of soda, as nearly as can be expected in such experiments; and it must be remembered, that the proportions of the component parts of neutral salts are not ascertained with precision.

According to the different experiments now detailed, 100 parts of this zeolite contain,

Silex (No. 1.)	-	-	-	51.5
Lime (No. 3 and 4.)	-	-	-	32
Argil (No. 2.)	-	-	-	5
Oxide of iron (No. 2.)	-	-	-	5
Soda, about	-	-	-	8.5
Carbonic acid and other volatile matter				5
				98.

with some traces of magnesia and muriatic acid.

The stone which has now been described resembles some of the varieties of tremolite mentioned by Saussure †, in the property of giving a phosphoric light by friction. Its specific gravity also is somewhat greater than that of the ordinary kinds of zeolite, as stated by mineralogists. Excepting in these particulars, however, it has the principal characters of

* The experiments which showed that soda was the alkaline basis of this salt, have not been stated here; because I formerly gave a description of the methods used in examining the same salt, in the paper on whinstone and lava, published in part 1. vol. v. Edinb. Transac. To avoid unnecessary repetition, I beg leave to refer to that paper, both with regard to the manner in which I endeavoured to determine the purity of the saline matter, and also that of the silex and some other earths.

† Voyages dans les Alpes, 1923.

a zeolite; for example, in its internal composition, in having been found in a whin rock adhering to prehnite, and in producing a jelly with acids. Tremolites have a higher specific gravity than this stone, are more infusible, and are considerably different in their composition*. Besides, such kinds of tremolite as I have examined cannot be decomposed by acids even when boiling, and must be heated with potash or soda before their component parts can be separated; but the substance in question is completely decomposed by acids, like the greater number of zeolites, in a very few minutes, and without the assistance of heat. For these reasons it appears to me to be a zeolite.

LI. *Experiments respecting the Action of some lately discovered Metals and Earths on the Colouring Matter of Cochineal.*
By M. HERMSTAEDT †.

TO prepare the cochineal for these experiments, two ounces of Mexican cochineal of the first quality, being reduced to fine powder, were boiled in a tin basin with 74 ounces of distilled water. The liquor was then filtered and measured: it had lost two ounces by evaporation. It was then divided into portions of $2\frac{1}{2}$ ounces for each experiment.

A piece of kersyemere dipped in this tincture when taken out was of a lilac colour.

Exp. I. A saturated solution of very pure cobalt in nitric acid was dropped into a portion of the tincture of cochineal. The tincture became very clear, assumed a yellowish red colour, but remained diaphanous. After twelve hours there was deposited a precipitate of a sulphur-red colour; which, however, was in such small quantity that it was impossible to collect it.

Exp. II. Part of the solution of cobalt in nitric acid was diluted with water heated to ebullition in a glass vessel, and kept boiling for three minutes, with a piece of kersyemere 24 inches square. The kersyemere thus prepared being then immersed in the warm tincture of cochineal, immediately assumed a saturated bright red colour, leaving the tincture

* Kirwan's Mineralogy, vol. i. p. 278. *Traité de Mineralogie par Hally*, tome iii. p. 151 and 227.

† From Scheier's *Allgemeines Journal der Chemie*, January 1802.

colourless. The stuff, after it was washed and dried, retained a bright *mordoré* colour.

Exp. III. A neutral solution of cobalt in sulphuric acid was added to the tincture of cochineal. The tincture assumed a darker colour, and a violet precipitate was deposited. A piece of stuff impregnated with this solution of cobalt, and then dipped in tincture of cochineal, acquired a saturated violet colour.

Exp. IV. A neutral sulphuric solution of uranium gave with tincture of cochineal a precipitate almost black; but when a piece of stuff was dipped in the same solution, and then dyed with tincture of cochineal, it assumed a very agreeable grayish colour inclining to green.

Exp. V. A solution of cobalt in nitric acid, treated in the same manner, gave the same results; but with this difference, that the colour on the stuff was a little brighter.

Exp. VI. Fifteen grains of tungstic acid were put into a glass vessel, and six ounces of distilled water being poured over it, the whole was reduced by evaporation to four ounces. The solution assumed a turbid aspect, and a blueish white colour. A part of this solution being poured into tincture of cochineal, communicated to it a bright violet colour. A piece of kerseymere, being boiled for three minutes in this solution, was immersed in the warm tincture of cochineal: when taken out it was of a bright *ponceau* (poppy) colour.

Exp. VII. Fifteen grains of concrete molybdic acid were dissolved in water as above. It dissolved entirely, and the solution became clear and transparent. Being dropped into the tincture of cochineal, a dark violet precipitate was obtained. A piece of kerseymere boiled in the acid solution assumed a colour approaching to bright green, which, when the stuff was dried in the sun, passed to a gray inclining to bright blue. A piece of kerseymere impregnated with the same solution, being immersed in warm tincture of cochineal, assumed a very agreeable violet colour.

Exp. VIII. Arsenic acid, being mixed with the tincture of cochineal, the dark red colour of the latter was transformed into yellowish red, but without any deposit being formed. A piece of kerseymere was then boiled for three minutes in a very dilute solution of the same acid, and the stuff thus prepared was immersed in warm tincture of cochineal. The stuff immediately assumed a bright scarlet colour inclining strongly to yellow. Drying, and, in particular, pressing with a hot iron, made this colour lose a little of its brightness, and caused it to become darker.

Exp. IX. A solution of arseniate of soda slightly acidulated was applied as a mordant to another piece of kerseymere, and by immersion in tincture of cochineal a dark *mordoré* colour was obtained.

Exp. X. The same was repeated with alkaline arseniate of soda: an agreeable lilac was obtained.

Exp. XI. Common white arsenic dissolved in water, gave a lilac colour somewhat dark.

Though the author intended only to try the action of the metals lately discovered on the colouring matter of cochineal, results before obtained from lead induced him to subject this metal also to some new trials. He undertook at the same time to ascertain how far the use of nitrate of tin is indispensably necessary in dyeing common scarlet, by endeavouring to substitute for that salt muriate of the same metal. These researches gave rise to the following experiments:

Exp. XII. A solution of acetite of lead being poured into tincture of cochineal, a violet blue precipitate was formed. A piece of kerseymere prepared with acetite of lead was then immersed in the same tincture, and a very agreeable violet colour was obtained.

Exp. XIII. A solution of fine English tin in pure muriatic acid was exposed for four weeks in an open vessel to the action of the air. A piece of kerseymere being boiled in this solution, and then immersed in warm tincture of cochineal, it assumed a bright scarlet colour.

This result is the more remarkable, as it has hitherto been believed that it was impossible to dye scarlet without a solution of tin in aqua-regia; and indeed the red obtained by employing common muriate of tin inclines to violet. It appears, therefore, that the oxygen of the nitric acid brightens the colour. As the same state of oxidation may be communicated to muriate of tin by exposure to the air as by nitric acid, the expense occasioned by the use of this acid and that of sal-ammoniac may be spared by substituting muriatic acid, which is much cheaper.

Exp. XIV. A piece of kerseymere was boiled for three minutes in a neutral solution of muriate of barytes, and then immersed in tincture of cochineal. The stuff assumed a dark colour, which, after being washed and dried, changed to an agreeable violet.

Exp. XV. Nitrate of barytes employed as a mordant gave a ponceau red exceedingly agreeable.

Exp. XVI. Acetite of barytes tried for the same purpose, gave

gave a dark red ponceau; which, however, possessed great brightness.

Exp. XVII. A piece of kerseymere was dipped for three minutes in a solution of muriate of strontian, and then immersed in a bath of cochineal. It assumed a dark colour; which at first imitated that of scarlet, but which by drying passed to crimson.

Exp. XVIII. A neutral solution of nitrate of strontian produced a bright reddish brown.

Exp. XIX. Acetite of strontian produced a bright ponceau.

The results of these experiments prove, not only that the metals and earths subjected to trial possess a certain chemical affinity for the colouring matter of cochineal, and are capable of fixing it on stuffs, but that they possess also the property of producing with the same pigment very different shades. They prove besides, that the nature of the acid, which serves as a solvent to these substances, exercises a great influence on the shades produced.

The results obtained with the oxide of arsenic and the acid of that metal, are no less worthy of attention. The difference of the colours produced is particularly remarkable. The oxygen, no doubt, had the greatest share in this phenomenon, as this principle manifests, in a very evident manner, its great influence in the production of scarlet by the muriate of tin oxidated by the air.

LII. *On the Manner of Hunting and Sporting by the English in Bengal.* Communicated by Colonel G. IRONSIDE*.

FEW parties of pleasure can be more agreeable than those for hunting, formed by ladies and gentlemen in Bengal, particularly at some distance from the presidency of Fort William, where the country is pleasanter, and game of every kind in greater plenty. Any time between the beginning of November and end of February is taken for these excursions; during which season the climate is delightfully temperate, the air perfectly serene, and the sky often without a cloud.

To transport the tents and other requisites, for the accom-

* From the *Asiatic Annual Register* for 1801.

modation of the company, to some verdant spot, near to a grove and rivulet, previously selected, elephants and camels are borrowed; small country carts, oxen, and bearers hired, at no considerable expense, the price of all kinds of grain, and wages of course, being exceedingly reasonable. Nor does the commanding officer of the troops within the district often refuse a guard of sepoys to protect the company from the danger of wild beasts, (for such generally resort to the haunts of game,) or the depredations of still wilder banditti, now and then pervading the country.

The larger tents are pitched in a square or circle, while those for the guards and servants usually occupy the outer space. Every marquée for a lady is divided into two or three apartments, for her camp-bed, her closet, and her dressing-room; is carpeted or matted, and is covered with a spreading fly, for defence against rain, or exclusion of casual heat, the air ventilating powerfully between the vacuity (about two feet) of the tent and its canopy in unremitted undulation. The doors or curtains of the marquée, wattled with a sweet-scented grass, are, if the weather chance to become sultry, continually sprinkled with water from the outside; and a chintz wall, stained in handsomely-figured compartments, encompasses the whole.

For the supply of common food, if no village be very near, petty chandler shops enow are engaged by the family banyans (house stewards) to accompany them, glad to profit of such an opportunity of gain. Liquors and every species of European articles are provided by the party themselves.

Horses are employed for the conveyance of the gentlemen, and palanquins for the ladies, with their female attendants; and, where the roads will admit of it, close and open English carriages also.

Part of the morning sports of the men, commencing at dawn of day, consist in rousing and chasing the wild boar, the wolf, and antelope (or gazelle), the roebuck, the musk, the red and other deer, hares, foxes, and jackalls: besides the common red, the spotted and the small moose, there are ten or twelve sorts of hog or short-bristled deer. Boars are usually found amongst the uncultivated tracts, or the more regular plantations of sugar-canes, which give to their flesh the finest flavour imaginable. Wolves and jackalls are seen prowling and lurking, at break of day, about the skirts of towns and villages, or retiring from thence to their dens within woods; or within pits, hollows, or ravines, on the downs. Hares shelter in the same situations as in England.

The

The hog, roebuck, and musk deer, conceal themselves amongst the thickest heath and herbage, and the antelope and large deer rove on the plains. All these animals, however, resort not rarely to the jungles (or very high coarse and implicated grafs), with which the levels of Hindutan abound, either to graze, to browse, or in pursuit of prey.

A country of Asia abounding in such variety of game, is, of course, not destitute of wild beasts; the principal of which are the tiger, leopard, panther, tiger cats, bear, wolf, jackall, fox, hyæna, and rhinoceros. The leopards are of three or four kinds.

Or the gentlemen divert themselves with shooting the same animals; as also common partridge, rock partridge, hurriâl or green pigeons, quail, plover, wild cocks and hens, curlews; black, white, and gray peacocks; florikens, storks of several kinds and colours, together with water hens, Braminy geese, cranes, wild geese and ducks, teal, widgeons, snipes, and other aquatic fowl, in infinite abundance; many of them of extraordinary shape, of glowing variegated plumage, and of unknown species; whose numbers almost cover the water whilst they swim, and, when alarmed, and flushed from the lakes, like a cloud, absolutely obscure the light.

The foxes are small, slenderly limbed, delicately furred with a soft brown hair, and by no means rank in smell; feeding principally upon grain, vegetables, and fruit. They are exceedingly fleet and flexible, though not strong or persevering. When running, they wind in successive evolutions to escape their pursuers, and afford excellent sport. Their holes are usually excavated, not in woods, but on hillocks, upon a smooth green sward or lawn, where, in a morning or evening, they are seen playing and frisking about with their young. They feed generally amongst the corn, and are oftenest found within fields of mustard or linseed, when it has sprouted up high enough to conceal them.

A minor critic, on perusal of Æsop's or rather Pilpay's fables, ridiculed the idea of foxes feeding upon grapes; but, had he consulted any Asiatic natural history, he would have learnt that they subsist upon grain, pulse, and fruit, particularly grapes and pine-apples when within their range, much more than upon flesh or fowl. Or, had he turned to the Bible, he would have there found the following passage in confirmation of it:—"Take us the foxes, the little foxes, that spoil the vines, for our vines have tender grapes."—*Canticles*, c. ii. ver. 15.

Jackalls are rather larger than English foxes; but of a

Brown colour, clumsier shape, and not so pointed about the nose. In nature, they partake more of the wolf than of the dog or fox. Their real Asiatic name is shugaul, perverted by English seamen trading to the Levant (where they are in plenty on the coasts of Syria and Asia Minor) into jackalls.

Of the partridge there are several kinds, one with a white belly, and another something like grouse, only more motley feathered.

Plover too are various; and, when the weather becomes warm, ortolans traverse the heaths and commons in immense flocks.

There are no pheasants in the woods of Bengal or Bahar nearer than the confines of Assam, Chittagong, and the range of mountains separating Hindustan from Tibet and Napaul. But there, particularly about the Morung and in Betiah, they are large and beautiful, more especially the golden, the burnished, the spotted, and the azure, as well as the brown Argus pheasant.

As for peacocks, they are every where in multitudes, and of two or three species. One tract in Orissa is denominated More-bunje, or the Peacock District.

Cranes are of three sorts, and all of a cærulean gray: the very lofty one, with a crimson head, called *jarus*; the smallest, called *curcurrah*, (the *demoiselle* of Linnæus and Buffon,) uncommonly beautiful and elegant, whose snow-white tuft, behind its scarlet-glowing eyes, is the appropriate ornament for the turban of the emperor alone; and the middle-sized one with a black head, the common *grus*. They return to the northern mountains about the autumnal equinox, after cessation of the periodical rains, with their young, in myriads of flights, frequent as the wood pigeon in North America; and sometimes, when the wind is very violent, flocks of them mount to a vast height in the air, and there wind about in regular circles, seemingly with much delight, and venting all the time a harsh discordant scream, heard at a considerable distance.

In the wilds of Hindustan certainly originated the common domestic fowl, for there they are discovered in almost every forest. They are all bantams, but without feathers on their legs; the cocks are in colour all alike, what sportsmen call ginger red; they have a fine tufted cluster of white downy feathers upon their rumps, are wonderfully stately in their gait, and fight like furies. The hens are invariably brown. It is extremely pleasant, in travelling through the woods early in a morning, to hear them crowing, and to perceive the

hens and chickens skulking and scudding between the bushes. For food, they are neither so palatable nor tender as the tame fowl.

Florekins are amongst the *non descripta*, I believe, in ornithology. A drawing can alone exhibit an adequate representation of this fine bird; it harbours in natural pastures amongst the long grass, on the extremity of lakes, and the borders of swampy grounds, lying between marshy soils and the uplands. Hence its flesh seems to partake, in colour and relish, of the nature and flavour of both the wild duck and the pheasant; the colour of the flesh on the breast and wing being brown, but on the legs perfectly white, and the whole of the most delicate, juicy, and savoury flavour conceivable.

There are only three claws to its feet; the roots of the feathers of the female are of a fine pink colour.

When the cock rises up, some fine black velvet feathers, which commonly lie smooth upon his head, then stand up erect, and form a tuft upon his crown and his neck.

When set by dogs, it lies close, and scarcely ever rises till the fowler is so near as almost to tread upon it. The nest of it is made amongst the grass.

You read of them in descriptions of ancient knightly festivals of the Nevilles, Percys, Mortimers, Beauchamps, Montacutes, De Courceys, Mohuns, Courtenays, and Mowbrays, under the name, I believe, of *flanderkins*; but whether they were then native of England, I am uncertain.

