L. R. 1.

Library

Vol. 53. JANUARY 1819. No. 249.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

# THE PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

NUMBER CCXLIX.

*For JANUARY* 1819.

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*

PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE LANE:

And sold by CADELL and DAVIES; LONGMAN, HURST, REES, ORME, & BROWN; HIGHLEY; SHERWOOD and Co.; HARDING; UNDERWOOD; SIMPKIN and MARSHALL; London: CONSTABLE and Co. Edinburgh: BRASH and REID; DUNCAN; and PENMAN, Glasgow: and GILBERT and HODGES, Dublin.

In the Press, and speedily will be published,

THE GAS BLOW-PIPE, or ART of FUSION by burning the Gaseous Constituents of Water; giving the History of the Philosophical Apparatus so denominated; the Proofs of Analogy in its Operations to the Nature of Volcanoes; together with an *Appendix*, containing an Account of Experiments with this Blow-pipe.

By EDWARD DANIEL CLARKE, LL.D.
Professor of Mineralogy in the University of Cambridge, Member of the Royal Academy of Sciences at Berlin, &c. &c.

Printed for T. Cadell and W. Davies, Strand.

---

## ENGRAVINGS.

Vol. XLIII. A Plate to illustrate a New Transit Instrument invented by Sir H. C. ENGLEFIELD, Bart.—A Plate to illustrate the Use of Air-Vessels in Plants. By Mrs. IBBETSON.—A Plate to illustrate M. SEMENTINI's new Apparatus for producing Oxygen Gas to restore suspended Animation—Mr. READE's Paper on the Refraction of the Solar Rays—and Mr. HARGREAVES's Observations on Colours.—A Plate to illustrate Mr. J. WHITFORD's mechanical Substitute for Leeches; and Mr. J. TILLEY's Hydro-pneumatic Blow-pipe.—A Plate to describe Mr. R. HUGHES's Gudgeon for the Shaft of a Water-wheel; and Mr. PADBURY's Guard for a Carriage-wheel.—A Plate to describe Captain PEAT's Temporary Ship's Rudder.—A Quarto Plate of Mr. SAMUEL JONES's Sofa Bed.

Vol. XLIV. A Plate to illustrate Mr. HUME's Gazometer and Blow-pipe; a Proposal for an Improvement of the Galvanic Trough; and a new Apparatus for preparing pure Muriatic Acid.—A practical Diagram for obtaining the Lunar Distances observed by a Sextant.—Electrical Apparatus to illustrate Mr. BRANDE's Paper on some new Electrical Phænomena.—A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Cuticle of Leaves.—BRUNTON's Patent Chain Cable.—Figures relative to Dr. BREWSTER's Paper on the Affections of Light transmitted through crystallized Bodies.—A Plate to illustrate Dr. BREWSTER's Paper given in our last Number.

Vol. XLV. A Plate to illustrate the Nourishment produced to the Plant by its Leaves. By Mrs. IBBETSON.—A Plate to illustrate Mr. BAKEWELL's Sketch of the Arrangement of the Rocks and Strata in the Northern Counties of England.—Plates to illustrate Mr. ROBERTSON BUCHANAN's Description of the Steam-Boats on the Clyde; and Mrs. IBBETSON's Paper proving that the Embryos of the Seeds are formed in the Root alone.—A Plate to illustrate Mr. JOHN WALTERS's Improvements in Naval Architecture.—A Quarto Plate on the Roots of Plants.—Plate of Mr. SINGER's Electric Columns; Mr. WALKER's Electrometer; ROCHON's Apparatus for ascertaining the Heat of coloured Rays.

Vol. XLVI. Mr. T. JONES's New Reflecting Compass.—Mr. WOOLF's Patent Boiler for Steam Engines and other Purposes.—A Plate to illustrate Mr. WOOLF's Improvement on the Steam-Engine, by which the possibility of Steam escaping past the side of the Piston is effectually prevented.—A Plate to illustrate some Electrical Experiments by M. DE NELIS of Malines; with an Extension of them by Mr. SINGER and Mr. CROSSE.—A Plate to illustrate the Electrical Experiments of M. DE NELIS of Malines.—WOOLF's improved Steam-Engine.—A Plate to illustrate Mr. EVANS's Paper on guiding Balloons through the Atmosphere.—A Plate

Vol. 53. February 1819. No. 250.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

# THE PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

NUMBER CCL.

*For FEBRUARY* 1819.

WITH AN ENGRAVING BY PORTER,

Illustrative of Dr. Ure's Experiments on Caloric, Mr. Luckcock's Paper on the Atomic Philosophy, and Mr. Bolton's on the Purification of Coal Gas.

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*
PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE-LANE:
And sold by Cadell and Davies; Longman, Hurst, Rees, Orme, & Brown; Highley; Sherwood and Co.; Harding; Underwood; Simpkin and Marshall; London: Constable and Co. Edinburgh: Brash and Reid; Duncan; and Penman, Glasgow: and Gilbert and Hodges, Dublin.

## TO CORRESPONDENTS.

Mr. H. Meikle on Friction, &c. came to hand too late for the present Number.

---

To the Owners and Lessees of Coals and other valuable Minerals; *particularly those whose Works may be suffering from any of the perplexing natural Difficulties, to which subterranean Operations are liable.*

Mr. Farey, Sen. *Mineral Surveyor and Engineer,* begs to announce, that those considerable Surveys in Scotland and in England, on which he has for three years past been so entirely occupied, as to decline attending to many professional applications, are now completed; and that in consequence, some Months of his Time during the ensuing Summer and Autumn are yet at his disposal, and for which he would be glad to form Engagements.

It has been Mr. Farey's object of Study and his long and extensive practice, to give effect to the practical and local knowledge of the resident Agents entrusted with the management of Mineral Works, by advice on any of the impediments to a profitable conduct of such Works, arising from *Faults,* excess of *Water, Exhaustion* of the known Seams, Veins or Beds, &c. &c. by the application of new and scientific principles, in the investigation of whatever is regular in the *Strata* and *Veins* of the Estate and its vicinity, whereon he is consulted, and in the investigation, founded on correct principles and extensive experience, of all the various *Deficiencies, Contortions, Dislocations* and *Accidents,* which the Strata and Minerals have experienced, at the time, or since they were first deposited.

And where such are desired by the Owner or Lessee, Mr. Farey has been used, to embody all the information so acquired, in Mineral *Maps, Sections* and *Reports,* which will record for future use, and hand down to the heirs of the Estate, those essential particulars of the subterranean facts and Works, within it; which will hereafter in a principal degree *affect the value,* and perhaps *the practicability of getting* those deeper portions of the Minerals, which in almost every instance remain.

Already a large number of Mineral Works have experienced great delays, and unnecessary Expenses, because the making and preserving of such Documents as have been alluded to, were not earlier understood and correctly practised; but at a period not very distant, this evil will be experienced in a tenfold degree.

Detached and imperfectly described Surveys and underground Documents exist, on most Estates, as well as a still larger body of correct knowledge, in the Memories of the Agents, Overseers, and Workmen, which ere long will become quite useless, or be irretrievably lost, together with all the benefits which these can confer, unless they are collected, investigated, compared and completed, in such Maps, Sections and Reports, as it has been a principal part of Mr. F's practice, to form, for Mineral Owners.

Mr. Farey's *terms,* and the nature of his practice, may be known by Letter, or by an Interview, at his House, No. 37, Howland Street, Fitzroy Square, London.

Vol. 53. MARCH 1819. No. 251.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

THE

# PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

NUMBER CCLI.

*For MARCH* 1819.

WITH AN ENGRAVING BY PORTER,

Representing Mr. RENNIE's Apparatus employed in his Experiments on the Strength of Materials; and the Marquis RIDOLPHI's Improvement on the Gas Blow-pipe.

*BY ALEXANDER TILLOCH,*

M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*

PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE-LANE:

And sold by CADELL and DAVIES; LONGMAN, HURST, REES, ORME, & BROWN; HIGHLEY; SHERWOOD and Co.; HARDING; UNDERWOOD; SIMPKIN and MARSHALL; London: CONSTABLE and Co. Edinburgh: BRASH and REID; DUNCAN; and PENMAN, Glasgow: and GILBERT and HODGES, Dublin.

## TO CORRESPONDENTS.

Mr. Upington's Communication in our next.

Dr. Forster on British Warblers also in our next.

Mr. Lowe on Coal-gas, &c. would have appeared in our present Number, could the Figure have been engraved in time.

Mr. Murray's second Favour reached us too late for insertion this month.



---

## ENGRAVINGS.

Vol. XLVI: Mr. T. Jones's New Reflecting Compass.—Mr. Woolf's Patent Boiler for Steam Engines and other Purposes.—A Plate to illustrate Mr. Woolf's Improvement on the Steam-Engine, by which the possibility of Steam escaping past the side of the Piston is effectually prevented.—A Plate to illustrate some Electrical Experiments by M. De Nelis of Malines; with an Extension of them by Mr. Singer and Mr. Crosse.—A Plate to illustrate the Electrical Experiments of M. De Nelis of Malines.—Woolf's improved Steam-Engine.—A Plate to illustrate Mr. Evans's Paper on guiding Balloons through the Atmosphere.—A Plate illustrative of Dr. Brewster's Paper on Light.—A Quarto Plate to illustrate Sir H. Davy's Paper on the Fire-damp of Coal-Mines, and on Methods of lighting the Mines so as to prevent its explosion; and the Account of Mr. Stephenson's Safe-Lamp for Coal-Mines.

Vol. XLVII. Illustrated with a Quarto Plate describing the Planisphere of Dendera.—A Quarto Plate to illustrate Mr. Brown's Paper on Architecture.—A Plate to illustrate Sir George Cayley's Paper on Aërial Navigation; and Mr. London's Hydrometer.—A Quarto Plate of the Temple of Kournou at Thebes.—A Plate of the new Baths at Ramsgate.

Vol. 53. APRIL 1819. No. 252.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

# THE PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

NUMBER CCLII.

*For APRIL* 1819.

WITH AN ENGRAVING BY PORTER,

Illustrative of Mr. MEIKLE's Paper on Calorific Radiation; Mr. LOWE's on the Purification of Coal Gas; and Mr. HUGHES's on ascertaining Distances.

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*

PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE-LANE:

And sold by CADELL and DAVIES; LONGMAN, HURST, REES, ORME, & BROWN; HIGHLEY; SHERWOOD and Co.; HARDING; UNDERWOOD; SIMPKIN and MARSHALL; London: CONSTABLE and Co. Edinburgh: BRASH and REID; DUNCAN; and PENMAN, Glasgow: and GILBERT and HODGES, Dublin.

The following Works will be published in May by William Phillips, George-Yard, Lombard-Street, London.

TRANSACTIONS of the GEOLOGICAL SOCIETY. Vol. V. Part I. with Plates. 4to.

AN ESSAY on CHEMICAL ANALYSIS, chiefly translated from the Fourth Volume of the last Edition of the *Traité de Chimie élémentaire*, &c. by M. THENARD; with numerous Additions, comprehending all the latest Discoveries and Improvements in this Branch of the Science, with Plates.

By J. G. CHILDREN, F.R.S. L. and E. F.A.S. &c. &c.

In One Volume 8vo.

The Second Edition, in One Volume Crown 8vo., of

AN ELEMENTARY INTRODUCTION TO MINERALOGY, including Descriptions of Minerals, and Notices of the Places and Circumstances in which they are found; especially the Localities of British Minerals. The most important Crystalline Forms are printed on the same pages with the Descriptions. Designed for the use of the Student.

By WILLIAM PHILLIPS, F.L.S.

Member of the Geological Societies of London and Cornwall.

---

## ENGRAVINGS.

Vol. XLV. A Plate to illustrate the Nourishment produced to the Plant by its Leaves. By Mrs. IBBETSON.—A Plate to illustrate Mr. BAKEWELL's Sketch of the Arrangement of the Rocks and Strata in the Northern Counties of England.—Plates to illustrate Mr. ROBERTSON BUCHANAN's Description of the Steam-Boats on the Clyde; and Mrs. IBBETSON's Paper proving that the Embryos of the Seeds are formed in the Root alone.—A Plate to illustrate Mr. JOHN WALTER's Improvements in Naval Architecture.—A Quarto Plate on the Roots of Plants.—Plate of Mr. SINGER's Electric Columns; Mr. WALKER's Electrometer; ROCHON's Apparatus for ascertaining the Heat of coloured Rays.

Vol. XLVI. Mr. T. JONES's New Reflecting Compass.—Mr. WOOLF's Patent Boiler for Steam Engines and other Purposes.—A Plate to illustrate Mr. WOOLF's Improvement on the Steam-Engine, by which the possibility of Steam escaping past the side of the Piston is effectually prevented.—A Plate to illustrate some Electrical Experiments by M. DE NELIS of Malines; with an Extension of them by Mr. SINGER and Mr. CROSSE.—A Plate to illustrate the Electrical Experiments of M. DE NELIS of Malines.—WOOLF's improved Steam-Engine.—A Plate to illustrate Mr. EVANS's Paper on guiding Balloons through the Atmosphere.—A Plate illustrative of Dr. BREWSTER's Paper on Light.—A Quarto Plate to illustrate Sir H. DAVY's Paper on the Fire-damp of Coal-Mines, and on Methods of lighting the Mines so as to prevent its explosion; and the Account of Mr. STEPHENSON's Safe-Lamp for Coal-Mines.

Vol. XLVII. Illustrated with a Quarto Plate describing the PLANISPHERE of DENDERA.—A Quarto Plate to illustrate Mr. BROWN's Paper on Architecture.—A Plate to illustrate Sir GEORGE CAYLEY's Paper on Aërial Navigation; and Mr. LONDON's Hydrometer.—A Quarto Plate of the Temple of Kournou at Thebes.—A Plate of the new Baths at Ramsgate.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

# THE PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

NUMBER CCLIII.

*For MAY* 1819.

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*
PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE-LANE:
And sold by Cadell and Davies; Longman, Hurst, Rees, Orme, & Brown; Highley; Sherwood and Co.; Harding; Underwood; Simpkin and Marshall; London: Constable and Co. Edinburgh: Brash and Reid; Duncan; and Penman, Glasgow: and Gilbert and Hodges, Dublin.

## TO CORRESPONDENTS.

Professor HIGGINS on his Atomic Theory;—and Mr. PETER NICHOLSON on a New Method of Treating Factorial and Figurate Numbers—have been received, and will appear in due course.

Vol. 53. June 1819. No. 254.

*Published the Last Day of every Month,*
[PRICE 2s. 6d.]

THE

# PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,
THE LIBERAL AND FINE ARTS,
GEOLOGY,
AGRICULTURE,
MANUFACTURES AND COMMERCE.

NUMBER CCLIV.

*For JUNE 1819.*

WITH AN ENGRAVING BY PORTER,
Illustrative of Dr. Olinthus Gregory's Paper on the different Rates of Pennington's Astronomical Clock at the Island of Balta, and at Woolwich Common.

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

*LONDON:*
PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE-LANE:
And sold by Cadell and Davies; Longman, Hurst, Rees, Orme, & Brown; Highley; Sherwood and Co.; Harding; Underwood; Simpkin and Marshall; London: Constable and Co. Edinburgh: Brash and Reid; Duncan; and Penman, Glasgow: and Gilbert and Hodges, Dublin.

# THE PHILOSOPHICAL MAGAZINE AND JOURNAL:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY,

AGRICULTURE,

MANUFACTURES AND COMMERCE.

---

*BY ALEXANDER TILLOCH,*
M.R.I.A. M.G.S. M.R.A.S. MUNICH, F.S.A. EDIN. AND PERTH, &c.

---

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

VOL. LIII.

*For JANUARY, FEBRUARY, MARCH, APRIL, MAY, and JUNE,* 1819.

*LONDON:*

PRINTED BY RICHARD AND ARTHUR TAYLOR, SHOE LANE:

And sold by CADELL and DAVIES; LONGMAN, HURST, REES, ORME, and BROWN; HIGHLEY; SHERWOOD and Co.; HARDING; UNDERWOOD, London: CONSTABLE and Co. Edinburgh: BRASH and REID; DUNCAN; and PENMAN, Glasgow: and GILBERT and HODGES, Dublin.

THE

# PHILOSOPHICAL MAGAZINE AND JOURNAL.

## I. *On the Nature and Laws of Friction.* *By Mr.* Thomas Tredgold.

The great perfection to which the art of constructing machines has arrived in this country would lead a person, unacquainted with the real nature of its progress, to imagine that the laws which regulate the motion of bodies had been deeply studied; and that every aid which reason or scientific experiment could give, had been successfully employed to surmount the natural difficulties of the subject.

This, however, is not the case; as it has been through repeated trials, and tentative methods only—attended with an immense loss of capital—that this perfection has been attained: and it is a lamentable fact, that even now the knowledge of machinery is so much confined to particulars, and exists in so detached and unconnected a state, that were any sudden revolution to happen in the affairs of this country, the greater part of it would be buried in oblivion.

One great defect in the theory of machines is the want of proper formulæ to calculate the effect that can be produced by a given power; and one of the most common causes of failure is our imperfect knowledge of the nature, laws, and quantity of friction.

How often has an ingenious machine been contrived with the fairest prospect of success, but, when tried on a large scale, it has either been racked to pieces in a few months by requiring a greater moving power than it was calculated to sustain—or it has been totally inefficient for its intended purpose?

Long practice may give the power of erecting machines of the same kind with tolerable success, under a considerable difference of moving power; but this very practice must have arisen out of repeated trials, and is generally dear-bought wisdom, though seldom at the mechanician's own expense.

In whatever manner an effect is produced by the intervention of of machinery, a certain portion of the moving force is lost in friction; in some cases nearly the whole, and in all it is considerable. The importance therefore of a correct mode of calculating the effect of friction is perhaps one of the greatest desiderata in mechanical science.

The greater part, if not the whole, of our knowledge respecting friction, is the result of experimental inquiry; and the few investigations that have been attempted have been conducted as if it depended wholly on the internal structure of bodies: at least such is the principle adopted by Parent and Belidor*, who considered bodies to be composed of spherical particles, and that friction consisted in the force lost in raising these spherical protuberances over one another. But were that the case, there could not be a difference in the friction of different bodies. The most ingenious and elegant illustration of the nature of friction is that given by Professor Leslie (in his Inquiry into the Nature of Heat, &c.) The Professor very justly observes that "its existence demonstrates an unceasing mutual change of figure, the opposite planes during the passage continually seeking to accommodate themselves to all the minute and accidental varieties of contact. The one surface being pressed against the other becomes, as it were, compactly indented by protruding some points and retracting others. This adaptation is not accomplished instantaneously, but requires very different periods to attain its *maximum*, according to the nature and relation of the substances concerned"

I will now endeavour to exhibit, in its most simple form, the relation between the friction and those properties of bodies by which it is affected, in hopes that it may tend to elucidate the subject; and also furnish some valuable hints respecting the nature of the bodies that are best adapted to move on one another with the least friction.

The form of the surfaces of bodies is determined by their internal structure; and whatever degree of smoothness may be given by art, it is impossible to render those surfaces perfect planes: and when two bodies are pressed together, the surfaces in contact will, in proportion to the force, become indented into one another. Whatever may be the depth of indentation, when the body is caused to slide, a part equal to this depth is supposed to be abraded or torn away. That such an abrasion does take place, is apparent from common observation, as all bodies wear when exposed to friction. There are, however, some very flexible bodies that by yielding escape being abraded, such as caoutchouc, &c. which appear to require an extension of these principles to include them.

* *Architecture Hydraulique.*

Assuming

Assuming, then, that the surfaces are actually abraded in the case of motion, and that the magnitude of the base of each indented part is proportional to the depth of indentation; also let F be the friction; I the depth of indentation; and A the force necessary to abrade or tear the surfaces indented together: then

$$F : I \times A. \quad (1)$$

That is, the friction is directly as the depth of indentation and the resistance to abrasion.

## I. *Of the Friction of Bodies moved from Rest.*

When the surfaces of bodies are pressed together, whether it be from the weight of one of the bodies or any other force, a certain time must elapse before the indentation is a maximum; which, when the modulus of elasticity of the body is known, may be easily determined from the principles of dynamics. But in the case now under consideration the body is supposed to be moved from rest, and consequently that the indentation is a maximum and proportional to the pressure: call this pressure P. And as the extension and compression of bodies are equal when the forces are equal, let the extension corresponding to the weight that would produce fracture be denoted by E; also make L = the length, and B = the breadth of the surfaces in contact.

Now the indentation will be directly as the pressure and the extensibility, and inversely as the length and breadth; that is,

$$I : \frac{P \times E}{L \times B} \quad (2)$$

The resistance to abrasion will be directly as the surface and as the cohesive force of the body; and let C be the cohesive force, then

$$A : L \times B \times C. \quad (3)$$

But by the general proportion (1) $F : I \times A$, therefore, by Prop. (2) and (3) $F : P \times E \times C$. (4)

Hence it appears that when bodies of the same kind are moved from rest, the friction is as the pressure, as has been shown by experiments. It also appears that the friction is directly as the extensibility and cohesion; or that body which bends the most, and sustains the greatest weight at the time of fracture, will have the greatest degree of friction, and *vice versâ* *.

Hitherto the rubbing surfaces have been considered to be of the same material: but when the materials are of different kinds, that which has the least cohesive force will be abraded; and as it

* There are several qualities of bodies which depend on the cohesion and extensibility; but their names convey a very imperfect idea of their nature. The following definitions are submitted for the consideration of the reader.

When the extensibility and cohesion are at the least, I would call the body *brittle*. When they are a maximum, I would call it *tough*. When the cohesion it can only be torn away to the depth which the more coherent body indents into it, in the general proportion

$$F : P \times E \times C, \ (4)$$

E must be the extensibility of the more coherent body, and C the cohesion of the other body.

Consequently,—adhering to the definitions of hardness, &c. given in a preceding note,—a hard body moving on a soft one will have less friction than a hard body rubbing against a hard body, or a soft body moving on a soft one. But a tough body moving on a brittle one, will have more friction than brittle moving on brittle, or tough on tough bodies. These are important deductions in a practical point of view, particularly when it is recollected that Coulomb obtained results which agree with them, in his experiments on friction.

## II. *Of the Friction of Bodies in Motion when the Motion is uniform.*

In the preceding investigation the indentation was supposed to have reached its *maximum*. This, however, cannot be the case when the body is in motion, unless this motion be very slow.

But when the indentation does not attain its maximum, it will vary directly as the extensibility, the force, and square of the time, and inversely as the area of the surface; or, because the other quantities are constant in the same body, putting T for the time, we have

$$I : T^2, \ (5).$$

But the time is inversely as the velocity of the body; and substituting this value of T, we have

$$I : \frac{1}{V^2}, \ (6).$$

Also, the surface abraded, in a given time, will be as the area of the body, and the space passed over: therefore

$A : V. L. B. C$, or because $L. B. C$ is a constant quantity for the same body, $A : V$, (7).

By Prop. (1) $F : I \times A$, therefore $F : \frac{1}{V}$, (8).

In uniform motions, then, the friction is inversely as the velocity.

hesion is a maximum, and the extensibility a minimum, the body may be called *hard*: and when the cohesion is a minimum, and the extensibility a maximum, the body may be called *soft*. Consequently the hardness would be as $\frac{C}{E}$; or if M be the weight of the modulus of elasticity $\frac{C}{E} = M$; then, we have hardness : M; softness : $\frac{1}{M}$; toughness : CE; and brittleness : $\frac{1}{CE}$. And the friction of tough bodies would be the greatest, and that of brittle bodies the least.

III. *Of*

### III. *Of the Friction of Bodies when the Motion is uniformly accelerated.*

In this case the general proportion (6) remains the same as when the motion is uniform, that is $I : \frac{1}{V^2}$.

But by the laws of accelerated motion the space abraded will be as the square of the velocity; the body being moved from rest. Therefore $A : V^2$, (9).

And $F : I \times A$, becomes $F : 1$, (10).

Consequently in this case friction is an uniformly retarding force, as Professor Vince has shown by his ingenious experiments.

In the case of bodies moved from rest, the theory above stated fully explains the phænomena observed by Coulomb: it removes all the seeming anomalies respecting the friction of heterogeneous bodies, and enables us to determine the quantity of friction from the properties of bodies which have been investigated. The most convenient method of doing this is to change the general proportions into equations; the constant members of which may be easily got from experiments. Let these constants be $a$, $b$, and $c$, for the three cases then,

In bodies moved from rest $F = P \times E \times C \times a$,

In uniform motions $F = \frac{P \times E \times C \times b}{V}$.

And in uniformly accelerated motions, $F = P \times E \times C \times c$.

Consequently when $a$, $b$, and $c$ are determined for one body, the friction of any other body may be found, its extensibility and cohesive force being known, or the weight of its modulus of elasticity and cohesive force being known;

For weight of modulus $= \frac{\text{cohesive force *}}{\text{extensibility}}$.

The bodies should be free from any intermixture of hard particles, otherwise these laws will not obtain: and it may be further observed, that friction is increased by introducing the fragments of hard bodies between the rubbing surfaces; as these fragments become indented into the surfaces in proportion to their hardness, and consequently cause a greater degree of abrasion. On this principle the art of stone-sawing, &c. depends. On the contrary, the introduction of soft substances prevents the surfaces acting upon one another, thus lessens the abrasion, and consequently the friction; but in order that these substances may produce the desired effect, it is necessary that they should be of a sufficient degree of consistence to keep the bodies from indenting into one another: hence it is that tallow answers better

* An extensive set of tables of the cohesive force of bodies may be found in Phil. Mag. vol. L. p. 421, and the extensibility or modulus of elasticity may be got from Dr. T. Young's Nat. Phil. vol. ii. p. 509.

than oil. When grease of any kind is in too liquid a state for preventing friction, it may be improved by adding the powder of any mineral that soils easily, such as black-lead, &c.

On the preceding principles the durability of bodies exposed to friction might be easily ascertained. When the surfaces are of the same kind, the durability will be inversely as the indentation, and consequently inversely as the extensibility. When the surfaces are of different kinds, the durability will be inversely as the extensibility of the harder surface.

It is obvious that when bodies roll, different laws will obtain; but the subject might be treated in a similar manner, which will be considered at some future period.

THOMAS TREDGOLD.

---

## II. *On Roads and Wheel-Carriages. By Mr.* BENJAMIN WINGROVE.

THAT important branch of our political œconomy, the management of the public roads, whether considered in reference to convenience or burthen, forms an object of such consequence to the community at large, and to the agricultural interests in particular, that I think no apology necessary for intruding on the public a communication on that subject.

The vast increase of the commerce and wealth of this country has long demanded the convenience and luxury of good roads; and the *whole art necessary for their construction and preservation* has been, for many years past, imparted to the public by various treatises and essays, which are to be found in the libraries of every establishment for the advancement of science and knowledge. Our enlightened legislature has too, by various general and local statutes, furnished all the requisite powers and authorities for effecting so important a design. Yet, notwithstanding a call so imperious, information so adequate, and power so efficient, a supineness truly unaccountable has, till within a few years past, prevailed throughout the country on this interesting subject. I might indeed aver that, in some parts, the system has been altogether retrograde. The inconveniences which have resulted from this great popular neglect, have however, at last, proved insupportable; and in consequence the reformation of the road system has commenced with a zeal and energy that cannot fail to produce the most successful issue.

In the northern counties, particularly in Yorkshire and Nottinghamshire, and in some parts about London, (in all which Mr. Clay has successfully introduced his ingenious machinery, improvements have been effected. In this part of the kingdom, the

the Bristol commissioners began the work of amendment; and their general surveyor, Mr. M'Adam, has revived, with improvement, a plan long practised in this county, and admirably calculated for roads which, like those in the Bristol trust, are composed of excellent materials. The commissioners of this district also determined on removing the reproach which the bad state of their roads had brought on Bath and its neighbourhood. They confided the execution of their works to my direction; and notwithstanding the existing paucity of proper materials, and in spite of usage more destructive than in any other part of England, the system I have adopted has been crowned with complete success; as the present excellent state of our roads will, I trust, sufficiently testify. From these and other districts, in which reformation has been adopted, the light of improvement is extending throughout the country with a rapidity and spirit that promise to overcome every obstacle, and finally to effect a grand and general scheme of reformation in the road system.

My object in this address is not to discuss plans or theories. In passing, however, I may be allowed to remark, that in all popular objects taken up with enthusiasm, schemes of delusion are often hastily adopted. Thus, in this instance, the art of the engineer, on which the *stability of every system of road-making must depend*, appears to be overlooked; and the whole merit and importance of the scheme is ascribed to mere mechanical means, which will not bear indiscriminate application, and, even where locally advantageous, may afford only a temporary benefit. The partial disappointments hence arising may occasionally prove prejudicial to the progress of the general work: but as the spirit of inquiry, when once awakened, is too strong to be subdued, science will, in the end, be sure of its triumph. I therefore entertain a belief, that within a few years, *if due legislative precautions be taken*, the highways of this kingdom will exceed in excellence all that has ever been enjoyed by a nation, since the dissolution of the Roman empire.

The means of giving permanency, then, to a measure, on which so much of the ease and safety of society depends, must infallibly excite the solicitude and inquiry of the public. But surely it is always better to meet evils by anticipation, and guard against them by timely exertion, than to wait their effects before a remedy be devised; and I trust that this communication will be found contributive to that end.

I think that I shall be supported in stating as an axiom, *that it is not only essential, but indispensable, that there should be a reciprocal adaptation between the roads and the carriages which pass over them.* That this adaptation does not now exist, more particularly where the roads are properly constructed, must be obvious

obvious to any observer of facts. An inspection of the wheel-carriages now in common use throughout the country will, I venture to affirm, afford abundant evidence of the accuracy of that observation. Many of these carriages might justly be described as engines for the destruction of good roads, and for the punishment of the animals doomed to drag them along. My observation and experience in the usage of roads has wrought a conviction in my mind, that, unless a reformation be effected in the construction and regulation of wheels and wheeled carriages, millions will be wasted, and roads in a state of excellence will be altogether denied to those districts which do not possess the means of providing good materials.

This subject has within the last twenty years been so often brought before the public, and explained with so much perspicuity and ingenuity, that it would be highly presumptuous in me to descant on it. Need I mention the works of Edgeworth, the admirable essays and experiments of Cummings, (whose positions, though doubted or disputed on some points, still appear to lead the mind to conviction:) or should I remind the public that years ago the whole of this important matter, both as regards the construction of wheels and the general management of roads, underwent a full examination before a Committee of the House of Commons, and that a copious and valuable mass of evidence was obtained, which has been long since published to the world? Notwithstanding these proceedings of the legislature, which produced an exposition fraught with so many valuable facts, still has this matter, so important to the country at large, and to the landed interest in particular, been permitted ever since to remain dormant. To what can such an extraordinary apathy or indifference be attributed? Is it that human ingenuity is believed to have attained to its acme, and that mechanical improvements have ceased? The numerous philosophical establishments and public repertories of the country will prove the contrary. Are not, then, these delays solely attributable to the inveteracy of custom and its concomitant prejudices? To overcome such obstacles is a difficult task. Scepticism will ever come in aid of ancient establishments. Let it be so. I would not overturn one system, until the merits of that which is to be substituted had undergone due investigation, and its superiority been proved. As however opinions are, or may be, at variance on this subject, inquiry is the only means of attaining to the truth; and it is with an humble desire to kindle and extend that spirit of inquiry, that I have framed this address.

Having thus declared that my views in this publication are merely to excite inquiry and investigation, it would be neither necessary nor becoming in me to impose on the attention of the public

public by any schemes or measures of improvement which I may contemplate in reference to the foregoing. I trust, however, that I may assume the privilege of mentioning a few points of a general nature, which call loudly for parliamentary interposition.

The present mode of *dragging waggon wheels* in descending hills, if continued, will render every effort for the preservation of roads in hilly countries wholly unavailing; for, in fact, the smoother and more even we render the surface, the more destructive is the system of dragging. The custom on smooth roads is to drag "rough," as it is termed, that is by tying the wheel so as to bear on a projecting angular nail, which sometimes rises above the streak of the wheel, half and even three-quarters of an inch, operating on the most consolidated surface literally as a plough. This destructive plan cannot be more severely felt than on the roads about Bath; where the hills, which are the avenues to the city, for all ponderous materials, stone and coals, are steep and long. But every hilly country will exhibit abundant evidences of this terrific mischief. I am unwilling to express my opinion as to a remedy; but I should think that a shoe, as it is here designated, not as made at present, but *properly constructed* and *properly used*, is preferable to any other mode of dragging: at all events, "dragging *rough*" should be interdicted.

The restrictions now in force as to the *breadth* of *carriages* are also productive of serious evils. At the period when the general Highway and Turnpike Acts were passed, (13th of the present king,) the roads were then generally narrow, especially at the entrances of towns and cities; but the commercial intercourse of the country, though comparatively with its present extent of small importance, was increasing, and wheeled carriages of all burthens obtaining. The legislature, therefore, to meet the convenience of the public, thought it necessary to regulate the width or breadth of wains and waggons, so as to make them suitable to the then confined state of the roads; and it was accordingly enacted, that all wains and waggons should be of the width of four feet six inches from inside to inside of the wheels; but a breadth of wheel was allowed to heavy carriages. It was, according to some, from this restriction, that the extreme conical wheel now so much in public use, and deemed so injurious to the roads, owes its introduction. Now it will be readily seen, that this compulsive uniformity in the breadth of carriages has conduced in a great measure to the rutting of roads, as every carriage covers the same space. By repealing this law, (and the roads being universally extended in width, there is no reason for its continuance,) and regulating the breadth of carriages, those with broad wheels by a maximum and minimum, and those with narrow wheels by a maximum only, an immediate improvement, or rather diminution of of injury, to the roads, would of course follow: for by varying the breadth of carriages according to the breadth of wheel, or according to any other given rule, the wheels of each would require a different line, and so, in a certain degree, each successive carriage would operate as a roller, instead of contributing to make ruts, which is the effect of the present restrictions, from the insurmountable aptitude of horses and drivers to pursue the same track.

Although no exposition of the injurious effects of this law has appeared in any of those parts of the printed evidence taken before the Committee of the House of Commons which have fallen under my eye, yet, I conclude that a mischief and a remedy so obvious could not have escaped the attention of the numerous and well-informed gentlemen who have inquired into, or written on, the subject. I do not, therefore, either in that or any other point embraced in this address, claim the merit of originality. My motive, as already disclosed, is merely to invoke an investigation, which may, in the end, bring all the conflicting opinions which have been promulgated, or which may exist, on these important matters, into collision; and thus that errors may be detected, and the necessary changes and reformations established on bases of truth and science. I have, therefore, refrained as much as possible from intruding my own humble opinions on the notice of the public. I think it necessary however to add, that I shall at all times be ready to disclose my sentiments on the matters to which I have in any degree alluded, should it appear necessary; and an inclination to forward the work of improvement induces me thus publicly to invite fair criticism on my works, and to declare that the public may obtain from me a full exposition of the plans I have pursued.

Bath Roads Office, Dec. 12, 1818.

---

## III. *On the Scheme of a Perpetual Full Moon. By Mr.* Henry Meikle.

*To Mr. Tilloch.*

Sir, — Of all the various ways in which human weakness manifests itself, perhaps there is none wherein it is more pompously displayed than by pretending to improve the mechanism of the universe.

Our own country is not altogether barren of such pretensions; and if at any time we are likely to run short of scepticism, we have only to call for help from the continent. There is an instance of this, in a work from which better things might have been

been expected; where Laplace is introduced alleging that had the moon been made to enlighten the earth, Nature has been frustrated in her design, for that end is not answered. Our author then, compassionating the weakness of Nature, proposes the scheme of a perpetual full moon. With how much wisdom, we shall see immediately.

If the moon were always in opposition, or full, it is evident that she would then be a primary planet, and a superior one too; for she would revolve about the sun as a centre, and her orbit would also include the orbit of the earth. Now, since in this case the periods of the earth and moon are equal, the forces with which they are urged to the sun must be as their distances from it. If, therefore, $\odot$, $\ominus$, and ☽, be the masses of the sun, earth, and moon; $x$ the distance of the earth from the sun; and $x+y$ the distance of the moon from the sun: Then $\frac{\odot}{x^2} - \frac{\text{☽}}{y^2}$ may denote the force urging the earth to the sun*, and $\frac{\odot}{(x+y)^2} + \frac{\ominus}{y^2}$, that drawing the moon to the sun; hence $\frac{\odot}{x^2} - \frac{\text{☽}}{y^2} : \frac{\odot}{(x+y)^2} + \frac{\ominus}{y^2} :: x : x+y$. But if the distance at which the earth alone would revolve about the sun in a year be $=1$, we have also $\frac{\odot}{x^2} - \frac{\text{☽}}{y^2} : \frac{\odot}{1^2} :: x : 1$, and $\frac{\odot}{(x+y)^2} + \frac{\ominus}{y^2} : \frac{\odot}{1^2} :: x+y : 1$; $\therefore x^3 + \frac{\text{☽}\, x^2}{\odot y^2} - 1 = 0$, and $\frac{1}{(x+y)^2} + \frac{\ominus}{\odot y^2} = x+y$. Let $\odot = \cdot 333928$, $\ominus = 1$, and $\text{☽} = \frac{1}{68\cdot 5}$; then $x = \cdot 9998566$, and $y = \cdot 01007544$.

The distance of the real moon from the earth is $\frac{1}{390}$ nearly; so that in this case it would be $3\cdot 93$ times as far off; and the light received from it being inversely as the square of the distance, will only amount to $\frac{1}{15\cdot 4}$ of what it now is: also, since the action of the moon to raise the tides is reciprocally as the cube of the distance, we shall only have $\frac{1}{60\cdot 7}$ of the present tides.

If ☽ were such that $\frac{1}{\overline{390}|^3} : y^3 :: \frac{1}{68\cdot 5} : \text{☽} = \frac{\overline{390y}|^3}{68\cdot 5}$, we should

* In strictness, the force urging $\odot$ and $\ominus$ together is $\frac{\odot + \ominus}{x^2} + \frac{\text{☽}}{(x+y)^2} - \frac{\text{☽}}{y^2}$; and that urging $\odot$ and ☽ together is $\frac{\odot + \text{☽}}{(x+y)^2} + \frac{\ominus}{x^2} + \frac{\ominus}{y^2}$. But the above is sufficiently accurate for the present purpose.

then

then have the proper light and tides; because the moon would present the same apparent disk, and its mass would also have the same ratio to the cube of its distance. By substituting $\frac{\overline{390y}|^3}{68\cdot5}$ for ☽, the equations are $x^3 + \frac{\overline{390}|^3 y}{68\cdot5} - 1 = 0$, and $\frac{1}{\overline{x+y}|^2} + \frac{1}{\odot y^2} = x+y$; from which $x = \cdot9839696$ and $y = \cdot01884823$: so that the moon's distance from the earth will be 7·35 times as far as at present; and its mass 397·2 times what it now is, which is 5·8 times the mass of the earth, or fully eight times its size.

Laplace has certainly in this, as well as in some of his other pious speculations, extended his researches beyond the bounds of truth. Manifold doubtless were the ends of the moon's creation; and among others, it is manifestly designed and admirably fitted for giving light to the earth. On the other hand, the contrivance of a perpetual full moon loudly proclaims what a confused inefficient system would have resulted, had even so great a man as Count Laplace been consulted.

It appears from both examples, that the common centre of gravity of the earth and moon is further from the sun than 1, the mean radius of the ecliptic. That this must be the case, whatever be the mass of the moon, is easily shown. For, if possible, let the centre of gravity be at the distance unity; then since $y$ is divided by the centre of gravity into $\frac{☽ y}{1+☽}$, and $\frac{y}{1+☽}$, we should have $x = 1 - \frac{☽ y}{1+☽}$, and $x+y = 1 + \frac{y}{1+☽}$. Hence, the sum of the products of the mass of each planet into the sun's attraction would be represented by $\frac{\odot \times 1}{\left(1 - \frac{☽ y}{1+☽}\right)^2} + \frac{\odot \times ☽}{\left(1 + \frac{y}{1+☽}\right)^2}$, which will equal $\frac{\odot(1+☽)}{1^2}$, if the centre of gravity were in the ecliptic, and the centripetal exactly balancing the centrifugal force. But by performing the division, $\frac{1}{\left(1 - \frac{☽ y}{1+☽}\right)^2} + \frac{1}{\left(1 + \frac{y}{1+☽}\right)^2} =$ $\frac{1+☽}{1^2} + \frac{☽}{1+☽} \times 3y^2 - \frac{☽ - ☽^3}{\overline{1+☽}|^2} \times 4y^3 + \&c.$ The centre of gravity must therefore be at a greater distance than unity, otherwise the centripetal would overpower the centrifugal force.

Let $1+v$ be the distance of the centre of gravity from the sun, then $x = 1 - \frac{☽ y}{1+☽} + v$; $x + y = 1 + \frac{y}{1+☽} + v$; and since the sun's attraction must equal the centrifugal force, or $x \times 1$

+

$+(x+y)\,☽ = \frac{1}{x^2} + \frac{☽}{\overline{x+y}|^2}$, we have $1+☽+(1+☽)\,v=$

$$\frac{1}{\left(1-\frac{☽ y}{1+☽}+v\right)^2} + \frac{☽}{\left(1+\frac{y}{1+☽}+v\right)^2} = 1+☽-2(1+☽)\,v+$$

$\frac{☽}{1+☽} \times 3y^2+3(1+☽)v^2-$&c. or $v=\frac{☽ y^2}{\overline{1+☽}|^2}$ very nearly. In the first example, $v=\cdot00000144$, and in the second, $v=\cdot00004457$.

To apply this in the case of the real moon, we have $y=\frac{\cos. z}{390}$, the angular distance of the sun and moon being $z$. Hence,

$$v=\frac{☽ y^2}{\overline{1+☽}|^2}=\frac{\frac{1}{68\cdot5}\times\cos.^2 z}{\left(390\left(1+\frac{1}{68\cdot5}\right)\right)^2}=\cdot0000000932\cos.^2 z;$$ so that

the common centre of gravity of the earth and moon is about nine miles further from the sun in syzygies than in quadratures.

The mean value of $v$ for an entire lunation is found by multiplying it by $\dot{z}$, when it becomes $\frac{☽\,\dot{z}\cos.^2 z}{300\times\overline{1+☽}|^2}$, the fluent of this or the sum of all the $v$'s is $=\overline{z+\sin. z\cos. z}\times\frac{☽}{2(390(1+☽))^2}$; and this, when $z=360°$, becomes $360°\times\frac{☽}{2(390(1+☽))^2}$, which divided by $360°$ gives $\cdot0000000466$ for the mean increase of the radius vector.

It would hence appear, that the earth's orbit (if the time be given) is increased in consequence of its connexion with the moon; and that the radius vector of the sun, along with that of the centre of gravity, is lengthened by unity in the 7th decimal place at syzygies. Although the earth and moon are in motion about their common centre of gravity, this cannot protect it from these little inequalities; for gravitation is regardless of motion, and the centrifugal force the same as if the earth and moon were concentrated in their common centre of gravity.

If you think this speculation deserving a place in your excellent Miscellany, the insertion of it will much oblige,

Sir,

Your very humble servant,

HENRY MEIKLE.

## IV. *A Postscript to the Paper "On the Swallow" inserted in No.* 246. *By Mr.* Gavin Inglis.

*To Mr. Tilloch.*

Strathendry Bleachfield, Dec. 7, 1818.

Sir, — On reading my communication On the Swallow, inserted in your Number for October last, I find I had omitted one anecdote, which, although trivial in itself, may without impropriety be inserted, as it tends in some measure to elucidate the wisely-discriminating penetration of these wonderfully sagacious little creatures, when deviating from the general habits of their species. The anecdote was connected with, and should have followed,

" I have known both kinds in a bad season, when short of flies to nourish and bring forward their young, abandon whole nests of the last sittings to perish, when the ultimate period of their departure arrived, but never knew them separate and leave the other divisions behind." Neither did I ever know even a straggling deviation, except in one solitary instance, and which must have been the result of deliberation, dictated by the peculiar circumstances of the season, conjoined with heart-ties of the tenderest parental affection.

In the year 1814, by accident the nests with the second incubation of two pair had fallen and the eggs were broken. This misfortune was repaired with all possible dispatch by rebuilding, and a fresh sitting of eggs produced . but by this circumstance, and consequent delay, these nestlings were thrown far behind their twin-kindred of the same brood. And when the period of departure arrived, they had not gained sufficient fledging to leave the nest. The weather however was dry, and the season upon the whole favourable. The parents of both nests, contrary to the practice in unfavourable years, allowed the colony to depart, remained behind after every swallow but themselves was gone, nourished and brought forward their second brood, put them through all their trainings and facings, and, in about fourteen days after their associates had gone, took their departure, directing and protecting the flight of their young to join the departed colony.

I have now to communicate one additional fact, which I consider a complete refutation of their fancied subaquatic hibernation. During the past summer, the servants observing the attention I was bestowing on every movement of the swallows, were quite alive to point out every thing regarding them that appeared any way particular. From the fineness of the season, and no lack of food, the young brood all survived; and towards the period of their hibernating, joined in all probability by other distant colonies, they mustered numbers far beyond what I ever remember

ber to have seen in any former year, but not a white-tailed one could ever be detected in the assembled multitude. Their gathering song was more than usually cheerful; their training and spiral flights, from their augmented numbers, were particularly amusing; and their merry-making was louder and longer heard after their flight was beyond the reach of the visual organs: perhaps this might be heightened by an uncommonly mild humidity in the air, which being more conductory of sound than a dry atmosphere might aid the vibration of their noisy clamour. At length they took their final departure, leaving "not a rack behind," under all the similar circumstances of former years. On the evening of the seventh day, however, after they had totally disappeared, we had again the unusual pleasure of a revisitation from our old friends. It was a fine summer evening; the exhalations of the meridian sun hovered over our heads in calm serenity; while not a breath of wind nor the rustling of a leaf disturbed the rays of the sun, half smothered, half reflected, glimmering through a misty veil of snow-white brightness, and heightened by the increasing obliquity of the departing beams, which threw over the waning day an air of heavenly sublimity. Enticed from the elevated regions (to which I am of opinion they retire, and keep on the wing during the whole of their absence, or through which they wing their flight to distant climes) by the uncommon mildness and calm serenity of the evening, the swallows were first heard but faintly, as at a great distance in the air. Their well-known voice however was instantly recognised, and the sound of the ethereal crowd (of swallows) brought some of the servants from the field, to intimate the return of their old and particular friends. From the *increasing* sound, we discovered they were gradually continuing their descent, till their well-known and familiar tones were distinctly heard in loud clamour by every servant on the field. None ventured to descend below the vapour; consequently none of them were seen, although they remained within hearing for nearly an hour together. They reascended with the going down of the sun, and have never been heard nor seen again. Yours sincerely,

GAVIN INGLIS.

---

## V. *On the Manufacture and Uses of Animal Charcoal, known by the Name of Ivory Black, &c. By the Chevalier* CADIT DE GASSICOURT.

THE physical and chemical properties of animal charcoal have been known only for a few years. Formerly bones and ivory were calcined in close vessels merely to procure a fine black for paint-



ing;

ing; but, since the discovery of the properties of charcoal as a purifier and clarifier, they make use of it in sugar-refineries, laboratories, and stills, as well as for purifying oil, &c. Many manufactories have been established, and the preparation of bone-black is now become a separate art, of interesting consideration.

There are many manufacturers of animal charcoal in Paris. Their process is very simple. Some, after filling a number of earthen or iron pots with broken bones, lute on the cover with potters' earth, then pile one over the other in a potters' kiln, which is heated with wood or pit-coal: when the degree of heat becomes sufficient to decompose the gelatine and oil of the bones, the luting cracks in small fissures, and gives issue to the carbonized hydrogen gas, which escapes from the furnace by several small apertures made for the purpose, one above another, and on reaching the atmospheric air becomes ignited, and is consumed. When this flame goes out, the combustion is completed. In England and France, other manufacturers distil bones in cylinders of cast-iron that run through a great fire-place, or in iron alembics; but in these manufactories the bone-black is looked upon as of only secondary importance; for it is for the purpose of making carbonate, sulphate, and muriate of ammonia, that they generally distil bones. Without that, the black would come too dear, and be seldom demanded, notwithstanding its utility.

In this process, the form of the vessel is of small importance, provided it be well closed: the great point is to make use of the least fuel possible, and apply the heat equally every where. When this is done on a large scale, the most convenient furnaces are those employed in London, and of late in Paris, for the gas-lights. With this apparatus, you have two choices to make; the first, to make use of the gas for lighting, and it renders a whiter and more lively flame than the gas of mineral coal; the second is the conveniency of burning this gas in the fire-place itself, and thus greatly œconomizing fuel *. If the gas is to be employed as fuel, the iron cylinders or cucurbits should be so disposed as to admit of their contents being easily renewed. There are several means for this purpose; but the simplest is to place a disk of strong plate-iron in the bottom of each cylinder, riveted to one or two

* We here omit a few lines in which the author recommends, if the gas is to be employed as fuel, " to adapt two diaphragms of wire-gauze to the funnel which conducts the gas under the fire-place, to prevent explosions." It is plain, from his recommending this, that he has never tried any experiments respecting the combustion of hydrogen, or hydro-carbonic gas, neither of which can explode till after they have been mixed with the atmospheric air. He has been thinking of Sir H. Davy's lamp, where it is necessary to prevent the passage of combustion, the surrounding gas being in a mixed state, ready for explosion;—and so in Dr. Clark's lamp, in which the gas in the reservoir is in a like condition.

iron

iron rods a little longer than the cylinder. As soon as the combustion is over, by drawing out the rods the disk at once carries down all the coal into an extinguisher adapted to the mouth of the cylinder. The disk is then pushed down, and the cylinder is charged and stopped again before it has time to cool. The time saved by this method œconomizes a considerable quantity of fuel.

It is, however, very essential that the cylinders or cucurbits receive the heat equally every where, and that depends on the construction of the furnace. This is a difficult problem to resolve: however, many coal-distillers have effected it, by rendering their cylinders or cucurbits moveable, so as to be able to turn them four or five times during the operation, and present every side to the full force of the fire alternately.

In Monsieur Robert's manufactory at the Gros Caillou, where they extract oil from garbage, Monsieur Barruel, head chemist of the School of Physic, got a great furnace constructed for distilling bones, in which the laws of pyrotechny are so strictly adhered to, that he can heat his cylinders with cow-dung only, and completes the distillation by consuming the gas in the body of the furnace. His cylinders are always hot; and the operations succeed so rapidly, that the expense of fuel is hardly sensible.

Every kind of bones employed in close vessels does not yield a similar kind of coal; this coal varies in quality, according as they employ old or young animals' bones, round or flat, heavy and compact, or spongy and light ones. The analysis of these various kinds of charcoal has made us acquainted with the cause of this difference. It was natural to think that young animals' bones contained more gelatine than those of old quadrupeds; and, consequently, ought to yield a deeper black and more charcoal. This was an error; for great round bones, such as the femur and tibia of oxen, yield more coal when distilled than similar bones of equal weight taken from calves. The proportion of black charcoal in young animals' bones is only four or five per cent., while that of old compact bone amounts to forty. This is the reason why ivory black is the most intense of all animal blacks.

Animal charcoal is a mixture of phosphate of lime, a small quantity of quick-lime, and coal (or calx of carbon). The property of clarifying liquids depends on the mixture of these four substances, none of which separately enjoys this property so perfectly. Now, as all manufacturers are in the habit of deciding on the quality of their materials,—when the bones do not appear to contain much gelatine, they take care to add, in the furnace, soft animal matter, such as clotted blood, tripe or guts, membranes, &c. This is the reason why many refiners esteem most the black produced by the calcination of blood and potash, in Prussian-blue manufactories.

From the foregoing observations it is evident, whether animal charcoal is intended for painting or clarifying, that which contains the greater proportion of carbon is to be preferred; and this proportion is always easily discovered, by the application of muriatic acid to the coal. This acid dissolves the calcareous salts and the lime; after which the purged coal remains alone. It is then dried and weighed:—should it equal forty-hundredths of the analysed coal, it is very fit for painting and clarifying; but the painters require it much finer than the refiners.

Many refiners, who make advantageous use of animal black, have wisely judged that it might serve more than once. So that when it has lost its effect as a filtering clarifier, they wash it well in a great quantity of water, and calcine it again with or without the addition of animal matter. They have remarked, that this coal, twice or thrice calcined, was more advantageous, and clarified syrups better, than that which had been calcined only once. The manufacturers of bone-black are, consequently, interested in buying up the coal from the refiners (after they have made use of it), to calcine it over again.

We have remarked, that bone-black was the better for containing a great quantity of carbon: that is true, but that is not all; it is indispensable that the mixture of these different elements be exact, and, above all, that it be well powdered. For this purpose, some manufacturers make use of a pounding-mill, like the paper-makers; others, mill-stones; and some, cylinders. All these methods are good, and the nature of the situation must decide on which. Now, some manufacturers grind the bone-black dry, while others make use of water; and this latter method is both more expeditious and wholesomer for the workman; after that, it is dried before being offered for sale.

In sugar-houses bone-black is sometimes employed as a simple filter, and in this case they only pour the syrup on the moistened animal coal: but when required as a clarifier, it must be boiled up with the sugar, in the proportion of one-tenth to the quantity of sugar to be clarified. Before the sugar, dissolved in a sufficient quantity of water, has been boiled, and brought to the consistence of syrup, the coal is poured, little by little, into the boiler. After seven or eight minutes' longer boiling on the fire, all is thrown together into a woollen bag disposed for that purpose. The syrup at first passes a little coloured by the coal it carries along with it; but then they pour it back into the bag, and it runs out clear.

Syrups worked with coal yield a much more abundant crystallization, and of a very superior quality, to syrups worked without it.

It is to M. Lowitz we owe the discovery of the property of powdered

powdered charcoal for clarifying animal and vegetable substances, at the same time that it takes away their smell. In 1791 he clarified gum-arabic, gelatine, beer, milk, red wine, vinegar, tincture of cochineal, &c.; but the greater part of these substances had been decomposed. He attenuated the smell of bitumen, flowers of benzoin, bugs, empyreumatic oils, the infusion of valerian, &c. by the sole use of wood coal.

In 1810, M. Figuier, professor of chemistry in Montpellier, after repeating M. Lowitz's experiments, tried animal charcoal, and found it possessed a stronger power of clarification than vegetable coal. Since this period, both are employed to keep water fresh at sea, and to purify oil and water, meat and fish, in the first stage of putrefaction. They moreover make use of it to render the most corrupt water potable, to clarify honey, syrups, &c.

M. Guilbert, a confectioner in Paris, remarked that wood-charcoal, which had been long moist, and during this state exposed to the rays of the sun, clarifies much better than what is pulverized dry, and employed immediately. He advises to leave the charcoal intended for purifying some time in pure water, to grind it in the water, and then expose it to the light, covered an inch deep with this liquid; and to employ it after being drained, but still in a moist state. No one has as yet examined the effect of light on animal charcoal, according to M. Guilbert's process: this experiment, however, is worthy the attention of chemists and manufacturers.

---

## VI. *On new Combinations of Oxygen and Acids. By M.* L. J. Thenard*.

These combinations were obtained by treating the peroxide of barium with acids. They are mostly very remarkable, and deserving of the attention of chemists.

The first I observed was the combination of nitric acid with oxygen. Peroxide of barium (barytes saturated with oxygen) when moistened, falls to powder with but little increase of temperature. When mixed, in this state, with seven or eight times its weight of water, if dilute nitric acid be poured gradually on it, by agitation it will dissolve without giving off any gas. The solution is neutral, producing no change on turnsole or on turmeric. If the requisite quantity of sulphuric acid be added to this solution, a copious precipitate of sulphate of barytes is thrown down, and the liquid when filtered is merely water holding *oxygenized nitric acid* in solution.

This acid, which in almost all its properties resembles nitric

* From *Annales de Chimie et Phys.* tom. viii.



acid,

acid, is liquid and colourless. When heat is applied, it instantly gives off oxygen; but to effect complete decomposition it must be kept boiling for some time. From this it follows that to concentrate it by heat, without altering it, would be very difficult. The method by which I succeeded was, by placing it in a capsule, along with another capsule full of lime, under the receiver of an air-pump, and then exhausting the receiver till the mercurial gauge stood ten or twelve centimetres below the common barometer; by which means I got it sufficiently concentrated to give out eleven times its bulk of oxygen gas, whereas in its first state it gave out only one and a half time its volume of that gas.

This oxygenized acid readily combines with barytes, potash, soda, ammonia, and neutralizes them; but I fear it will be next to impossible to crystallize the salts thus formed; for on the least application of heat the acid is decomposed, giving out oxygen. They are decomposed even when left to spontaneous evaporation: at least I found it so with the oxygenized nitrate of barytes, at the very instant of crystallization. They decompose likewise under an exhausted receiver; as is the case with alkaline bicarbonates, which boil violently in an exhausted receiver and become simple carbonates. But the oxygenized nitrates when reduced to nitrates do not change their state of neutralization.