The height of the cock florekin of Bengal, from the ground, when he stands, to the top of his back, is seventeen inches.

The height from the ground to the top of his head, when he holds it upright, is twenty-seven inches.

The length from the tip of his back to the end of his tail, is twenty-seven inches.

In no part of southern Asia did I ever hear of woodcocks; but amongst the breed of snipes there is one called the painted snipe, larger than ordinary, and which well compensates for want of the former.

Fishing, both with lines and diversity of nets, is the employment of other sets of the party; or the hawking of herons, cranes, storks, and hares, with the falcon; and of partridge and lesser birds, with the sparrow and small hawks.

Ladies now and then attend the early field: if it be to view the coursing or hawking, they mount upon small gentlest (for they are all gentle) female elephants, surmounted with arched-canopied and curtained seats; otherwise they ride on horseback; more frequently however in palanquins, under which, as well as under the elephants and horses, the birds, (particu-

cularly the white stork or paddy bird,) when pounced at by the hawks, and the little foxes, when hard pressed by the dogs, often fly for shelter and protection. In general, however, the ladies do not rise betimes, nor stir out till the hour of airing.

The weapons in use on these expeditions are, fowling-pieces, horse pistols, light lances or pikes, and heavy spears or javelins; and every person has, besides, a servant armed with a scymitar or sabre, and a rifle with a bayonet, carrying a two-ounce ball, in the event of meeting with tigers, hvænas, bears, or wild buffaloes. Some of the ladies (like Thalestris or Hypolita, quite in the Diana style,) carry light bows and quivers to amuse themselves with the lesser game.

The dogs are, pointers, spaniels, Persian and European greyhounds, and strong ferocious lurchers. Near Calcutta a few gentlemen keep English hounds; but their scent quickly fades, and they soon degenerate.

But the liveliest sport is exhibited when all the horsemen, elephants, servants, guard, and hired villagers, are assembled and arranged in one even row, with small white flags (as being seen furthest) hoisted pretty high at certain distances, in order to prevent one part of the rank from advancing before the rest. Proceeding in this manner, in a regular and progressive course, this line sweeps the surface like a net, and impels before it all the game within its compass and extent. When the jungle and coppice chance to open upon a plain, it is a most exhilarating sight to behold the quantity and variety of animals issuing at once from their coverts: some are driven out reluctantly, others force their way back into the brake. During this scene of development, rout, and dispersion, prodigious havoc is made by the fowlers, falconers, and huntsmen, whilst the country people and children, with sticks and staves, either catch or demolish the fawns, leverets, wild pigs, and other young animals, which have returned into the coppice.

Instances occasionally occur, where the natives of the vicinage petition the gentlemen to destroy a tiger that has infested the district, to the annoyance and devastation of their flocks and shepherds, and perpetual alarm of the poor cottagers themselves. Although an arduous and perilous adventure, and what the gentlemen all profess, in their cooler moments, to reprobate and decline, yet, when in the field, they generally comply with the solicitation, and undertake the exploit. Their instant animation, not unattended with emotions of benevolence and compassion, presently supersedes every dictate of prudence, and, spite of their predetermination, they proceed

proceed to the assault, the villagers all the while standing aloof. If conducted deliberately, with circumspection, and with the aid of the sepoy, they soon accomplish their purpose, and bring in the most dreadful and formidable of all tremendous beasts, amidst the homage and acclamations of the peasantry. But should they lose their presence of mind, prolong or precipitate the conflict, act with incaution, or attack the exasperated infuriated savage with tumult and confusion, the event is often fatal, by his seizing, lacerating, and crushing, every creature within his reach; nor ceasing to rend, tear, claw, and destroy, to the very moment of his destruction, or of his flight.

Sometimes do the natives entreat the gentlemen to rid them of wild buffaloes, (the largest of all known animals, the elephant excepted,) that have laid waste their cultivation; and at others, to clear their vast tanks, or small neighbouring lakes, of alligators, which devour their fish, or do mischief on shore. So much hazard is not incurred, however, by achievements of this sort, as from the encounter of a tiger; for though the hides of those creatures resist a ball from a firelock at common musket distance, they are by no means impenetrable to shot from a rifle, or other pieces with a chamber, or of a wider calibre.

A drum, with a banner displayed from the hall-tent, gives signals to the company for their meals.

Breakfast is a most delightful repast: the sportsmen return keen, fresh, ruddy, and voracious: and the appearance of the ladies in simple loose attire, the elegant dithabille of clearest muslin with plain floating ribbons, and dishevelled tresses, captivate to fascination. Nor is the palate less gratified: English, French, Italian, and Dutch viands, all combine to provoke it, by a profusion of cold victuals, salted and dried meats and fish, hams, tongues, sausages, hung-beef, fallads, chocolate, coffee, tea, fresh milk, preserves, fruit, and eggs, rendered still more grateful by the most sprightly cheerfulness and Auroral gaiety.

After breakfast, conveyances of different sorts are prepared for an airing, not merely for the sake of airing only, but to view some natural or artificial curiosity or manufacture; some noted town, distinguished mosque, celebrated pagoda, renowned dirgah, or venerable mausoleum; some consecrated grove, the sequestered residence of fakerees, or some extensive prospect from the summit of rugged cliffs, impending over an expanse of water, bordering perhaps a level lawn, whose verdure is vaulted only, not concealed, by a disguised assemblage of stately columniated palms of four different species,

tufted and foliaged only, in graceful inclinations at their capitals, all equally ornamental, the date, the cocoa-nut, the beetel, and the palmyra.

Between the airing and an early dinner, the hours are irregularly disposed, as chance may dictate, or caprice suggest. Some play at cricket and quoits, swim, jump, fence, run a match of horses, or shoot at a mark; whilst others direct the mountaineers and woodmen (who rove about in bands for this express purpose) where to inveigle, entangle, or kill beasts, birds, fish, and snakes, for which they are furnished with variety of implements, such as matchlocks, tiger-bows, spears, darts in grooves, balls in tubes, pellet-bows, lined rods, stakes, and bushes; fascinating allurements, such as painted, spotted, and foliaged screens, bells, nets, and torches, bundles of twigs, rushes, and reeds, artificial ducks and decoy birds, with traps, gins, springs, snares, and other stratagems and inventions of wonderful enchantment, ingenuity, mechanism, and contrivance.

It is somewhat extraordinary, but nevertheless a fact, the influence of fascination possessed by the tiger, and all of his, (the feline) species, over many other creatures. Spied by deer particularly, they stop at once, as if struck by a spell, while the tiger lies still, his eyes fixed on them, and quietly awaiting their approach, which they seldom fail to make gradually within his spring; for the large royal tiger cannot run speedily or far. The glow of their eyes is fierce and powerful. I myself once passed a royal tiger in the night near a wood, and could plainly perceive the scintillations from his eyes. He was deterred from approaching us by the light of flambeaux, and the noise of a small drum which we carried, and was beat by a servant for the purpose of scaring him away.

Wherever tigers roam or couch, a number of birds continually collect or hover about them, screaming and crying as if to create an alarm. But the peacock seems to be particularly allured by him; for the instant a flock of pea-fowl perceive him, they advance towards him directly, and begin strutting round him with wings fluttering, quivering feathers, and bristling and expanded tails. Of this enticement the fowlers also make their advantage; for, by painting a brown cloth screen, about six feet square, with black spots or streaks, and advancing under its cover fronting the sun, the birds either approach towards them, or suffer them to steal near enough to be sure of their mark, by a hole left in the canvas for them to fire through.

Several other instances of the fascination of animals I have myself been witness to in Bengal. Three or four times, where
a line

a line of troops were marching in a long uninterrupted series, passed a herd of deer; I observed that when their attention was taken off from grazing, by the humming murmuring noise proceeding from the troops in passing, they at first and for a while stood staring and aghast, as if attracted by the successive progression of the files, all clothed in red. At length, however, the leading stag, "*vir gregis ipse*," striking the ground, snorted, and immediately rushed forward across the ranks, followed by the whole collection, to the utter dismay and confusion of the soldiery: thus running into the very danger one naturally supposes they must have at first been anxious to avoid. The men, who were apprised by the sound of their approach, stopped, and made way for them. Over the heads of the others, who were heedless and inattentive, they bounded with wonderful agility, and fled over the plain.

Driving one evening along the road in a phaëton, and pretty fast, I perceived a young heifer running near the carriage, with her eyes intently fixed upon one of the hind wheels; by the whirling of which the animal seemed completely struck and affected. Thus pursuing her object for about a quarter of a mile, she, by a sudden impulse, rapidly darted forward towards the wheel, which then striking her nose, the attention of the creature became interrupted by the violence of the friction, and was, of course, withdrawn: she then immediately stood stock still, and presently after turned about slowly and made off.

Beyond all other animals, however, serpents possess most eminently this occult power: frequently are they seen revolved on the branches of trees, or on the ground, meditating their prey, either birds, squirrels, rats, mice, bats, frogs, hares, or other animals.

The ladies, as they are inclined, either read, walk, swing, exercise themselves in archery, or at shuttlecock in the groves; or they sing and play in their tents. Others, whilst at work, are read to by their companions; of all amusements, perhaps, the most delectable.

At the end of a convivial dinner, every soul, provided the weather prove sultry, or they find themselves fatigued, retires to repose.

On rising from this fæta, (of all listless indulgences the most soothing, comfortable, and refreshing, and certainly most wholesome, all animals inclining to sleep after nourishment,) carriages are again in readiness, or light boats where a stream or lake is near, to give the company the evening's respiration,

(which the inhabitants of colder regions taste only in poetical description,) breathing health as well as recreation.

The twilight being short under the tropics, the day, of course, shuts in presently after sun-set, when cards and dice become part of the evening's entertainment. Chess, back-gammon, whist, picquet, tredrille, quinze, and loo, are the favourite games. These, with domestic sports, antics, gambols, tricks, pranks, and frolics, where the humour prevails; together with the flights of jugglers, feats of tumblers, (in which performances the Hindus are expert adepts,) and dances of the natives, wile away the time, and beguile it not unpleasantly to the hour of supper, the principal meal; when a repast, enlivened by every elevation of spirit and kindly disposition that can conduce to promote good humour and festive hilarity, terminates the day.

These parties generally continue, with some variation in the amusements, fifteen or twenty days; and the dissolution of them is as generally lamented, with heart-felt regret, by the individuals who compose them.

LIII. *Observations upon the Monsoons, as far as they regard the Commerce and Navigation of the Port of Bombay* *.

OUR readers will not require to be told that our year is divided into two grand seasons, or, as they are called, the south-west and north-east monsoon; that the first generally prevails from May to the middle of September inclusive, the other during the remaining months; yet we must premise this as an introduction of what follows.

We need scarcely to observe, that during the south-west monsoon all the ports and roadsteads on this side of India deny approach; so much so, that between the 15th of May and the 1st of September ships are precluded by their policies from touching upon the Malabar coast, or from lying in Surat roads between the 1st of May and the 1st of September. Generally speaking, the monsoon is considered to extend from Dunder-head, the southern extremity of Ceylon, to the Persian Gulf; in order to attain which, they who should sail at this season would be obliged to make what is called a southern passage, that is, go first to the south of the equator before they could stretch over to the westward; a voyage that would occupy, for Muscat about forty days, and

* From the *Asiatic Annual Register* for 1802.

to Bufforah about two months. The same objection exists against sailing at this season to any part of the Arabian coast. As for the Red Sea, it is considered in vain to attempt entering it at this season; nor can it be said to be favourable to sail now to the Cape, the Mauritius, or any port to the westward.

To the other side of India, on the contrary, it is now the most advantageous period of departing. From the middle of April, even to the middle of August, a voyage to Madras may be made in about 12 or 15 days; to Bengal from 15 to 20 days: after this time it becomes excessively tedious, from the necessity of keeping to the eastern side of the bay, to avoid the violent weather on the Coromandel coast. For the same reason the south-west monsoon is eligible to leave Bombay for any of the ports in the Gulf of Bengal or the Streights of Malacca; hence also it is the season for sailing to China: after the 20th of August, however, what is called the direct passage to China becomes very precarious, with much probability of finding blowing weather in the Chinese seas.

With regard to the ports from which ships may be expected to arrive at Bombay during this monsoon, it may be laid down as a general rule, that the quarters favourable to sail to during any season, are those that it is unfavourable to expect arrivals from, and *vice versa*: hence from the Persian Gulf, the Red Sea, the Cape of Good Hope, and the westward in general, this is the most seasonable period to expect arrivals: from Muscat a trip may now be made in 10 or 12 days, from Mocha in 20 days, and Suez in about a month. It should be remarked, that after September the Red Sea admits of no egress; ships consequently remaining there beyond that time, must continue there all the north-east monsoon, and are said to have lost their passage: on this account, the 25th of August is the latest day to which our cruisers are allowed to remain at Suez. From the Cape a passage may be made in five or six weeks; from the Mauritius, in three weeks or a month.

The south-west monsoon is also the most favourable season in which a passage may be made from Batavia or any ports to the eastward through these southern streights: from Batavia to Bombay, in particular, a passage may be made in about 35 days. From Madras and Bengal, during the south-west monsoon, it is necessary to make the southern passage in order to reach Bombay: this will require, in a passage from Madras, from 30 to 40 days, and from Bengal from 45 to 60 days, from the necessity of working out of the river, and beating down the bay to clear Acheen Head. From the

Streights

Streights of Malacca it is an arduous task to sail for this port, or even to any one on the peninsula of India, owing to the difficulty of working round Acheen Head.

We have now to treat of the north-east monsoon, or the season which may be considered as included between the 15th of August and the 15th of April; in which the first circumstance that occurs to us to remark is, that our coast is rendered in a peculiar manner secure and favourable to navigation; it is now considered the most eligible period for sailing to the Persian Gulf, and in general to all ports to the westward. To Muscat the trip is generally 15, and to Bufforah 28 days. The time suitable for sailing to Mocha and Suez is from the middle of February to the middle of March, when a passage may be made to the first in 18 days, to the second in 25. If a ship be delayed till the latter end of March or the beginning of April, the passage becomes more tedious, being then obliged to make the land to the southward of the island of Socatra before the gulf can be entered, on account of the southerly winds which prevail, and a current setting to the northward. After the 15th of April, a ship bound to the Red Sea would be very likely to lose her passage.

Between the 15th of August and the 15th of September it may be considered favourable to sail to Madras and Bengal; but after this time the season is suspended, owing to the setting in of the north-east monsoon on the other side of India, which closes the ports on the coast of Coromandel, Golconda, and Orissa, between the 15th of October and the 15th of December; at least this period is excepted in common policies of insurance. After this time, again, a passage may be made to Madras in 30, and Bengal in 50 days. This season may be deemed unfavourable to the coast of Pegue and the Streights of Malacca; but for the Streights of Sunda, Batavia for example, it is the best adapted—a passage thither may be made in 35 days.

With regard to the seasonable imports in this monsoon, it is at no time more advantageous than now for coming from the Coromandel coast, and, in short, the whole bay: a passage may be made from Madras in 20 days, from Bengal in a month, and Penang a month. From the Persian Gulf it is no less favourable, the passage from Muscat being about ten days; and from Bufforah 28. The Red Sea is now closed; nor is it reasonable to expect arrivals from the Cape or the Streights of Sunda; from the latter, in particular, it is almost impossible at this season to make a tolerable passage.

LIV. *Method of obtaining inodorous Benzoic Acid.* By
M. F. GIESE*.

THE benzoic acid, such as we obtain it in the dry or humid way, always retains a peculiar strong agreeable odour, which has hitherto been considered as a particular character of this acid. The numerous experiments I have made on this acid show that chemists in this respect have been in an error, and that the benzoic acid may be deprived of all its odour without injuring its principles or altering its nature.

I was led to this observation by remarking, that the same acid extracted from the urine of graminivorous animals, when deprived of all urinous odour, is perfectly inodorous. This circumstance induced me to believe that the odour of the benzoic acid might be foreign to it; and to ascertain this fact I made the following experiments:

I united odorous benzoic acid to a solution of potash, and then precipitated by muriatic acid. On each repetition of the experiment the odour was sensibly diminished, and after the third it had totally disappeared.

As the acid retained all its characters, this seems to prove that in these operations it had experienced no particular modification †. This result was previously indicated by its acquiring, in the progress of the experiment, the odour of benzoic acid obtained in the humid way, which is much weaker than that of the same acid obtained by sublimation.

I afterwards invented another method, more direct and less troublesome, for depriving this acid of its odour. It is founded on the greater solubility of the benzoic acid in spirit of wine than in water; and on the solubility of the benzoic oil, which is the principle of its odour, in diluted spirit of wine. This method is as follows:

Dissolve benzoic acid in as small a quantity as possible of spirit of wine: filter the solution, and drop water into it until no more precipitate is formed, or until the precipitate formed begins to be redissolved. Separate the liquor by filtration, and dry the acid, which remains on the filter, at a gentle heat.

* From Scherer's *Allgemeines Journal der Chemie*, February and March 1802.

† I can certify that a specimen of this acid, shown to me by the author, was absolutely free from odour. I requested M. Giese to subject the inodorous acid to sublimation, in order to ascertain whether a decomposition experienced by the heat was not the cause of its odour. He complied with my request; but he observed no alteration in the acid, nor had it resumed its odour.—SCHERER.

I shall here add, that having saturated the benzoic acid with lime, and decomposed the benzoate thence resulting by the muriatic acid, I obtained an acid without odour; and that M. Richter obtained the same inodorous acid by decomposing the benzoate of potash by acetite of lead, and then the benzoate of that metal by the sulphuric acid: but of all these methods that by spirit of wine is to be preferred.

LV. *On the Mammoth.* By Governor POWNALL.

To Mr. Tilloch.

I SIR, I READ, at Bath, the account which the Philosophical Magazine, published by you, gave the public of the mammoth. In my way from Bath to this place, I continued a few days in London: I went twice to see the skeleton of this enormous animal: the first time to take a general view of it; and some days after, when I had fully reasoned in my recollection on the general construction of it, I went a second time to examine it in detail, as far as my superficial knowledge in comparative anatomy would enable me.

I shall not in this letter go over all the parts to which I gave my attention, but notice only those parts on which some doubts remained with those who had not seen it, and which, rightly understood, lead to some probable conjectures as to the mode and time of its existence in life. I am, Sir,

Your most obedient humble servant,

Everton House, J. POWNALL.
Jan. 1, 1803.

DOUBTS were made as to ribs being set edgeways, so different from all other animals of our earth; yet such is the fact, as appears not only from the insertion of their heads, but from their curvature; also from their sides, wherein is the groove into which the cartilages, by which they are connected, were inserted. These ribs appear to be of the same form and to be in the same position as the ribs of fishes, and so designed for the same purpose, to resist an external compressure of more weight and force than the pressure of the atmosphere.

The printed description left it totally undecided whether this animal had hoofs or toes. On examining the setting on of the foot, it appears that it hath the eight usual bones, in two rows, four in each row, in the carpus, which all animals having digits or toes have: and it hath five toes, whereon,

as

as appears from the form of the end-bones, it had nails, not claws.

The position given to the tusks seemed doubtful; but, on a view of the fact, it is decisive that they could not have been placed otherwise. They are of a spiral curvature of one quarter turn: they are so inserted into the head as to go back alongside the shoulders, but at such a distance, as, by the turn of the head with some curvature of the body, to reach the sides and hinder parts, and from their construction and position point out evidently, at least to me, that they were weapons of defence against such of its enemies as might attack it in the flank or rear, and of destructive offence also in such case. Of this more hereafter.

The neck is so short that the animal could not reach the ground with its mouth: the line from the withers to the end of the under-jaw is about one-third of the line from the withers to the ground. I did not take an actual measure of this, but I will venture to assert it from my habit in drawing.

This animal, if a grazing animal, might indeed, as the moose deer do, feed on young shoots of the woods, or the bark; or, by going into morasses up to the breast in water, feed on the long grasses and water-plants which grow therein: but it is decidedly a carnivorous animal. The woods of the earth in which this animal could live, move, and sustain its being, must have been totally different from such as at present cover the face of the earth; otherwise his enormous form, with the position of his tusks, must have rendered him incapable of penetrating or passing through them.

Now here let the ingenuity and wit of our philosophers most renowned as naturalists search into the fact, and tell us what sort of animals could have been his prey, and where such could exist in sufficient abundance to sustain this enormous animal; and if any such ever did exist, which we now know nothing of, how he could, be his capacity for velocity supposed to be what it may, how he could hunt them in woods into which he could not penetrate, and through which he could not pass.

The question then arises and remains in doubt, Where must we look for his habitation and his food? Not being able to find either in the present state of the earth, my research is led to seek it under some other state of this planet. In searching for such state of things, I go to the first information we can obtain of the *history of this fact*, in the divine book of Genesis, written under inspiration: and there I am taught that the original state of this planet, *in the first period* of its existence, was that of an aqueous planet. The waters,

over

over the face of which the Spirit of God moved, covered the whole surface of the globe, and had remained in that state for two uncertain periods, until the working of nature under the command of God forced up and elevated the earth in parts, so that the waters were gathered together, which took place in a *third period* of the progressive existence of this our planet.

But apart all authority, any true philosopher, who meets by tracing back the operations of nature in her progressive advance to the present state of the planet, will find it in its first period an aqueous planet; will find that light or caloric, or whatever that first power was, specially gave course to other powers; and that the powers of evaporation, both expansive and attractive, were and are the causes of the separation of the elastic fluid, the atmosphere; that the earth has been thrown up from the bottom of these waters by various explosions and volcanic eruptions: and that the earth became, under these processes, in its vegetative state, a fit habitation, first, for the fowls of the air and all flying insects; and next for the beasts of the field and all creeping things; and lastly, for man, exactly according to the philosophic description given in the divine narrative. But while he considers this advancing progression, he will find nothing to decide as to the length and continuance of each of these periods. That these periods are not to be understood as *days*, is part of the fact. Because three of these periods were past, according to the narrative itself, before that division of time took place, which was not till the fourth period.

I shall now, grounding myself on the fact as above stated, assume that this planet was, in its first period of existence, an *aqueous planet*; and finding nothing to decide or determine the continuance of this period, assume also that it continued, according to the course of nature in her progression, in this state for an indefinite period; and further, that in this period and in this state of the planet "God created great whales and every living creature which moveth, which the *waters brought forth abundantly* after their kind." I find it difficult to conceive that these waters, which are descriptively said thus to *bring forth so abundantly*, should remain for four periods of the planet's existence totally unproductive till the fifth. The only way that I find to reconcile this difficulty in the divine narrative, is, that these marine beings are omitted to be noticed until they are classed with all other living terrestrial creatures under one head, according to the order of method, not the order of time, in the fifth period, when the earth became a proper *habitation* for such terrestrial

trial creatures. Whether the general denomination of *great whales*, so peculiarly expressed here, extended to the leviathan, the behemoth, and other species of great animals, I am not critic enough to judge: but that there were several other great animals in these waters is a fact.

On this ground I am disposed to think that, if any remains of any great animals are found amid the wreck which the parts of this planet have suffered in the revolutions of its nature, whose species are not now to be found in living existence, and to whom the present state of the earth could neither give an *habitation* or food, even a cautious naturalist may, on theory founded in a combination of circumstances, fairly suppose that those great animals had their existence under the circumstances of the first period of this planet as an aqueous one, and were destroyed by the revolution which converted it into a terrestrial one; and that even those who were not destroyed in that catastrophe must have become annihilated, as the present state of the earth is not suited to their existence.

The skeletons of this species of animal, which is by a Russian word denominated mamouth or mamoud, as being enormous like the elephant, and which might just as properly have had the name leviathan, or behemoth, given to it, are found in different and distant parts of the world, and under different climates, as on the banks of the Ohio, in the dominions of the state of New York, and on the banks of the Obie in Siberia. This circumstance again points out that these animals must have inhabited some element wherein the climates did not vary to the degree in which they now do on the earth, and whereby there was a general free communication from one side of the globe to the other, which doth not now take place. Moreover, as the earth is now constituted, and as the animals thereon exist, the indigenous animals of Europe and of America, howsoever similar in their external apparent classes, are variations in the one country from what they are in the other.

Besides the skeletons of these animals called mammoth, there have been found in other regions of the earth parts of other skeletons of enormous animals. The skeleton of one such, which is now in Spain, was found in South America. This, from the drawing made of it, appears to differ from the mammoth: but, having been accustomed to doubt the vagueness of draughts, I can suppose that this may, on examination, be found to be of the same nature*.

There

* We have reason to believe, from a correct drawing, and some particulars, which have reached us of the animal here alluded to, that it is of a different

There are also found, in different regions in the earth, the exuviae and remains of animals of a scale in magnitude much beyond those it affords in its present state, about which it seems almost impossible to fix any line of conjecture. They are found in all strata, the marine ones chiefly in calcareous strata: this skeleton lay in a calcareous stratum.

The supposition that this animal was a marine one, and dwelt in the ocean, relieves the account of it from all difficulties as to its habitation and food. What the woods of the present earth deny, the ocean gives full and free course to—all its enormous animal capacities of motion. The *abundant supply* of the ocean could give food for this carnivorous animal, and food which came within its power to attain, on the banks of flat fish, and in the beds of shell fish. This removes all difficulty as to its sustenance. That the ocean did bring forth such food in such abundance, the phenomena of the marine animal composition of the strata of the present state of the earth evinces.

That this animal was carnivorous appears to be a decided fact; it might therefore live in an element where was no grazing food: from its enormous bulk it would require a supply of animal food which the earth could not give, and which could only be found in the abundance which the waters bring forth.

There are parts in the *debris* of the skull which have some comparative resemblance to the whale, as to the purpose of breathing under water; and from the width of the jaws, somewhat similar to that of fish, one may imagine, when imagination is set to work, that this animal might have had in those parts some glands calculated to carry on the same operation as the gills of fish perform. The ribs, as observed above, more similar to those of fish than to those of terrestrial animals, are by their construction and position ordained to resist a much heavier and more forcible external compression than the atmosphere creates.

I shall make no apology for any part of this *theory*, because, being declared to be theory, every one is at liberty to approve or disapprove the whole or any part thereof; yet I cannot but think that some very sober analytic philosophers may repose their imaginations if not their conviction upon it, until the present or some future system of philosophy supplies them with a better. I will therefore venture to say to any philosophical society, royal or liberal,

— Si quid novisti rectius istis,
Candidus imperti: si non, his utere mecum.

different species from the mammoth. We shall here mention only one specific difference—its ribs are nearly cylindrical.—EDIT.

I will

I will not close my reflections on this subject, which was found in North America, and is now exhibited in London by Mr. Peale, a young American, by whose persevering industry it was dug up, without saying in very truth, and not in compliment, that this exhibition will derive every advantage which can arise from an object of this sort, from the modest scientific knowledge and the preciseness of information which this young man, in the true analytic way of an American, explains it; and from the collection of other articles with which he accompanies such explanation as with a commentary.

LVI. *Remarks on the present State of Aërostation.* By
Mr. G. J. WRIGHT*.

SUBSEQUENT to the discovery of marine navigation, the daily proofs of aerial flight, as witnessed among the feathered tribe, served to suggest to the antients the probability of piercing the unexplored regions of the atmosphere: various have been their attempts for this purpose, which (agreeably to the then pre-eminence of mechanical over the other branches of philosophy) were confined to the invention of machines to assist man himself in imitating the motions of the feathered race, but more particularly to the contrivance of flying automata, as may be learnt from the writings of many authors.

To enumerate and particularize these inventions would be of no avail, especially as the bare recital of many of them would at once confirm their absurdity; so that we may reckon nothing to have been practically concerted toward aërostation till the experiment of one Gusman, a Portuguese friar, who is reported, early in the 18th century, to have launched a paper bag into the air; which however soon fell, after attaining the height of 200 feet.

Many doubts have arisen respecting the truth of this statement, principally from the supposed unacquaintance of the philosophers of that early period with the qualities and varying densities of aerial fluids, as also the little probability that an elastic fluid could be confined, for any length of time, by paper, of which it has been asserted that the pores are indeed impermeable to air, though water easily percolates them: hence it has been inferred that the particles of water are finer than those of air. 'Tis certainly true that air may be confined by paper, provided such air be destitute of moisture, and

* Communicated by the Author.

incapable of exerting a chemical action thereon : but if water passes the pores of paper, it is most probably occasioned by its first effecting a solution of the mucilage, by which means the rest of the fluid finds an easy passage ; for, the hotter the water, the quicker does it percolate ; and this is not attributable to any supposed attenuation of the individual particles of the fluid, but to an actual solution of the paper itself ; otherwise the strength of each single fibre would remain unimpaired by the difference of temperature in the water ; the contrary to which the manufacture of paper itself will evince.

The difficulty, therefore, of obtaining the gases in a state of dryness in so large a quantity as is required for aërostatic experiments, will ever remain an impediment to the use of paper for any other than balloons of small diameter, and on the principle of Montgolfier. Two brothers of this name, natives of France, considering the difference in the specific gravity of heated and cool air, justly imagined, that if a bag, sufficiently large, were filled with the former, the weight of the inclosed heated air and bag together would be less than an equal bulk of atmospheric air of ordinary temperature, and that such an apparatus would ascend till it should attain that elevation where the respective gravities would correspond.

Experiment fully verified the opinion they had formed, and M. Pilatre de Rozier was the first to make trial of its security.

The inconveniences peculiar to machines rendered buoyant by heated air, arose from the impossibility of keeping up the elevated temperature of the inclosed air without the continued renewal of fuel, and that in large quantity ; whereby the travellers were exposed to great danger from the occasionally sudden and unavoidable expansion of the flames, and their inability to command that uniformity of rarefaction so necessary to the safety of the voyage.

As aërial chemistry had been before this time making rapid advances, so the philosophical world, through the indefatigable labours of the honourable Mr. Cavendish, had been made acquainted with the properties of inflammable air, whose specific gravity, in a tolerably pure state, is at least twelve times lighter than atmospheric air. Doctor Black first applied this newly discovered gas to balloons, by suggesting its inclosure in an air-tight bag, as capable of raising itself into the atmosphere, agreeably to the common hydrostatic axiom, that bodies immersed in a fluid heavier than themselves must inevitably float in that fluid ; and that, as the density of fluids is proportionate to their heights, so the lighter body will continue to rise till its gravity shall correspond

spond with that of an equal bulk of the fluid in which it is immersed. Although Dr. Black undoubtedly first suggested the propriety of applying inflammable air to aërostatic purposes, Mr. Cavallo had the honour of first putting it into practice, which we find him to have been engaged in performing in the year 1782: but his experiments went no further than a demonstration of the doctor's suggestions; and the ascent of soap-balls filled with inflammable air (as being the first experiment of the kind) is an original idea, for which we are indebted to him.

The first inflammable-air-balloon was launched on the continent by Messrs. Roberts and a Mr. Charles in the year 1783; and the greater expediency of these latter machines over those elevated by heated air, soon raised them to that pre-eminence they seemed justly entitled to: yet even with these there was conjoined the disadvantage of not being able to raise or lower them without a loss of ballast in the first, and of gas in the latter case. This suggested the idea of inclosing a bag of heated air in one of inflammable air, whereby, on varying the temperature of this inner balloon, the whole apparatus could be raised or lowered *ad libitum*, without loss of gas or ballast. But as the vicinity of fire to hydrogen air and common air endangers a mutual explosion, so this unfortunate plan deprived the world of that most intrepid philosopher M. Pilatre de Rozier, who has the honour to bear the palm of aërostation, in being the first man who ever abandoned himself to the atmosphere in a balloon.

If we consider the natural disposition of Frenchmen, ever prompting them to the pursuit of novelty, we shall not be surpris'd to find them warm advocates for the progress of this new art; eccentricity in the choice of their researches and amusements having been ever a prominent trait in their national character. Enlivened by the native softness of their climate, their dispositions partake of that gaiety which is to be found only in a country like theirs, where a less sluggish atmosphere and more uniform temperature tend to preserve a constant vivacity of mind. A latitude so favoured with serenity of season produces an abundance of vegetables and fruits, the want of a greater mixture of which in the diet of Englishmen causes the more prevalent sedateness of their manners, subdues a tendency to volatility, and keeps them from wandering from one pursuit to another. Hence we are less likely to witness among ourselves that sudden enthusiasm for the progress of any new art, and especially of this (to some) seemingly unimportant one: we have therefore had very few instances here of balloon excursions undertaken by

really philosophical men; and, except Mr. Baldwin, none have contributed aught to the science. His treatise *, compiled from the memoranda of a single voyage, is without its equal, and under such a philosopher the art must soon have attained all the perfection it could be capable of; while its present low state can be attributed only to the impossibility of finding his rival. The treatise of Mr. Cavallo † is an excellent book for practical purposes; and in these two volumes we find all the yet ascertained facts relating to aërostation ‡; the pamphlets compiled by others being of no value, as containing for the most part a repetition merely of trifling occurrences of no avail to future balloonists.