Hence it is apparent that oxygenized nitric acid, instead of becoming more fixed when united with bases, acquires, on the contrary, the property of abandoning, with greater facility, its oxygen. So true is this, that if a concentrated solution of potash be poured on a neutral concentrated solution of oxygenized nitrate of potash, a brisk effervescence ensues, and oxygen is given off: nor can it be doubted that the potash acts upon nitrate properly so called. Thus, relatively to oxygenized nitric acid, the bases act as the ordinary acids do relatively to certain peroxides; for instance, sulphuric acid on the black oxide of manganese.

The oxygenized nitric acid does not act upon gold; but it dissolves very readily the metals soluble in nitric acid; and the solution generally takes place without the disengagement of gas, and produces heat: but in some cases a little oxygen is given off at first, particularly if the action be too violent, as is the case when this acid, so concentrated as to contain fifteen times its volume of oxygen, is poured upon zinc.

To ascertain how much oxygen this acid contains, I began by analysing the deutoxide of barium. I heated some barytes with an excess of oxygen in a small curved tube standing over mercury. This base, in passing to the state of a peroxide, absorbed almost as much oxygen as it contained: but as I ascertained that barytes extracted from the nitrate always contains a little peroxide, I conclude that the peroxide contains double the quantity that

that exists in the protoxide; while in the neutral nitrates the quantity of oxygen of the acid is to that of the oxide as 5 to 1; consequently in oxygenized nitric acid the azote will be to the oxygen in volume as 1 to 3,—on the supposition that the acid is pure; that is, contains no oxygenized nitric acid.

The phosphoric, the arsenic, and probably the boracic acid are, like the nitric acid, capable of uniting with oxygen; and they retain it much more strongly. This is also the case with the oxygenized arseniates and phosphates: I therefore hope to obtain these salts in a solid state.

All the attempts which I have hitherto made to procure oxygenized sulphuric acid have failed. My experiments on acetic acid have been more satisfactory. This acid dissolves the deutoxide of barium with nearly the same facility that the nitric does. No effervescence follows; and by the foregoing process an acid is obtained, which, when saturated with potash, and heated, gives off a great quantity of oxygen gas:—showing that the oxygen, when assisted by heat, unites in part with the carbon, and likewise with the hydrogen of the acid.

I examined likewise the action of liquid muriatic acid on the deutoxide of barium. I expected that water, chlorine and muriate of barytes would be the result, but it was otherwise. I obtained oxygenized muriatic acid, which I separated by means of sulphuric acid. This result appeared so singular, that I made numerous experiments to demonstrate it. The most decisive was this: I took a fragment of barytes, which, in passing to the state of deutoxide, had absorbed 12·41 centilitres of oxygen gas; I mixed it with water, and then dissolved it in diluted muriatic acid. I then precipitated all the barytes by sulphuric acid. The filtered liquid gave no precipitate by either sulphuric acid or nitrate of barytes. The liquid in this state I saturated with potash, and heated it gradually till it boiled. It yielded nearly the volume of oxygen absorbed at first by the base. When I add, that oxygenized muriatic acid leaves no residuum when evaporated; that barytes after being oxygenated requires the same quantity of acid as before oxygenation, to make it pass to the state of neutral muriate; and that the muriate formed exactly resembles common muriate, the existence of oxygenized muriatic acid will not, I conceive, admit of doubt. I obtained it only at that degree of concentration in which it contains four times its volume of oxygen. It is a very acid, colourless liquid, almost void of smell, and powerfully reddens tincture of turnsole. It is decomposed when raised to the boiling temperature, and converted into oxygen and muriatic acid. When saturated with barytes, potash or ammonia, it decomposes still more readily, giving off a quantity of oxygen. It dissolves zinc without effervescence. It has no no action on gold at the ordinary temperature, at least in the space of a few minutes. With silver it occasions as lively an effervescence as when an acid is poured on a carbonate; because water and chlorine being formed by the reaction of the oxide and the muriatic acid on each other, the oxygen united with the acid being suddenly disengaged assumes the gaseous form.

This property of the oxygenized muriatic acid being decomposed by oxide of silver, liberating the oxygen, may probably enable us to form several other oxygenized acids with facility. Thus, with this acid and a solution of fluate of silver we may expect to obtain oxygenized fluoric acid.

In oxygenized muriatic acid the hydrogen and oxygen are in the proportions required to form water.

These, which are the principal results that I have hitherto obtained, make us acquainted with a new class of bodies, which may probably prove numerous in species. We must discover them, ascertain their properties, and the different circumstances in which they are capable of being formed; and see whether other bodies, besides acids, be not capable of combining with oxygen. A laborious set of experiments is thus chalked out, the results of which shall be laid before the Academy.

I have, since these observations were read, satisfied myself that by the process pointed out to obtain oxygenized fluoric acid, not only this, but likewise oxygenized sulphuric acid, may be obtained. Indeed all the acids susceptible of being oxygenized may easily be procured in that way. Oxygenized fluoric acid does not give off its oxygen at a boiling temperature, but oxygenized sulphuric acid parts with it easily.

I have also ascertained that oxygenized nitric and muriatic acids may be combined with new doses of oxygen; as is probably the case with the other acids. To obtain these new compounds, it is only necessary to treat the oxygenized acid with the deutoxide of barium, as stated above: thus to superoxygenize oxygenized muriatic acid, saturate this acid with deutoxide of barium. The sulphuric acid precipitates the barytes, and the liquid is then decanted off, which will be found to contain all the oxygen furnished by the two portions of deutoxide of barium on which the operation is performed.

It deserves to be noticed, that the same acid may be repeatedly oxygenized by the same process. I have oxygenized it as often as seven times.

Whether these kinds of combinations take place in definite or indefinite proportions, must be ascertained by future experiments. But however this may be, when an excess of barytes water is poured on the oxygenized nitric or on the oxygenized muriatic acid, or into these acids superoxygenized, an abundant crystal-

line

line precipitate of deutoxide of barium is thrown down, of the form of pearly scales, but little soluble in water; but at the temperature of 50° this liquor decomposes it, and converts it into oxygen gas and barytes, or protoxide of barium.

Like barytes, both strontian and lime are capable of being superoxygenized by the superoxygenized acids. The hydrate of deutoxide of strontian has a considerable resemblance to that of barium; while that of lime is in finer plates.

It seems probable that I shall be able, by the same methods, to oxygenize the earths, or some of them; and to superoxidize many of the metallic oxides. To effect this, I propose to put an excess of base with the acid, or to dissolve the base in the acid, and then to precipitate by potash: or I will put the oxygenized muriates in contact with oxide of silver, which, by seizing the muriatic acid, will favour the combination of the oxygen with the oxide wished to be superoxygenized.

---

## VII. *Description of an Acid Principle prepared from the Lithic or Uric Acid. By* William Prout, *M.D. Communicated by* W. H. Wollaston, *M.D. F.R.S.**

During an investigation of the principles of the urine, with the view of elucidating the pathology of that secretion, I was led to examine the well-known beautiful purple substance produced by the action of the nitric acid and heat upon the lithic acid, and which has usually been considered as one of the characteristic distinctions of the lithic acid. This purple substance proved to be a compound of ammonia, and a peculiar principle having the properties of an acid;—the description of which, and of its compounds, constitutes the object of the present paper.

This acid principle may be obtained by digesting pure lithic acid in dilute nitric acid: an effervescence takes place, and the lithic acid is dissolved. The excess of nitric acid is then to be neutralized with ammonia, and the whole slowly concentrated by evaporation. As the evaporation proceeds, the colour of the solution gradually becomes of a deeper purple, and dark red granular crystals (sometimes of a greenish hue externally) soon begin to separate in abundance. These crystals are a compound of ammonia with the acid principle in question. The ammonia may be removed by the sulphuric or muriatic acid, and thus the acid principle obtained in a separate state. As, however, I found some little care requisite to obtain the acid quite free from colour, it may not be deemed superfluous to state the precise method I usually followed for that purpose. The compound with ammonia,

* From the Transactions of the Royal Society for 1818, Part II.

ammonia, above mentioned, was dissolved in a solution of caustic potash, and heat applied to the solution till the red colour entirely disappeared. This alkaline solution was then gradually dropped into dilute sulphuric acid, which uniting with the potash, left the acid principle in a state of purity.

The acid principle is likewise produced from lithic acid by chlorine. Iodine has also the same remarkable property, though in a much less striking degree. When lithic acid is boiled with iodine for some time, a partial solution of the lithic acid is effected; and if to this solution a little ammonia be added, and the whole evaporated to dryness, a perceptible quantity of the beautiful purple compound of ammonia and the new acid principle will be obtained. I am not aware that any other substance is capable of producing this change, though the circumstance is by no means improbable.

To prevent circumlocution, I shall in future call this principle the *purpuric acid*, a name suggested by Dr. Wollaston, from its remarkable property of forming compounds with most bases of a red or purple colour.

The purpuric acid, as obtained above, usually exists in the form of a very fine powder, of a slightly yellowish or cream colour; and when examined with a magnifier, especially in water, appears to possess a pearly lustre. It has no smell nor taste. Its specific gravity is considerably above that of water, though, from the minute state of division in which it exists, it usually takes a considerable time to subside in that fluid. When suffered to separate slowly from a large quantity of water, or any other fluid capable of holding it in solution, it sometimes assumes the form of thin pearly scales.

The purpuric acid is very little soluble in water. One tenth of a grain boiled for a considerable time in 1000 grains of water was not entirely dissolved. The water assumed a purple tint, which it retained after it was cold, though it became very slightly turbid on cooling*. The purpuric acid is insoluble in alcohol and ether. In all the mineral acids, when concentrated and in excess, and in solutions of the different alkalies, it dissolves readily; but it is insoluble, or nearly so, in dilute sulphuric, muriatic, and phosphoric acids, and also in solutions of the oxalic, citric, and tartaric acids. Concentrated nitric acid readily dissolves it with effervescence; and if the acid be in excess, and heat be applied,

* I am not quite sure whether the purple tint here mentioned depends upon the actual solution of a minute portion of the purpuric acid; and, consequently, whether it naturally forms a purple solution, or whether the colour be owing to the formation of a little ammonia from the decomposition of a minute proportion of the acid, which, combining with the remainder of the acid, forms the purpurate of ammonia. I incline to the latter opinion.

a portion

a portion of the purpuric acid is decomposed, ammonia is formed; and on driving off the excess of nitric acid by heat, the purpurate of ammonia is obtained, precisely as if a little of the lithic acid had been treated in a similar manner. Chlorine, likewise, dissolves the purpuric acid, and apparently produces the same changes upon it as the nitric acid. It readily dissolves also by the assistance of heat, in concentrated acetic acid.

The purpuric acid does not sensibly affect litmus paper, probably on account of its insoluble nature. When exposed to the air it does not deliquesce, but gradually assumes a purplish tint, apparently by attracting a little ammonia from the atmosphere, or perhaps from the evolution from itself of a little of the same alkali by spontaneous decomposition.

Submitted to heat, it neither melts nor sublimes, but acquires a purple hue from the formation of ammonia, and afterwards burns gradually, without yielding any remarkable odour. Subjected alone to heat in close vessels, it yields a considerable proportion of the carbonate of ammonia, some prussic acid, and a little fluid having an oily appearance; while a portion of pulverulent charcoal remains. When given quantities were burnt with the oxide of copper, in the manner formerly described by me *, data were obtained, which appeared to show that one hundred parts consist of

| | | |
|---|---|---|
| Hydrogen | 4·54 | corresponding with 2 atoms or proportions. |
| Carbon | 27·27 | ................ 2 ditto |
| Oxygen | 36·36 | ................ 2 ditto |
| Azote | 31·81 | ................ 1 ditto |

The purpuric acid combines with the alkalies, alkaline earths, and metallic oxides. It is capable of expelling the carbonic acid from the alkaline carbonates, by the assistance of heat, and does not, as far as I have observed, combine with any other acid. These are circumstances sufficient, as Dr. Wollaston has observed, to distinguish it from an *oxide*, and to establish its character as an *acid*. On the supposition then, that it be named the *purpuric acid*, its compounds with different bases must be denominated *purpurates:* on some of the most remarkable of which I shall now proceed to make a few remarks.

*Purpurate of ammonia.* This salt crystallizes in quadrangular prisms, which, when viewed by transmitted light, are transparent, and of a deep garnet red colour; but by reflected light, their two broadest opposite faces appear of a brilliant green, closely resembling that of the wings of some of the beetle tribe, as for example, of the *Cetonia aurata*, while their other two opposite faces appear of a dull reddish brown colour; or, if the light be very strong, slightly green. This peculiarity seems to be possessed

* See Medico-Chirurgical Transactions, vol. viii. p. 526.

in

in a greater or less degree by all the other alkaline, and perhaps earthy salts; and doubtless depends upon the structure of the crystals. The purpurate of ammonia is soluble in about 1500 parts of water at 60°, but in boiling water is much more soluble. The solution is of a beautiful deep carmine, or rose red colour. In pure alcohol and in ether, it is little if at all soluble. The aqueous solution has a slightly sweetish taste, but no smell. By adding this aqueous solution of the purpurate of ammonia to neutral saline solutions of other bases, most of the following purpurates were formed.

*Purpurate of potash.* When a saturated boiling solution of the purpurate of ammonia is added to a solution of the bicarbonate of potash, a dark brownish red precipitate takes place, which is the purpurate of potash. If, however, this salt be slowly formed, it may be obtained in a crystalline form; and the crystals appear to possess the same peculiarity with respect to colour, as those of the pupurate of ammonia above mentioned. This salt is much more soluble than the purpurate of ammonia.

*Purpurate of soda.* This salt, when obtained by the same means as the purpurate of potash, is of a dark brick red colour. It may, however, be obtained in crystals. It is much less soluble than the purpurate of potash. Three thousand times its weight of water at 60° did not completely dissolve it. The colours of the solutions of this salt, and of potash, differ slightly from one another, and also from that of the purpurate of ammonia; but it is not easy to describe these differences so as to render them intelligible.

*Purpurate of lime.* This salt, when obtained by adding a boiling saturated solution of the purpurate of ammonia to a solution of the muriate of lime, exists in the form of a powder much resembling in colour the crust of the lobster before it is boiled. This salt is but little soluble in cold water; but in boiling water it is more soluble, and the solution is of a beautiful reddish purple colour.

*Purpurate of strontian.* This salt obtained as above, with the nitrate of strontian, exists in the state of a dark brownish red powder, with a slight tinge of green. It seems to be more soluble than the purpurate of lime, and forms a purple solution.

*Purpurate of barytes.* Obtained as before described, with the acetate of barytes, this salt assumes the form of a dark green powder, not apparently differing much in point of solubility from the purpurate of strontian; and forming, like that salt, a purple solution.

*Purpurate of magnesia.* This is a very soluble salt. Its solution is of a beautiful purple.

*Purpurate of alumina.* When a solution of the purpurate of ammonia

ammonia was added to a solution of alum, no perceptible change took place immediately; but after some time the colour of the solution disappeared, and a small quantity of a white substance separated, which was presumed to be the purpurate of alumina, but it was not examined.

*Purpurate of gold.* When a solution of the muriate of gold is dropped into a solution of the purpurate of ammonia, the colour becomes yellowish, but no precipitation takes place. Hence, this salt may be presumed to be very soluble.

*Purpurate of platina.* The muriate of platina changes the colour of the purpurate of ammonia to a yellowish scarlet, but produces no precipitation.

*Purpurate of silver.* Solutions of the acetate or nitrate of silver, dropped into a solution of the purpurate of ammonia, produce a deep purple precipitate; and the water is left nearly colourless. Hence the purpurate of silver appears very insoluble.

*Purpurate of mercury.* A solution of the proto-nitrate of mercury produces, with the purpurate of ammonia, a beautiful reddish purple precipitate, and the water is left nearly colourless. A solution of the oxymuriate of mercury produces at first no change; but after some time a copious light rose-coloured precipitate occurs, and the solution is left colourless.

*Purpurate of lead.* A solution of the nitrate of lead, dropped in a solution of the purpurate of ammonia, renders it of a rose red colour; but no precipitation takes place.

*Purpurate of zinc.* A solution of the acetate of zinc produces with the purpurate of ammonia a solution and precipitate of a beautiful gold yellow colour; and a most brilliant iridescent pellicle, in which green and yellow predominate, forms on the surface of the solution.

*Purpurate of tin.* A solution of the muriate of tin changes the purpurate of ammonia to a scarlet; but this rapidly disappears, and the solution becomes colourless. After a few hours, white pearly crystals form in abundance, which is the purpurate of tin.

*Purpurate of copper.* A solution of the acetate or sulphate of copper changes the purpurate of ammonia to a bright yellowish green colour, but produces no precipitation.

*Purpurate of nickel.* The nitrate of nickel imparts to the purpurate of ammonia a greenish tinge, but produces no precipitation.

*Purpurate of cobalt.* The acetate of cobalt changes the colour of the same salt to a pale scarlet. After some time, reddish granular crystals form, which are the purpurate of cobalt.

*Purpurate of iron.* A solution of the green sulphate of iron changes

changes the colour of the purpurate of ammonia to yellowish red, but produces no precipitate.

Such is a very brief account of the *purpurates*, as far as I have examined them. It may at first sight appear singular, that such an insoluble acid should form so many soluble compounds; but when we reflect upon the subject, and consider what a very small quantity of the purpurate of ammonia is retained in solution by water, and that this small quantity has been made the standard of comparison in the above experiments, our surprise is considerably lessened, and we feel no difficulty in conceiving, that if the purpurates were compared with the nitrates, for example, the former would be found by far the least soluble.

From the very small quantities on which I have been obliged to operate, and from other circumstances, I can offer but little respecting the constitution of the purpurates. Those which I have attempted to analyse appear to be anhydrous, and to be composed of two atoms of the acid, and one of the base; and if this be correct, the same composition may perhaps be referred to most, if not all the compounds above mentioned. The purpuric acid, however, appears capable of forming subsalts and supersalts, with most bases, many of which seem to be very little soluble.

With respect to the characteristic properties of the purpuric acid, I apprehend it may be readily distinguished from all other substances by the beautiful colours exhibited by its alkaline and earthy salts, independently of its other properties, which are likewise peculiar.

The purpuric acid and its compounds probably constitute the basis of many animal and vegetable colours. The well known pink sediment, which generally appears in the urine of those labouring under febrile affections, appears to owe its colour chiefly to the purpurate of ammonia, and perhaps occasionally to the purpurate of soda. Some of the purpurates, as for example that of lime, might be probably used as a paint. They might be also used for dyeing, especially wool and other animal productions*. On this part of the subject, however, as I have little that is certain to offer, I do not deem it prudent to enter at present.

* I may here observe, that the solution of lithic acid in nitric acid has the property of tingeing the skin and other animal substances in a very permanent manner. The colour does not, in general, appear till the substance has been exposed to heat, or, what is more effective, to the light of the sun. In the latter case, particularly, a deep purple tint soon makes its appearance, and the substance tinged (more especially the skin) emits during the process a strong and peculiar smell, closely resembling that produced by the nitrate of silver, when applied to the skin, and exposed to similar circumstances.

VIII. *On*

## VIII. *On the Question "Whether Music is necessary to the Orator,—to what Extent, and how most readily attainable?"* *By* HENRY UPINGTON, *Esq.*

[Continued from vol. lii. p. 409.]

Blair's Hill, Cork, Jan. 7, 1819.

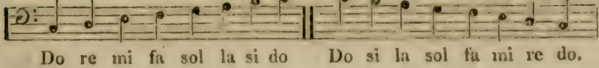
SIR, — HAVING terminated the examination of the *Speaker* in your Magazine for December, and offered my opinion in that, as well as in the preceding numbers, on the apparent analogy between our modern music and the character of speech, I have now ultimately to present you with a narration of the different experiments that I made for the intended improvement of the *Speaker*, in the delivery of written language;—which process, I have the pleasure to assure you, not only realized, to a certain extent, my wishes, but also added (and very considerably too) to the dignity and *impressiveness* of his ordinary conversation.

Experience has every day shown us, that even the most easy and graceful speakers in common life, are frequently incapable of modulating any species of language, whether written or extemporaneous, whose composition is much superior to that of their politer colloquy. The *Speaker* was similarly unfortunate. I essayed his capability with a few passages of the "Spirit of Patriotism" by Lord Bolingbroke. He studied them—pointed out the emphatical words, nay even *felt the subject*; and then repeatedly attempted the delivery—but failed. With *him*, as with the generality of our orators who aim at dignity, a wearisome monotonous *see-saw* was substituted for that easy and expressive modulation which the passages required. Selections from our Church Service were then delivered; and in these his modulation was more varied—but at the same time was altogether inappropriate, and destitute of solemnity. What was to be done? *Experiments* were the object—and on these the solution of our question "Whether music is necessary to the orator" was eventually to depend.

The different experiments then to which I resorted shall constitute the subject of my present and following letter; and although it will appear that I have led the *Speaker*, by my inexperience in this novel walk, to one particularly ill-judged proceeding [solfaying the entire octave]; yet as the candid declaration of my error may in all likelihood be attended with some advantage to others, I acknowledge it without reserve.

*Solemnization of the Octave.*

[Performed on the Piano Forte.]



When the execution of this solfay was tolerably attained, I indulged the *Speaker* in the playing, and attempting at the same time to sing, a few favourite songs with which he was in some degree acquainted—an indulgence that I fear was injudicious, every one of those songs, "God save the King" excepted, being, for oratorical purpose, too extensive in compass and too wide in its intervals. Undecided, however, at this period, as to the propriety or impropriety of this modulating exercise, I acquiesced in the desire of the *Speaker*, and facilitated the acquirement of those songs by the following very simple contrivance, which any gentleman unacquainted with music, who wishes to devote a leisure hour to the cultivation of suitable productions, may instantly employ.

*Implement for playing simple Tunes with Facility on the Piano Forte.*

[Any method of *fingering* which the performer shall find most convenient, will equally answer his purpose. The *Speaker* scarcely ever used any other than the forefinger or forefinger and thumb of his right hand.]

Prepare a thin slip of deal or any other timber, sufficiently long to extend from any C of the piano to its double octave;—and about one inch and a half broad. Glue to its bottom an equally long slip [fourteen inches] of white paste-board, which shall project about one inch beyond the margin of the timber. On this paste-board the musical letters of the double octave, exactly corresponding with their *local* situation on the piano, are written in the manner specified. Then insert perpendicularly in the timber, at *x z*, two wires, each about six or eight inches long, more or less, bent backward at the upper extremities in the form of hooks. The implement is now complete; and while in use it is suspended horizontally, by means of these hooks, from the top of the piano—*over*, and almost in contact with the keys of any appropriate disdiapason.

The extremities of the *black* keys of the piano must project about 3-4ths of an inch beyond the margin of the paste-board.

*Sketch of the Implement.*

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *x* | | | | | | | | | | | | | *z* | |
| C | D | E | F | G | A | B | c | d | e | f | g | a | b | c |

A suitable alteration of the characters of our *time-table*, for prosodial equivalents, rendered this little plan still more satisfactory to the *Speaker*. Instead of the usual minim crotchet, quaver, and semiquaver, I substituted the following signs:

For

| | | | |
|---|---|---|---|
| For the Minim equal to | 8 | = | or very long. |
| Crotchet .. | 4 | — | long. |
| Quaver .. | 2 | ◡ | short. |
| Semiquaver | 1 | ◡̈ | very short, adding the *dot*, |

whenever it occurred, in the common way*.

Now with respect to the application—it is hardly necessary to say, that the songs intended for execution should previously be transcribed by a musical assistant †. In the doing of this, it is in my opinion preferable *not* to set down the *words* of any subject, but the representative *letters* of the tune; each of which letters, by its own name, (with the exception of F pronounced Fa,) should be played and sung distinctly and separately, without regarding the *slurs*. The *accurate* execution of *time*, too, is quite unnecessary; nor should the oratorical practitioner, while singing or playing, indulge himself in the attempt of *beating* it at all. As to the *flats* and *sharps*, each should be individually noted, at all times, for his convenience; every *unmarked* letter being thus considered as a *natural*.

The manner in which I set down for the *Speaker*, our own national air "*God save the King*," will sufficiently illustrate my design, care having been taken to give him the chastest conception of the *time*, by singing for him smoothly, and yet with as much variation of *forte* as I deemed expedient, this as well as every other tune which he attempted.

*God save the King.*

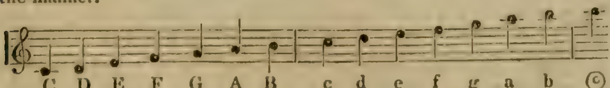
| | | | | | |
|---|---|---|---|---|---|
| — — — | — . ◡ — | — — — | — . ◡ — | — — — | =. |
| c c d | B c d | e e f | e d c | d c B | c |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| — — — | — . ◡ — | — — — | — . ◡ — | — ◡ ◡ ◡ ◡ | — . ◡ — | — — — | =. |
| g g g | g f e | f f f | f e d | e f e d c | e f g | f e d | c |

So much for the mechanical process of attainment, on which,

* May not these characters (within a circumscribed ratio, and without nice attention to their relative lengths) be sometimes useful to an oratorical student? Almost every printed book has sufficient space between its lines to receive them: besides, they should be *sparingly* employed. Would not the circumflex too ˜ set over a word, be a very convenient general sign for *expression?*

† Any person of the least ingenuity may, with the assistance of a methodized *cliff table*, transcribe for himself. An example of the *treble* will show the manner.




Even *transposition* from one *key note* to another may be effected by a table. It is very easily made.

as indispensably connected with my theme, I have dwelt much longer than I could otherwise have desired. Let us now turn to a more interesting topic. What were the evident effects produced on the *Speaker* by solfaying the octave; and accompanying with his voice, after much perseverance, some ten or a dozen y-lselected tunes which he had fancied?—The reverse of improvement—alternate rant and feebleness without modulation; sometimes striking even the octave itself by a sudden *plunge*—and at other times exhibiting a puerile imbecility, by sinking beyond the power of graceful recovery. This total extinction of all modulation I was not indeed prepared to expect; but I must certainly take to myself the credit of foreseeing that the articulation of his short unemphatic syllables would sustain some injury. It did so—and to that extent, that in the recital of poetry, a person who had not known the subject must frequently have guessed at the meaning by the context.

For the *present*, then, I relinquished all hopes of improvement by musical expedients. Nothing short of a radical subversion of all antecedent oratorical habits, and the substitution of new habits in their stead, could to all appearance realize my ultimate design—and hence, the delivery of ancient hexameter presented itself to my view.

My consideration now was—By what eligible means could such delivery be accomplished, and especially by the *Speaker?* I recollected the beneficial result predicted to practitioners by Messrs. de Port Royal, in their excellent Greek Grammar*, and to that

* As I have mentioned this admirable Grammar, I shall call the reader's attention to a remarkable fact which it records—that in ancient practice the τυ of τετύφωμεν was the accented or highest note of this word; while the φω, although a lower note, was (like our long emphatic syllables) *sustained* longer and fuller than any other syllable of the word; which grave and majestic pronunciation has been called by Martian Capella, who lived in the fifth century, " the very soul of sounds and the foundation of harmony."

*Dionysius Thrax's* definition of accents in general as " Dissonants of the enharmonic voice" is too vague for any rational deduction: he meant, in all probability, no more than that such syllables were spoken, not sung;, or, in Italian phraseology, were *syllabized* not vocalized. [For the interpretation of these terms see Phil. Magazine for May 1818.]

The author of *Prosodia Rationalis*, who tortures every quotation without ceremony, would interpret the words ὁμαλισμὸν ἐν τῇ βαρείᾳ, which are used by Dion. T. in the same passage—as " levelling *to* the grave;" and this for the mere justification of his own (*Steele's*) doctrine, that the grave accent was constituted by a *downward slide!* If any obvious meaning can be attached to the quoted words, is it not *that* of levelling a syllable [depriving it of its upward slide] in the act of executing the grave?

Obscurely as Dionysius Thrax may have written, he is *perspicuity itself* compared with our own Mr. Steele or Mr. Walker, in their " *Prosodia Rationalis*," and " Elements of Elocution." However, it is very possible that *D. Thrax understood his* subject.

work

work I turned in expectation of materials. It is an easy matter in pronunciation," says Mons. Lancellot, to elevate any syllable we please, and, if requisite, to make it slide nimbler; and on the contrary, to depress another, and at the same time to give it, if necessary, a slower motion. Wherefore, although several have been of opinion that it would be advisable not to mark any accents at all, yet I would not proceed to such an extremity; for, by giving a double sound to the diphthongs so as to let the two vowels be heard, though all in one breath, and uttering the long vowels more slowly and more in the hollow of the mouth than the short ones—and adding afterwards the difference of the accents, which only consists in pushing the voice a little in order to give it its elevation, [the syllables maked *grave* in the series of a period should be merely *sustained*,] we shall easily fall into that proportion which is neither harsh nor difficult, but contains a sweetness acknowledged by all the ancients, and an *utility* which will be quickly perceived by those who will give themselves the trouble of a little application."

This is the learned declaration of Messrs. de Port Royal with regard to accent and quantity—particularly calculated, as the writer informs us, for the meridian of *France*. But as neither a foreign pronunciation, nor even the original sounds of the Greek and Roman letters are in any way auxiliary to the improvement of *our* language, for the more dignified delivery of which a rude approximation and no more towards accent, and a comparatively close approximation towards quantity are here intended—I could not by any means consent to Mons. Lancellot's proposal. And particularly with respect to accent; although I have no doubt that Mons. L. *himself* did really find the execution as facile as he describes; yet, judging by my own experience, I must consider it altogether unattainable by the generality of even our *musical* countrymen. The very simple method, therefore, which I suggested to the *Speaker*, as a *muscular* rather than a musical exercise—and which, in the *outset* of his practice, he perseveringly pursued *, was this.

OF ACCENT.

1st. That every *acuted* syllable should be *pushed* up—and

* After sufficient practice in this muscular exercise, the student must himself determine how far any occasional after-application may be useful; and he may likewise, if desirous, converse rather frequently for some days in his native tongue, so as to obtain his ordinary facility of utterance—of which (if his pristine habits have been sufficiently broken) he may fancy himself almost deprived. The *Speaker* on whom this accentual experiment was tried, became actually alarmed. He imagined that he had lost his voice, or at least the usual power of connecting his words even in common colloquy.

with considerable exertion when such syllable is comparatively *un*-emphatic; as for example, the first syllable in ἄειδε or the third syllable of ουλομένην. If in a higher note too than the preceding syllables, which in the first instance is the νιν of Μηνιν, and in the second the λο or λομ of ουλομένην, so much the better.

2d. That every *circumflexed* syllable be *rounded* (a character appertaining to Forte and Piano rather than to Note or Inflexion, although introductory to the latter); the Speaker holding always in recollection that this accent was particularly destined for the preservation of *equability*, which either undue elevation or depression, abstractedly considered, must destroy.

3d. That every syllable marked *grave* be prevented from unduly rising – viz. in such manner that the delivery of such syllable shall not interfere with the *independence* of the succeeding, as the χας of ψυχὰς with the α of ἄϊδι.*

4th. That every syllable preceding an accent, as the two first of ουλομένην οιωνοῖσι and χολωθεὶς, be steadily and evenly delivered.

5th. That the syllable immediately following an acuted antepenult should, when *emphatic*, as the ει of ἄειδε, be steadily *sustained* (not suffered to ascend) on whatever part of the scale it may happen most conveniently to be struck: but when comparatively *un*-emphatic as the third syllable ρι of ελώρια—that *then* every effort, if necessary, be employed to prevent it from *sinking* too much below the acuted syllable.

6th. That the *final* syllable of every word whose penult or antepenult is acuted, as the δε and νην in ἄειδε and ουλομένην, be *kept down*.

7th. That the final syllable of every word whose penultimate is circumflexed, as the ος of Αχιλῆος, be delivered as inclination or necessity may suggest.

The accentual, or rather muscular exercise which was practised by the *Speaker* being thus minutely detailed, I shall offer a few words on his progress. During this exercise, which, accompanied by that of quantity, lasted, with ordinary interruptions, for three or four weeks, he was occasionally visited by my *associate* —who, perceiving that certain syllables were at length habitually *slided upward*, pointed out those syllables to his notice. The capability of executing several other upward slides soon followed; and this was afterwards succeeded by the graceful exe-

* The last syllable of μυρὶ, which should be *grave*, is printed as an *acute* in most of our copies; whereas the *latter* character, if attempted by an unmusical student, would involve the succeeding word Αχαιοῖς. Except when succeeded by a Pause or by Enclitics, the grave accent should never (in the case of exercise) be exchanged for an acute: and even before pauses (the final one or Period excepted) the grave character may be optionally retained.

cution

cution of an occasional circumflex*, together with a more close approximation to accentual rules in general. The *downward* slide too, after previous elevation, and when succeeded by a pause, (as for example on the *ων* of *Ἡρώων* in the exordium of the Iliad,) was also found practicable: and, what may appear in some degree extraordinary—this slide was on *such* occasions not very ill-suited for manly recitation. Nevertheless it must be observed, that as energy increased, the downward slide of every description, even that characteristic portion attached to the circumflex itself, did in the same ratio disappear. I shall next proceed to my suggestions on

### TIME OR QUANTITY†.

1st. That the *vowel* of every syllable prosodially long, whether by nature or position, should obtain what is termed by our countrymen "the long sound"—the *Speaker* particularly guarding, in the cases of *position*, against rendering the syllable *too* long.

2d. That the diphthong *ου*, as generally pronounced by *us*, being in many instances too short for the completion of long quantity (as in the word *ουλομένην*)—should in such cases be pronounced nearly as if written *ouoo*: that is—that the diphthong *ου* itself should be wholly retained, but dexterously extended by the annexation of a sound nearly similar to the vocal element *oo* in *poor;* thus constituting a graceful *triphthong*, the execution of which may almost instantly be attained, and which when properly accomplished, shall be altogether undiscoverable in many English words, even by the most delicate English ear ‡.

* Moving up and down the stopper of a Pitch Pipe during the continuance of sound, is probably the best method, if the Experimenter has a tolerable ear, of learning the slide and circumflex.

† The best general rule for the execution of quantity, with those who are unwilling to give themselves additional trouble, is this: That every syllable whose quantity is long be rendered perceptibly longer than its contiguous syllable whose quantity is short: And that no long syllable interposed between two long ones shall be decidedly short. As to short syllables compared with each other, the difference between these is immaterial, if the Greek or Latin language be properly articulated. Not so with our own language—our particles and other muttered syllables give all the effect of long quantity to the contiguous articulated short ones. Hence, in a great degree, the impossibility, in *English*, of establishing any rules for quantity.

‡ This artful management of our short vowels should be studied by our Tragedians, as decidedly preferable to that *puerile whine*, which, until Mr. KEAN appeared on our stage, was perpetually obtruded on our ears. I have heard the last syllable of "*accomplish'd*" pronounced, in solemn recitation, fully as long as the first syllable of "*Glory*"—to the astonishment of every person present. It (the vowel) was originally practised thus, ĭēē, but was afterwards so artfully *shaded* that no one could discover the deception. The ordinary sound of short *i* was first given to the ear—*ee* instantaneously followed—and the syllable or rather vowel then terminated as it began.

3d. That in syllables prosodially *short*, the present short sounds of all our vowels should, as far as possible, be retained: but where impracticable or ungraceful, as in the first and last syllable of ἄειδε, or the second syllable of *recubans*, that *then* the long sound shortened in its dimensions be introduced. Here too it must be noticed, that all half-articulated or *muttered* sounds are inadmissible—such as that with which the generality of readers distinguish or rather *ex*-tinguish the second syllables of *Tityre* and *Tegmine*, which syllables should necessarily be read as if written *tee* and *mee*; for otherwise these words, in place of becoming Dactyls, would be converted into a species of Cretic, thus — ◡ —.

4th. That the *iteration* of consonants, as the λ of Ἀχιλλεύς, the *l* of *Amaryllida*, &c. being foreign to our English usage, and now rendered needless, should never be attempted.

5th. That in order to obviate all *drawling* habits, the comparatively unemphatic long syllables should, when expedient, yield the precedence, in length, to the more emphatic long ones.

[To be continued.]

---

IX. *New experimental Researches on some of the leading Doctrines of Caloric; particularly on the Relation between the Elasticity, Temperature, and latent Heat of different Vapours; and on thermometric Admeasurement and Capacity. By* ANDREW URE, *M.D.*

Glasgow, July 1817.

1. *On the elastic Force of Vapours, with new Formulæ to determine it at any Temperature; and a Review of those given by* DALTON *and* BIOT.

THE phænomena attending the conversion of liquids into elastic fluids, were first accurately investigated by Dr. Black. He observed in the rising of vapour, and melting of ice, a beautiful system of relations, connecting and modifying the grandest operations of nature, while they were destined to afford new principles for the advancement of the arts. If it be the prerogative and characteristic of genius, to discover in the most familiar, or, as some would say, vulgar phænomena, that mystic chain of causation, which had eluded all other eyes, unquestionably, the doctrines of latent heat entitle their author to rank in the first class of philosophers.

Dr. Black directed his attention principally to the establishment of the general laws, which he placed on an immoveable

* From the Transactions of the Royal Society for 1818, Part II.

basis;

basis; leaving to his pupils, the subordinate task of investigating their individual applications. Hence, the elastic forces of the vapours, arising from different bodies, at different temperatures, seem to have occupied him very little, if at all. This subject was examined, however, with great ability, by two of his most distinguished friends, Professor Robison and Mr. Watt. The investigations of the former were published in the *Encyclopædia Britannica*, article *Steam*; while we have still to regret our ignorance of those executed by the latter philosopher, with probably a more complete apparatus, and more extensive views. We are indebted to him, indeed, for some curious observations on the latent heat of steam, at different temperatures, which make us lament more, the want of those on the elastic forces themselves.

Mr. Dalton, whose peculiar speculations on caloric and meteorology led him to study the formation and variable elasticity of vapour with great attention, has since then favoured the world with many excellent dissertations, and is now reckoned the first authority on the subject. Mr. Dalton's experiments on the steam of water were carried no higher than its ordinary boiling point; but from the observed progression of its elastic force he investigated a formula, and calculated from it a table for the higher temperatures*.

In the second number of the *Journal Polytechnique*, M. Betancourt, an eminent Spanish engineer, long resident at Paris, published a set of experiments on the same subject, the results of which differ from those of Mr. Dalton in many particulars, but most remarkably in the higher part of the scale.

Having had my mind often called to this important inquiry in the course of my public lectures on the applications of Science to the Arts, an apparatus of a very simple nature occurred to me, about two years ago, by which I hoped to be able to determine, with great precision, the elastic forces of vapours at any temperature, from zero of Fahrenheit to a much higher degree of heat than even Betancourt seems to have reached. The experiments were made soon after that time, but circumstances have till now prevented me from arranging them for publication.

With Betancourt's apparatus I am not acquainted, having seen only the brief table of results, inserted in our systematical works on chemistry. Professor Robison's consisted of a strong boiler or digester, containing the water, and furnished with three small apertures; the first receiving the bulb of a thermometer, the second covered with a safety-valve, and the third having a barometer tube attached. At first I used a similar construction; but finding it hazardous, and somewhat unmanageable in the high

* Manchester Memoirs, vol. v. p. 563.

heats,

heats, and difficult to render air-tight in the lower temperatures, I abandoned it, after some unsatisfactory trials. At the low degrees of heat, the vacant part of the barometer tube introduces errors, since it has not the temperature of the boiler; and the bulb of the barometer, used in high heats, occasions a similar fallacy in the determination of the true elasticities.

Still, however, it was ingeniously conceived, and the results furnish good approximations, creditable to the celebrated experimenter*. They agree nearly with those of Betancourt, being obtained probably in a similar way. The method adopted by Mr. Dalton is recommended by an elegant simplicity. It is merely a common barometer, into which a little of the vapour-giving liquid is introduced, so as to moisten, and float above the mercury. The vapour which is generated, depresses more or less the barometric column. Hence, by subjecting the liquid to successive degrees of temperature, the corresponding depressions of the barometer, or elasticities of the vapour, are obtained.

The only difficulty in this mode of operating, is to bring a considerable length of vertical tube to an uniform temperature.

Mr. Dalton, well aware of this source of error, obviated it in a great measure, by taking a series of different tubes, decreasing in their lengths with the increasing expansions of the vapour, and concomitant descent of the mercurial column. In several experiments conducted on this plan, I found it scarcely possible to obtain results rigidly corresponding with each other, when the column of vapour, exposed in the barometer tube to the influence of surrounding heat, exceeded two inches in length.

M. Biot, in his system of physics recently published, while he adopts Mr. Dalton's results as the basis of his reasoning, treats fully of this difficulty, and suggests an ingenious means of avoiding it. "We have had occasion several times to remark," says he, "that the temperature of a mass of liquid which cools in the air, is not entirely the same at the bottom, as it is at the top of the vessel; because the colder particles subside into the lower strata, by the excess of their weight. Thus the temperature of the column of hot water, which surrounds the tube in the preceding experiment, cannot be rigorously uniform throughout its whole height. We may endeavour to render it equal, by agitating and mingling the different strata of which it is composed; but this would be attended with no little difficulty. It would be better to have several thermometers suspended at different heights, in the body of the water, and to take the arithmetical mean of their indications Or otherwise, which would probably be more exact, we might employ a thermometer having a cylindrical

* See *Encyclopædia Britannica*, vol. xvii. p. 739, 2d edition.

bulb,

bulb, equal in length to the column of vapour. It would then be necessary that the column of water should rise sufficiently above this vapour to allow the thermometer bulb to be equally immersed, or we must make on its indications the small correction mentioned p. 59, in order to reduce the temperature of the cylinder of mercury to the temperature of the reservoir. The employment of such a thermometer may appear at first sight sufficiently difficult, since it seems that the length of the cylindrical reservoir must be very considerable, if the elastic force of the vapour be great*."

He then proceeds to show how this difficulty may be obviated (as indeed it had previously been by Mr. Dalton), by taking barometer tubes successively shortened, as the force of the steam is augmented by heat. He proposes to use four, between the freezing and boiling points of water, each being two decimeters, or nearly 8 inches long, and the thermometer bulb having also that length. The plan which I imagined, as it completely obviates the source of errors arising from the large and variable space occupied by the vapour, supersedes the necessity of employing M. Biot's singular remedy. It likewise avoids other complications, introduced by the heating and consequent elongation of the mercurial column itself attending all the other methods; and scarcely capable of being exactly appreciated at high temperatures with the apparatus of Professor Robison.

The space over which the vapour extends in my instrument, need never be greater than half an inch of the barometer tube, against the side of which part the oblong bulb of a delicate thermometer rests, so as to indicate the true temperature. And though the liquid and incumbent vapour are thus always restricted to the summit of the barometer tube, we can, notwithstanding, measure its progressive range of elasticity, from zero of Fahrenheit to one hundred, or even two hundred, degrees above the boiling point of water, from an elasticity of 0.07 of an inch, to that capable of sustaining 14 feet, or even 36 of mercury. Fig. 1 (Pl. I.†) represents the construction employed for temperatures under and a little above the boiling point. Fig. 2 and 3 are used for higher temperatures; the last is the more convenient of the two. Each was suspended from a lofty window ceiling, and placed in a truly vertical position by means of a plumb line.

One simple principle pervades the whole train of experiments; which is, that the progressive increase of elastic force developed by heat from the liquid, incumbent on the mercury at $l\ l'\ l''$, is measured by the length of column which must be *added* over L,

* *Traité de Physique*, tome i. p. 268.

† This Plate will be given with our next Number.

the primitive level below, in order to restore the quicksilver to its primitive level above, at *l*. These two stations, or points of departure, are nicely defined by a ring of fine platina wire twisted firmly around the tube.*

At the commencement of the experiment, after the liquid well freed from air has been let up, the quicksilver is made a tangent to the edge of the upper ring, by cautiously pouring mercury in a slender stream into the open leg of the syphon D. The level ring below is then carefully adjusted.

From the mode of conducting my experiments, there remained always a quantity of liquid in contact with the vapour, a circumstance essential to accuracy in this research.

Suppose the temperature of the water or the oil in A to be 32° F., as denoted by a delicate thermometer, or by the liquefaction of ice; communicate heat to the cylinder A, by means of two Argand flames, playing gently on its shoulder at each side. When the thermometer indicates 42°, modify the flames, or remove them, so as to maintain an uniform temperature for a few minutes. A film or line of light will now be perceived between the mercury and the ring at *l*, as is seen under the vernier of a mountain barometer when it is raised a few feet off the ground. Were the tube at *l* and L of equal area, or were the relation of the areas experimentally determined, then the rise of the quicksilver above L would be one half, or a known submultiple of the total depression, equivalent to the additional elasticity of the vapour at 42° above that at 32°. Since the depressions, however, for 30 or 40 degrees in this part of the scale are exceedingly small, one half of the quantity can scarcely be ascertained with suitable precision, even after taking the above precautions. And besides, the other sources of error, or at least embarrassment, from the inequalities of the tube, and from the lengthening space occupied by the vapour, as the temperature ascends, render this method of reduction very ineligible.

By the other plan we avoid all these evils. For whatever additional elasticity we communicate to the vapour above *l*, it will be faithfully represented and measured, by the mercurial column which we must add over L, in order to overcome it, and restore the quicksilver under *l* to its zero or initial level, when the platina ring becomes once more a tangent to the mercury*.

At E a piece of cork is fixed, between the parallel legs of the syphon, to sustain it, and to serve as a point by which the whole is steadily suspended.

For temperatures above the boiling point, the part of the syphon

* Rings of other metals will not suit; for, their expansions being much greater than that of glass, they become loose with the elevation of temperature.

phon under E is evidently superfluous, merely containing in its two legs a useless weight of equipoised mercury. Accordingly for high heats, the apparatus fig. 2, or 3, is employed, and the same method of procedure is adopted. The aperture at O, fig. 3, admits the bulb of the thermometer, which rests as usual on $l''$. The recurved part of the tube is filled with mercury, and then a little liquid is passed through it to the sealed end. Heat is now applied by an Argand flame to the bottom of C, which is filled with oil or water, and the temperature is kept steadily at 212° for some minutes. Then a few drops of quicksilver may require to be added to D″ till L″ and $l''$ be in the same horizontal plane. The further conduct of the experiment differs in no respect from what has been already described. The liquid in C is progressively heated, and at each stage mercury is progressively added over L″ to restore the initial level, or volume at $l''$, by equipoising the progressive elasticity. The column above L″ being measured, represents the succession of elastic forces. When this column is wished to extend very high, the vertical tube requires to be placed for support in the groove of a long wooden prism.

The height of the column in some of my experiments being nearly 12 feet, it became necessary to employ a ladder to reach its top. I found it to be convenient in this case, after observing that the column of vapour had attained its primitive magnitude, to note down the temperature with the altitude of the column; then immediately to pour in a measured quantity of mercury nearly equal to three vertical inches, and to wait till the slow progress of the heating again brought the vapour in equilibrio with this new pressure, which at first had pushed the mercury within the platina ring at $l''$. When the lower surface of the mercury was again a tangent to this ring, the temperature and altitude were both instantly observed.

This mode of conducting the process will account for the experimental temperatures being very often odd and fractional numbers. I present them to the public as they were recorded on the instant in that particular repetition of the experiment which I consider most entitled to confidence. To trim and fashion the results into an orderly-looking series, would have been an easy task; but in my opinion this is a species of deception very injurious to the cause of science, and a deviation from the rigid truth of observation, which ought never to be made for any hypothesis. We shall afterwards have ample opportunities of exposing the fallacy of such premature geometrical refinements.

The thermometers were constructed by Creighton, with his well-known nicety, and the divisions were read off with a lens,

so

so that $\frac{1}{10}$ of a degree could be distinguished. After bestowing the utmost pains in repeating the experiments during a period of nearly two months, I found that the only way of removing the little discrepancies, which crept in between contiguous measures, was to adopt the astronomical plan of multiplying observations and deducing truth from the mean. It is essential to heat with extreme slowness and circumspection, the vessels, A, B, C. One repetition of the experiment occupies on an average 7 hours.

[To be continued.]

---

## X. *On Specific Heat.* *By Mr.* JOSEPH LUCKCOCK, *of Birmingham.*

MUCH ingenuity and patient research have been displayed on the subject of Specific Heat; the thermometer, the meltings of ice, and the times of cooling heated substances, have been the basis of these calculations; and imposing algebraical formulæ have been brought in aid, to give to them the air of demonstrations: the results, however, are unsatisfactory; for in the attempts to fix the natural zero, or point of absolute privation of heat, some have placed it at 900° below the scale of Fahrenheit, whilst others have depressed it to 11000°.

This has principally arisen from a want of precision in our ideas, from the want of a definition of heat. My Essay on the atomical philosophy, published by Longman and Co., has been some time before the public; wherein I have endeavoured to set this matter right. I have identified the matter of heat with the electric fluid, that it is the element of fluidity, and to which I have given the name of Fluidium; because of the meagreness of the terms applied to the subject; such as heat of capacity, or specific heat; heat of transmission, or thermometric heat; creating a confusion of ideas in the mind, of hot heat and cold heat: the term Fluidium may well express latent heat, or heat of capacity, or specific heat; and the term *Heat* will well express its transmission by the means of chemical or electrical agency; and in which sense I shall use the terms, considering Fluidium as a substance, and Heat as a quality.

Sir H. Davy, speaking of the production of light and heat, very happily expresses himself 'that it is a *general* result of the actions of any substances possessed of strong chemical attractions, or different electrical relations, and that it takes place in all cases in which an intense and violent motion can be conceived to be communicated to the corpuscles of bodies:' and he might have added that there can be no chemical attraction, no chemical action whatever, without electrical relations, without the aid of of fluidium; *for without fluidium in its electrical relations, all ponderable matter must be inert and dead.*

Mr. Dalton, after a train of reasoning, considers the proposition as demonstrated, 'that the specific heats of equal *bulks* of elastic fluids are directly as their specific gravities,' &c. The means before noticed for ascertaining the bulk of fluidium in certain bodies, appear only to show the degrees of *heat*, as a quality; the result of the action of bodies operated upon; whether it is the expulsion or attraction of fluidium, in its passage to or from those bodies, its force or velocity, or whether they are placed in the relative situation of an electrical machine, and become the mere carriers or conductors of fluidium; and appear to have nothing whatever to do with its bulk or quantity.

Suppose a substance could be found, whose specific gravity was such, that it should contain 1 cubic inch of solid ponderable matter, in a cubic foot or 1728 inches; it is evident that the ponderable matter would be 1 inch, and the fluidium 1727 inches; and a substance of twice the density, or specific gravity, containing 2 cubic inches in a cubic foot, would contain of fluidium 1726 inches, &c. To apply this proposition to the case, we have only to assume a zero, or a condensation of ponderable matter that shall be supposed to have its fluidium totally abstracted; and from which will result the following table:

| Substances compared. | Specific Gravity, or Ounces in a foot solid. | Bulk of Fluidium in a cubic foot in parts of 30000. | 3d Col. Water being considered a unit. | 3d Col. Fluidium being the unit. |
|---|---|---|---|---|
| Fluidium .. .. | ·0 | 30000· | 1·03448 + | 1·00000 |
| Hydrogen .... | ·08886 | 29999·91114 | 1·03448 | ·99999 |
| Aqueous vapour | ·50352 | 29999·49648 | 1·03446 | ·99998 |
| Water ...... | 1000·00000 | 29000·00000 | 1·00000 | ·99996 |
| Gold ........ | 19277·00000 | 10723·00000 | ·36975 | ·35743 |
| Zero ........ | 30000·00000 | 0· | ·0 | ·0 |

In the 1st column, or substances compared, the zero is taken at 30000 ounces to the solid foot,—the question would not be marially affected by taking it at 10 or 100 times that quantity, it would only throw the numerical expressions in the 3d column still nearer together; in the 4th column the water is reduced to an unit, for the sake of comparing it with other tables already published, with a view of exposing their errors; the 5th column, where fluidium is represented by an unit, is the proper expression; it also shows how much we have to regret that so much learning should have been so misapplied; for these results 'are as the specific gravities,' and having tables of specific gravities, we have by induction all we want on the subject of specific heat.

J. LUCKCOCK.

## XI. *Notices respecting New Books.*

*Observations on the Preparation of Extracts which are obtained by the Method of* Storck, *and on the spirituous Extract of Vanilla.* By Dr. F. Marabelli, Emeritus Professor in the University of Pavia, &c.*

In pharmacy there is a number of important remedies derived from the vegetable kingdom, and known by the generic name of Extracts. Modern chemists have counted among the immediate principles of vegetables, one, designated by the name of extractive principle, having particular characters; but the class of medicines known in pharmacy as extracts, although they contain this extractive principle are yet very compound bodies, having it mixed more or less with different other substances. The exact and perfect preparation of these extracts has in all ages occupied the attention of the zealous cultivators of pharmacy. Hence it has happened to these medicines, the same as to all others, that it depends on the manner in which they are prepared, to account for their greater or less efficacy in the diseases to which they are applied; and also, whether they are entirely inert, or even injurious. To obtain these extracts in a state fit for the various purposes to which they are employed in medicine, it is generally necessary, besides the usual precautions for the preparations of all extracts, to observe also another relative to the particular kind or species of such remedies. In fact, how much does it assist in the preparation of some extracts, such as those of chicory, *yellow* succory, and many others, to conduct the process so that they may not contain the smallest portion of green *fecula*, or that substance known under the name of *parenchyma*, which is of a resinous nature, while in other cases it is equally useful that they should retain this green *fecula*, which separates in boiling from the juice employed for the preparation of these extracts, particularly those from poisonous plants, such as *cicuta*, *aconitum*, *stramonium*, *hyoscyamus*, &c.! The *fecula* of the juice of vegetables from which the first-mentioned extracts are made, is known to be destitute of any medical virtue; and hence, whenever, in the preparation of these extracts, the juice only carefully purified is not used, or when the process is not conducted in a manner so as not to contain the smallest portion of *fecula*, extracts will be produced mixed more or less with an inert substance, which is a useless weight on the stomach: on the other hand, the celebrated Dr. Baron de Storck has demonstrated, that in the *fecula* incorporated with the other abovementioned extracts resides in a great measure the activity of those remedies. Under this impression he

* From the *Giornale di Pavia*, 4to. Bimestre, Aug. 1818.

he wished always to prepare extracts with the unpurified juice of these plants, that is, with juices evaporated to the due consistence without separating from them the *fecula:* this practice has been generally adopted even by other physicians.

But, on attentively observing the extracts obtained by this process, it was discovered that the *fecula* existing in them undergoes a greater or less degree of carbonization during their preparation; and hence the extracts themselves experience a marked alteration. It was imagined to avoid this inconvenience by proceeding in the preparation of this kind of extracts in the following manner, which consists in exposing the juice of the vegetable from which it was designed to make an extract, to a gentle heat, in collecting a part of the *fecula* which is separated from the juice by means of the heat, in evaporating the juice purified in this manner to the *consistence* almost of an extract; and finally, at the end of the operation incorporating with it the *fecula* placed apart. In a similar manner the abovementioned extracts have been prepared by Parmentier, one of the more recent writers who has diffused much light on the nature and preparation of the extracts; and this method has been followed in preference to that of Storck by the best informed French and Italian therapeutists. But this process runs the risk, that sometimes the first *fecula* which can combine with the extract may suffer some alteration, and this in consequence of the length of time necessary to reduce the purified juice to a due consistence, especially where the quantity is considerable. In other respects, it is unquestionable that by this process we may succeed in incorporating the extracts with this *fecula* in its natural state, and consequently obtain these extracts exempt from carbonization. But, opposed to this advantage, the extracts prepared according to this process are subject to another imperfection, since, in consequence of the *fecula* which is found in a grumous state, it cannot be incorporated either intimately or equally throughout the mass: the extracts thus obtained contain more or less of small clots of a different colour: besides, it is difficult to reduce them to a convenient degree of consistence without danger of altering them, consequently they are subject to become rapidly mouldy.

In the *Apparatus medicaminum* which I was commissioned to compile for the use of our hospital in 1790, and also in another which I published in Brescia in 1797, I have detailed a process for preparing extracts of the above kind, by which means they are obtained with all the necessary requisites for keeping, and in a state more fit for medical use. The process consists in separating the *fecula* by the ordinary method from the juice which is to yield the extract. Dry this *fecula* carefully either in the sun, or with a moderate heat; then pulverize it into a fine powder,

der, sift it, and afterwards mix it intimately and accurately with the abovementioned juice reduced by a well regulated evaporation to the consistence of a somewhat soft extract. The extracts procured in this manner and compared with those prepared according to Parmentier's plan, and still more with that of Storck, operate with much greater energy, and besides have a uniform mass both in consistence and colour, and are not subject, if prepared with the necessary care, either to become mouldy, like those before mentioned, or to be in the smallest degree carbonized, as happens in using the method of Storck *.