Subsequent to the experiment of Messrs. Charles and Roberts, many voyages were undertaken, both in France and this country, during the years 1784 and 1785: and after the public curiosity was in some measure abated, the pursuit itself sunk in the general opinion, and received attention only from a Mr. Blanchard, a French gentleman, who for years before had been devising various methods to fly by mechanical means. This amateur (who has made near fifty aërial voyages, and who, in his several attempts to improve the art, has met with some unfortunate accidents) is the original inventor of the parachute; but his essay therewith was not attended with success to himself §, although the animals he at times had committed to it for descent never experienced the slightest shock. Excepting then Mr. Blanchard, we find the art making no further progress; and even the attempts of this gentleman for the purpose proved abortive.

The second æra of aërostation may be said to commence with the establishment of the aërostatic school at Meudon, in the vicinity of Paris ||; and the first immediate service of a balloon appears to have been derived in the battle of Fleurus, in the Austrian Netherlands, where from an elevated station the French aëronaut beheld the movements of the enemy; and by indicating the same by a telegraph purposely attached to the car, the battle is reported to have been gained by the French, principally from this contrivance to overlook the ope-

* *Aëropaidia*, or Narrative of a Balloon Excursion from Chester; by T. Baldwin, A. M. 1786.

† *History and Practice of Aërostation*; by Tiberius Cavallo, F. R. S. London 1785.

‡ In the French language we have *Description des Expériences Aërostatiques*, par M. Faujas St. Fond. 2 tom.

§ In an experiment at Bâle, in venturing to descend by his parachute, he unfortunately broke his leg.

|| See the account of the French aërostatic institute in the sixth volume of the *Monthly Magazine*.

rations of the combined armies. Various reports have at times reached us concerning the pretended flourishing state of this *aërostatic* school; but during the few years of its establishment no improvements appear to have been made further than the composition of the varnish, which is brought to the greatest perfection; and Mr. Garnerin informed me the establishment itself is now given up.

We find then that the apparatus itself has undergone no confirmed improvement; perhaps from the pursuit being generally attended to by enthusiasts in novelty, strangers to genuine science natural or mechanical. Thus an *aëronaut* in the present day is compelled to go in the direction of the wind; and in descending, calmly sits in his car to be knocked against every tree, house, or hedge, that may come in his way. So long, therefore, as *aërial* adventurers are liable to such dangerous dilemmas, it is no wonder we find so few inclined to repeat their voyages; as the transitory enjoyment of a view above the clouds, is seldom sufficient to incite a second attempt under such threatening circumstances.

The restoration of peace affording to foreigners an opportunity of visiting this country, whether prompted by curiosity or to exhibit the productions of their inventive genius, this crisis proved a means of again exciting the attention of the English public to the almost forgotten subject of *aërostation*, as revived by the advertisements of Mr. Garnerin; a man of an ingenious turn of mind, without that collateral acquaintance with the several sciences on which rests the only sure foundation for improving the arts, and especially this peculiar branch of philosophy, which seems to be his native *forte*.

Having made a number of *aërial* voyages, his mechanical acquaintance with the requisites for insuring success was confirmed by frequent experience; but further than this we do not find him to have attained. He is also the first *aëronaut* that has succeeded in a safe descent by the parachute—an experiment which is of the first consequence to the progress of *aërostation*. The late voyages made in this country by this latter gentleman are fresh in the memory of every one, and we have only to regret that so experienced an adventurer should possess so small a share of the knowledge requisite to raise *aërial* navigation to the perfection it might perhaps otherwise soon attain.

As an advocate for ascertaining the issue of whatever may be dubious in the present state of our knowledge, I felt anxious to seize so happy an opportunity of investigating what degree of diminished pressure the human constitution could support, as presented in the intended experiment with the pa-

rachute: for this reason I offered to Mr. Garnerin, that, as his balloon was capable of carrying four persons, it would be fully adequate to the conveyance of two, together with the parachute and ballast: under such circumstances it would be necessary to suspend the parachute beneath the car; and my intention was to occupy the latter myself. An offer so advantageous for securing Mr. Garnerin's machine (otherwise left at random) was rejected by him, from the acknowledgement of his doubts respecting the event of so novel an experiment. But I trust this experiment will not long remain unattended to by such as may have an opportunity of performing it: the effects subsequently taking place from the loss of a weight of upwards of 200 pounds at an elevation of 10,000 feet, are not so terrific as might be imagined; as during this after-ascend no danger could attach to the machine; for, its neck being open, and thereby affording an exit to the gas, now somewhat more expanded by the absence of the mechanical pressure of the 200 pounds just lost, yet gradually still more expanding itself as it attains in this ascension a zone of air of lesser density, would necessarily prevent any rupture from that cause; while, if the aeronaut found his respiration too much affected to allow his attainment of the utmost height surmountable under these circumstances, he could have nothing to fear so long as he has the valve at command. Neither have we any cause for apprehension from the velocity likely to take place, if the traveler is not too near to the body of the balloon, or in a fitting position; in both which cases it is doubtful whether the approximation to a vacuum* in the *wake* and immediately in the vicinity of the lower pole of a large spherical body, ascending with great velocity, might not endanger *asphyxia*, from the suddenly diminished density of the air received into the lungs †.

At the same time, to such as descend by a parachute from a balloon left at random, I would advise an attention to the following simple precaution, which cannot fail of insuring the

* Agreeably to what we learn in projectiles, that a body moving with a velocity of 1200 feet in a second, leaves behind it an actual vacuum; also exemplified in the common exercise of swinging, where a slightly suffocating sensation is experienced in the retrograde motion of the machine, occasioned by the person sitting in the wake formed by the recoil of his own body.

† As I have no intention to speak in this place of the effects likely to ensue to an aeronaut in cases where, the valve being unexpectedly found out of repair, he is obliged to remain at the then unavoidable equilibrium, I shall reserve these points of discussion as the subject of a paper I propose to transmit at a future opportunity, in immediate reference to the probable effects of diminished atmospheric pressure on the animal system.

speedy descent and recovery of the latter. In ascending with a parachute according to the present construction (the aëronaut being out of the reach of the neck of the balloon), it will be advisable to leave the neck open about a foot or more: previous to the ascent procure a cord whose length must equal half the perpendicular circumference of the balloon when at its full distension; attach one end of the cord to the zenith of the balloon externally, or to the netting immediately over it, and (leaving it detached throughout the whole of its remaining length) to the other end fasten a weight of about 20 pounds. I say, when the separation between the parachute and balloon is made, the latter, being destitute of any other poise, will gradually yield to this above-mentioned weight, and by its means the open neck of the balloon will progressively be made to ascend; while the zenith will be drawn downwards, the machine thereby inverted, and the pressure of the external atmospheric air will in a short time force out the inflammable gas, and the whole bag quickly descend*.

It would appear, from the above short review of the state of aërostation, that we have as yet made no further progress than the attainment of the means of rising into the atmosphere, of ascending and descending a very limited number of times, and of departing from the machine in safety in case of any immediate wish on the part of the traveller when his stay therewith appears hazardous. As these are matters sufficient to dispel apprehension from the minds of those who may be inclined to attend to this branch of philosophy, it may not be amiss to subjoin those requisites and precautions, an attention to which will not fail to enable the amateur to pursue this modern discovery with expedience and economy.

The stuff uniformly made use of in the construction of balloons to be raised by inflammable air is silk lustring, (*taffetas lustré*;) which is a substance extremely well calculated for the purpose, as possessing the valuable properties of closeness of texture and uncommon strength, yet of little weight †: but the

* Finding Mr. Gouerin, notwithstanding repeated applications, averse to my accompanying him in the manner I proposed, I advised him to take advantage of this easy method of securing his machine; but he chose rather to follow his own opinion in project of fastening the neck of the balloon, in order that, as it afterwards continued to ascend to a more rare atmosphere, the force of the expansion of inflammable air (thus prevented from effecting) might overcome the resistance of the silk, and cause a rupture sufficient to let out the gas: but in our French Island the machine might have been irrecoverably left in the room before these effects had taken place.

† Balloons to be raised by heated air are constructed of linen finished

the price of this silk, though more moderate in France, is in this country so high* as to augment the expence of a middling-sized balloon almost to a prohibition to any but the wealthiest individuals. I do not see, therefore, why strong cambric muslin, rinsed in drying oil †, (previous to sewing the pieces together,) should not fully answer every purpose. After providing the necessary quantity of the stuff, and each piece having been properly prepared with the drying oil, let the corresponding edges be sewed together in such a manner as to leave about half an inch of one piece beyond the edge of the other, in order that this may, in a subsequent row of stitches, be turned over the latter, and both again sewed down together: by so doing, a considerable degree of strength is given to the whole bag at the seams, and the hazard of the gas escaping doubly prevented. Having gone in this manner through all the seams, the following method of Mr. Blanchard is admirably calculated to render them yet more perfectly air-tight. The seam being doubly stitched as above, lay beneath it a piece of brown paper, and also another piece over it on the outside; upon this latter pass several times a common fire-iron heated just sufficiently to soften the drying oil in the seam: this done, every interstice will be now closed, and the seam rendered completely air-tight.

The neck of the balloon being left a foot in diameter and three in length, and all the seams finished, the bag will be ready to receive the varnish, a single coating of which on the in a solution of alum or sal-ammoniac and common size: Mr. Cavallo recommends a gallon of water to a pound of each of the two ingredients: it may then be sewed into the required shape, and afterwards once varnished on the outside with merely drying linseed oil, adding a small quantity of neat's-foot oil to prevent its being sticky. The *liquor silicium*, or liquor of flints of the chemists, prepared by melting together one part of sand or powdered flints and four parts of fixed alkali, might, perhaps, be advantageously substituted for the saline ingredients above mentioned, as rendering paper or cloth varnished therewith perfectly incombustible.

* Silk lustring may be purchased on the continent at five shillings the yard, but here for not less than nine.

† In rendering oil drying for aërostatic purposes we should avoid the use of metallic oxides, as litharge, &c., which rot the stuff of the envelope; besides that hydrogen gas, by gradually reducing the metals, corrodes such varnish, turning it black, and in time causing it to crack. The best method to prevent these inconveniences is to allow the oil to stand for several weeks over unslaked lime, or to dissolve in it a small quantity of gum-sandarac, gum-lac, mastich, seed-lac, or common resin; all of which, when finely powdered, may be dissolved in linseed oil by well boiling, thus communicating to the oil the property of drying, yet retaining elasticity. Silk and canvas for umbrellas, &c. are varnished with a solution of either resin or gum-lac, melted with drying linseed oil to the consistence of a thick balsam, so as not to run about: thus varnished they are very little heavier than before, though impermeable to air or water.

outside

outside is found preferable to the former method of giving an internal as well as an external coat. The compositions for varnishing balloons * have been variously modified; but, upon the whole, the most approved appears to be the bird-lime varnish of M. Faujas St. Fond, prepared after Mr. Cavallo's method as follows:

“In order to render linseed oil drying, boil it, with two ounces of sugar of lead and three ounces of litharge † for every pint of oil, till they are dissolved, which may be in half an hour. Then put a pound of bird-lime and half a pint of the drying oil into an iron or copper vessel whose capacity should equal about a gallon, and let it boil very gently over a slow charcoal fire till the bird-lime ceases to crackle, which will be in about half or three quarters of an hour: then pour upon it two pints and a half more of the drying oil, and let it boil about an hour longer, stirring it frequently with an iron or wooden spatula. As the varnish whilst boiling, and especially when nearly done, swells very much, care should be taken to remove in those cases the pot from the fire, and replace it when the varnish subsides; otherwise it will boil over. Whilst the stuff is boiling the operator should occasionally examine whether it has boiled enough; which may be known by observing whether, when rubbed between two knives and then separated from one another, the varnish forms threads between them, as it must then be removed from the fire: when nearly cool, add about an equal quantity of spirit of turpentine: in using the varnish, the stuff must be stretched and the varnish lukewarm: in 24 hours it will be dry.”

Every balloon should be provided with a valve so constructed as to open inwards, having also a spring to keep it shut. The string by which this valve is regulated must pass through a small hole in the lower part of the balloon to the car; its length must be such as to allow several coils of it to remain in the boat: this is a requisite precaution, as, when the inflammable air is much expanded, the horizontal diameter of the balloon is so much more extended, and its lower

* As the elastic gum, known by the name of Indian rubber, has been much extolled as a varnish, the following method of making it, as practised by Mr. Blanchard, may not prove unacceptable:—Dissolve elastic gum, cut small, in five times its weight of rectified essential oil of turpentine, (ethereal spirit of turpentine of the shops,) by keeping them some days together; then boil one ounce of this solution in eight ounces of drying linseed oil for a few minutes; strain the solution, and use it warm.

† The metallic oxides are less exceptionable in the outer varnish of a balloon than internally, as the first soaking in drying oil serves to shield the external varnish from the action of the gas.

pole consequently drawn proportionably upwards, that the firing of the valve will be otherwise out of the traveller's reach; an accident which has frequently obliged them to climb up into the netting to regain it. The valve itself should be covered with soft leather, reaching an inch or two beyond its edge every way. Its situation should be upon the equator*, (and not, as generally directed, near the top,) else the lightest gas will be that which will escape; not to mention also the greater inconvenience in the latter case, arising from the establishment of a complete current of atmospheric air through the balloon by the neck and valve together (the neck being generally left open a few inches), whereby a quantity of the lighter gas is carried off greater than one would imagine. To obviate this, the neck and valve should never be both open at one time; and I apprehend the accidents frequently occasioned by the usually rapid descent and rebounding of a balloon, are to be attributed to an inattention to this precaution; the gas being violently carried out of the valve by a current of air running through the balloon, and this current increasing with the velocity of the descent; so that, when the valve is again closed, the balloon is found to have decreased in levity much more than was wished for.

The car for balloons may be left to the option of the amateur, remembering that light weight, and the property of floating if descending over water, be attended to.

[To be continued.]

LVII. *Extract from a Memoir on the Properties of Ytria Earth compared with those of Glucine; on the Fossils in which the former of these Earths is contained; and on the Discovery of a new Substance of a Metallic Nature.* By A. G. EKEBERG †.

THE first part of this memoir contains an account of some experiments, made by M. Ekeberg, to establish the difference between glucine and the earth discovered in the gadolinite, and called ytria or gadoline; but as the peculiar nature of each of these earths is already well known

* The opening of the valve being sometimes required during the rapid ascension of a balloon, and being followed also by a quick descent, the equator is pointed out as the most proper situation in which to place the valve, to prevent the atmospheric air from rushing in either case into the balloon.

† From the *Transactions of the Academy of Sciences at Stockholm* for 1802, first quarter.

to chemists, it is here needless to repeat what has been already said on that subject.

As the other is interesting on account of its novelty, we shall lay before our readers the observations made on it by the author.

Though the mineral substance I discovered, says he, contains yttria, it could not be classed in a system of mineralogy as a species of earth, on account of the more abundant mixture it contains of another substance equally remarkable, and which must increase the class of metals, already very numerous. I found this substance in two fossils, obtained from different places: in one of them, it was united with iron and manganese; and in the other, with the former of these metals and gadoline.

This new metallic substance is distinguished by its insolubility in all acids. The only re-agent which has any action on it is caustic fixed alkali. When subjected to heat with this alkali, if the mass be then lixiviated, it partly dissolves in the water, and suffers itself to be precipitated from that solution, by means of an acid—but without the precipitate being in any manner attacked, whatever be the quantity of the acid employed. When separated by the filter, and dried, it remains under the form of an exceedingly fine white powder, which does not change its colour even at a red heat. If the remaining mass be treated with acids, the same powder is obtained. Its specific gravity, after being brought to red heat, is 6.5 0. It is fusible by the blow-pipe, by the addition of alkaline phosphate and borate of soda, but communicates no colour to the flux.

Exposed to a strong heat in a crucible, without any other mixture than pounded charcoal, it is reduced to a button moderately hard, having some metallic splendour at its surface, but a dull blackish fracture. Acids have no other action on this kind of regulus, but that of bringing it to the state of white oxide in which it was before. The circumstances of the reduction, as well as the specific gravity of this singular substance, seem to assign it a place among the metals, and I have sufficient reasons for being persuaded that it is none of those already known. The substances with which it might be confounded are the oxides of tin, tungsten, and titanium, which are soluble in caustic alkalies, and which, under some circumstances, resist acids. But the oxide of tin is easily dissolved and reduced: tungsten immediately discovers itself by its solubility in ammonia, and by the blue colour which it communicates to phosphate

phate of soda: the oxide of titanium gives a hyacinth colour to borax, and becomes soluble in acids by fusion with carbonate of potash*.

Before I describe the chemical analysis which I undertook of the two substances, which I consider as ores of the new metal, it is proper I should give a description of their external characters. In order to avoid circumlocution, when necessary to name them I shall venture to give them a generic denomination. Taking advantage of the usage which admits mythologic appellations, and to express the property which the new metal has, of not becoming saturated with the acids in which it is immersed, I shall apply to it the name of *Tantalus*. For the ore composed of tantalus, iron and manganese I propose the name of *tantalite*; and for the ore containing yttria, that of *yttrotantalite*, which will not be found longer than that of *siderotitanite*.

The specimen of tantalite was given to me by M. Geeger, director of the mines; who assured me that this substance has been known since 1746, and considered as a problematic variety of the garnet of tin, (*zinngrauen*.) It is found near the farm of Brokaern, in the parish of Kimito, and government of Abo, in Finland, in a large mountain on the borders of the Baltic. The matrix is composed of white quartz and mica, with veins of red feldspar in large laminae, matters of which the sides of the vein are formed: the titanite is found dispersed throughout it, in the form of garnet.

What I saw was in detached crystals, of the size of a walnut, and the best defined seemed to approach the octhaedral form; they were charged with parcels of feldspar and mica.

Its surface is smooth, shining, and blackish.

Its fracture is compact, and has a certain metallic splendour: the colour of the fracture is not every where the same; it varies between grayish blue and the black of iron.

When powdered, it is blackish gray inclining a little to brown.

It has sufficient hardness to strike fire with steel.

I have not observed that it has any attraction for the magnet.

Its specific gravity is 7.953.

The yttrotantalus is found in the same place and in the same matrix as the gadolinite. Klaproth says that the latter

* I had, however, entertained some suspicions in regard to the identity of the new substance and the last-mentioned metal; and I was not fully convinced of its not existing, but by comparing it with the titanized iron of Norway, which I decomposed for that purpose.

is found incrufted in a granitic mafs: but though the conftituent parts of granite are found there from time to time, it is no lefs certain that the real matrix is nothing elfe than feldfpar, as is evidently feen in the large mine of Ytterley. The mica and quartz found there form diftinct parts, and do not enter into combination with the feldfpar*; but in general it is a rock of feldfpar, interfefted by large veins of mica, in a direction almoft perpendicular; and it is in the proximity of thefe veins that the gadolinite as well as the yttrantalus muft be fought for. The firft is generally found attached on one fide to a vein of argenteous mica, and the reft of its volume enveloped by feldfpar. The fecond never adheres immediately to the mica. The clumps (*roggons*) which it forms, become enveloped with a thin cruft of feldfpar, feparate from the grand mafs by thin ftrata of grayifh black mica. The veins charged with thefe *roggons* are rarely infulated; feveral of them are found together, feparated only from each other, and from the principal rock, by fimilar fides of mica. It was thus that I for the moft part found thefe fubftances placed by nature, and it is very rarely that they are found in grains diffeminated throughout the rock of feldfpar.

The largeft *roggons* which I found of the ore of the yttrantalus had not attained to the fize of a walnut. The fracture of them was granulated, of an iron black colour, with a metallic fplendour.

Its hardnefs is not confiderable; it can be fcraped by means of a knife, but with difficulty.

When powdered it is of a grayifh colour.

It exercifes no action on the magnet.

I found its fpecific gravity to be 5.130; but as it was not poffible for me to find a piece entirely free from feldfpar, I fufpected that its real gravity muft be a little more confiderable.

We fhall terminate this extract by a fhort view of that part of M. Ekeberg's memoir, which relates to the analyfis of the gadolinite, and the comparifon of the yttria with glucine, which in feveral works has been confidered as being of the fame nature.

Gadolinite, when pure, is fufficiently compact to ftrike fire with fteel.

It is found crystallized in an imperfect manner, like fome kinds of garnets.

It contains glucine.

* I fpeak here only of the mafles of the principal rock, without denying the poffibility of finding there fome fragments in which the three fubftances are intermixed.

Besides the distinctions established by Klaproth and Vauquelin between the gadoline and glucine, these two earths appear to be different by the following peculiar properties:

The specific gravity of gadoline differs considerably from that of glucine, which is only 2.967, while that of gadoline is 4.842. The last earth is the heaviest of all the earthy substances known; since it surpasses by 0.482 the gravity of barytes, which weighs only 4.000.

It is soluble in alkaline carbonates.

It is absolutely insoluble in caustic alkalies.

It is not, like glucine, precipitated by succinates.

LVIII. Observations on the Change which Carbonic Acid Gas experiences by the Electric Spark, and on the Decomposition of the same Gas by Hydrogen Gas. By THEODORE DE SAUSSURE.*

I. Change which Carbonic Acid Gas experiences by the Electric Spark.

DR. PRIESTLEY had observed that carbonic acid gas dilated by the electric spark, and experienced a modification which prevented it from being entirely absorbed by lime water, or by alkalies. C. Monge examined with the greatest care what took place in this experiment, and found that the gas produced by electrification was inflammable gas. I shall here describe in a few words the principal results of this observation: A column of carbonic acid gas, of 34 inches, contained by mercury, rose to 35 inches and a half, after having been traversed for a long time by electric sparks, which circulated between iron conductors. It could not be dilated any more by further electrification. The wires as well as the mercury were oxidated. Potash could only absorb 21 inches and a half of this column of acid gas: the remaining 14 inches were inflammable gas. C. Monge accounts for these phenomena by supposing that the carbonic acid gas does not experience the least alteration in its principles, and he reasons nearly as follows: The conductors and the mercury, by decomposing the water held in solution in the carbonic acid gas, produce two opposite effects, of which nothing is observed but the difference. 1st. The volume of the acid gas is diminished, by being deprived of the water which it held in solution. 2d. The volume of the elastic fluid is augmented, by the development of the hydrogen gas of the water de-

* From the *Journal des Mines*, No. 68.

composed. The residuums of gas after the operation are a mixture of hydrogen gas, resulting from the decomposition of the water, and carbonic acid gas deprived of water.

This very ingenious explanation was without doubt the only one which could present itself at the time when it was given. Had it been just, it would have been necessary, by restoring to the acid gas condensed by desiccation the water it had lost, to dilate it again, and to augment about 12 inches the column in question. As C. Monge did not submit his explanation to this decisive proof, I thought proper to attempt it.

I caused to circulate for 18 hours electric sparks in the bulb of a matrafs which contained 13 cubic inches of pure carbonic acid gas, and without any mixture of water superabundant to that which it might naturally hold in solution. The mercury, in which the inverted matrafs was immersed, rose to about the half of its neck. After electrification, the metallic fluid was found oxidated black, as had been observed by Monge and Priestley; but my conductors, which were of copper, were not sensibly altered. The elastic fluid had experienced a small dilatation, which appeared to me not to exceed the tenth part of a cubic inch. I then made about a grain of water† to pass in contact with the aeriform gas contained in the matrafs. I let it remain there for several days, without perceiving any dilatation in the volume of the gases, the residua of the operation. I then moistened, with a drop of water which I introduced, the whole inside of the matrafs—but in vain—the mercury constantly remained at the same height. I however found, on absorbing by potash the residuum of the acid gas, that a cubic inch of carbonic acid gas had disappeared, and had been replaced by a quantity nearly equal, or rather superior, to the inflammable gas. The 20 cubic centimetres occupied in the neck of the matrafs a column four inches in length; and the acid gas, had the supposed explanation been just, would have been dilated

* It supposes that the carbonic acid gas may hold in solution a great quantity of water. But this assertion is not proved by any other direct experiment. Dr. Priestley was not able to calcine carbonate of barytes but by the help of a current of aqueous vapour, which he caused to circulate on that earth brought to a red heat. This result may be explained by the affinity alone of the water for the barytes. It is besides possible that the carbonic acid gas dissolves at a red heat a certain quantity of water, and dilates much in this solution, without producing these effects at the temperature of the atmosphere.

† It is needless to observe here, that water can absorb no more than its own volume of acid gas with the pressure of the atmosphere, and that the drop of water introduced into the matrafs could not produce by this absorption any sensible change in the volume of the elastic fluid.

through all that space. I then thought that this inflammable gas did not arise from the decomposition of the water, but from that of the carbonic acid itself by the metal. I indeed found that this gas was not hydrogen gas, but carbonous gas perfectly pure. I burnt 100 parts of it on mercury, with about a third of oxygen gas. I did not perceive water after this combustion, which left for residuum 77 parts of carbonic acid gas.

The dilatation which the latter experiences by electrification may be explained by the different densities of the carbonous gas and the carbonic acid gas. I was not able to verify the observation of C. Monge respecting the dilatation experienced by the carbonic acid gas, after electrification over mercury.

If it was not possible to reduce entirely the acid gas into carbonous gas by these processes, it was because the first strata of metallic oxidation presented an obstacle to further oxidation, by preventing the points of contact. The development of the carbonous gas produced therefore an analogous effect.

It results then from my observations, that the change which carbonic acid gas undergoes by electrification does not arise from the decomposition of the water, but from the partial decomposition of the carbonic acid gas, which becomes carbonous gas, giving up a part of its oxygen to the metal introduced in these experiments.

II. *Decomposition of Carbonic Acid Gas by Hydrogen Gas.*

It was long supposed that carbonic acid gas could be decomposed by hydrogen gas; but no one was able to effect it, though many experiments were made on that subject. I had observed, that a mixture of equal parts of hydrogen gas and carbonic acid gas, contained by mercury and left to itself, had decreased in volume in the course of a year. When I then caused the residuum of acid gas to be absorbed by potash, and had burnt the hydrogen gas, I found that there was formed in this combustion carbonic acid gas: but these results were not very sensible; and what took place in this operation was to me mere conjecture. Since that time I have been able to confirm in a decisive manner this first observation, by causing the electric sparks to circulate in a mixture of carbonic acid gas and hydrogen gas. In a few moments I saw the volume of the gas decrease, drops of water formed, and the acid gas pass almost entirely to the state of carbonous gas. The following are the details of one of these experiments: I introduced into a cylindric glass jar
about

about nine lines in diameter, and closed by mercury, a mixture of four parts in volume of carbonic acid gas, and three parts of hydrogen gas. The space occupied by the two æri-form fluids united formed a long column of seven inches, so that each part in volume of the glass corresponded to one inch in length of the column. I caused the electric spark to circulate by iron conductors. The condensation of the gas, which at first took place very rapidly, became always slower; after twelve hours electrification, its progress was almost insensible. The very fine drops of water, formed during the operation in the upper part of the tube, disturbed its transparency. The column of æri-form fluid was reduced to four inches. It then experienced in its length a diminution equal to three inches. I then introduced into it potash, which could absorb only one inch of carbonic acid gas. The three remaining inches were carbonous gas almost pure. I burned by means of the electric spark, 100 parts of it with oxygen gas, and they left for residuum 64 parts of carbonic acid gas.

It is seen, then, that three inches of carbonic acid gas were decomposed, and passed to the state of carbonous gas, by combining a part of their oxygen with the hydrogen gas introduced. It is seen also that the latter, by losing the elastic state to form part of the water resulting from this combination, produced the condensation observed in the volume of the two gases.

It is to be remarked, that the mercury and conductors in this experiment were not considerably oxidated.

It has long been observed, that hydrogen gas, confined by water in contact with atmospheric air, decreases very slowly in volume, and then burns with a flame less vivid. It has been supposed that this gas filters through the water in the atmosphere; but there is nothing to support this explanation. In my opinion, it is more probable that the carbonic acid gas of the atmosphere filters alone through the water, according as it is decomposed by the hydrogen gas, which decreases in the ratio of this decomposition.

LIX. *Some Account of* RICHARD KIRWAN, *Esq.* LL. D.
F. R. S. and P. R. I. A.

THIS gentleman, who has distinguished himself so much by his philosophical and geological labours, was bred to the law, and exercised his profession as a barrister, till infirm health, and the death of his elder brother, a member of the Irish parliament, occasioned him to become an experimental

inquirer into the phenomena of nature. Having devoted his attention to chemistry and natural philosophy, he set out in this new mode of life, in or near London, about the year 1779 or 1780. He made his debut with some papers read in the Royal Society, for which he received the Copley medal, about the year 1781. The titles of these papers are as follow:—Experiments and Observations on the Specific Gravities and Attractive Powers of various Saline Substances: read Nov. 16, 1780.—Continuation of these Experiments and Observations: read April 11, 1782.—Conclusion of the Experiments and Observations concerning the Attractive Powers of the Mineral Acids: read Dec. 12, 1782.—Remarks on Mr. Cavendish's Experiments on Air: read Feb. 5, 1784.—Remarks on Specific Gravities, taken at different Degrees of Heat; and an easy Method of reducing them to a common Standard: read Feb. 17, 1785.—Experiments on Hepatic Air: read Dec. 22, 1785.

Mr. Kirwan returned to his native country about the year 1789, and some time after was appointed President of the Royal Irish Academy; a place which he continues to hold, with honour to himself and advantage to the philosophical world. The papers with which he has enriched the Transactions of the learned body over which he presides are: An Essay on the Variations of the Barometer: read March 1, 1788.—Observations on Coal Mines: read Jan. 10, 1789.—Experiments on the Alkaline Substances used in Bleaching; and on the Colouring Matter of Linen Yarn: read April 4, 1789.—On the Strength of Acids and the Proportion of Ingredients in Neutral Salts: read Dec. 24, 1790.—A Comparative View of Meteorological Observations made in Ireland since the Year 1788, with some Hints towards forming Prognostics of the Weather: read Feb. 2, 1793.—Reflections on Meteorological Tables, ascertaining the precise Signification of the Terms Wet, Dry, and Variable: read July 23, 1793.—State of the Weather in Dublin from the 1st of June 1791 to the 1st of June 1793.—Examination of the supposed Igneous Origin of Stony Substances: read Feb. 3, 1793.—Essay in Answer to the following Question, proposed by the Royal Irish Academy: What are the Manures most advantageously applicable to the various Sorts of Soils, and what are the Causes of their beneficial Effect in each particular Instance? read Jan. 4, 1794.—Meteorological Observations made in Ireland in the Year 1793: read Jan. 25, 1794.—Experiments on a New Earth found near Stronthian in Scotland: read Jan. 9, 1794.—Of the Composition and Proportion of Carbon in Bitumens and Mineral Coal: read Dec. 19, 1795.—

1795.—Synoptical View of the State of the Weather in Dublin: read Jan. 9, 1796.—Thoughts on Magnetism: read March 19, 1796.—On the Primitive State of the Globe, and its subsequent Catastrophe: read Nov. 19, 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1797.—Additional Observations on the Proportion of real Acid in the three ancient known Mineral Acids, and on the Ingredients in various Neutral Salts and other Compounds: read Dec. 16, 1797.—Essay on Human Liberty: read July 28, 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1799.—Observations on the Proofs of the Huttonian Theory of the Earth, adduced by Sir James Hall: read Feb. 8, 1800.—An Illustration and Confirmation of some Facts mentioned in an Essay on the Primitive State of the Globe: read May 5, 1800.—An Essay on the Declivities of Mountains: read April 28, 1800.—Of Chemical and Mineralogical Nomenclature: read March 24, 1800.—Remarks on some Sceptical Positions in Mr. Hume's Inquiry concerning the Human Understanding, and his Treatise of Human Nature: read October 20, 1800.—Synoptical View of the State of the Weather at Dublin in the Year 1800.—Of the Variations of the Atmosphere: read May 11, 1801.—Synoptical View of the State of the Weather at Dublin in the Year 1801.