I shall now proceed to notice the spirituous extract obtained from what is commonly called *vanilla*, or the pod of an exotic vegetable called by Murray *Epidendrum vanilla*. Since 1802 the excellent Professor Carminati had urged me to subject this drug to a chemical analysis, particularly as I was occupied in taking from it a spirituous extract, he being desirous to add on the *vanilla* other observations to the numerous interesting medical experiments which he had undertaken in that and the succeeding years. This obliges me to relate the preparation and the result of it relative to the abovementioned spirituous extract, adding to them my own reflections. I placed six ounces of the pods of *vanilla* cut into very small pieces to digest four days in 108 ounces of alcohol. The tincture which I extracted was of a reddish-brown colour, and had the same aromatic taste as the *vanilla*. Afterwards, I subjected the extracted tincture to a careful distillation, until I had collected about two-thirds of the alcoholic liquor, which in taste and smell could scarcely be distinguished from pure alcohol, although when mixed with water some very thin white flakes were separated. I afterwards filtered the liquor which remained after the distillation; it had a deep reddish-brown colour, and in both taste and smell it resembled *vanilla* itself, the taste was even somewhat piquant. Finally, I exposed this liquor to a mild and uniform evaporation, by the well regulated heat of a stove, until it was reduced to the consistence of a soft extract, which I found weighed an ounce and a half. The *vanilla* which had suffered the action of the alcohol, and which formed the residuum of the above-mentioned tincture, I determined to digest again for other eight days with the alcohol remaining after the distillation of the first tincture; and having subjected this second tincture to the same operation as the first, to obtain the above-mentioned extract, I drew from it $\frac{39}{48}$ths of an ounce, or

* The author here relates an instance of M. Germain, apothecary in chief to the French military hospital at Hamburgh and Altona in 1807, being totally ignorant of his process; and also that of his countryman Parmentier; with which the translator has thought it unnecessary to trouble the English reader, who is perhaps acquainted with many similar cases.

468 grains of the spirituous extract of *vanilla* nearly equal to the first. Thus, from six ounces of *vanilla* I had two ounces and $\frac{1}{4}\frac{5}{8}$ths, or 180 grains of a spirituous extract of *vanilla*, composed of a resinous extractive substance, containing a condensed quantity of the aromatic principle of *vanilla* itself analogous to that of benzoin, very diffusible, and durable for a long time; it contained besides the benzoic acid peculiar to this drug; and in consequence of these principles, such an extract retains the original intense odour and taste of the *vanilla* pods.

These observations are not reconcileable with the remark of the erudite Murray speaking of the *vanilla* pod, in his *Apparatus medicaminum*, vol. v. that with alcohol none of its fragrant odour is extracted; but he subjoins, with his usual ingenuousness, the assertion of Geoffroy, *Traité de Matiere Medic.* tom. iii. that by digestion with spirit of wine the taste and smell of *vanilla* are extracted. Considering that from the physical characters only of the *vanilla* pods, it is evident that they are capable of exercising a considerable medical action sufficiently sensible and energetic, it is inconceivable why they are so rarely employed in medicine. Murray in the above-mentioned work observes, "rarissime instar medicaminis adhibetur, licet multa spondeat in systemate nervoso refocillando." Professor Carminati and Chevalier Borda make similar reflections; and the latter advises, instead of the aqueous infusion of *vanilla*, prescribed by some practitioners, that the spirituous infusion should always be preferred, as more certainly active and advantageous. The spirituous extract of *vanilla*, therefore, as far as I know, has not hitherto been introduced, nor used in medicine, except by Professor Carminati; who has used it with the most complete success. I also have seen this extract attended with the most happy effects in cases of hypersthenic nervous affection, and have observed it evince an action very similar to that of musk, exercising even a property intensely stimulating and diffusible. Hence I conclude, that the extract of which I have been speaking should be considered without doubt as a most efficacious remedy, and of great value, in many important cases of disease; and in the treatment of affluent persons it unites the estimable advantage of being of a grateful and pleasant taste to the greater part of patients. It is also unquestionable that this extract merits the preference to *vanilla* taken in substance, since it contains detached and in a small compass the active principles of *vanilla*, and may be administered more usefully in smaller doses, more conveniently and exactly than the *vanilla* itself.

Finally: considering the condensed quantity of the aromatic principle of *vanilla* which this extract contains, its particular nature, and the medicinal properties which it exercises on the animal

animal œconomy, I conclude that it should occupy in the vegetable kingdom the same place as musk does in the animal, to which it has much analogy. In addition to this, I shall add another observation which accident enabled me to make in confirmation of the preceding. In the year 1802, I happened to neglect a quantity of this extract left to settle in an earthen vessel, simply covered with a slip of paper which was even badly adapted to the handle of the vessel. After fourteen years, having accidentally discovered this same extract, I was agreeably surprised to find that although forgotten so many years, and badly *covered*, it was still in an excellent state, and the odour alone which it exhaled was sufficient to convince any one that it was an extract of *vanilla*. I left it in the same state, and now after sixteen years it has all the fragrance of *vanilla*, almost the same as when newly prepared.

---

*Osservazioni per servire alla Storia di una Specie di Julus.*—"Extract of Observations to illustrate the History of a Species of Julus very common in the Plains of Pisa." By Dr. PAUL SAVI, Assistant Professor of Botany in the University of Pisa.

The species of *Julus* called by the Italians *Centogambe* is generally viewed with some feelings of aversion, and hitherto has been very little observed, although its powers of destruction are very considerable. The individuals of the species here described vary in size according to their sex, the males being always less than the females; the greatest length of the former amounts to two inches and 3-twelfths, that of the latter to three inches and 10-twelfths, and thick in proportion. These insects are of a blackish brown colour on the upper side, on the under of a whitish yellow: their heads are nearly of the same thickness as their bodies, round, of a dark colour, somewhat deeper on the upper part; in the middle is a small depression with two cavities or slight indentations; the anterior part advances like a kind of upper lip, and is rounded in the middle. The eyes are an oblong oval, manifestly composed of several small hemispheric black shining eyes. The antennæ are placed in two cavities under the eyes, are clavated, a little longer than the head, dark yellow, pubescent, and composed of seven articulations. The under lip is round, having its external or inferior superfice unequal, with four protuberances, the two lateral and larger ones terminating in two obtuse teeth. The mandibles are composed of three pieces; the superior is round, deep yellow, very hard, dentated, and situated inside the mouth; the middle piece is almost triangular, of a softer consistence and grayish yellow colour: the inferior or third piece is of a cubic figure; the two latter are outside

outside the mouth laterally on the under lip. Behind the head is the first segment or ring, curved in the form of a saddle, broad above and narrow below; it is about double the size of the other rings, and is called the corselet; from the corselet to the extremity of the body there are many rings, the number of which varies according to the sex and age; in males the most mature there are about 59, in females 64; these rings are of a horny nature, clear, smooth and incomplete, having the figure of two flat rings or hoops inchased into each other, broader on the upper side and narrower on the under; their juncture has a button-like appearance; the breadth of each ring is about one-third its diameter; the colour of these rings is black in the part superior, yellowish white in the inferior, at the edges of a dirty yellow and shining; the first two rings and the last three are without the button-like structure, to which in all the others the legs are attached; the sixth ring in the male is also without this kind of button, having in its place the organs of generation; the body of the insect is terminated by two kind of hemispheres which are covered with a yellowish down. The legs of this insect vary in number like the rings, and generally consist of four situated on the narrow part of the button; they are of a whitish yellow, diaphanous, covered with a thin down, sufficiently long, composed of six pieces almost equal, and terminated by a nail of a darker colour; their length is equal to two-thirds of the diameter of the insect's body. The second ring in both male and female is without legs, and in the female between this ring and the first are situated the generative organs. The following is the best technical description which the author can give of this insect, which is different from the *Julus terrestris* and *J. sabulosus*, and approaches nearer to the *J. fuscus* and *J. Indus*, although both the latter are Oriental animals; hence he calls it *J. communis*.

Julus *segmentis supra nigris, subtus albidis, pedibus unicoloribus albidis, antennis capiti subæqualibus, albo-cinereis, ano obtuso, ultimo segmento obtusè acuminato.*

The Professor, although he kept a number of these animals in his house, has never been able to observe them deposit their eggs, they being sterile with him; but in the body of females he observed eggs nearly mature, roundish, of a dirty yellow colour, and the diameter of half a line; the females deposit an immense number of eggs in the earth, on stones or wood according to the nature of the places which they inhabit, the eggs occupying the whole length of their bodies. The youngest Julus which he has seen was two lines long and one-third thick, of a clear yellow, and semi-transparent. Immense numbers are found under rotten wood; their growth is not very rapid, increasing consecutively their rings and legs, changing successively their skins.

 This

This mutation of skin resembles more that of the crustaceous animals than the insects, differing from the former in this, that every mutation brings a slight increase to the young Julus, and the successive mutations continue till it has finished growing. Previous to casting the old skin, which opens at the head above the eyes, the animal walks out of it in the new. The Julus is drowsy or torpid, and does not eat, a state which continues twenty-four hours. It appears that, like the *Crustacea*, the young Julus eats its old skin. In one of those ejected covers Dr. Savi found all the parts quite distinct, as the eyes, antennæ, rings, legs, and, what is more extraordinary, the intestinal canal and the superficies of the trachea. This Julus also, like the crabs and shrimps, can reproduce its legs and antennæ if destroyed. The stigmata and trachea were discovered at the junctures of the legs with the body, and immediately within the button-like juncture of the rings. The circumstance which led to this discovery of the position of the stigmata and trachea was in consequence of immersing these insects in olive oil to ascertain the duration of their life; when little air bubbles immediately appeared at the junction of every pair of legs. Hence it appears that the stigmata and trachea pass along the under side of the insect in its whole length. Lastly, this animal is furnished with a fœtid liquor, which it can secrete occasionally, and which has some singular properties. It was well known that these insects have a very offensive smell, but it remained for Dr. Savi to discover its cause. If this Julus be irritated, by touching it suddenly and with sufficient force to intimidate it, immediately a very pungent and disagreeable odour is emitted. It appears that on each side of the animal there is a line of pores, one of which is in each ring, through which a yellow fœtid liquor transpires. These pores have been confounded with the stigmata, but they are in fact merely the orifices of the little bladders which contain this stinking liquid. Among the singular properties of this yellow fluid is that of staining the skin on which it is allowed to dry, of a bright red, similar to that produced by muriate of mercury or muriate of gold, and the colour is indestructible, and can only be removed by time. This liquor removed from its reservoirs, in a short time, when viewed with a microscope, assumes the form of very limpid octohedral crystals; its gravity is similar to that of olive oil; it is of a reddish yellow colour; its smell is strong, pungent, and to some similar to that of chlorine; its taste is very caustic, and produces a sensation on the tongue like the prick of a needle; it unites with water, but much better and more eagerly with spirit of wine; the latter did not renew the colour of paper stained with turnsole and reddened with acid: but a piece of paper coloured with turnsole and exposed to this yellow liquor, after

after a certain time becomes red. Neither muriate of barytes nor nitrate of silver poured into the vinous solution of this liquor produced any precipitate; a little oxalic acid produced a slight whiteness. At a moderate degree of heat it evaporates without changing its colour, yielding yellowish vapours. In uniting the vapours of this liquor with those of nitric acid, no white smoke appeared. Put the aqueous infusion into a small portion of spirit of wine in which an infusion of those bladders had been made, and no whitening or precipitate occurs, but a very rapid vertical movement takes place as if the vesicles had become animated. It is probable that the spirit of wine which enters into these vesicles, in uniting with the water, gives them this motion. On examining another species of Julus, the author found it possessed of a fœtid liquor having a milky white colour, and of an insupportable smell.

---

*Transactions of the Literary Society of Bombay.* With Engravings. Vol. I. 4to. pp. 319.

The first volume of Transactions now published, of the Literary Society of Bombay established in 1804, contains the following articles:—Discourse at the opening of the Society. By Sir James Mackintosh, President.—An Account of the Festival of Mamangom, as celebrated on the Coast of Malabar. By Francis Wrede, Esq. (afterwards Baron Wrede).—Remarks upon the Temperature of the Island of Bombay during the Years 1803 and 1804. By Major (now Lieutenant Colonel) Jasper Nicholls.—Translations from the Chinese of two Edicts: the one relating to the Condemnation of certain Persons convicted of Christianity, and the other concerning the Condemnation of certain Magistrates in the Province of Canton. By Sir George Staunton. With Introductory Remarks by the President Sir James Mackintosh.—Account of the Akhlauk-e-Nasiree, or Morals of Nasir, a celebrated Persian System of Ethics. By Lieut. Edward Frissel of the Bombay Establishment.—Account of the Caves in Salsette, illustrated with Drawings of the principal Figures and Caves. By Henry Salt, Esq.—On the Similitude between the Gipsy and Hindostanee Languages. By Lieut. Francis Irvine of the Bengal Native Infantry.—Translations from the Persian, illustrative of the Opinions of the Sunni and Shia Sects of Mahomedans. By Brig. Gen. Sir John Malcolm, K.C.B.—A Treatise on Sufiism, or Mahomedan Mysticism. By Lieut. James William Graham.—Account of the present compared with the ancient State of Babylon. By Capt. Ed. Frederick of the Bombay Establishment.—Account of the Hill Fort of Chapaneer in Guzerat. By Capt. William Miles.—The Fifth Sermon of Sady, translated from the Persian.

Persian. By James Ross, Esq.—Account of the Origin, History, and Manners of the Race of Men called Bunjaras. By Capt. John Briggs.—An Account of the Parisnath-Gowricha, worshipped in the Desert of Parkur; to which are added a few Remarks upon the present Mode of Worship of that Idol. By Lieut. James Mackmurdo.—Observations on two Sepulchral Urns found at Bushire in Persia. By William Erskine, Esq.—Account of the Cave Temple of Elephanta, with a Plan and Drawings of the principal Figures. By William Erskine, Esq.—Remarks on the Province of Kattiwar; its Inhabitants, their Manners and Customs. By Lieut. James Mackmurdo.—Remarks on the Substance called Gez or Manna, found in Persia and Armenia. By Capt. Ed. Frederick.—Account of the Cornelian Mines in the Neighbourhood of Baroach. By John Copland, Esq.—Some Account of the Famine in Guzerat in 1812 and 1813. By Capt. James Rivett Carnac.—Plan of a Comparative Vocabulary of Indian Languages. By Sir James Mackintosh, President of the Society.

---

Dr. Spurzheim is preparing for the press a Treatise on the Education of Youth, founded on the Discrimination of individual Character by the Form of the Head.

One of the most useful observations made by Dr. Spurzheim in his late physiological work on the Brain, is that *on the nature of Hydrocephalus*, and of the state of the brain in that disease. This is a subject in a great measure unconnected with his Craniology; it is one which is duly appreciated by most anatomists, as having been handled by him; and the anatomists of various countries who have written on the same disorder, have borrowed their most useful observations from his elaborate dissections. The anatomical reader is particularly referred to "Spurzheim's Reply to the Reviewers," recently printed at Edinburgh, and to the Physiog. Syst. article *Hydrocephalus*.

A small tract has been circulated lately respecting the opposition which the Doctrine of the Brain met with in England, wherein the author represents the opposition as proceeding on the selfish principle of envy, and the fear of personal observation; and makes the shrewd observation, that "those persons who are most strenuous against Spurzheim's doctrine are conscious of not having the most intellectual heads."

---

An amusing Work has just issued from the press, from the pen of Thomas Bewick of Newcastle, the celebrated wood-engraver. It is a collection of ancient fables principally from Æsop, illustrated with numerous wood-cuts done by Mr. Bewick in in a very masterly style: equal, if not superior, to those of his History of Quadrupeds and of British Birds.

---

Dr. E. D. Clarke has in the press a Treatise entitled "The Gas Blow Pipe, or Art of Fusion by burning the Gaseous Constituents of Water;" giving the History of the Philosophical Apparatus so denomiuated; the Proofs of Analogy in its Operations to the Nature of Volcanoes; together with an Appendix containing an Account of Experiments with this Blowpipe.

---

## XII. *Proceedings of Learned Societies.*

### ROYAL SOCIETY.

Nov. 5, 1818. The Croonian Lecture was read by Sir E. Home. It had for its subject the conversion of Pus into granulations of new Flesh. According to Sir Everard, granulations which appear to consist of a congeries of tortuous vessels, are formed in a way similar to the blood-vessels, as described by him in a former paper *. Pus, when first secreted, is a transparent fluid, a pellicle of which, in this state, covers the little prominences of the granulations. Under this pellicle particles of air (supposed to be carbonic acid) are exuded, upon which vessels seem to be moulded, which soon become distended with the red blood. They chiefly lie horizontally, and minute red spots are also visible, supposed to be the terminations of vessels running in a perpendicular direction. This paper was accompanied with drawings.

Nov. 12. A paper "On the Laws which regulate the Absorption of polarized Light by doubly refracting Crystals," by Dr. Brewster, was read. He was led to this investigation by observing the phænomena presented by the acetate of copper when exposed to polarized light. The paper treats first of the absorption of polarized light by crystals of one axis; and, secondly, by crystals having more than one; and concludes with remarks on the effects of heat in modifying the absorption of polarized light by crystallized bodies. Heat does not, as is generally posed, produce the pink colour of some topazes, but discharges the yellowish colouring matter of one medium, leaving the pink colouring matter of another, and which originally existed in it. The author seems to be of opinion, from his experiments, that the colouring particles of crystals are confined to different media, and are not dispersed indiscriminately throughout their mass, as is commonly believed.

* Phil. Trans. 1818, Part I.

The sittings on the 19th and 26th were suspended on account of the death of the Queen. On the 30th, being St. Andrew's day, the annual election of the President, Council, and other Officers took place; and the Copley Medal was presented to Robert Seppings, Esq. for his papers relative to improvements in ship-building; accompanied with a suitable speech by the venerable Presiddent.

Dec. 10. A paper entitled "Observations on the Decomposition of Starch by the Action of Air and Water at common Temperatures," by M. Theodore de Saussure, was commenced. The reading was continued on

Dec. 17. Some starch boiled in water was, for two years, exposed to a temperature between 68° and 77° under a glass jar. About one-third of it was, at the end of that time, found converted into saccharine matter, presenting all the properties of sugar made from starch by the action of sulphuric acid. The author also found, on examination, that a species of gum was formed, like that obtained by roasting starch, and another substance which he denominates *amidine*, which remained insoluble in water and acids, and gave a blue colour with iodine. When air is present, during the exposure, water and carbonic acid gas are given off in considerable quantities, and charcoal is deposited: when air is excluded no water is formed, only a little carbonic acid and hydrogen are liberated, and no carbon is deposited. The author could not determine whether the quantity of sugar produced was effected by the presence or absence of air.

A paper by C. Babbage was also read at this meeting, On the Solution of certain Problems relating to Games of Chance, calculated to show that some questions supposed, hitherto, to defy analytical investigation may be subjected to algebraic reasoning.

Dec. 24. A paper by Capt. Duff, R.N. was read, On the Prevention of the Dry Rot in Timber. The author proposed that experiments should be instituted, to ascertain whether the water of peat mosses employed to impregnate sound timber, and also timber partially decayed by dry-rot, would save the one, and prevent the further ravages of the dry-rot in the other. He rests his suggestion on the well-known fact, that wood submerged in peat-moss is preserved sound for ages.

## GLASGOW LITERARY SOCIETY.

Dec. 10, 1818. An account of some very interesting experiments, performed by Dr. Ure, on the body of a criminal executed at Glasgow on the 4th of Nov. last, was read before this Society. The paper commences with some appropriate general physiological views relating to the application of galvanism, in which the author

author notices particularly the researches of Dr. Wilson Philip on the relation between Voltaic electricity and the phænomena of life, of which we have given some accounts in our preceding volumes. The author gives the following detail of his experiments*:

"The subject of these experiments was a middle-sized, athletic, and extremely muscular man, about thirty years of age. He was suspended from the gallows nearly an hour, and made no convulsive struggle after he dropped; while a thief executed along with him, was violently agitated for a considerable time. He was brought to the anatomical theatre of our University in about ten minutes after he was cut down. His face had a perfectly natural aspect, being neither livid nor tumefied; and there was no dislocation of his neck.

"Dr. Jeffray, the distinguished Professor of Anatomy, having on the preceding day requested me to perform the galvanic experiments, I sent to his theatre with this view, next morning, my *minor* Voltaic battery, consisting of 270 pairs of four-inch plates, with wires of communication, and pointed metallic rods with insulating handles, for the more commodious application of the electric power. About five minutes before the police officers arrived with the body, the battery was charged with a dilute nitro-sulphuric acid, which speedily brought it into a state of intense action. The dissections were skilfully executed by Mr. Marshall, under the superintendance of the Professor.

"*Exp.* 1.—A large incision was made into the nape of the neck, close below the *occiput*. The posterior half of the *atlas vertebra* was then removed by bone forceps, when the spinal marrow was brought into view. A considerable incision was at the same time made in the left hip, through the great gluteal muscle, so as to bring the sciatic nerve into sight; and a small cut was made in the heel. From neither of these did any blood flow. The pointed rod connected with one end of the battery was now placed in contact with the spinal marrow, while the other rod was applied to the sciatic nerve. Every muscle of the body was immediately agitated with convulsive movements, resembling a violent shuddering from cold. The left side was most powerfully convulsed at each renewal of the electric contact. On moving the second rod from the hip to the heel, the knee being previously bent, the leg was thrown out with such violence as nearly to overturn one of the assistants, who in vain attempted to prevent its extension.

"*Exp.* 2.—The left phrenic nerve was now laid bare at the outer edge of the *sterno-thyroideus* muscle, from three to four inches above the clavicle; the cutaneous incision having been

* Journal of Science and the Arts, No. XII.

made

made by the side of the *sterno-cleido-mastoideus.* Since this nerve is distributed to the diaphragm, and since it communicates with the heart through the eighth pair, it was expected, by transmitting the galvanic power along it, that the respiratory process would be renewed. Accordingly, a small incision having been made under the cartilage of the seventh rib, the point of the one insulating rod was brought into contact with the great head of the diaphragm, while the other point was applied to the phrenic nerve in the neck. This muscle, the main agent of respiration, was instantly contracted, but with less force than was expected. Satisfied, from ample experience on the living body, that more powerful effects can be produced in galvanic excitation, by leaving the extreme communicating rods in close contact with the parts to be operated on, while the electric chain or circuit is completed, by running the end of the wires along the top of the plates in the last trough of either pole, the other wire being steadily immersed in the last cell of the opposite pole, I had immediate recourse to this method. The success of it was truly wonderful. Full, nay, laborious breathing instantly commenced. The chest heaved, and fell; the belly was protruded, and again collapsed, with the relaxing and retiring diaphragm. This process was continued, without interruption, as long as I continued the electric discharges.

"In the judgement of many scientific gentlemen who witnessed the scene, this respiratory experiment was perhaps the most striking ever made with a philosophical apparatus. Let it also be remembered, that for full half an hour before this period, the body had been well nigh drained of its blood, and the spinal marrow severely lacerated. No pulsation could be perceived meanwhile at the heart or wrist; but it may be supposed that, but for the evacuation of the blood,—the essential stimulus of that organ,—this phænomenon might also have occurred.

"*Exp.* 3.—The supra-orbital nerve was laid bare in the forehead, as it issues through the supra-ciliary *foramen*, in the eyebrow: the one conducting rod being applied to it, and the other to the heel, most extraordinary grimaces were exhibited every time that the electric discharges were made, by running the wire in my hand along the edges of the last trough, from the 220th to the 227th pair of plates; thus fifty shocks, each greater than the preceding one, were given in two seconds: every muscle in his countenance was simultaneously thrown into fearful action; rage, horror, despair, anguish, and ghastly smiles, united their hideous expression in the murderer's face, surpassing far the wildest representations of a Fuseli or a Kean. At this period several of the spectators were forced to leave the apartment from terror or sickness, and one gentleman fainted.

"*Exp.*

"*Exp.* 4.—The last galvanic experiment consisted in transmitting the electric power from the spinal marrow to the ulnar nerve, as it passes by the internal condyle at the elbow; the fingers now moved nimbly, like those of a violin performer; an assistant, who tried to close the fist, found the hand to open forcibly, in spite of his efforts. When the one rod was applied to a slight incision in the tip of the fore-finger, the fist being previously clenched, that finger extended instantly; and from the convulsive agitation of the arm, he seemed to point to the different spectators, some of whom thought he had come to life."

An hour was spent in these experiments, when an experiment was made with a view of determining the quan:ity of residual air in the lungs; after the detail of which, the author proceeds as follows:

" In deliberating on the above galvanic phænomena, we are almost willing to imagine, that if, without cutting into and wounding the spinal marrow and blood-vessels in the neck, the pulmonary organs had been set a-playing at first, (as I proposed) by electrifying the phrenic nerve (which may be done without any dangerous incision,) there is a probability that life might have been restored. This event, however little desirable with a murderer, and perhaps contrary to law, would yet have been pardonable in one instance, as it would have been highly honourable and useful to science. From the accurate experiments of Dr. Philip, it appears that the action of the diaphragm and lungs is indispensable towards restoring the suspended action of the heart and great vessels, subservient to the circulation of the blood.

"It is known, that cases of death-like lethargy, or suspended animation, from disease and accidents, have occurred, where life has returned, after longer interruption of its functions than in the subject of the preceding experiments. It is probable, when apparent death supervenes from suffocation with noxious gases, &c. and when there is no organic læsion, that a judiciously directed galvanic experiment will, if any thing will, restore the activity of the vital functions. The plans of administering Voltaic electricity hitherto pursued in such cases, are, in my humble apprehension, very defective. No advantage, we perceive, is likely to accrue from passing electric discharges across the chest, directly through the heart and lungs. On the principles so well developed by Dr. Philip, and now illustrated on Clydsdale's body, we should transmit along the channel of the nerves, that substitute for nervous influence, or that power which may perchance awaken its dormant faculties. Then, indeed, fair hopes may be formed of deriving extensive benefit from galvanism; and of

raising

raising this wonderful agent to its expected rank, among the ministers of health and life to man.

"I would, however, beg leave to suggest another nervous channel, which I conceive to be a still readier and more powerful one, to the action of the heart and lungs than the phrenic nerve. If a longitudinal incision be made, as is frequently done for aneurism, through the integuments of the neck at the outer edge of the *sterno-mastoideus* muscle, about half-way between the clavicle and angle of the lower jaw; then on turning over the edge of this muscle, we bring into view the throbbing carotid, on the outside of which, the *par vagum*, and great sympathetic nerve, lie together in one sheath. Here, therefore, they may both be directly touched and pressed by a blunt metallic conductor. These nerves communicate directly, or indirectly, with the phrenic; and the superficial nerve of the heart is sent off from the sympathetic.

"Should, however, the phrenic nerve be taken, that of the left side is the preferable of the two. From the position of the heart, the left phrenic differs a little in its course from the right. It passes over the *pericardium*, covering the *apex* of the heart.

"While the point of one metallic conductor is applied to the nervous cords above described, the other knob ought to be firmly pressed against the side of the person, immediately under the cartilage of the seventh rib. The skin should be moistened with a solution of common salt, or, what is better, a hot saturated solution of sal-ammoniac, by which means the electric energy will be more effectually conveyed through the cuticle, so as to complete the Voltaic chain.

"To lay bare the nerves above described, requires, as I have stated, no formidable incision, nor does it demand more anatomical skill, or surgical dexterity, than every practitioner of the healing art ought to possess. We should always bear in mind, that the subject of experiment is at least insensible to pain; and that like is at stake, perhaps, irrecoverably gone. And assuredly, if we place the risque and difficulty of the operations, in competition with the blessings and glory consequent on success, they will weigh as nothing, with the intelligent and humane. It is possible, indeed, that two small brass knobs, covered with cloth moistened with solution of sal-ammoniac, pressed above and below, on the place of the nerve, and the diaphragmatic region, may suffice, without any surgical operation. It may first be tried.

"Immersion of the body in cold water accelerates greatly the extinction of life arising from suffocation; and hence less hopes need be entertained, of recovering drowned persons after a considerable interval, than when the vital heat has been suffered to

continue

continue with little abatement. None of the ordinary practices judiciously enjoined by the Humane Society, should ever on such occasions be neglected. For it is surely criminal to spare any pains which may contribute, in the slightest degree, to recall the fleeting breath of man to its cherished mansion."