Mr. Kirwan is also the author of the following works: Essay on Phlogiston; Elements of Mineralogy, 2 vols.; Geological Essays; Essay on the Analysis of Mineral Waters; and (in the present volume) A Reply to Mr. Playfair's Reflections on Mr. Kirwan's Refutation of the Huttonian Theory of the Earth; and an Illustration and Confirmation of some Facts mentioned in an Essay on the Primitive State of the Globe.

LX. *Observations on the Law of the Expansion of Water at Temperatures below 42°; extracted from a Paper on the Power of Fluids to conduct Heat.* By JOHN DALTON*.

MY first attempt was to ascertain the precise degree of cold at which water ceases to be further condensed, and likewise how much it expands in cooling below that degree to the temperature of freezing, or 32°. For this purpose I took a thermometer tube, such as would have given a scale of 10

* From *Journals of the Royal Institution of Great Britain.*

inches with mercury from 32° to 212° , and filled it with pure water. I then graduated it by an accurate mercurial thermometer, putting them together into a basin filled with water of various degrees of heat, and stirring it occasionally. As it is well known that water does not expand in proportion to its heat, it does not therefore afford a thermometric scale of equal parts, like quicksilver.

From repeated trials agreeing in the result, I find that the water thermometer is at the lowest point of the scale it is capable of, that is, water is of the greatest density, at $42\frac{1}{2}^{\circ}$ of the mercurial thermometer. From 41° to 44° inclusively the variation is so small as to be just perceptible on the scale; but above or below those degrees the expansion has an increasing ratio, and at 32° it amounts to $\frac{1}{8}$ th of an inch, or about $\frac{1}{7\frac{1}{2}}$ th part of the whole expansion from $42\frac{1}{2}^{\circ}$ to 212° , or boiling heat. During the investigation of this subject, my attention was arrested by the circumstance, that the expansion of water was the same for any number of degrees from the point of greatest condensation, no matter whether above or below it: thus, I found that 32° , which are $10\frac{1}{2}^{\circ}$ below the point of greatest density, agreed exactly with 53° , which are $10\frac{1}{2}^{\circ}$ above the said point; and so did all the intermediate degrees on both sides. Consequently, when the water thermometer stood at 53° , it was impossible to say, without a knowledge of other circumstances, whether its temperature was really 53° or 32° . Recollecting some experiments of Dr. Blagden in the Philosophical Transactions, from which it appears that water was cooled down to 21° or 22° without freezing, I was curious to see how far this law of expansion would continue below the freezing point, previously to the congelation of the water, and therefore ventured to put the water thermometer into a mixture of snow and salt, about 25° below the freezing point, expecting the bulb to be burst when the sudden congelation took place. After taking it out of a mixture of snow and water, where it stood at 32° (that is 53° per scale), I immersed it into the cold mixture; when it rose, at first slowly, but increasing in velocity, it passed 60° , 70° , and was going up towards 80° , when I took it out to see if there was any ice in the bulb—but it remained perfectly transparent. I immersed it again and raised it to 75° per scale, when in an instant it darted up to 128° ; and that moment taking it out, the bulb appeared white and opaque, the water within being frozen. Fortunately it was not burst; and the liquid which was raised thus to the top of the scale was not thrown out, though the tube was unsealed. Upon applying the hand, the ice was melted, and the liquid resumed its station.

This experiment was repeated and varied, at the expense of several thermometer bulbs; and it appeared that water may be cooled down in such circumstances, not only to 21° , but to 5 or 6° , without freezing, and that the law of expansion above mentioned obtains in every part of the scale from $42\frac{1}{2}^{\circ}$ to 10° or below; so that the density of water at 10° is equal to the density at 75° .

LXI. *Remarks on certain Properties of Barytes in its Combination with Mineral Acids; and on two new Salts never before described.* By J. HUME, Esq.*

FROM a number of experiments I have occasionally made on *barytes*, but chiefly on it when combined with mineral acids, I have been led to draw some conclusions and observe phenomena, which, I believe, have hitherto been either totally unknown, or so very imperfectly detailed, as, no doubt, to have frequently been a source of error. This earth, for I am not yet disposed to class it with alkalies, certainly possesses peculiar habitudes, or rather, when compared with those of other earths and alkalies, and its own combinations compared with each other, some singular anomalies, which I have never yet seen pointed out by chemical writers. Amongst many others, the following appear the most prominent, and therefore demand first to be noticed.

1. That sulphate of barytes is completely *soluble* in sulphuric acid; forming a saline *fluid* or acidulous sulphate, analogous, in some of its characters, to phosphate of lime and many other salts, with capacity for excess of acid; decomposable by water alone, which returns it to simple sulphate; and this salt never has been enumerated by any author.

2. That carbonate of barytes is also totally decomposed by, and soluble in, sulphuric acid, forming, of course, the same *acidulous* sulphate. Respecting any figure this new salt may put on, I have not yet been able fully to determine; but I strongly suspect it may, under particular circumstances, be made to crystallize.

3. That nitrate of barytes, not in crystals only, but even a saturated aqueous solution, is perfectly *insoluble* in nitrous acid of the usual specific gravity.

4. That carbonate of barytes may entirely be changed into nitrate by nitrous acid in its *concentrated* state. The converse of this has hitherto been maintained.

* Communicated by the Author.

5. That muriate of barytes is virtually *insoluble* in muriatic acid.

6. That carbonate of barytes may be rendered into muriate by *concentrated muriatic acid*.

7. This may not appear to be, with propriety, placed after the others; it ought nevertheless to be named, since no author has given any account of it. It is, that sulphate of strontian has also a capacity for super-saturation; forming, like No. 1, an acidulous sulphate in *solution*, and decomposable by water.

In several chemical works, written by very eminent men, I have frequently observed some of the above results very nearly accomplished; and have been amazed to find such palpable truths had escaped their notice: yet, on a careful examination of the context, I confess, I could never find a single proof that any one of these peculiarities of barytes has been known to the full extent as above detailed. In respect to No. 1, there is no mention of an *acidulous* sulphate nor of *fluidity*, in an essay, where I expected to find it, written in 1790 by C. Fourcroy*. It may also be remarked, that in a more modern work by the same very excellent chemist, speaking of sulphate of barytes, he expresses himself thus: "Il paraît cependant dissoluble par des *moyens* que la nature nous *cache* encore, puisqu'il est visiblement cristallisé par l'eau. On ne peut pas le faire cristalliser artificiellement †." The same author had affirmed the perfect insolubility of carbonate of barytes in nitrous (or nitric, for it is not yet decided) acid: "L'acide nitrique le plus concentré n'a absolument aucune action sur le carbonate de barite natif en morceau, ce sel y reste intact absolument comme dans l'eau ‡." This is quite contrary to the result of my experiments, even with little more heat being employed than the common atmospheric temperature. Indeed, regarding the effect of mineral acids upon the native carbonate of witherite, for it would be unfair, in this place, to speak of *artificial* carbonate, the same author sums up his opinion in one sentence: "Que les acides ne l'attaquent point en masse, et lorsqu' ils sont concentrés §." Since no part of this analysis has yet been re-

* Analyse de Carbonate de Baryte natif, &c. § 3.

† Système des Conn. Chimique.—"It, however, appears to be soluble by *means* which nature still *conceals* from us, since it is evidently crystallized by water. It cannot be made to crystallize artificially."

‡ Ibid. "The most highly concentrated nitric acid has absolutely no action on native carbonate of barytes in bits. This salt remains in it absolutely unattacked, as in water."

§ Analyse, &c. § 4.—"That the acids do not attack it in a mass, and when they are concentrated."

tracted,

tracted, but, on the contrary, if possible, more completely confirmed by the author's writings since that period, I have been less scrupulous in applying these quotations to my purpose. Though another author has, in one solitary sentence, apparently flatly contradicted C. Fourcroy, yet, on a closer inspection of the work, (2de édition *considérablement augmentée*,) which I should call a *third* edition, it does not appear that any one of these habitudes or anomalies has been clearly demonstrated to exist. The sentence is, to say no more of it, evidently conditional, and no mention made either of *concentration* or *dilution*: "Tous les acides minéraux décomposent ce sel," (meaning carbonate de barite &c.) But my doubts were completely removed, at least respecting what I have stated at Nos. 3 and 4, when I read a whole page †, where we find detailed a most circuitous process for purifying nitrous acid by litharge and nitrate of silver.

I purposely forbear to mention any method I pursued to accomplish each combination; as it appears to me to be within the limits of the meanest capacity, and obvious to every chemist to obtain the same results.

No. 108, Long Acre,
January 24, 1803.

LXII. *On the Utility of Prussiate of Copper as a Pigment.*
By CHARLES HATCHETT, Esq. F. R. S. †

THE accidental discovery made by Diesbach of the pigment called Berlin or Prussian blue, about the year 1710, and which afterwards was published by Woodward in the Philosophical Transactions for 1724, was soon adopted by artists and manufacturers, so that in a short time the great utility of this colour was completely established: it is therefore remarkable, that but little attention has been subsequently paid to the colorific properties of the other metallic prussiates.

The experiments made by Mr. Brown with the prussic lixivium on various metallic solutions do not merit particular attention, as the results evidently show that a very large portion of the alkali remained unsaturated with prussic acid, and thus the effects appeared different when the lixivium was prepared with blood or with muscle §.

Bergman has, however, more accurately examined the pro-

• Analyse, &c. § 7.—"All the mineral acids decompose this salt."

† Manuel d'un Cours de Chimie. *La Gange*.

‡ From Journals of the Royal Institution of Great Britain.

§ Philosophical Transactions 1724, p. 17.

perties of metallic precipitates, (*Opuscula*, tom. ii. p. 385), and especially notices the various colours of the prussiates; but neither he nor any other chemist, as far as I am acquainted, has pointed out to artists the utility of prussiate of copper as a pigment. During some late experiments, I was much struck with the beauty of this precipitate, and was therefore induced to make several trials of it as a paint: the results exceeded my most sanguine expectations. I afterwards prepared a large quantity, which at my request several gentlemen (particularly B. West, esq. P.R.A., John Trumbull, esq., and sir H. C. Englefield,) were so obliging as to try in oil, and in water; and I have had the satisfaction to learn, that in beauty and intensity it surpasses every brown paint now in use, with the additional advantage, that, by reason of its purple tint, it forms with white various shades of bloom or lilac colour, which do not appear liable to fade like those which are formed by means of lake.

The prussiates obtained from acetite, sulphate, nitrate, and muriate of copper, are all very beautiful; but the finest and deepest colour is afforded by the muriate. I have found also that prussiate of lime can be better depended upon for this purpose than prussiate of potash. The best mode, therefore, of forming this pigment, is to take green muriate of copper, diluted with about ten parts of distilled or rain water, and to pour in prussiate of lime until the whole is precipitated: the prussiate of copper is then to be well washed with cold water on the filter, and to be dried without heat.

LXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

AN account of a journey to the summit of Whararai, a mountain in the island of Owhyhee, by Mr. Archibald Menzies, naturalist on board the *Discovery*, captain Vancouver, was read on the 9th and 16th of December.

In January 1799, the *Discovery*, being stationed in Karakakooa bay, Mr. Menzies was desirous of making a botanical excursion into the island of Owhyhee, in company with some other gentlemen of the expedition, and, in particular, of ascending a conical mountain in the neighbourhood, called Whararai. For this purpose he was furnished with a numerous company of attendants by the king of the island, under the command of one of the chiefs, who was made responsible for his safety, and for his perfect accommodation with provisions of all kinds, and who executed his task with as much fidelity

fidelity as the whole troop performed their labours with alacrity. Mr. Menzies had a portable barometer of a simple construction, by which he ascertained the height of different places as accurately as the time would allow. The island appeared to be in general in a state of high cultivation: the provisions for the journey consisted of live hogs, poultry, dried fish, yams, and cocoa-nuts, in quantities that loaded more than twenty men. They left the sea-side the 17th of January, after coming by water to the foot of the mountain, the barometer standing at 30.10, the thermometer at 81°, at noon. The road was through lava and other volcanic productions for about three miles: here the plantations of bread-fruit trees began, and the country was fertile and pleasant; the night was passed in the uppermost village, consisting of a few scattered huts. Beyond this was a thick forest, skirted by fruitful plantations of bananas and plantains: about three miles within the forest, the elevation appeared to be 2600 feet above the sea. The thermometer was 59°, at noon. The natives constructed a number of small huts, which afforded shelter to the whole party for the night at the upper extremity of the forest. Here the thermometer was at 58°, in the evening: the uniformity of temperature at heights considerably different, Mr. Menzies attributes to the shelter of the forest, and the evaporation from the trees. But the next morning the thermometer was at 43°. The summit of the mountain was rugged and barren: Mr. Menzies arrived at it in a few hours from the last station. It afforded a very extensive view of the island, although parts of it were hidden by clouds: its most conspicuous features were two other mountains, of which the summits are covered with perpetual snow, bearing E. N. E. and S. E. by E. of Whararai. On this hill there is a very deep crater of a volcano, with ashes and cinders appearing quite fresh: the natives consider it as the habitation of evil spirits, whom they attempt to pacify by offerings of various kinds. The party of travellers spent the whole of this and the following day on the mountain, and passed the night in caverns thatched with plantain leaves, and strewn with grass and mats for the occasion. The *Sophora tetraptera* was in flower, as a small shrub; in the lower parts of the island it becomes a tree, of which the natives make their spears, and which takes a fine polish. The *dodonæa viscosa* thrived on the summit of the hill; and a small shrubby geranium was found there. The height appeared to be 8000 feet above the sea. The thermometer was lower at sun-set than at seven in the morning.

Mr. Menzies descended on the south-east side of the hill,
and

and arrived in the afternoon at a deep cavern, where he passed the night. Hence he made a fruitless attempt to ascend the snow-clad mountain, on the other side of the valley, in which the natives accompanied him with the greatest reluctance: the same cavern received him the following night. The centre of the island between the three mountains is barren and uninhabited: it appears to be elevated about 5000 feet above the sea. Returning towards the shore, the party arrived the next evening at a village nine or ten miles from Karakakooa bay, surrounded by fields and plantations in the highest possible state of cultivation; its elevation appeared to be about 2000 feet. Here they were entertained by an exhibition of much grace and great activity in the performance of a female dancer belonging to a strolling party. The next day was the last of the excursion; and the natives were dismissed with rewards of knives, files, scissars, looking-glasses, and tape, of which a small portion was surrendered by each to the king. The barometer now stood at 30.12, and the thermometer at 74°.

On the 13th of January the Society resumed its sittings after the Christmas holidays. An interesting paper, by Charles Hatchett, esq. on the alloying of metals, was read on that evening, and continued on the evening of the 23d. It results from his experiments that platina should not be employed as an alloy for gold, as it makes the gold assume a white colour. A number of experiments were made with pieces of gold coin, to ascertain the effects of the excess of motions similar to what they experience by rubbing in the pocket, and by being transported from one place to another. By these it was found, that copper in the proportion of 1-12th was the best alloy for gold; and that the deficiency found of late in the gold coin was not owing to the wear of circulation; as, in a quantity of guineas rather loosely packed, and sent to some distance by the coach, the wear was all upon a few, and on those the impression was quite obliterated: yet they were not found much deficient in weight, the work being by the action pressed in, and not as it were filed off.

ROYAL SOCIETY OF EDINBURGH.

This learned body has published the second part of the fifth volume of its Transactions, which presents the following papers:—Remarks on a mixed Species of Evidence in Matters of History; with an Examination of a new Historical Hypothesis in the *Mémoires pour la Vie de Pétrarque*: by the Abbé de Sade: by Alexander Fraser Tytler, esq.—Description of an Extra-uterine Fœtus; by Mr. Thomas Blizard.

zard.—Meteorological Abstract for the Years 1797, 1798, and 1799; by Mr Playfair.—A new and univereal Solution of Kepler's Problem; by James Ivory, Esq.—Description of some Improvements in the Arms and Accoutrements of Light Cavalry, &c.; by the Earl of Ancrum.—A new Method of expressing the Co-efficients of the Development of the Algebraic Formula $(a^x + b^x - 2ab \cos. \phi^n)$, by means of the Perimeters of two Ellipses, when n denotes the half of any odd Number; with an Appendix, containing the Investigation of a Formula for the Rectification of any Arch of an Ellipse: by Mr. William Wallace.—Chemical Analysis of an uncommon Species of Zeolite; by Dr. Robert Kennedy.