### CORK SOCIETY FOR PROMOTING KNOWLEDGE.

In a paper read some months ago before this Society, the author states, that on opening a paper in which he had some time before put some sulphate of zinc, he found in its place a yellowish-brown substance entangled in a fine silky thread. On searching the bottom of the box in which this little parcel with others had been deposited, he found a portion of the lost sulphate and a large spider of the species *Aranea scenica*. To ascertain whether the spider was the thief, the author closed him up in the box with two ounces of the sulphate, of which it was found, at the end of ten weeks, he had eaten a considerable quantity. At the time the paper was read the insect seemed in perfect health, having in about six months eaten nearly four ounces of the sulphate. Other metallic salts—sulphates, muriates, and nitrates, were also offered to the spider, but he would not touch them, even when denied his favourite salt. From some experiments made on the yellow powder, the author concludes that the sulphate of zinc had been deprived of part of its acid in passing through the spider.

### ROYAL INSTITUTE OF FRANCE.

*Sitting of the 18th Jan. 1819.*

M. Thenard read a memoir, which he accompanied with a repetition of a part of his new experiments on the absorption of oxygen by water.

M. Dupree read a notice on the Scientific Establishments, and on the ancient and modern Edifices of the Scottish Capital.

M. Serres read a memoir on the Laws of Osteology, and particularly on the formation of articular cavities.

M. Fourier read a memoir on the Mathematical Theory of Insurances.

M. Yvart made a verbal report on the work of Mr. Farey on the agriculture of Derbyshire.

### ROYAL ACADEMY OF SCIENCES, PARIS.

A gift of a sum of money from an anonymous donor having been transmitted to this Academy for the foundation of a prize in physiology, a gold medal of the value of 440 franks will be given to the author of that printed work, or manuscript, sent to the Academy before the 1st of December 1819, which shall be considered

dered to have contributed most to the progress of experimental physiology. The decision will be announced early in the following year.

### ROYAL ACADEMY OF SCIENCES, BELLES LETTRES AND ARTS, ROUEN.

This Academy proposes as a prize question, the following subject:—" What are the most proper methods, dependent or independent of Wedgwood's Pyrometer, for measuring with accuracy the temperatures required in certain arts, as in glass, porcelain, or iron furnaces?"—Prize, a medal of the value of 300 francs. The papers to be written in French or in Latin, and sent in before the 1st of July next.

### ACADEMY OF SCIENCES, ST. PETERSBURG.

The Academy has proposed the following questions:—

1. To repeat the experiments that have been performed on Potash and on Soda, and on their metallic bases; and to examine with precision the results thence deducible.

2. To subject ammonia to a particular and careful examination, in order to ascertain with precision the relative merits of the opinions that have been entertained respecting its nature and composition; and the possibility of insulating the metal asserted to be contained in it.

3. To examine with greater accuracy than hitherto effected, the metallic substances yielded by the earths; ascertain the possibility of presenting them pure and isolated; describe their properties in that state, and in combination with other substances; and point out the various and determinate relations in which they should be placed.

Premium 100 ducats of Olanda, and one 100 copies of the memoir itself. The papers to be delivered to the Secretary before the 1st of January 1820.

### ACADEMY OF MEDICINE, PARIS.

The following subject has been proposed by this Academy:—" To determine generally the influence of Pathological [morbid] Anatomy on the progress of medicine; and in particular on the diagnosis and treatment of internal diseases." Prize, a gold medal of the value of 300 franks, to be adjudged at an extraordinary public sitting in October 1819. The memoirs to be in French or in Latin, and transmitted before August to M. le Docteur Chordel, sécrétaire générale du Cercle Médical, rue Casette, Paris.

### SOCIETY OF MEDICINE, MARSEILLES.

This Society has proposed, as the subject of a dissertation, the following questions:—1. What diseases of the Uterus are liable

liable to be confounded with cancer and ulceration of this organ? —2. By what characteristics may they be distinguished in a decided manner?—3. What curatives or palliatives has experience proved to be most efficacious?—It is requested that chemical observations and examinations after death may be made the basis of the observations offered. The prize is a gold medal of the value of 300 francs. The dissertations to be in French or in Latin, and sent to M. Trucy, Secretary to the Society, before July next.

ROYAL MEDICAL SOCIETY, BOURDEAUX.

This Society has proposed the following Prize Question:— "What are the results of too rapid a growth? What the means best adapted to moderate its progress when injurious, and remedy the evils which it produces?"—The memoir to contain precise facts supported by medical practice, and not merely a development of hypothesis. To be written in French or in Latin, and transmitted to the Secretary before July 1819. Premium 300 franks.

---

## XIII. *Intelligence and Miscellaneous Articles.*

### CADMIUM.

This new metal, which was discovered by M. Stromeyer in the autumn of 1817, while officially examining the apothecaries' shops in Hanover, is described by M. Gay-Lussac* as resembling tin in colour, lustre (but not tarnishing in the air), softness, ductility, and the crackling sound which is heard when this metal is bent. Cadmium, when exposed to heat, is changed into an orange-yellow oxide, not volatile, and easily reduced again to the metallic state: it gives no colour to borax; dissolves readily in acids, and forms colourless salts, from which it is precipitated, white, by alkalies: by the hydrosulphuric acid it is, like arsenic, precipitated yellow; by zinc, in the metallic state. Specif. grav. at 77° of Fahr. 8·635.

This metal has been more recently examined by J. G. Children, esq.† He found its spec. grav. compared with distilled water at 60° to be 8·67, and when hammered 9·05. He describes it as resembling tin in external appearance, hardness, ductility, and sound when bent; fusible considerably below a red-heat, and very volatile—but its oxide remains fixed in that temperature. It dissolves readily in cold diluted nitric acid, and the evaporated solution leaves a deliquescent salt soluble in alcohol, to the flame of which it gives no colour. The sulphuric and hy-

* *Annales de Chimie et de Physique*, tom. viii.

† Journal of Science and the Arts, vol. vi.

drochloric

drochloric acids do not act readily on cadmium, but they instantly dissolve its oxide. The evaporated hydrochlorate attracts moisture; and at a heat below redness is volatilized.

A neutral solution of the nitrate gives, with prussiate of potash, a white precipitate; with hydrosulphuret of ammonia, a fine bright yellow precipitate; with a solution of sulphuretted hydrogen, a precipitate of the same colour, which passes to a crimson when heated, but becomes yellow again on cooling; with oxalate of ammonia, a white precipitate insoluble in oxalic acid. Potash, ammonia, and their carbonates, give a white precipitate; chromate of potash, succinate and benzoate of ammonia, infusion of galls and sulphate of soda cause no precipitation.

Cadmium is readily precipitated by zinc from its solution in hydrochloric acid, in the metallic state; but not so readily from nitric acid.

When ammonia is employed to precipitate the oxide of cadmium from its solution in an acid, the precipitate is redissolved by excess of the alkali: potash does not dissolve the oxide, but throws it down from its solution in ammonia—furnishing a ready method of separating it from zinc, and of ascertaining its presence when accompanied by a large portion of that metal, as in blende.

"Dissolve the mineral supposed to contain cadmium, in nitric acid; to the filtered solution add ammonia in excess, to throw down the oxides of iron, and redissolve those of zinc and cadmium: pure hydrate of potash will then separate the latter, which, when redissolved in diluted hydrochloric acid, will afford the characteristic bright yellow precipitate on the addition of sulphuretted hydrogen."— By this process Mr. Children separated the metal from a brown lamellar blende from Freyberg, furnished to him by Mr. Heuland.

## LAMPIC ACID.

In the course of his experiments on the nature and properties of flame, Sir Humphry Davy made known the curious fact, that certain combustible bodies may be made to combine with oxygen at comparatively low temperatures. Sir Humphry's discovery was applied to the keeping a platinum wire in a state of ignition by means of a lamp with spirit of wine—the result by this slow combustion is a peculiar acid. To obtain this in larger quantities, J. F. Daniel, esq. employed the head of an alembic properly supported, to the beak of which he applied a receiver, and under its larger opening placed a small lamp, with a coil of platinum wire. In the account which he has published in the Journal of Science (No. XII.) he states that a little nicety is requisite in trimming the lamp, and in placing it so as to obtain the best

best results. Too much of the cotton must not be exposed, to much of the liquid will evaporate unchanged and adulterate the product; nor must the lamp be placed too high in the alembic, which would extinguish it, or so low as to allow the vapour or be dissipated. With this lamp Mr. Daniel made several experiments.

The first vapours which he collected were those from spirit of wine. The condensed liquid was slightly acid, and of a pleasant pungent smell. In the sequel the acid was proved to be the same as that produced from ether largely diluted with water and spirit of wine.

Spirit of turpentine gave a liquid of a light amber colour, and agreeable odour, which, by evaporation of the superfluous spirit, gave a resin of a deep amber colour, very fragrant, and quite free from turpentine, inflammable, and yielding much charcoal. It is soluble in spirits of wine, from which it precipitates in a white state by adding water to the solution.

His experiments with camphor did not succeed to his satisfaction; but with ether he succeeded perfectly, and obtained above a pint and a half of the condensed vapour, consisting principally of the new acid, to which, as pledging no hypothetical views of its composition, and merely serving to recall to the mind "its mode of formation, and its connexion with that brilliant chain of investigation which is the boast of science and the triumph of humanity," he has given the name of *Lampic Acid.*

This acid when first collected is a colourless liquid, of an intensely sour taste, and pungent odour; yielding when heated a vapour extremely irritating and disagreeable. It is purified by careful evaporation, yielding alcoholic vapour, and not that of ether. When thus rectified its specific gravity is 1015. It reddens vegetable blues; decomposes all the earthy and alkaline carbonates; and forms with them neutral salts, all of which are more or less deliquescent.

According to Mr. Daniel's experiments, *Lampate of Soda* consists of acid 62·1 and soda 39·7. This salt is very deliquescent, of a not unpleasant saline taste; is difficultly crystallized, and is speedily decomposed by heat.

*Lampate of barytes* by composition consists of acid 39·5, barytes 60·5. Decomposed by sulphuric acid, its composition comes out acid 40·2, barytes 59·8. It crystallizes readily in colourless transparent needles, is less deliquescent than the lampates of soda, of potash, or of ammonia, and is very soluble in water.

*Lampate of potash* can hardly be distinguished by taste from lampate of soda, is less deliquescent, and not easily obtained in crystals.

*Lampate of ammonia* is of a brown colour, volatile, evaporates below 212°, and gives a very disagreeable odour, like that of burning animal matter.

*Lampate of lime* is very deliquescent, of a caustic bitter taste.

*Lampate of magnesia* has a sweetish astringent taste, something like that of sulphate of iron.

All these salts are inflammable, and burn with flame, leaving a large residue of charcoal.

But, according to the author, the most curious and distinguishing characters of the lampic acid arise from its action upon the metallic oxides.

*Lampate of gold.* When some of it is poured into a solution of muriate of gold, the metal in a few hours is precipitated in the metallic form, and a thin film of gold attaches itself to the glass. The reduction is almost instantaneous if the mixture be heated. If the lampate of potash or of soda be poured into the same solution, a light yellow precipitate is thrown down, decomposable by a very low heat, and which then gives a beautiful precipitation of the metal.

*Lampate of platinum.* The colour of muriate of platinum is much heightened by the acid, but the muriate is not reduced. Lampate of potash and of ammonia both precipitate from it a yellow very crystalline salt, not reducible separately by a boiling heat; but when mixed, an instant precipitation of metallic platinum ensues, which coats the tube: the liquid becomes colourless.

*Lampate of silver.* The acid added to nitrate of silver gives a precipitation, which at first is of a purplish brown colour—an effect resulting from the action of the metallic particles on the rays of light. A portion of the metal lines the tube, and part falls to the bottom. It is easily fused by the blowpipe. The solution of oxide of silver on the lampic acid is of a sea green colour. A heat below 212° decomposes it, and precipitates the metal.

*Lampate of mercury.* When the acid is added to a solution of nitrate of mercury, a metallic shower takes place, and globules of mercury accumulate at the bottom of the vessel. It acts readily on the red oxide of mercury, yielding a white bulky salt sparingly soluble in water. Dried on blotting-paper it spontaneously decomposes in a few days, yielding globules of mercury. Lampate of mercury exposed to heat in a retort, a violent effervescence takes place; metallic globules immediately begin to collect, and dense fumes are given off, which when condensed are pure lampic acid.

*Lampate of copper.* Black oxide of copper dissolved in the acid gives a liquid of a beautiful blue, which by gentle evapora-

tion

tion in the vacuum of an air-pump yields blue rhomboidal crystals: the solution when boiled precipitates the metal of a deep red.

*Lampate of lead.* Red oxide of lead dissolved by the acid gives a white easily-crystallizable salt, of a sweetish taste, which burns with flame, and glows like a coal.

Neither the acid nor its salts have any action on the oxide of tin or on salts of tin. The acid has no action on the red oxide, on the sulphate, or on the nitrate of iron; but the lampates of potash and ammonia, separately, turn the nitrate to a beautiful blood-red colour, without precipitate, and joined throw down the red oxide.

Lampic acid instantly blackens when sulphuric acid is added to it, and a large quantity of carbon is disengaged: with nitric acid, nitrous gas is given off and oxalic acid formed.

By analysis the acid appears to Mr. Daniel to be composed of 40·7 of carbon, 7·7 of hydrogen, 51·6 of oxygen and hydrogen, in the proportions which form water = 100.—This analysis is interesting, as affording an exception to the general rule laid down by the French chemists, that in all vegetable acids the oxygen is to the hydrogen in a proportion greater than is necessary to form water.

Mr. Daniel suggests that the singular property of the lampic acid and its salts, of precipitating the metals, may hereafter be usefully applied to the plating of delicate works with gold and platinum.

---

## LITHIA—LITHIUM.

For the discovery of the new fixed alkali *lithia*, having for its base a new metal (*lithium*), we are indebted to a pupil of Berzelius, M. Arfvresdon, who obtained it from *petalite*, a mineral which by his analysis was found to be composed of silica 80 parts, alumina 17, and the new alkali 5 parts.—It is extracted from the petalite by calcining the latter, in powder, with carbonate of barytes, separating the earths, and obtaining the alkali combined with an acid. Its combinations with acids are, generally, very fusible. The sulphate and muriate liquefy below a red heat; the carbonate, when red-hot, acting violently on the platinum crucible. The former crystallizes readily, and retains no water of crystallization; nor is their solution precipitable by muriate of platinum, or by tartaric acid. The nitrate crystallizes in rhomboids, and attracts moisture: the muriate is highly deliquescent: the carbonate is difficultly soluble in water; and when evaporated the salt crystallizes in slender prisms. It has a greater capacity for saturating the acids than even magnesia.

M. Vauquelin verified these experiments, and found that with sulphur lithia yields a yellow-coloured sulphuret: by his analysis it consists of oxygen 43·5 and lithium 56·5. Sir Humphry Davy was, we believe, the first who reduced it to the metallic state. Lithium bears a strong resemblance to sodium.

By some recent experiments of Mr. Children *, 17·7 grains of the sulphate contain lithia 5·7; sulphuric acid 12; and lithia itself 57·89 of lithium, and 42·11 of oxygen = 100.

### PLATINUM.

A new method of purifying platinum has been discovered by the Marquis of Ridolfi, calculated to diminish the price of that most useful metal. His process is as follows: Separate, mechanically, from crude platina, such foreign bodies as can be detected by the eye: wash the crude metal in dilute muriatic acid; fuse it with four times its weight of lead, and throw the melted alloy into cold water. Then pulverize it; mix with it an equal weight of sulphur; throw the mixture into a Hessian crucible previously heated to whiteness; put a cover on the crucible, and keep it at a red heat for ten minutes. When cold a brilliant metallic button, containing platinum, lead and sulphur, will be found under the scoriæ. Add a little more lead, and fuse the alloy again. The sulphur now separates itself with the scoriæ, and an alloy of platinum and lead is found at the bottom. Heat this button to whiteness, and in this state hammer it on an anvil with a hot hammer, and the lead will be pressed out by the hammering. Platinum thus prepared is malleable and ductile like the best platinum prepared by more expensive processes; and is of the specific gravity of 22·630. It is probable that this platinum still contains a minute portion of lead, being heavier than pure platinum; but it will be found equally applicable to most purposes, and especially for vessels for the makers of sulphuric acid.

### WOODANIUM.

M. Lampadius gives the above name to a new metal which he has discovered in some English ores; but the characters of the ores are not mentioned in the letter which he has addressed to Dr. Müller on this subject.

### HYDROGURETTED CARBONIC OXIDE.

Dr. Thomson has discovered a new compound inflammable gas to which he has given the above name. Its specific gravity is 913, that of common air being 1. It is not absorbed nor altered by water. It burns with a deep-blue flame, and detonates when mixed with oxygen, and fired. It is a compound of oxygen, hydrogen and carbon; and Dr. Thomson considers it as being three volumes of carbonic oxide, and one of hydrogen, condensed by combination into three volumes.

* Journal of Science and the Arts, vi.

## PRUSSIAN BLUE AND STARCH.

M. Vincent, a French apothecary, states* that if four parts of starch and one part of Prussian blue be well triturated together in a mortar, and then boiled in a large quantity of water, the liquor acquires a green colour before it begins to boil; when it becomes brown, and a precipitate is formed, which, though treated with acids, does not resume its blue colour. The liquid forms a fine Prussian blue when a solution of sulphate of iron mixed with an equal volume of solution of chlorine is added to it. When evaporated no gluey substance is deposited; but, if evaporated to a small volume, on being suffered to cool, it yields a glutinous matter, which dries in the open air, and may again be easily dissolved in water. The starch, therefore, has changed its nature and been converted into a kind of gum.

## STARCH-SUGAR.

The process of M. Kirchoff for converting the amylaceous fecula (starch) into sugar by means of sulphuric acid, has already received some useful applications; but the most useful is, doubtless, the conversion of this sugar into beer. Mingled in a proper quantity of water, set in fermentation and hopp'd according to the method of brewers, this syrup furnishes a beer which is light, brisk, strong, and of an agreeable savour. This refreshing and healthy beverage may be prepared any where; it requires neither mill nor expensive vessels, so that the cultivator and artisan may make it in their dwellings. Already two manufacturers are employed in preparing it in quantities, and they estimate that it will only cost them a centime the livre. (¼d. the gallon.)

## RED SNOW.

Our readers must all have heard of the *red snow* stated to have been found by our northern navigators lying upon the surface of snow lodged in ravines, for upwards of 100 miles along the coast of Baffin's Bay. Quantities were collected and brought home in bottles; that is, the colouring substance and the water of the snow on which it lay, with other substances apparently foreign, which had been taken up with the snow. Dr. Thomson has published the result of experiments made upon small quantities of the colouring substance. On opening a phial of what had been collected, an offensive smell, similar to that of putrid sea weed, or excrement, was perceptible. After some time the colouring matter subsided, leaving the water colourless. Examined with a magnifier it appeared to consist of minute particles, somewhat globular, of a brownish-red colour. This, separated on a filter and dried,

* In the *Journ. de Pharm.* for June 1818.

parted with its red colour, which was succeeded by a yellowish-green tint. The smell now somewhat resembled that of train oil. Even when heat was used it was found insoluble in alcohol, caustic potash, and other menstrua that were tried. Nitric acid assisted by heat changed the colour to green; and if concentrated and in excess, decomposed it entirely. When the excess of acid was driven off by heat, a greenish-yellow residuum was obtained, without any trace of the pink hue afforded by lithic acid under similar circumstances. Chlorine instantly bleached it. Exposed alone to heat, it gave a dense white inflammable smoke. The charcoal left, yielded by incineration a minute quantity of ashes, presenting "traces of lime, iron and silex, the last two of which were probably extraneous." It is evident then that this substance does not owe any of its properties to lithic acid, or oxide of iron; but, on the contrary, seems to be an organized substance; and the most probable opinion respecting its nature is, that it is "a production of some cryptogamous plant." It seems probable, from the red colour disappearing by exposure to the air, that it has undergone some change by keeping.

### POTATOES.

What resources does the potatoe present to us? Its stalk considered as a textile plant furnishes in Austria a cottony flax—when burned, it yields much potash. Its apples, when ripe and crushed, ferment and give spirits by distillation. Its tubercles made into a pulp are a substitute for soap in bleaching. Cooked by steam, the potatoe is a most healthy food: by different manipulations it furnishes two kinds of flour—a gruel and a parenchyma, which may be applied to increase the bulk of bread made from grain. Treated by a chemist, it is converted into vinegar, beer, and spirits.

### TO DESTROY INSECTS.

A Pennsylvanian farmer has observed that "the water in which potatoes have been boiled, sprinkled over grain or plants, completely destroys all insects, in every stage of existence, from the egg to the fly." If so, why should it not have the same effect on fruit trees? The experiment we doubt not will be tried by many

### SEED-CORN.

It has been found in some recent experiments, that there have been no failures in a given number of seeds sown after having heated, while twelve out of a score of good seed that had not heated have failed to vegetate. In consequence, inquiry is on foot to ascertain whether heated grain might not be substituted with advantage for common seed.

AMERICAN

### AMERICAN SEA SERPENT.

T. Say, esq. of Philadelphia, in a letter received from him by Dr. Leach, announces that a Captain Rich had fitted out an expedition purposely to take this leviathan, of which so much has been said in the newspapers and even in some scientific journals. He succeeded in " fastening his harpoon in what was acknowledged by all the crew to be the veritable sea serpent (and which several of them had previously seen and made oath to) : but when drawn from the water, and full within the sphere of their vision, it proved that this serpent, which fear had loomed to the gigantic length of 100 feet, was no other than a harmless Tunny (*Scombrus Thynnus*) nine or ten feet long!"

### SINGULAR PHÆNOMENON.

Some time last week, Mr. John Lacock of this place, a gentleman of undoubted integrity and veracity, while splitting a cedar-tree into quarters, for posts, discovered in the heart of it a living toad about half-grown. The cavity in which it was lodged was but merely large enough to contain it, and there was not even the smallest communication from the cavity for the circulation of any air ; the tree was perfectly solid, and from its size is supposed to be of twenty or thirty years growth. As soon as the tree was quartered, the toad instantly crawled from its confinement, and still lives.—*From the Westchester (N. York) Herald, June* 9.

### WIRE BRIDGE.

A new bridge has been thrown over the river Kelvin, at Garscube-house, Dumbartonshire, the seat of Sir Islay Campbell, bart. wholly composed of iron wire, without any support in the centre. The length is 100 feet, and it is nine feet above the surface of the river.

### NEW MOVING POWER.

M. Pattu, a French engineer, has proposed to apply to mechanical purposes the expansion communicated to water by increase of temperature, without converting it into steam. Thus a piston in a cylinder over water will receive an elevation (or, *vice versâ*, a depression) equal to that which the surface of the water experiences by the application of heat. This power we know is irresistible ; but it is, at the same time, necessarily slow : however, he proposes to accelerate the motion by the usual well known mechanical means : and to save time in the repeated movements required for continued motion, the heated water is not to be retained till it cools in the engine, but to be replaced by cold water to which the heat is to be applied for each stroke.

## PHOSPHATE OF IRON FOUND IN BRITAIN.

Sir,—I perceive in Thomson's Annals for May, that Doctor Bostock is named (with an appearance of some magnificence) as the discoverer of Phosphate of Iron in Britain—*Suum cuique.* That substance was long ago discovered in great abundance in forming the excavations for the West India docks, occupying the places of the roots of plants that had grown in the peat. Mr. Sowerby's cabinet still contains the specimens—It also occurs on the commons of Woolwich and Plumstead.

PHILALETHES.

---

## ON CORRESPONDENTS.

*To Mr. Tilloch.*

Blair's Hill, Cork, Jan. 4, 1819.

Sir,—You will no doubt permit me to recall your attention to a letter signed "*Unus,*" which appeared in your Magazine for last April, referring me to a "*Pocket Companion*" for harmonic information. Not imagining that any writer, though anonymous, could venture *intentionally* to mislead me, or rather to mislead the public, when the means of almost instantaneous detection were in every man's power, I ordered that work from London; and having lately perused it throughout, I can safely take upon me to assure you, that, so far from containing any harmonic information, it can hardly be said to glance at this question at all.

In future, therefore, I shall take no notice of any anonymous production which, (like that of "*Unus*") does not in *itself* immediately bear upon my subject.

I am, sir, your most obedient servant,

HENRY UPINGTON.

---

## LIST OF PATENTS FOR NEW INVENTIONS.

To Denis Johnson, of Long Acre, Middlesex, coach-maker, for an invention communicated to him by a certain foreigner residing abroad, of a machine for the purpose of diminishing the labour and fatigue of persons in walking, and enabling them at the same time to use greater speed, which said machine he intends calling The pedestrian curricle.—Dated 22d Dec. 1818.—6 months allowed to enroll specification.

To John Ruthven, of the city of Edinburgh, printer, for his improved drag for coaches, carriages, or other vehicles, which operates by raising a wheel or wheels off the ground from the outside of the coach, carriage, &c. without stopping the horses.—23d Dec.—4 months.

To Alexander Adie, of the city of Edinburgh, optician, for his improvement on the air-barometer, which improved instrument is to be called a Sympiesometer.—23d Dec.—2 months.

To

To William Johnson, of Salford, Manchester, Lancashire, for certain improvements in the construction of furnaces or fire-places for the purposes of heating, boiling, or evaporating water and other liquids; which improvements are applicable to steam-engines and other purposes, whereby a greater saving in the consumption of fuel is effected, with a more complete destruction or consumption of smoke, by combustion, than has hitherto been produced.—24th Dec.—2 months.

To Henry Faveryear, of Castle-street, Leicester-square, gentleman, for a machine for the cutting of veneers in wood and other substances.—24th Dec.—6 months.

To Frederick Clifford Cherry, of Croydon, Surrey, for his box-case or frame-forge, which may be readily transported from place to place, applicable to shipping, agriculture, and a variety of other purposes where portability and œconomy are desirable.—2d Jan. 1819.—2 months.

To Charles Tanner, of Plymouth, in the county of Devon, tanner, for certain improvements in preserving or curing raw hides and skins by the application of certain materials hitherto unused for that purpose.—4th Jan.—2 months.

To William Carter, of Shoreditch, Middlesex, printer, for his improved methods of preparing cork bark usually employed in the manufacture of corks.—6th Jan.—6 months.

To John Pontifex, of Shoe-lane, London, coppersmith, for improvements in the means of raising water for giving motion to machinery and other purposes.—7th Jan.—6 months.

To John Simpson, of Birmingham, Warwickshire, plater, for his method of constructing and making harness on an improved principle for horses and other animals used for the purpose of drawing or conveying carriages—to be called Release harness.—15th Jan.—6 months.

To Charles Smith, of Piccadilly, Middlesex, superfine colour-manufacturer, for his improvement in the method or form of making up superfine oil- and water-colours for drawing, painting, and other purposes.—15th Jan.—6 months.

To Robert Salmon, of Woburn in the county of Bedford, esq., and William Warrell, of Chenies in the county of Buckingham, engineer, for sundry apparatus for cooling, condensing and ventilating worts, liquors, and all other fluids or solid matters.—15th Jan.—6 months.

To John Gregory, of Penny Fields, parish of All-Saints Poplar, Middlesex, shipwright, for his combination of machinery consisting of a fire-escape ladder, and the various apparatus necessary for the safety of persons and property in such cases, part of which machinery is applicable to other useful purposes.—15th Jan.—6 months.

COMETS.

COMETS.

A new comet has been discovered in Pegasus by M. Pons of Versailles; and another in Hydra. On the 30th of November, the latter, at $17^h$ 37′ mean time, had 179° 38′ R.A. and 29° 17′ S. Dec. On the 1st of December, at $17^h$ 57′, its R.A. was 180° 39′; Dec. 28° 47′. It has a pale nebulosity, is roundish, and 5 or 6 minutes in diameter. It is approaching us, and will, it is expected, become visible to the naked eye.

*Right Ascension and Declination of* JUNO.

| 1819. | Right Ascension. | Declination. | Log. of Distance from the Earth. | 1819. | Right Ascension. | Declination. | Log. of Distance from the Earth. |
|---|---|---|---|---|---|---|---|
| Jan. 4 | 166°53′ | 1°40′ S. | 0·29422 | April 10 | 155° 0′ | 9°29′N | 0·30519 |
| 8 | 167 0 | 1 37 | 0·28598 | 14 | 154 55 | 9 48 | 0·31587 |
| 12 | 167 2 | 1 30 | 0·27776 | 18 | 154 55 | 10 4 | 0·32682 |
| 16 | 166 57 | 1 19 | 0·26991 | 22 | 155 1 | 10 17 | 0·33791 |
| 20 | 166 46 | 1 5 | 0·26247 | 26 | 155 12 | 10 27 | 0·34911 |
| 24 | 166 28 | 0 48 | 0·25559 | 30 | 155 29 | 10 34 | 0·36034 |
| 28 | 166 5 | 0 26 | 0·24931 | May 4 | 155 50 | 10 39 | 0·37155 |
| Feb. 1 | 165 36 | 0 2 | 0·24373 | 8 | 156 15 | 10 42 | 0·38269 |
| 5 | 165 2 | 0 26 N. | 0·23901 | 12 | 156 46 | 10 42 | 0·39372 |
| 9 | 164 23 | 0 58 | 0·23519 | 16 | 157 20 | 10 42 | 0·40458 |
| 13 | 163 40 | 1 31 | 0·23244 | 20 | 157 58 | 10 36 | 0·41527 |
| 17 | 162 54 | 2 7 | 0·23091 | 24 | 158 39 | 10 30 | 0·42575 |
| 21 | 162 7 | 2 45 | 0·23011 | 28 | 159 24 | 10 22 | 0·43603 |
| 25 | 161 17 | 3 24 | 0·23078 | June 1 | 160 11 | 10 12 | 0·44607 |
| Mar. 1 | 160 28 | 4 4 | 0·23264 | 5 | 161 2 | 10 0 | 0·45587 |
| 5 | 159 39 | 4 44 | 0·23565 | 9 | 161 55 | 9 47 | 0·46539 |
| 9 | 158 52 | 5 23 | 0·23981 | 13 | 162 50 | 9 33 | 0·47464 |
| 13 | 158 8 | 6 1 | 0·24508 | 17 | 163 48 | 9 17 | 0·48363 |
| 17 | 157 26 | 6 38 | 0·25138 | 21 | 164 48 | 9 0 | 0·49262 |
| 21 | 156 50 | 7 43 | 0·25861 | 25 | 165 49 | 8 41 | 0·50067 |
| 25 | 156 17 | 7 46 | 0·26666 | 29 | 166 53 | 8 22 | 0·50865 |
| 29 | 155 50 | 8 16 | 0·27545 | July 3 | 167 58 | 8 1 | 0·51618 |
| April 2 | 155 28 | 8 43 | 0·28485 | 7 | 169 4 | 7 40 | 0·52326 |
| 6 | 155 11 | 9 7 | 0·29481 | | | | |

*Right Ascension and Declination of* CERES.

| 1819. | Right Ascension. | Declination. | Log. of Distance from the Earth. |
|---|---|---|---|
| Jan. 1 | 18° 35′ | 0° 58′ | 0·4071 |
| 5 | 19 7 | −0 26 | 0·4159 |
| 9 | 19 43 | +0 7 | 0·4245 |
| 13 | 20 24 | 0 41 | 0·4330 |
| 17 | 21 8 | 1 16 | 0.4414 |
| 21 | 21 56 | 1 52 | 0·4495 |
| 25 | 22 48 | 2 29 | 0·4574 |
| 29 | 23 42 | 3 6 | 0·4650 |
| Feb. 2 | 24 40 | +3 43 | 0·4722 |
| 6 | 25 40 | 4 21 | 0·4793 |
| 10 | 26 44 | 4 59 | 0·4862 |
| 14 | 27 50 | 5 37 | 0·4928 |
| 18 | 28 59 | 6 15 | 0·4991 |
| 22 | 30 11 | 6 53 | 0·5051 |

*To Mr. Tilloch.*

Croydon, 29th Dec. 1818.

SIR,—I beg to hand to you for insertion in your useful Magazine the quantity of rain and evaporation at Croydon in Surrey during the year 1818; and it will be found by comparison with the last year's gauge that the quantity of rain fallen this year is less by full one inch than what fell in 1817, the quantity in 1817 being 25·349 inches, and this year only 24·252 inches; and (what is remarkable) that although this year has been so fine, we had more rain by one inch and seven-tenths during the progress of the year to the beginning of October, than we had in the same period of 1817; the comparative dryness of October and December last past, having reduced the quantity on the whole year to the result above stated.

The evaporation you will perceive has this year been greater than the last by nearly five inches, the evaporation in 1817 being 22·227 inches, and in 1818, 27·064 inches.

I remain, sir, your obedient servant,

HENRY LAWSON.

P. S. The gauges are placed four feet from the ground, as described in your Magazine for January 1818.

*Rain and Evaporation noted at Croydon during the Year* 1818.

| Month. | Rain. | Evaporation. | Month. | Rain. | Evaporation. |
|---|---|---|---|---|---|
| From | | | 1818. | | |
| 28 Dec. 1817, | | | 12 to 19 July, | 0·023 | 1·132 |
| to 4 Jan. 1818, | 0·126 | 0·015 | 19 to 26 | 0·170 | 1·444 |
| 4 to 11 | 1·092 | 0·145 | 26 to 2 Aug. | 0.218 | 0·958 |
| 11 to 26 | 0·615 | 0·320 | 2 to 9 | 0·001 | 1·354 |
| 26 to 1 Feb. | 1·101 | 0·242 | 9 to 16 | 0·000 | 1·087 |
| 1 to 8 | 0·056 | 0·069 | 16 to 23 | 0·003 | 0·754 |
| 8 to 15 | 0·010 | 0·049 | 23 to 30 | 0·089 | 0·801 |
| 15 to 22 | 0·719 | 0·150 | 30 to 6 Sept. | 1·209 | 0·973 |
| 26 to 1 Mar. | 1·088 | 0·295 | 6 to 13 | 0.103 | 0·563 |
| 1 to 8 | 2·265 | 0·516 | 13 to 20 | 0·268 | 0·556 |
| 8 to 15 | 0·391 | 0·309 | 20 to 27 | 1·997 | 0·401 |
| 15 to 22 | 0·219 | 0·423 | 27 to 4 Oct. | 0·940 | 0·373 |
| 22 to 29 | 1.090 | 0·419 | 4 to 11 | 0·363 | 0·291 |
| 29 to 5 April | 0·015 | 0·468 | 11 to 18 | 0·255 | 0·325 |
| 5 to 12 | 1·169 | 0·367 | 18 to 25 | 0·071 | 0·238 |
| 12 to 19 | 0·053 | 0·573 | 25 to 1 Nov. | 0·231 | 0·172 |
| 19 to 26 | 1·059 | 0·421 | 1 to 8 | 0·113 | 0·140 |
| 25 to 3 May. | 1·049 | 0·664 | 8 to 15 | 0·925 | 0·140 |
| 3 to 10 | 1·507 | 0·721 | 15 to 22 | 0·374 | 0·101 |
| 10 to 17 | 0·309 | 0·575 | 22 to 29 | 0·478 | 0·054 |
| 17 to 24 | 0·030 | 0·835 | 29 to 6 Dec. | 0·206 | 0·065 |
| 24 to 31 | 0·003 | 0·889 | 6 to 13 | 1·072 | 0·022 |
| 31 to 7 June, | 0·000 | 1·299 | 13 to 20 | 0·187 | 0·012 |
| 7 to 14 | 0·025 | 1·135 | 20 to 27 | 0·018 | 0·071 |
| 14 to 21 | 0.274 | 0·818 | | | |
| 21 to 28 | 0·359 | 1·079 | Total in the year | 24·252 | 27·064 |
| 28 to 5 July, | 0·013 | 1·182 | | | |
| 5 to 12 | 0·301 | 1·059 | | | |

*Meteorological Journal kept at Walthamstow, Essex, from December* 15, 1818 *to January* 15, 1819.

[Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *December* | | | |
| 15 | 36<br>41 | 30·10 | SE—Moon-shine and *cumuli;* sun, clouds and wind; very fine cold day. Clear moon and star-light. |
| 16 | 28<br>43 | 29·91 | NW.—Clear and *cumuli*; white frost at 7 A.M.; at 9 A.M. hazy; fine day; clear night. |
| 17 | 19<br>27 | 30·10 | SW.—White frost and hazy; fine sunny day; star-light at 6 P.M.; dark and foggy at 10 P.M. |
| 18 | 21<br>35 | 29·80 | SE.—NW.—Clear and clouds at 1 A.M.; fog before 9; sun through fog; 2 P.M. rain; dark and windy. |
| 19 | 27<br>35 | 30·10 | SE.—SE.—Clear at 7 A.M.; fog at 9; a fine day, sun and white frost; dark night. |
| 20 | 41<br>47 | 30·05 | SE.—Cloudy morn; damp day but some gleams of sun; dark night. Moon last quarter. |
| 21 | 47<br>47 | 29·90 | SW.—.WNW.—Clear and *cumuli*; fine day; clear and *cirrostratus*; clear night. |
| 22 | 26<br>31 | 30·40 | W.—S.—Hazy morn; very foggy; sun through fog; clear, bright star-light early; dark and foggy afterwards. |
| 23 | 23<br>35 | 30·40 | SE.—NW.—NE.—Very clear morn; some *cirrostratus*; very fine frosty day; beautiful icicles on the trees; clear star-light. |
| 24 | 29<br>30 | 30·20 | NE.—White frost and hazy; sun through fog; very foggy night. |
| 25 | 26<br>33 | 30·10 | NE.—Foggy morn and foggy day; rapid thaw; dark and windy. |
| 26 | 34<br>34 | 29·80 | SE.—Grey morn; grey cold day; dark night. |
| 27 | 34<br>41 | 30·00 | SE.—Clear and *cumuli*; at 10 A.M. perfectly clear sky; very fine day; night dark and windy. New moon. |
| 28 | 36<br>40 | 30·39 | N.—Clear and *cumuli*; grey day; at 10 P.M. dark and windy; at 11 star-light. |
| 29 | 30<br>37 | 30·50 | N.—Clear and *cirrostratus*; fine day; clear night. |
| 30 | 24<br>34 | 30·40 | SN.—NW.—Clear, and white frost; hazy day; dark night. |

*December*

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *December* | | | |
| 31 | 29 35 | 30·35 | NW.—W.—Cloudy, and white frost; fine sunny day; trees dropping; foggy night. |
| *January* 1819. | | | |
| 1 | 30 37 | 30·35 | SW.—Clear high; hazy low; some *cirro-stratus*; fine sunny day; very foggy at 1 P.M. at 9 dark, but less fog. |
| 2 | 36 41 | 30·00 | SE.—White frost and hazy; hazy day; hazy, but not very dark. |
| 3 | 30 37 | 30·00 | SE.—Grey morn; fine sunny day; clear night. Moon first quarter. |
| 4 | 37 | 33·20 | SE. Clear star-light morning; fine day; sun and hazy; moon bright. |
| 5 | 30 37 | 30·10 | SE.—Foggy morn; rather foggy day; light but not star-light. |
| 6 | 33 44 | 30·10 | SE.—Foggy; very fine day; clear and *cumuli*; moon-light; floating *stratus* passing over the moon. |
| 7 | 38 44 | 29·90 | SE.—Clear and *cumuli*; fine red sun-rise; fine day; *cirrostratus* and windy; rain after 3 P.M. and after dark. |
| 8 | 37 40 | 29·70 | NW.—S.—Clear morn; fine sunny day; light night, but neither moon nor stars visible. |
| 9 | 46 51 | 29·50 | SW.—Windy and cloudy; cloudy, windy, some sun and slight rain; moon-light. |
| 10 | 41 49 | 29·85 | SE.—SW.—Hazy and some sunshine; cloudy, windy, showers and wind. |
| 11 | 42 45 | 29·61 | SW.—Clear moon-light morn, and windy at 7 A.M.; at 8 hazy; sun and wind; very fine day; showery evening and night; moon and star-light. Full moon. |
| 12 | 36 48 | 30·00 | W.—SW.—Clear and *cirrostratus*; sun and hazy; fine day; fine moon and star-light. |
| 13 | 35 47 | 30·00 | SE.—Clear morn; sun and hazy at 8; some rain about 4 P.M.; fine clear moon-light night. |
| 14 | 46 51 | 29·90 | —SW.—*Cirrostratus* and windy; showers and windy; wind, *cumuli* and moon. |
| 15 | 40 49 | 30·00 | SW.—*Cirrostratus* at 7 A.M.; foggy at 8; cloudy day, and cloudy evening. |

Not any snow has been seen by the writer of this journal since the last spring; the mornings have been lately and frequently *clear* (early) before sunrise; and haziness came on about 8 or before 9 A.M.

*** Erratum in Nov. Mag.—16 Oct. for *Cirrus* read *Corona*.

METEORO-

METEOROLOGICAL TABLE

Extracted from the Register kept at Kinfauns Castle, N. Britain. Lat. 56° 23′ 30″.—Above the level of the Sea 129 feet.

| 1818. | Morning 8 o'clock. *Mean height of* Barom. | Morning 8 o'clock. *Mean height of* Ther. | Evening, 10 o'clock. *Mean height of* Barom. | Evening, 10 o'clock. *Mean height of* Ther. | Mean Tempr. by Six's Ther. | Depth of Rain. Inch. 100 | N° of Days. Rain or Snow. | N° of Days. Fair. |
|---|---|---|---|---|---|---|---|---|
| January. | 9·447 | 36·970 | 29·457 | 35·322 | 37·129 | 2·45 | 22 | 9 |
| February. | 29·464 | 34·321 | 29·453 | 34·643 | 35·857 | 0·86 | 14 | 14 |
| March. | 29.302 | 35·419 | 29·345 | 36·193 | 37·516 | 1·62 | 18 | 13 |
| April. | 29.732 | 39·333 | 29·733 | 38·833 | 41·266 | 1·03 | 7 | 23 |
| May. | 29·857 | 49·290 | 29·858 | 48·486 | 52·613 | 1·67 | 15 | 16 |
| June. | 29·869 | 57·430 | 29·839 | 55·900 | 59·033 | 1·34 | 10 | 20 |
| July. | 29·912 | 59·774 | 29·905 | 58·161 | 60·355 | 3·20 | 15 | 16 |
| August. | 29·960 | 55·709 | 29·942 | 54.548 | 56·903 | 0·70 | 7 | 24 |
| September. | 29·628 | 52·136 | 29·611 | 50·466 | 53·100 | 1·99 | 14 | 16 |
| October. | 29·711 | 51·032 | 29·709 | 50·193 | 52.387 | 1·40 | 12 | 19 |
| November. | 29·681 | 46·100 | 29·681 | 47·100 | 47·500 | 2·22 | 17 | 13 |
| December. | 29·908 | 38·451 | 29·917 | 38·419 | 39·226 | 1·41 | 9 | 22 |
| Average of the year. | 29·706 | 46·330 | 29·703 | 44·688 | 47·740 | 19·89 | 160 | 205 |

ANNUAL RESULTS.

MORNING.

| *Barometer.* | | | *Thermometer.* | |
|---|---|---|---|---|
| *Observations.* | *Wind.* | | *Wind.* | |
| Highest, 3d April, | NW. | 30·60 | 17th July, S. | 69° |
| Lowest, 5th March, | SW. | 28·12 | 3d & 4th July, W. | 21° |

EVENING.

| | | | | |
|---|---|---|---|---|
| Highest, 2d April, | NW. | 30·58 | 16th July, W. | 68° |
| Lowest, 4th March, | E. | 28·44 | 4th Feb. W. | 19° |

| *Weather.* | *Days.* | *Wind.* | *Times.* |
|---|---|---|---|
| Fair . . . . . . . . . | 205 | N. and NE. . . . . . . | 19 |
| Rain or Snow . . . . | 160 | E. and SE. . . . . . . | 132 |
| | | S. and SW. . . . . . . | 93 |
| | 365 | W. and NW. . . . . . . | 121 |
| | | | 365 |

Extreme Cold and Heat, by Six's Thermometer.

Coldest, 5th February . . . Wind W. . . . 17°
Hottest, 11th & 12th June . . Wind W. . . . 77°
Mean Temperature for 1818 . . . . . . . . . . 47° 740′

| RESULT OF THREE RAIN GAUGES. | In. 100 |
|---|---|
| No. 1. On a conical detached hill above the level of the Sea 600 feet . . . . . . . . . . . . . | 31·10 |
| — 2. Centre of the Garden, 20 feet . . . . . . . . | 28·07 |
| — 3. Kinfauns Castle, 129 feet . . . . . . . . | 19·89 |
| Mean of the 3 Gauges . . . . . . . | 26·35 |

METEORO-

## METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1818. | Age of the Moon | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| Dec. 15 | 15 | 40· | 30·16 | Cloudy |
| 16 | 16 | 30·5 | 30·14 | Misty |
| 17 | 17 | 33· | 30·10 | Fine |
| 18 | 18 | 39· | 29·80 | Rain |
| 19 | 19 | 36· | 30·26 | Fine |
| 20 | 20 | 47·5 | 30·04 | Cloudy |
| 21 | 21 | 43·5 | 30·22 | Fine |
| 22 | 22 | 36· | 30·45 | Ditto |
| 23 | 23 | 30·5 | 30·45 | Ditto |
| 24 | 24 | 31· | 30·32 | Cloudy |
| 25 | 25 | 34· | 30·11 | Fine |
| 26 | 26 | 33·5 | 30·96 | Cloudy |
| 27 | new | 36· | 30·26 | Ditto |
| 28 | 28 | 41·5 | 30·63 | Ditto |
| 29 | 29 | 36· | 30·65 | Fine |
| 30 | 30 | 35·5 | 30·50 | Ditto |
| 31 | 31 | 38· | 30·45 | Ditto |
| 1819. | | | | |
| Jan. 1 | 1 | 33·5 | 30·55 | Ditto |
| 2 | 2 | 36· | 30·50 | Cloudy |
| 3 | 3 | 36· | 30·38 | Ditto |
| 4 | 4 | 38· | 30·24 | Ditto |
| 5 | 5 | 41.5 | 30·26 | Ditto |
| 6 | 6 | 34· | 30·21 | Ditto |
| 7 | 7 | 42· | 29·83 | Ditto—rain at night |
| 8 | 8 | 39·5 | 29·91 | Fine—ditto |
| 9 | 9 | 50· | 29·52 | Cloudy |
| 10 | 10 | 48·5 | 29·80 | Ditto—rain at night |
| 11 | full | 43·5 | 29·74 | Stormy—snow at nght |
| 12 | 12 | 45· | 30·13 | Fine |
| 13 | 13 | 43·5 | 29·93 | Cloudy |
| 14 | 14 | 53· | 29·80 | Ditto |

METEORO-

## METEOROLOGICAL TABLE,

### By Mr. Cary, of the Strand,

*For January* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| Dec. 27 | 35 | 40 | 40 | 30·14 | 7 | Fair |
| 28 | 40 | 43 | 35 | ·52 | 8 | Fair |
| 29 | 35 | 39 | 30 | ·58 | 9 | Fair |
| 30 | 28 | 35 | 34 | ·45 | 4 | Cloudy |
| 31 | 28 | 35 | 32 | ·42 | 6 | Fair |
| Jan. 1 | 32 | 35 | 32 | ·49 | 6 | Foggy |
| 2 | 32 | 39 | 38 | ·45 | 0 | Foggy |
| 3 | 40 | 43 | 32 | ·33 | 9 | Fair |
| 4 | 28 | 40 | 35 | ·26 | 9 | Fair |
| 5 | 32 | 42 | 40 | ·24 | 10 | Foggy |
| 6 | 40 | 42 | 40 | ·08 | 9 | Fair |
| 7 | 41 | 47 | 45 | 29·77 | 10 | Cloudy |
| 8 | 37 | 44 | 40 | ·88 | 8 | Fair |
| 9 | 44 | 45 | 45 | ·62 | 0 | Rain |
| 10 | 43 | 50 | 54 | ·76 | 15 | Fair |
| 11 | 45 | 47 | 38 | ·84 | 16 | Fair |
| 12 | 40 | 50 | 45 | 30·17 | 12 | Fair |
| 13 | 45 | 47 | 42 | 29·92 | 13 | Fair |
| 14 | 46 | 52 | 50 | ·95 | 0 | Rain |
| 15 | 47 | 50 | 40 | ·84 | 14 | Fair |
| 16 | 39 | 42 | 41 | 30·27 | 15 | Fair |
| 17 | 47 | 50 | 42 | 29·38 | 23 | Stormy |
| 18 | 41 | 42 | 39 | ·55 | 21 | Fair |
| 19 | 36 | 46 | 40 | ·80 | 20 | Fair |
| 20 | 37 | 44 | 41 | ·50 | 18 | Fair |
| 21 | 37 | 44 | 37 | ·45 | 15 | Fair |
| 22 | 37 | 49 | 40 | ·36 | 15 | Cloudy |
| 23 | 38 | 53 | 44 | ·62 | 21 | Fair |
| 24 | 45 | 47 | 42 | ·47 | 19 | Cloudy |
| 25 | 42 | 47 | 40 | ·15 | 0 | Rain |
| 26 | 40 | 48 | 42 | ·42 | 17 | Fair |

N.B. The Barometer's height is taken at one o'clock.

## XIV. *On the Question "Whether Music is necessary to the Orator,—to what Extent, and how most readily attainable?" By* HENRY UPINGTON, *Esq.*

[Continued from p. 38.]

*To Mr. Tilloch.*

Blair's Hill, Cork, Jan. 7, 1819.

SIR, — IN the early part of this letter I laid before the reader an easy and expeditious method for executing the *notes* of any simple tune on the piano, by means of an oblong board. The mensuration of the *time* of syllables in the ratio of two to one is equally facile, nothing more being necessary than a *pendulum*, which, set in motion by the hand, shall perform a sufficient number of vibrations for the occasion*. *That* employed by the *Speaker* consisted of an ivory ball one inch in diameter, with a delicate brass hook, suspended by a silken thread, from a similar hook inserted in the under part of the projecting arm of a wooden stand—thus,

which, during operation, was fastened on a table by an iron clamp; and was used in the following manner for the cultivation of hexameter †.

The first exercise, and certainly the easiest, was that of *Tityre tu patulæ* down to *sylvas*. A fifteen-inch string, which is nearly equivalent to a three-quarter-second pendulum ‡, regulated the measure of the long syllable. *Ti* consequently occupied one vibration, *tyre* § the succeeding one, *tu* the third, *patu* the fourth, and

* Notwithstanding the very great difference in the *extent of swing*, as the power of this pendulum declines; yet the perceptible difference in the relative time of its vibrations, while any tolerable motion exists, is too trivial to affect our measurement.

† The experimenter will immediately discover by his pendulum, that although the stately and solemn *recitation* of an articulate language like the Greek or Roman, rather constantly admits the full ratio of two to one in its syllables; yet that in the ordinary *reading* of such languages, he must content himself for the most part with the ratio of three to two. The mensuration of this latter, and indeed of any other ratio than that of *two to one* —is, for the purposes of speech, not only useless but absurd.

‡ This pendulum is too long for ordinary poetry, and consequently a great deal too long for prose. The judicious practitioner must feel this observation as he proceeds.

§ For comparing the *short* syllables of any given dactyl with each other, the pendulum must be shortened in the ratio of four to one; *i. e.* if the long syllable shall occupy the vibration of a *sixteen*-inch pendulum—the short and so on throughout the passage; the *Speaker* steadily persevering until this slow movement was thus thoroughly commanded [not *read*, nor stops regarded] in a manly firm tone without whine or drawl, and his ear habituated to *proportion*. The passage was then recited, with occasional reference to the pendulum: and such licenses were taken for the convenience of delivery as were most approved by my *associate*—even the ratio of $\bar{3}, \breve{2}, \breve{2}$, being in many cases preferred by him to that of the perfect dactyl $\bar{4}, \breve{2}, \breve{2}$; and $\bar{3}, \bar{3}$ for the spondee instead of $\bar{4}, \bar{4}$.

Were I not unwilling to surpass the reasonable limits of this paper, I should submit to the inspection of the reader, not only this passage, but also that of *Arma virumque cano*, and *Μηνιν ἄειδε Θεὰ*, as recited by the Speaker. The *last* however having been more approved than the others, for its chasteness in the distribution of forte or emphatic syllables, by the musical gentlemen before whom it was delivered, must be considered most worthy our present attention: I give it therefore in its exact form* (as nearly as our ears could determine), with the relative proportions set down in *figures* over the respective syllables. In place too of encumbering this passage with rests, I have set down not *all* the actual pauses (which are more or less optional), but the ordinary prominent ones which are represented by grammatical stops; viz. the small, the intermediate, and the great, leaving it to the good understanding of the reader to supply those minor pauses which the necessary separation of words or the momentary relief

syllable [half the length of the long one] must require a pendulum of *four* inches—no more. In adjusting these pendulums, the centre of the ball must be considered as one extremity, the summit of the string as the other. This practice of equalizing the short syllables with each other is very useful, and is worthy the attention of most professional musicians. The *Speaker's* oratorical pendulum afforded me no small share of amusement in putting some excellent musicians to the test. I suspended from the ceiling of a room, a long string to which was attached an ivory ball similar to that belonging to the pendulum. Now, by the lengthening or shortening of either string I regulated different ratios or rendered them *irregular*, at pleasure; and setting both strings at the same time in motion, I found, to a demonstration, that in place of measuring a ratio of three to two, (or, as some pretend, a ratio of thirty-two to one)—scarcely an individual could be found who was capable of the *accurate* mensuration of even a *duple* ratio! Is not this an irrefragable proof that the principal requisite for the preservation of modern time (as I observed in a former paper) is merely the habitual *crowding* of the integral parts within the given boundary or bar, and not the relative proportions of those integral parts themselves?

* The author of *Prosodia Rationalis* has amused himself in his own scientific way by setting this passage in *musical* time, ratio of syllables six to one,—for the edification of Homer! If no other reason could be found for

relief of the organs may require. *Barring*, or even delineating the rhythmical boundaries in this sublime and wonderfully impressive language was found too troublesome: Although regular in the extreme, it is yet governed, when properly read, by such peculiar proportions, and so perpetually syncopated, that no musician whom I consulted could succeed in the operation*.

*Exordium of the Iliad, in* QUANTITY, *as recited by the* SPEAKER.

4 2 †2 4 2 2 3 3 4 2 2 3 2 2 4 3
*Μηνιν αειδε θεα, Πηληϊαδεω Αχιληος,*

4 2 2 3 3 4 2 2 3 4 4 2 2 4 2
*Ουλομενην; ἡ, μυρι Αχαιοις αλγε εθηκε;*

4 3 3 4 3 4 3 224 2 2 4 3
*Πολλας διφθιμους ψυχας, αϊδι προϊαψεν,*

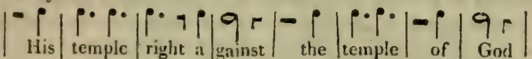
3 4 3 3 3 3 4 2 2 4 2 2 4 2
*Ἡρωων; αυτους δ᾽ ἑλωρια τευχε κυνεσσιν,*

---

for the rejection of Mr. Steele's metrical doctrine, than the monstrous unmeaning pauses which are introduced for the creation and preservation of *bars*, these pauses alone should seal its condemnation. To exhibit this subject in its clearest light, let us cast aside all his *symbols*; and, substituting the usual comma, semicolon, and colon, as pauses in their stead, let us apply them to the following passage which for the instruction of the *English* reader he has taken from the "*Paradise Lost*," and set accordingly.

" ; His temple right, against : the temple ; of God. ! ! !

Thus in the original (Mr. S.'s useless symbols being here exchanged for our musical characters). See *Prosodia Rationalis*, fol. 159. Ratio *two to one* —unusually moderate.




It is not in *pauses* only—but also in *metrical feet*, that our *rational prosodian* outrivals all competitors. He has given us

*beăutȳ* and *mūsĭc*, .... ......... as a pair of Spondees,
*beăutĭfŭllȳ* ...................... as a Procleusmaticus,
*cōnfĕssĭon* .... .... ............ as a Dactyl,
*ĕxquĭsĭte* and *sȳllăblē* ........ as Anapæsts,
*dĕclārătiōn* ...... ............... as a Di-iambus,

and *ābĭlĭtȳ* .... ...................... as a Choriambus!! And yet, strange to relate, this writer continues to be held up as competent authority by some of our bulky *Encyclopædias!*

* A pendulum, it is true, if used as on a former occasion, might have determined this useless question.

† The syllables *νιν* and *α*, when independently considered, are equal to each other; while the previous syllable *Μη* is equivalent to both: and yet this Dactyl cannot, in technical phrase, be *barred* or *beat*, in consequence of a minute interval [much less than the usual time of a comma] which, in well executed delivery, is interposed between the *νιν* and *α*. The same observation will hold good with many other Dactyls and Spondees throughout the passage: *pauses* are the principal agents of *syncopation*.

F 2

3 3 4 2 2 3 2 2 3 2 2 3 2 2 3 3*
Οιωνοισι τε πασι; (Διος δ'ετελειετο βουλη);

4 4 3 3 4 2 2 3 4 4 2 2 4 2
Εξ ὁυ δη, τα πρωτα διαστητην ερισαντε,

3 4 4 2 2 3 3 4 3 4 2 2 3 4
Ατρειδης τε, αναξ ανδρων; και δῖος Αχιλλευς.