ROYAL SOCIETY OF GOTTINGEN.

The following prize question has been proposed for the year 1804:

As many observations and theories respecting the nature, principles, and laws of atmospheric phænomena, which if subjected to proof and more accurately known might be of great importance and utility in improving the present system of meteorology, are contained in the works of the old and modern naturalists of the 16th century, the Society requires a history of meteorology from the time of the Greeks and Romans to the present period, drawn from authentic sources, and materials selected with critical attention to the object in view. The prize will be 50 ducats, and the papers must be transmitted to the society before the month of September of the above year.

LXIV. *Intelligence and Miscellaneous Articles.*

FROM PROFESSOR PICTET.

PARIS, January 1, 1803.
 PROFESSOR PICTET presents his most sincere respects to Mr. Tilloch, and embraces the opportunity of a friend to send him one or two communications, which may prove interesting.

In the sitting of the National Institute of December 29, a letter was read from M. Mollet, professor of natural philosophy at Lyons, in which he announced two facts which appear to be new. The first is the appearance of a small light in the air which surrounds the orifice of an air-gun when

when discharged in the dark. This experiment does not always succeed; and the cause of the differences observed in this respect is not yet known.

The second fact is the inflammation of any combustible matter, such as a small bit of linen rolled up, when put into the narrow canal in which the lower extremity of a pump for condensing the air generally terminates. Two or three strokes of the piston are sufficient to inflame it, according as the current of air produced is more or less rapid.

In the same sitting M. Seguin concluded a memoir, which he had announced in the preceding, on the discovery he pretends to have made of a new febrifuge principle, absolutely different from any of those before employed with greater or less success. He considers it as much superior to cinchona, on account of the certainty of its effects, and the facility with which it can be procured. This febrifuge is nothing else than *gelatine*, or common strong glue. He purifies it, mixes it with a little sugar and orange flower water, and rolls it out into large cakes, which he cuts into small squares of the size of an inch, weighing about a gros. The dose is from two gros to thirty-two, according to the age and circumstances of the patient. It is dissolved in water in such a manner that the beverage retains a considerable degree of consistence; and it is swallowed at once when the fit comes on. The same thing is repeated at the next fit, and it is seldom necessary to take a third.

The author has mentioned a number of persons to give testimony of the success of this remedy, all from the individuals who depend on his vast establishments of tanning and agriculture.

The Institute has appointed a commission, composed of Berthollet, Fourcroy, Des Effarts, and Portal, to examine the memoir, and give in a report on it after repeating the experiments.

M. Seguin has announced a series of memoirs, in which he says he will develop the whole theory of fever, determine what is the febrile principle properly so called, and what is the mode of action of febrifuge medicines. The results are waited for with a mixture of impatience and doubt.

GALVANISM.

Professor Aldini repeated his experiments on Galvanism at the Anatomical Theatre, St. Thomas's Hospital, during the last month. As the professor does not speak the English language, Mr. Astley Cooper explained to the gentlemen present. The Galvanic troughs, consisting of 120 pairs of silver

silver and zinc plates, of two inches square, with the metallic communications, were under the direction of Mr. Pepys jun.

The first series of experiments was on frogs. The head being severed, the sciatic nerves and the whole of the muscles of the thighs and legs were laid bare; a portion of the vertebræ was cut away between the two nerves, leaving a small portion as a holding part.

Exp. I. The prepared limbs being held by the portion of the vertebræ, the muscular part of the thigh or knee was brought by the operator in contact with the nerves. Contractions instantly took place without any metallic communication.

Exp. II. Two prepared frogs were laid on the surface of a dry earthen plate, the opposite knees and the vertebræ communicating; as soon as a metallic arc was made by a bow of wire, touching the nerve and muscle of one of the frogs, violent contractions took place in both.

Exp. III. Three prepared frogs were laid in the same order as in *Exp. II.*, only the parts of the animal were not in contact, *except* by a streak of water drawn by the finger from one to the other across the plate. As soon as a metallic communication was made between the nerve and muscle of one, all the three were thrown into motion, and at the same instant. If glass bars or metallic ones with a small portion of wax on one end are used, no contractions are excited.

Exp. IV. A prepared frog being held by the foot and a portion of the vertebræ, and the other foot being brought in contact with a silver waiter, such violent contractions were excited as to cause the limb apparently to leap along the plate.

Exp. V. The operator having hold of the feet of a prepared frog with one hand, and by wetted hands communicating with three persons or more, the last person completed the circle by touching the vertebræ; in doing which contraction instantly took place.

Exp. VI. Two prepared frogs being laid in the order before mentioned on an earthen plate, a third was laid between them reversed, the toes touching the vertebræ of the two. On a metallic communication being made, the two outward ones violently contracted, without any sensible effect on the middle one, though it served as the conductor to one.

The second series was on a decapitated dog, in which the troughs were made by a flexible metallic conductor to communicate with the desired part.

Exp. VII. A wire of tin communicating with one end of the trough being introduced into the rectum of the animal, the head being placed against the severed trunk, the communication

nication was made into the ear by a wetted wire, or flexible conductor, joining the opposite end of the troughs. The contractions were so violent as to throw the animal forward on the table.

Exp. VIII. The communications were exactly as in the last experiment, but the head was separated about six inches from the trunk, and only communicated by the moisture on the table. On forming the circle, the contractions were nearly as before.

Exp. IX. The head being removed, the communication was made with the spinal marrow; upon which the intercostal muscles were excited sufficiently to expire and inspire the atmospheric air with such force, as to blow out a lighted taper.

Exp. X. Rabbits which had been decapitated exhibited several of the before-mentioned phenomena. Two trunks or two heads placed together experienced contractions on the communication being made.

Exp. XI. A portion of the diaphragm being laid on an earthen plate, was subject to contraction on the communication being made.

Exp. XII. The heart was not subject to contraction by the Galvanic shock; but was affected mechanically, as it usually is by glass, resin, or any insulating pointed body.

Exp. XIII. Galvanic attraction was made sensible by the operator holding a prepared frog by its feet, placing the other hand on the spinal marrow of the dog, and bringing the sciatic nerves of the frog nearly in contact with the exposed ribs of the dog: the nerves were instantly attracted, and contraction took place.

Exp. XIV. The contraction of the pupil of the eye, by connecting the optic nerve with one end of the pile and touching the iris with the other conductor, was shown. This experiment was proposed by Mr. Babington.

The surgeons and pupils of Guy's and St. Thomas's Hospital very handsomely presented the professor with a gold medal*, as an acknowledgement of his attention and application in elucidating several of these compound experiments to their complete satisfaction.

* On one side are the arms of Guy's and St. Thomas's Hospital; on the other is the following inscription, surrounded with raised oak leaves:

Johanni Aldino,
Præclaro Physico,
Digno Galvani Nepoti,
Recens Experimentis commonstratis,
Professores et Scholares
Nosocom. St. Thomæ et Guy.
Libenter persolvunt.
MDCCCIII. Londini.

The following account of some experiments on a human subject we copy from the newspapers :

“ The body of Forster, who was executed on Monday the 17th of January for murder, was conveyed to a house not far distant, where it was subjected to the Galvanic process by professor Aldini, under the inspection of Mr. Keate, Mr. Carpue, and several other professional gentlemen. M. Aldini showed the eminent and superior powers of Galvanism to be far beyond any other stimulant in nature. On the first application of the process to the face, the jaw of the deceased criminal began to quiver, the adjoining muscles were horribly contorted, and one eye was actually opened. In the subsequent part of the process, the right hand was raised and clenched, and the legs and thighs were set in motion. It appeared to the uninformed part of the by-standers as if the wretched man was on the eve of being restored to life. This, however, was impossible, as several of his friends, who were under the scaffold, had violently pulled his legs, in order to put a more speedy termination to his sufferings. The experiment, in fact, was of a better use and tendency. Its object was to show the excitability of the human frame, when this animal electricity is duly applied. In cases of drowning or suffocation, it promises to be of the utmost use, by reviving the action of the lungs, and thereby rekindling the expiring spark of vitality. In cases of apoplexy, or disorders of the head, it offers also most encouraging prospects for the benefit of mankind. The professor, we understand, has made use of Galvanism also in several cases of insanity, and with complete success. It is the opinion of the first medical men, that this discovery, if rightly managed and duly prosecuted, cannot fail to be of great, and perhaps, as yet, unforeseen utility.”

To render the preceding account more interesting, we shall relate the following, either new, or not commonly known, facts.

1. Taking the cessation of excitability to the Galvanic stimulus as the criterion of life, the heart is not the *ultimum* but the *primum moriens*; for, while the muscles of the limbs were excited to strong contractions for even 7 hours' apparent death by suspension of a hot-blooded animal, the heart was utterly incapable of being excited to action, either by applying the extremity of the metallic arc to the surface or to the interior of this organ.

2. The lungs were equally inexcitable as the heart.

3. Not only were the muscles, but the skin and cellular membrane, excited to action by the Galvanic stimulus.

4. The

4. The contractions of the muscles were excited by the metallic arc or wire applied to the nerves supplying such muscles; but the nerves themselves were not affected, not even the largest nerve of the human body, the sciatic nerve.

5. Motion or raising up of the arm was produced (as if by volition) by the Galvanic stimulus.

6. A milky or coagulated matter was formed by repeated contractions of the muscle in contact with the copper wire, or wire of copper plated with silver: and the same appearance was seen when a plate of tin foil was interposed, for then this white matter was formed on this tin foil.

7. When the parts ceased to give out motion, or less motion, the motions were renewed with augmented force by wetting them with solution of sal-ammoniac.

8. It is scarcely necessary to remark, that the Galvanic stimulus excited contractions in parts which gave out no action to sulphuric acid, volatile alkali, and other stimuli.

Of the practical Uses of Galvanism.

The uses in common life of new facts are not always immediately apprehended; so that, although nothing very conclusive can be said, the present facts may be hereafter of great utility. In the meanwhile we observe:

1. That Galvanism may be a most powerful aid in restoring the vital actions suspended by submersion, by suspension, &c. although it does not act upon the lungs and heart; but if, at the same time that it excites the muscles in general, warm oxygen gas be applied to the lungs, and frictions and the hot bath be employed, much more may be effected than without Galvanism.

2. In many diseases consisting in cessation of action, the parts may be excited to action by this new stimulus, *if it be duly applied*. For this purpose a machine is required which will of itself, without manual assistance, apply effectually the Galvanic fluid for any length of time. Such an instrument has been constructed by Mr. Cuthbertson, and will no doubt hereafter be as commonly used as our present electrical machines.

3. In comparing electricity to Galvanism, it must be considered, that the former acts by its *intensity*, and the latter by its *quantity*: that the former, so intense, and sufficient if properly directed to knock a man down, shall yet not be in *quantity* enough to melt an iron wire or one of platina; but the latter shall melt these metals, yet scarcely produce a shock.

MISCELLANEOUS:

1. Hildebrandt, in a series of experiments on the action of both the carbonate and pure ammonia on copper, found no solution take place without the presence of atmospheric air. Hahnemann had ascribed the action to the carbonic acid obtained from the air, but this he has proved is without foundation. If the oxide of copper is used, a blue solution is produced without the admission of the atmosphere.

2. According to Vauquelin, the boracite called magnesian calcareous borate by the French chemists, is not a triple compound, consisting of boracic acid, magnesia and lime. When transparent and crystallized, he finds in it none of the latter substance, but only boracic acid and magnesia. When opaque, it is rendered so by lime, not in chemical combination.

3. An analysis of the waters of Plombiers, by Vauquelin, gives per pint:

- 1 gr. 1-6th of sulphurated soda.
- 5-8ths of muriated soda.
- 2-3ds of filix.
- 1-4th of carbonate of lime.
- 1 gr. 1-12th of carbonate of soda.
- 1-half of animal matter.

This animal matter is like albumen, and is only held in solution by the soda; as an acid instantly separates it, and causes it to precipitate.

4. Brugnatelli recommends nitric ether to be prepared in the following way:—Into a tubulated retort put one ounce of sugar and two ounces of alcohol: to the retort adapt a large receiver covered with wet cloths; secure the joint with pasted paper, then pour in three ounces of concentrated nitric acid by the tubulure: ebullition takes place, and an excellent ether of an orange colour passes into the receiver, which will not redden vegetable blues: as soon as the ether is all received, nitrous gas is evolved: the receiver must be immediately changed. By treating the residuary sugar with more nitric acid, oxalic acid very pure will be obtained.

5. Mr. Dabit, in the *Annales de Chimie*, No. 127, gives an account of some experiments on the residuum of sulphuric ether, from which he is induced to believe, that he has discovered an acid of sulphur in a state of oxygenation intermediate between the sulphuric and sulphureous acids. As yet he has not obtained it in a free state; and he founds his

conclusions upon the phænomena presented by its saline compounds.

In saturating the residuum of ether, mixed with water, with carbonate of lime, he obtained a solution which gave by evaporation a salt that crystallized in parallelepipeds, having but little taste, and being soluble in 100 parts of cold water. This salt was decomposed by sulphuric acid. By the action of oxygen gas, or of nitrous acid, it was converted into sulphate of lime; and, by being heated with charcoal, it gave a sulphuret of lime.

When it was mixed with a solution of carbonate of potash, soda, or ammoniac, a double decomposition took place, and the stronger acid combined with the alkalies.

Mr. Dabit has noticed some of the properties of its alkaline combinations, which are extremely analogous to those of the sulphites. He proposes to call the acid the oxygenated sulphureous acid. But the application of the name will most probably be generally considered as premature; and new characters will be required to distinguish it from the sulphureous acid, before its existence as a peculiar body can be implicitly admitted.

6. Dr. Benzenberg, in an essay on the improvement of object glasses for telescopes*, warmly recommends that the glass be suffered to cool in the pots without stirring, and that the mass be then divided in a horizontal direction, so that the variation of density may be regular, and then, by a proper form of the glasses, the errors of refraction may be corrected. The idea is not new, but it does not appear to have been carried into practice. Dr. Benzenberg considers achromatic telescopes as promising much more than reflectors, and thinks that they intercept much less light.

7. Mr. Sprenger of Jever gives an account† of his method of administering Galvanic electricity in cases of deafness. A small ball is applied to the external orifice of the ear, and a much larger one is held in the patient's hand; the communication is then formed and interrupted alternately by means of machinery, once in every second, for about four minutes daily, for a fortnight or more. He asserts that he has thus restored the sense of hearing to forty-five persons, and to four of them that of smell also. All who were completely deaf experienced relief, almost without exception; but a partial deafness did not appear to receive the same benefit. The ear was filled with wool, to avoid taking cold. The degree of advantage obtained was estimated by an instrument invented

* Gilbert's Annals.

† Ibid.

by Professor Wolke, in which a hammer falls from a certain point of a quadrant, so as to strike an elastic plate with a velocity capable of precise determination. These experiments relate to a subject so important that they must not be passed unnoticed, however improbable it may appear that Galvanic electricity should have any material advantage over electricity otherwise excited, and however we may be disposed to believe the report of other observers, that the relief is in general inconsiderable and only temporary.

ARTIFICIAL COLD.

Mr. Lowitz (*Journal de Chimie et de Physique*, by Van Mons,) concludes, from various experiments on artificial cold, of which a particular account is to be published in the Transactions of the Academy of Peterbourg,

1. That the principal cause of the cold produced during the solution of salts in water, depends upon some agency of their water of crystallization; for salts deprived of this water, instead of producing cold, produce heat.

2. Amongst the liquid acids, the muriatic acid is most efficacious for forming freezing mixtures; the nitrous acid is next to it in order; and the sulphuric acid is least powerful.

3. The liquid acids produce cold only because they occasion a quick solution of the snow, or salt, of the freezing mixture.

4. Caustic potash and the muriate of lime surpass very much, as cooling agents, the acids and the other saline substances.

5. The best proportion of the mixture of snow and muriate of lime, is two parts of the first to three parts of the last, mixed as accurately as possible.

6. Five pounds of muriate of lime are sufficient to freeze thirty-five pounds of mercury.

7. The deliquescent salts are much more proper for producing cold than the efflorescent salts.

8. That the deliquescent salts may produce the highest possible degree of cold, it is necessary that they contain the greatest possible quantity of water of crystallization; and that they be used in fine powder.

9. The snow employed should be that which has newly fallen, light and dry; and the experiments should be made at the commencement of a frost, and not during a thaw.

10. It appears that the superiority of the deliquescent salts to the acids is owing to the circumstance of their be-

coming fluid at the same time that they cause the snow to dissolve.

11. Caustic potash and muriate of lime possess, amongst other advantages, that of being easily restored, unaltered, to their solid state, after an experiment, by evaporation.

PRESERVING ANIMAL SUBSTANCES.

Mr. Chauffier employs, for preserving animal matters from putrefaction, a solution of oxygenated muriate of mercury, kept constantly in a state of saturation. The preparations remain immersed in it for a certain number of days; and, after they are thoroughly impregnated with it, may be dried by exposure to light and air. After the process, they are no longer susceptible of being easily decomposed; they preserve their form, become possessed of a great degree of hardness, and are not subject to the attacks of insects.

HUMBOLDT'S TRAVELS.

The *Berlinische Monatschrift*, a journal published monthly at Berlin, contains an interesting extract of a letter from M. Alexander von Humboldt, in which he gives an account of the progress of his travels through South America. It is written from Contreras, near Ibagua in New Grenada. Before he left Carthagena he paid a visit to the forest of Turbaco, celebrated for the size of its trees: some of them are eight feet in diameter, and are of the kind named *cavanillesia mocondo*, before observed by Jacquin, who travelled in the time of Francis I. M. von Humboldt, who had proposed to go to Peru, could not resist the desire he entertained of proceeding to Santa-Fé-de-Bajota to see the celebrated botanist Mutis, 72 years of age, and one of the friends of Linnæus.

Thus, instead of proceeding by sea to Guayaquil, which was much more convenient, he pursued the route to Quito by land through Santa-Fé. He first navigated, for forty-five days, along the river De la Madelaine, amidst the most dreadful tempests and the most dangerous cataracts. During this part of his journey he constructed a topographical chart of the country on four folio sheets, a copy of which was kept by the viceroy. When he arrived at Honda, in five degrees north latitude, he visited the mines of Mariquita and Sainte-Anne. In that country he found considerable plantations of cinnamon and nutmeg-trees; and whole forests of the tree which furnishes cinchona, and of the almond-tree, called by botanists *caryocar amygdaliferum*.

M. von Humboldt was at that time accompanied by a young

young Frenchman named Desieux, to whom the Spanish government had entrusted the care of these plantations. Our travellers at length reached the entrance of the Cordilleras (*la Bocca del Monte*), climbed up the first eminences, and came to the plain of Bajota, one of the highest of the globe. This plain was formerly a lake, containing a surface of 32 square leagues: in the middle of it is situated the town of Santa-Fé. M. von Humboldt was received here as if in triumph: sixty persons on horseback came to meet him; and the venerable Mutis had prepared a house for him near to his own. The king of Spain devotes 10,000 piastres per annum to this botanical establishment. For fifteen years past, thirty draftsmen have been employed in it under the direction of Mutis. They have executed 3000 drawings in folio, which are finished with all the delicacy of miniature painting. M. von Humboldt could compare the botanical collection of Don J. Celestino Mutis only to that of Sir Joseph Banks. M. von Humboldt measured the altitude of the mountains which surround Santa-Fé, several of which rise to the height of 2000 and 2400 toises. From Santa-Fé he was to proceed to Quito, and thence to Lima. He was to be at Acapulco in the month of May last year, and, after travelling through Mexico, he was to return to Europe by the Philippines and the Cape of Good Hope. Such a journey, undertaken by so enlightened a man, promises the happiest results to science.

SALTS OF IRON*.

The sulphate, muriate, and acetite of iron, at their minimum of oxidation, may be obtained in a very easy manner by means of the artificial sulphuret of iron. When artificial sulphuret of iron is acted upon by muriatic acid, or sulphuric acid in a state of dilution, or acetic acid, the sulphureted hydrogen gas, disengaged during the process of solution, prevents any hyper-oxygenated salt from being formed by the action of the atmosphere; and a clear fluid, in all cases, of a shade of green, is obtained, which, when freed by heat from any sulphureted hydrogen dissolved in it, gives a perfectly white precipitate with the alkaline prussiates, and is not found to alter the colour of solution of galls.

To form the least oxygenated nitrate of iron, by means of the artificial sulphuret, an acid of a specific gravity not greater than 1.12 must be used; and the solution must be made without the assistance of heat. After having been freed from sulphurated hydrogen, by being boiled for a minute or two, and

* From *Journal of the Royal Institution of Great Britain*.

then filtrated, it is found similar in its colour and physical properties to the weakest solutions of the other oxygenated salts.

When the sulphate and muriate of iron, at the minimum of oxidation, are obtained in the solid form, by evaporation from their solutions, they appear in regular crystals, which in each salt are a different shade of a very pale green colour; their tastes are exactly similar, being astringent, and leaving in the mouth the sensation of sweetness.

The least oxygenated nitrate of iron cannot easily be procured pure in the crystallized state; for when the solution of it is heated for any length of time, a new arrangement of its principles takes place; portions of the acid and of the water of the solution are decomposed; in consequence of which ammoniac is formed; and an oxygenated nitrate of iron, with excess of base, is deposited.

Amongst the salts of iron, at the minimum of oxidation, I have found the muriate the most convenient for exhibiting the experiments of Proust, and in eudiometrical processes with nitrous gas. It is more soluble in water than the sulphate, and very much more soluble in alcohol. D.

ERRATUM.

Page 82, lines 3 and 4, for "organ of instinct *and*," read "organ of instinct *of*."

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Fig. 6







Fig. 1.

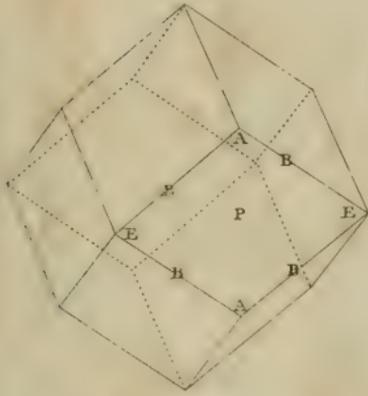


Fig. 2.

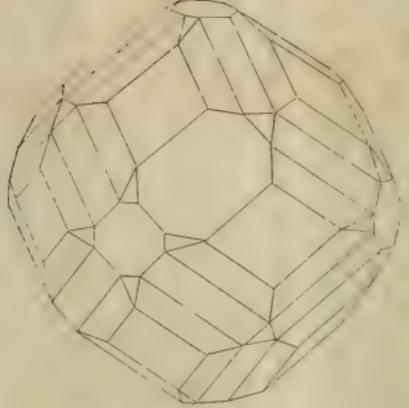


Fig. 3.

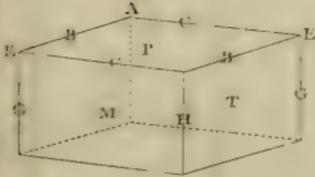


Fig. 4.

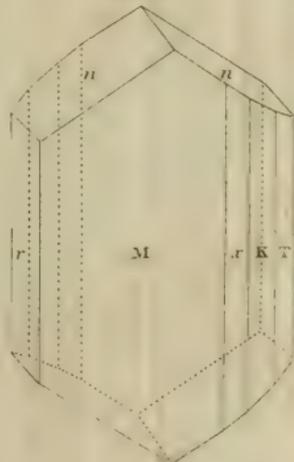


Fig. 5.

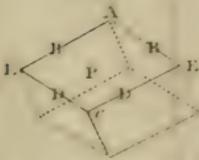


Fig. 6.

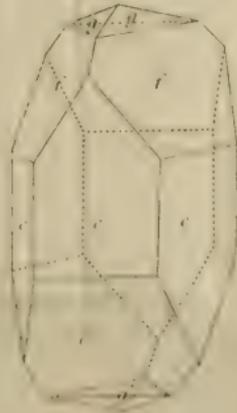
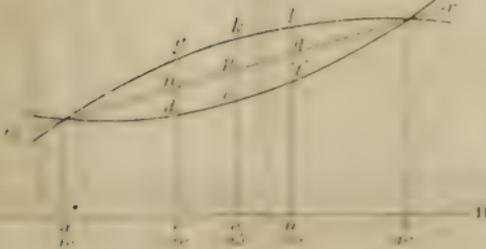
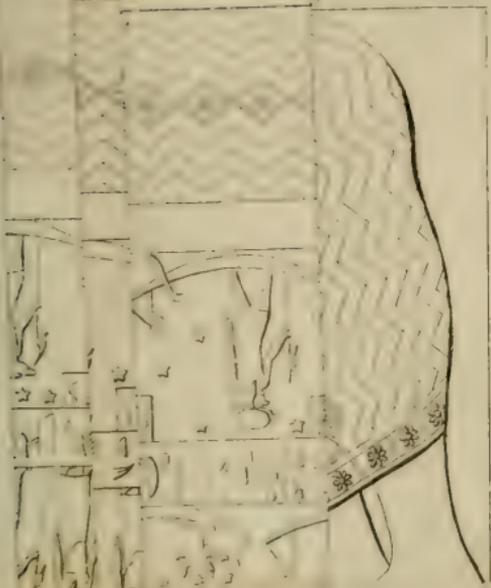


Fig. 7.





a. Pl. IV. Vol. XIV.



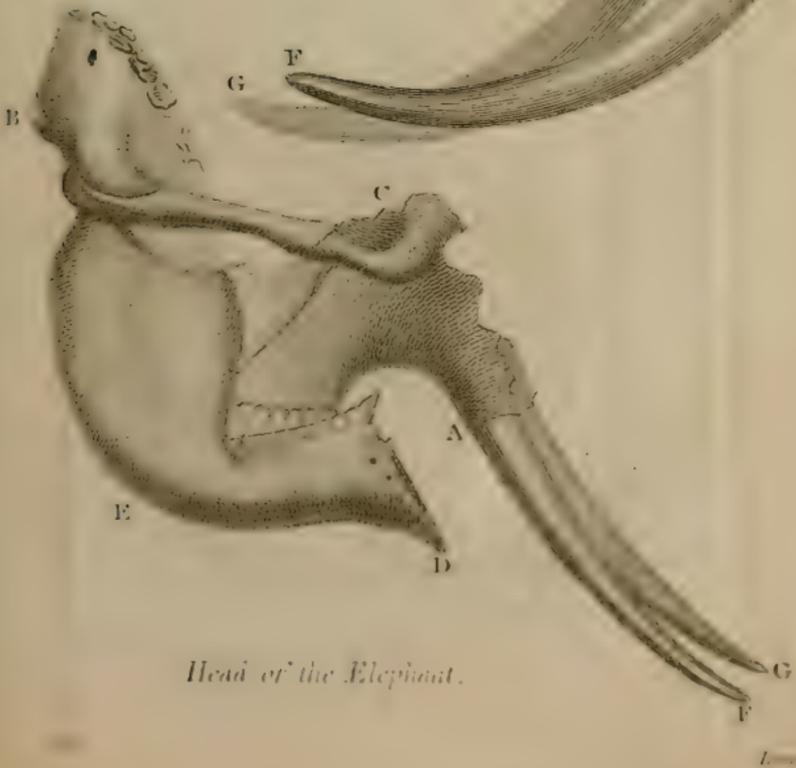
Head of the ...







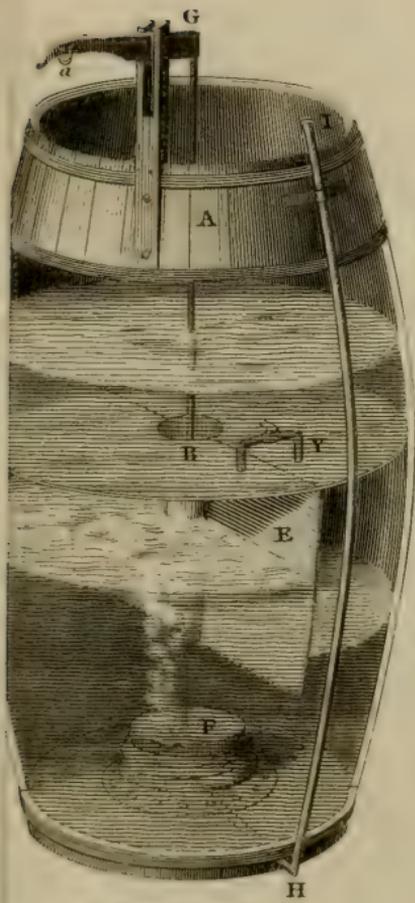
Head of the Mammoth.



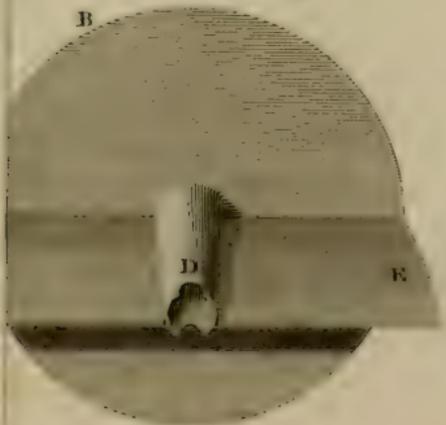
Head of the Elephant.



4.



B



2.

Fig 1

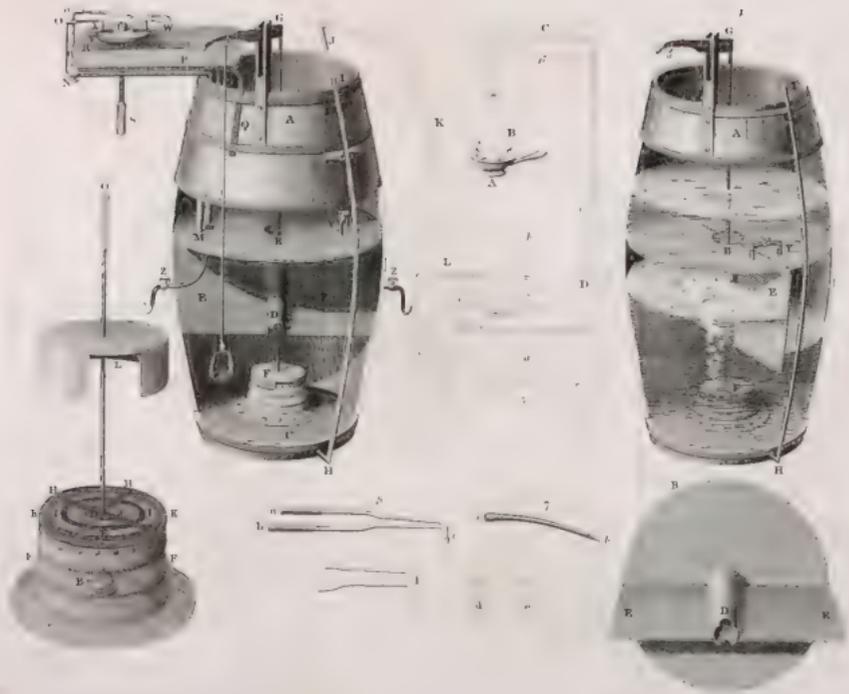


Fig. 1.

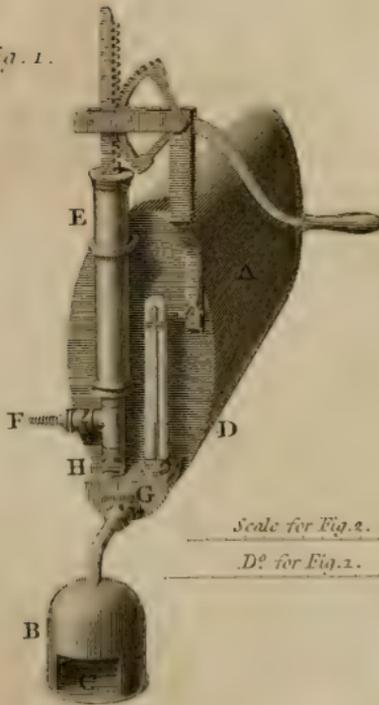


Fig. 2.



Matilda Lowry del.

W. Lowry sc.