Having thus circumstantially set down, as well as could be ascertained, the exact *quantity* in which this beautiful exordium was delivered by the *Speaker*, I could willingly indulge the reader with an equally exact notation of the *intervals:* but in truth, the modulating habits of the *Speaker*, although wonderfully improved by his muscular exercise, were yet, at *this* period, so very unchaste, ranting even in *octaves*, that I deemed it an inexpedient task; especially as his ear, notwithstanding his improvement, was still too incorrect to enable him to retrace any given number of his own intervals with sufficient accuracy for the purpose. However, as a desirable appendage to the foregoing representation of *quantity*, I shall anticipate my intended subject by the notation of those intervals in which this truly majestic passage was *afterwards* delivered. And as this passage so set, shall terminate my letter, I have to request of the intelligent reader, especially if a musical amateur, that he may not too hastily condemn either the apparent limitation of the measure, or the apparent limitation of the intervals. Musicians,—and, without any meditated offence, musicians perhaps equally scientific as the reader himself,—have wondered at the effect; nor did they previously believe it possible that so much sublimity, and at the same time so considerable a portion of melody, could be realized by language.

*Notes or Intonations*† *of the* Speaker *in delivering the aforesaid Exordium.*

[The flats and sharps within this passage govern no more than the *immediately succeeding* note or notes, upon the same line or space, which are found *uncontradicted*†. The very minute slide

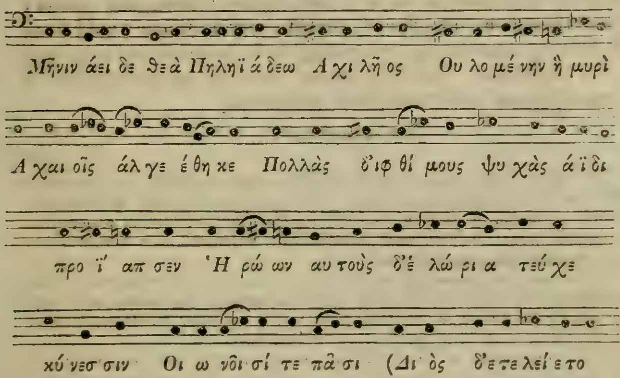
* The various changes of *key* within this exordium (for keys it undoubtedly has, although not regularly musical nor always definable,) must interest the scientific musician. I entertained an opinion in the early part of this work, that speech without sing-song was at *all times* destitute of key, but now find myself mistaken. The analysis of *this setting* must remove all doubts upon the subject.

† The *next* succeeding note of any *other* name [or letter] is held equivalent

slide which attaches to our letter *i*, and which in a few instances occurred with other vowels, is disregarded* in this *setting*;—nor has it been thought adviseable to remark in any way, the occasional imperfection of certain intervals.

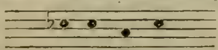
As to *emphatic syllables*, any attempt to describe them must bewilder the reader †. Let the experimenter beware, as usual, of omitting the REQUISITE for the execution of this Exordium.]

The *accents*, as will appear, were rather seldom executed by the *Speaker*.




---

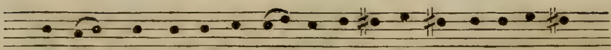
lent to a *contradiction*, and discontinues all further influence of a preceding sharp or flat. Hence, the *last* note within this example



is a *natural*; so is the third: but the first and second are *flats*.

* Must not every minute slide, such as that of a semiquarter tone, be rated even in *song* as a Monotone? Not one ear in a hundred can appreciate the difference. I have met some professional musicians, and not indifferent ones either—who, in *speech*, have mistaken a full semitonical slide for a fixed tone; particularly when the *ascent* of such slide was rapidly executed, and its remaining part, or rather the terminating part of the existing sound was steadily sustained, as thus

† Force is so peculiarly and so *delicately* distributed in this language, when read in quantity, that, like our select pieces of music, it may almost be said to possess all the optional advantages of forte and piano. The frequent, but by no means the perpetual tendency of forte is nevertheless in favour of the longer syllables: and yet, if the *quantity* be preserved, an optional change of emphasis does not seemingly render any individual word ambiguous. Hence the extraordinary *expression* of this wonderful language, which in all probability no present or future language shall attain.



*βου λή)* Ἐξ ὅυ δὴ τὰ πρῶ τα δι ασ τή την ε ρί σαν τε*

*Α τρέι δης τε ἄ ναξ αν δρῶν καὶ δῖ ος Α χιλ λεύς.* †

[The relative *duration* of the foregoing notes might have been accurately expressed by our crotchet, dotted quaver, and quaver: but had these been introduced, almost every musician would form such *barring* associations by viewing them, as to incapacitate him for the execution. For this reason, *separate* representations of the *quantity* and *notes* have been preferred.]

[To be continued.]

* This parenthesis was delivered, and with superior effect, in somewhat *slower time* than the general subject. And why should it not? Is it reasonable that a clause, in itself more solemn than the previous or succeeding one, should be *accelerated*, and consequently delivered with comparative levity, because it is parenthetical?

I had some time since the satisfaction of hearing a parenthesis of the XVth Chapter of Paul's first Epistle to the Corinthians *so recited;* and shall never forget the awful impression. The whole passage, which was rather clerically than theatrically spoken, proceeded thus—

"*In a moment—in the twinkling of an eye—at the last trump*—[these latter clauses in an ascending climax, the *last* with comparative forte] (*for the trumpet* SHALL SOUND)—[this *parenthesis*, for such it is in the original Greek though not in our English version, was deep, SLOW and swelling, followed by a considerable pause]—*the dead shall be raised*—[a pause somewhat shorter than the former]—*the* DEAD—[this word was thus iterated by the reciter] *shall be raised* INCORRUPTIBLE [the second syllable "cor" was considerably *opened*]—*and* WE [i. e. such of us as shall be found living on earth at this day] *shăll bĕ* CHANGED." [The word "changed" pronounced as *one* syllable, so as to close the sentence with a sufficiently good *anapæst*, whose energy and comparative rapidity gave a most powerful effect to the succeeding words "*O death,*" &c. which in *this* place were so introduced by the reciter.]

These were the prominent features of this sublime passage: but whether the *reading* (as we term it) is conformable with the Apostle's *meaning* I shall not say;—I relate merely what I heard.

† I had nearly omitted to observe, that the *slides* within the above passage, although designated by our usual *slurs*, are yet *continuous*. Distinct intervals must not be struck.

[In January Number, page 31, at the bottom, for *Solemnization* read *Solmization.*]

XV. *New*

## XV. *New experimental Researches on some of the leading Doctrines of Caloric; particularly on the Relation between the Elasticity, Temperature, and latent Heat of different Vapours; and on thermometric Admeasurement and Capacity.* *By* Andrew Ure, *M.D.*

[Continued from p. 44.]

### Table I.

*The elastic Force of the Vapour of Water in Inches of Mercury.*

| Temp. | Force. | Temp. | Force. | Temp. | Force. | Temp. | Force. | Temp | Force. | Temp. | Force. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24° | 0·170 | 115° | 2·820 | 195° | 21·100 | 242° | 53·600 | 270 | 86·300 | 295·6 | 130·400 |
| 32 | 0·200 | 120 | 3·300 | 200 | 23 600 | 245 | 56·340 | 271·2 | 88·000 | 295 | 129·000 |
| 40 | 0·250 | 125 | 3·830 | 205 | 25·900 | 245·8 | 57·100 | 273·7 | 91·200 | 297·1 | 133·900 |
| 50 | 0·360 | 130 | 4·366 | 210 | 28·880 | 248·5 | 60·400 | 275 | 93·480 | 298·8 | 137·400 |
| 55 | 0·416 | 135 | 5·070 | 212 | 30·000 | 250 | 61·900 | 275·7 | 94·600 | 300 | 139·700 |
| 60 | 0·516 | 140 | 5·770 | 216·6 | 33 400 | 251·6 | 63·500 | 277·9 | 97·800 | 300 6 | 140·900 |
| 65 | 0·630 | 145 | 6·600 | 220 | 35·540 | 254·5 | 66·700 | 279·5 | 101·600 | 302 | 144·300 |
| 70 | 0·726 | 150 | 7·530 | 221·6 | 36·700 | 255 | 67·250 | 280 | 101·900 | 303·8 | 147·700 |
| 75 | 0·860 | 155 | 8·500 | 225 | 39·110 | 257·5 | 69 800 | 281·8 | 104·400 | 305 | 150·560 |
| 80 | 1·010 | 160 | 9·600 | 226·3 | 40·100 | 260 | 72·300 | 283·8 | 107·700 | 306·8 | 154·400 |
| 85 | 1·170 | 165 | 10·800 | 230 | 43·100 | 260·4 | 72·800 | 285·2 | 112·200 | 308 | 157·700 |
| 90 | 1·360 | 170 | 12·050 | 230 5 | 43 500 | 262·8 | 75 900 | 287·2 | 114·800 | 310 | 161·300 |
| 95 | 1·640 | 175 | 13·550 | 234·5 | 46·800 | 264·9 | 77·900 | 289 | 118 200 | 311·4 | 164·800 |
| 100 | 1·860 | 180 | 15·160 | 235 | 47·220 | 265 | 78·040 | 290 | 120·150 | 312 | 167·000 |
| 105 | 2·100 | 185 | 16·900 | 238·5 | 50·300 | 267 | 81·900 | 292·3 | 123 100 | Another exp. | |
| 110 | 2·456 | 190 | 19 000 | 240 | 51·700 | 269 | 84·900 | 294 | 126 700 | 312° | 165·5 |

The apparatus employed in obtaining these results, has the peculiar advantage over all others, that the mercurial column is never heated. It is the concurrent opinion of all chemical philosophers, that caloric travels downwards in liquids with extreme slowness and difficulty. Indeed, Count Rumford's experiments led him to infer that heat could not descend in fluids at all.

It is evident that in my constructions, figures 1, 2, and 3, only that small portion of quicksilver, within the vessels A, B, and C, will be affected by the heat, but the measuring column is beyond the reach of its influence.

A surprising accordance will be perceived between my numbers, and those given by Mr. Dalton between 32° and 212°, though mine were obtained with a different modification of apparatus. Above the boiling point, where the table of Mr. Dalton is deduced from calculation, the accordance soon ceases. But as my apparatus and mode of using it were precisely the same as in the former part of the range, my results, if entitled to confidence in the one case, must be so in the other. At 280° Betancourt's number and mine are not much different, the former being

being 105 inches, the latter 102. Being perfectly convinced, by repeating the experiments in different circumstances, that Mr. Dalton's ratio of progression, though apparently accommodated to the intervals between 32° and 212°, could not serve for the higher ranges*, I endeavoured to discover a simple rule of more general application. It is above 212°, indeed, that for the purposes of art, the knowledge of the force of steam is required.

I first tried the differential method, so useful for determining the distant links of a concatenated series.

Without doing much violence to the above numbers, the forces corresponding to 100°, 110°, 120°, 130°, 140°, and 150°, may be written in a series of which the 5th order of differences $=0$. Then if $d'\ d''\ d'''\ d^{iv}\ d^{v}$, represent the first terms, in the first, second, third, fourth, and fifth order of differences, the $n$th term of the series is

$$a + \overline{n-1}\,.\,d', + \overline{n-1}\,.\,\frac{n-2}{2}\,d'', + \overline{n-1}\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,d''' + \overline{n-1}\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,\frac{n-4}{4}\,.\,d'''', + \&c.$$

In the above series for steam, $d'=0{\cdot}65$, $d''=0{\cdot}19$, $d'''=0{\cdot}04$, $d^{iv}=0{\cdot}01$, $d^{v}=0$. $a=1{\cdot}92$.

*Example* 1st. To determine the 8th term in the series, or the elastic force at $8\times10$, above 90°, (the first term 100° being included) or at 170°.

Here $n=8$

$$\begin{array}{lr} a + \overline{n-1}\,.\,d' = 1{\cdot}92 + 4{\cdot}55 = & 6{\cdot}47 \\ \overline{n-1}\,.\,\frac{n-2}{2}\,.\,d'' = & 4{\cdot}08 \\ \overline{n-1}\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,d''' = & 1{\cdot}40 \\ \overline{n-1}\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,\frac{n-4}{4}\,.\,d^{iv} = & 0{\cdot}35 \\ \hline & 12{\cdot}30 \end{array}$$

Observation gives 12·05, forming a good accordance.

*Example* 2. Required the 10th term, or $n=10$. For 190° F.

$$\begin{array}{lr} a + \overline{n-1}\,.\,d' = & 7{\cdot}77 \\ \overline{n-1}\,.\,\frac{n-2}{2}\,.\,d'' = & 6{\cdot}84 \\ n-1\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,d''' = & 3{\cdot}36 \\ n-1\,.\,\frac{n-2}{2}\,.\,\frac{n-3}{3}\,.\,\frac{n-4}{4}\,.\,d^{iv} = & 1{\cdot}26 \\ \hline & 19{\cdot}23 \end{array}$$

At 190° experiment makes it 19·00, still coinciding nearly.

* Dr. Young remarks on Dalton's ratio, "It is certain that this cannot be the law of nature, since about 394° the elasticity would become uniform, and then decrease, if the law be true."—Young's Natural Philosophy, 4to, vol. ii. p. 398.

By

By the same equation we find the 20th term or for 290° to be 124·28, while experiment gives 120·15, showing a difference of 4·13 inches. At a higher point the error becomes greater. We here see that a geometrical series may coincide apparently through a considerable range with experiment, and yet be inaccurate when further extended.

Dissatisfied, therefore, with this approximation, I prosecuted the inquiry, and had the happiness to discover a very simple and beautiful ratio, which will actually apply through an extensive scale of temperature, and is incomparably easier in practice than the preceding rule. The elastic force at 212° = 30 inches being divided by 1·23, will give the force for 10° below; this quotient divided by 1·24, will give that for 10° lower; and so on progressively. To obtain the forces above 212°, we have merely to multiply 30 by the ratio 1·23, for the force at 222°; this product by 1·22 for that at 232°, and thus for each successive interval of 10° above the boiling point.

Thus $30 \times 1{\cdot}23 = F_{222^\circ}$. $30 \times 123 \times 1{\cdot}22 = F_{232^\circ}$, using F to denote the force at any temperature $n$, according to the notation of Laplace.

By departing from the point of 210° F., we shall obtain results equally accurate, but more convenient for comparison with the experimental table. The following numbers exhibit the correspondence of this ratio with actual observation.

Table II.

*Observed Elasticity of aqueous Vapour compared with the Ratios.*

| Temp. | Calcul. Force. | Exper. | Temp. | Calcul. Force. | Exper. | Dalton | Betanc. | Robison. |
|---|---|---|---|---|---|---|---|---|
| 210° | 28·9 | 28·9 | 210° | 28 9 | 28·9 | 28 84 | 28 8 | 28·65 |
| 200 | 23·5 | 23·6 | 220 | 35·54 | 35·54 | 34.99 | | 35·80 |
| 190 | 19 0 | 19 0 | 230 | 43·36 | 43 10 | 41·75 | 45·5 | 44 70 |
| 180 | 15·2 | 15·16 | 240 | 52·46 | 51·70 | 49 67 | | 54 90 |
| 170 | 12 07 | 12·05 | 250 | 62 95 | 61·90 | 58·21 | | 66 80 |
| 160 | 9·50 | 9 60 | 260 | 74 91 | 72·30 | 67·73 | 80·17 | 80·30 |
| 150 | 7·42 | 7·58 | 270 | 88·89 | 86·30 | 77 85 | | 94·10 |
| 140 | 5·75 | 5·77 | 280 | 103·41 | 101·90 | 88·75 | 105·12 | 105 90 |
| 130 | 4 42 | 4 36 | 290 | 119 95 | 120·15 | 100·12 | | |
| 120 | 3·37 | 3·33 | 300 | 137·94 | 139·70 | 111·81 | | |
| 110 | 2·55 | 2·45 | 310 | 157·25 | 161·30 | 123·53 | | |
| 100 | 1 92 | 1·86 | 320 | 177·70 | | 135·00 | | |
| 90 | 1·43 | 1·36 | | | | | | |
| 80 | 1·06 | 1·01 | | | | Temp. | Betanc. | Robison. |
| 70 | 0·77 | 0·726 | | | | | | |
| 60 | 0·56 | 0·516 | | | | 32° | 0·0 | 0·0 |
| 50 | 0·40 | 0·36 | | | | 50 | | 0·12 |
| 40 | 0 28 | 0·25 | | | | 80 | 0·81 | 0 82 |
| 30 | 0·20 | 0·19 | | | | 100 | 1·65 | 1 60 |
| 20 | 0 14 | 0·14 | | | | 120 | 2 95 | 3·00 |
| 10 | 0·098 | | | | | 140 | 5·00 | 5·15 |
| 0 | 0·068 | | | | | 160 | 9·00 | 8 65 |
| | | | | | | 180 | 14·00 | 14·05 |
| | | | | | | 200 | 22·50 | 22 62 |

The rule on which the preceding table is formed, may be expressed in a manner better fitted to give *directly* the elastic force corresponding to any given temperature moderately distant from 212°. It becomes also more accurate.

Let $r$ = the mean ratio between 210° and the given temperature; $n$ = the number of terms (each of 10°) distant from 210°; F= the elastic force of steam in inches of mercury.

Then, Log. of F = Log. 28·9 ± $n$. Log. $r$; the positive sign being used above, the negative below 210°.

Or by common arithmetic, multiply or divide 28·9, according as the temperature is above or below 210°, by the mean ratio, involved to a power denoted by the number of terms. The product or quotient is the tension required.

*Example* 1st. The temperature is 140°. What is the corresponding elasticity of the vapour from water heated to that point? 140° is 7 terms of 10° each *under* 210°; 1·26 is the mean ratio $= \frac{1{\cdot}23+1{\cdot}29}{2}$; and, consequently, $r=1{\cdot}26$; $n=7$.

$$\text{Log. } 28{\cdot}9 = 1{\cdot}46090$$
$$\text{Log. } 1{\cdot}26 \times 7 = 0{\cdot}10037 \times 7 = -0{\cdot}70259$$
$$0{\cdot}75831, \text{ which is}$$

the logarithm of .. .. .. 5·732 inches.
Experiment gives .. .. .. 5·77 , difference ·04, inconsiderable.

*Example* 2. What is the tension of steam at the temperature of 290°?

$$r = \frac{1{\cdot}23+1{\cdot}16}{2} = 1{\cdot}195 \qquad n=8$$
$$\text{Log. } 28{\cdot}9 = 1{\cdot}46090$$
$$8 \text{ Log. } r = 8 \times 0{\cdot}07737 = +0{\cdot}61896$$
$$\text{Log. of } 120{\cdot}02 \text{ inches } 2{\cdot}07986$$

At 290° by experiment = 120·15.

*Example* 3. Temperature 250°. Force of steam in contact with water?

$$r = \frac{1{\cdot}23+1{\cdot}20}{2} = 1{\cdot}215 \qquad n=4$$
$$\text{Log. } 28{\cdot}9 = 1{\cdot}46090$$
$$4 \text{ Log. } r = 4 \times 0{\cdot}08458 = +0{\cdot}33832$$
$$\text{Log. of } 62{\cdot}98 \quad 1{\cdot}79922$$

At 250° Experiment 61·90

At these high heats, it is very possible that the experiment may be in error by one inch, which is the whole difference here. About half a degree of Fahrenheit misnoted, would give this deviation.

Such a correspondence, therefore, of observation with the calculated

culated results, shows that we have found a rule of perfect accuracy for all purposes of engineering, &c. If I am asked whether this formula coincides at every link with the chain of nature, I freely acknowledge, that I do not imagine it strictly so to do. But still it affords approximations such, that within moderate limits, I cannot tell whether to place more confidence in them, or in those found by experiment. It has moreover the rare advantage of being extremely simple, and level to the capacity of all practical men.

In Biot's excellent work above quoted, where many of the hitherto vague disquisitions of physical science have been happily brought within the pale of geometry, this celebrated philosopher has deduced, from Mr. Dalton's experiments on the force of steam, a general formula for determining its elasticity at any temperature.

In investigating this formula, he represents the decrease of the logarithms of the elastic forces by a series of terms of the form $an+bn^2+cn^3$; $a\ b\ c$ being constant coefficients.

$$\text{Thus, Log. } F_n = \text{Log. } 30 + an + bn^2 + cn^3.$$

It is unnecessary to employ powers of $n$ higher than the cube, because their coefficients would be insensible, as the calculation will show. To determine the coefficients $a\ b\ c$, he makes use of the elastic forces, observed at the temperatures on the centigrade scale of 100°, 75°, 50°, and 25°; whence result these conditions,

$$\begin{array}{ll} n=0 & F \ =30{\cdot}00 \text{ inches} \\ n=25 & F_{25}=11{\cdot}25 \\ n=50 & F_{50}=\ 3{\cdot}50 \\ n=75 & F_{75}=\ 0{\cdot}910 \end{array}$$

Substituting these conditions in the above general formula, and bearing in mind that the logarithm of a fraction is equal to the logarithm of the numerator minus the logarithm of the denominator, we have the three following equations of conditions.

$$\begin{array}{l} -0{\cdot}4259687 = 25.\,a + 625\ b + 15625\ c. \\ -0{\cdot}9330519 = 50.\,a + 2500\,b + 125000\,c. \\ -1{\cdot}5180799 = 75.\,a + 5625\,b + 421875\,c. \end{array}$$

Doubling the first, and subtracting it from the second, $a$ disappears; trebling it, and subtracting it from the third, $a$ also disappears. Then dividing each of the resulting equations by the coefficient of $b$, we have

$$\begin{array}{l} -0{\cdot}0000648916 = b + 75\ c. \\ -0{\cdot}00006404635 = b + 100\,c. \end{array}$$

Subtracting the one of these from the other, $b$ will disappear; and dividing it by the coefficient of $c$, we shall have $c$. Next, by by substituting the value of $c$ in one of these equations, we get $b$. Lastly, putting $b$ and $c$ in one of the two first equations, we have $a$. Thus we find

$$a = -0{\cdot}01537419550$$
$$b = -0{\cdot}00006742735$$
$$c = +0{\cdot}00000003381$$

Whence the whole formula $\text{Log. } F_n = \text{Log. } 30 + an + bn^2 + cn^3$ is completely determined, and may serve for calculating $F_n$, relative to any proposed value of $n$.

If we make, for example, $n = 100$, we shall have the elastic force at 100 degrees below the boiling point, or at the temperature of melting ice. We thus obtain

$$\text{Log. } F_n = 1{\cdot}4771213 - 2{\cdot}1778831 = -0{\cdot}7007618.$$

Or employing negative indices in order to make use of the ordinary logarithmic tables,

$$\text{Log. } F_n = \bar{1}{\cdot}2992382, \text{ whence}$$
$$F_n = 0{\cdot}19917 \text{ inches; and observation}$$
gives us 0·200.

The error is obviously insensible; and we may adopt, says M. Biot, our formula as representing the experiments of Mr. Dalton. To introduce the Fahrenheit degrees into the formula, calling them $f$, and counting from 212°, we have $\frac{5}{9}f = n$; and substituting this value of $n$ in the preceding formula, we obtain

$$a = -0{\cdot}00854121972$$
$$b = -0{\cdot}00002081091$$
$$c = +0{\cdot}00000000580,$$

whence $\text{Log. } F_f = 1{\cdot}4771213 + af + bf^2 + cf^3$, $f$ being the number of degrees of Fahrenheit, reckoning them from 212°, positive below and negative above this point of departure.

By the above formula, thus elaborately investigated by M. Biot, I have computed the elastic forces of steam at the three successive temperatures of 232°, 262°, and 312°, or 20°, 50° and 100°, above the boiling point of Fahrenheit's scale.

In the first case we have $f = -20$ and $af + bf^2 + cf^3 = 20 + 400\,b - 8000\,c$; $f$ is negative, being above the point of departure 212°, and, consequently, the products $af$ and $cf^3$ are positive, while $bf^2$ becomes negative.

$$\begin{aligned} 20\,a &= \phantom{+}0{\cdot}170824 \\ 400\,b &= -0{\cdot}008324 \\ 8000\,c &= +0{\cdot}000046 \\ \hline &\phantom{=+}0{\cdot}162546 + \text{log. } 30 \text{ or } 1{\cdot}477121 \\ &\phantom{=+}1{\cdot}477121 \\ \hline \text{Log. of } 43{\cdot}62 &= 1{\cdot}639667 \end{aligned}$$

By

| | |
|---|---|
| By Biot's formula therefore at 232° F. .. | 43·620 |
| My experiments .. .. .. .. .. | 44·700 |
| Mr. Dalton's table .. .. .. .. | 43·25 |
| Betancourt .. .. .. .. .. .. | 47·20 |
| By M. Pouillet's table at the end of Biot's 1st vol. computed from the above formula .. | 43·500 |

The difference between Biot and my experiments here is only 1·10 inches.

*2d Example.* Temperature 262° Fahr. $f=50$

$$\begin{aligned} 50\,a &= 0\cdot4270609 \\ 2500\,b &= -0\cdot0520272 \\ 125000\,c &= +0\cdot0007250 \\ \hline & \phantom{=}\ 0\cdot3757587 \\ \text{Log. } 30 &= 1\cdot4771213 \\ \hline \text{Log. of } F_{262°} &= 1\cdot8528800 \end{aligned}$$

| | |
|---|---|
| $F_{262°}=$ | 71·265 |
| Experiment .. | 74·600 |
| Dalton's table | 69·700 |
| Pouillet's table | 70·800 |
| Betancourt .. | 82·500 |

The disparity between Biot's formula and experiment becomes more apparent now: it amounts to 3·335 inches.

At 266° Fahr. which corresponds to 130° centigrade, I make it from Biot's first formula 77·053, while at 130° by M. Pouillet, it is 75·68 *; difference 1·973. Finally,

At the temperature of 312°, $f=100$

$$\begin{aligned} 100\,a &= 0\cdot854121972 \\ 10\cdot000\,b &= -0\cdot208109100 \\ 1000000\,c &= +0\cdot005800000 \\ \hline & \phantom{=}\ 0\cdot651812872 \\ & \phantom{=}\ 1\cdot477121300 \\ \hline \end{aligned}$$

Log. of $F_f = 2\cdot128934172$ $F_f = F_{100} =$ 134·57

| | |
|---|---|
| Experiment gives | 167·00 |
| Mr. Dalton's table | 125·85 |

The difference between experiment, and both calculations, is now excessive, and even between the two latter it amounts to nearly nine inches.

From this ample investigation, we may legitimately conclude,

* 130° centigr. gives by M. P. force of vapour $=1907\cdot07$ millimetres; of which taking 25·4 to the English inch, we have $\frac{1907\cdot07}{25\cdot4}=75\cdot08$ as above.

that

that we ought to receive such geometrical representations with great caution. M. Biot, indeed, with a candour becoming his genius, admits these formulæ to be merely tentative approximations. The high reputation of this philosopher, and the geometrical skill here displayed, might have led the scientific world to repose confidence in his formula, within the limits of $55\frac{1}{2}$ degrees centigrade $= 100$ Fahr. It was therefore entitled to a deliberate examination.

It is curious to observe that my very simple formula, Log. $F = \text{Log. } 28{\cdot}9 \pm n. \text{ Log. } r$, gives good approximations, through a much more extensive range, than the elaborate formula of the distinguished French geometer. Even when carried so high as the 310th degree of Fahr., we have

$$\text{Log. } 28{\cdot}9 + n. \log. r = 2{\cdot}19810 = \text{L}, F_{100}; \text{ hence}$$

$$F_{100} = 157{\cdot}8.$$

Experiment gives 161·3, a difference of only $3\frac{1}{2}$ inches at this prodigious elasticity; which may be deemed altogether unimportant in practice.

Biot's formula gives a result 31 inches, and Mr. Dalton's 40 in defect.

Of Professor Robison's higher numbers, it is merely necessary to examine the successive differences for every 10° above 212°. These are 7·2, 8·9, 10·2, 11·9, 13·5, 13·8, 11·8, and the second differences are $+1{\cdot}7 + 1{\cdot}3 + 1{\cdot}7 + 1{\cdot}6 + 0{\cdot}3 - 2{\cdot}0$.

Such striking irregularities cannot exist in the progression of nature. Betancourt's are liable to a similar censure. We may find indeed small discrepancies in the best observations at such temperatures.

§ II. *Experiments to determine the elastic Forces of the Vapours of Alcohol, Ether, Oil of Turpentine, and Petroleum or Naphtha.*

The determination of the elasticities of these vapours is a very interesting problem in chemical philosophy. It may possibly unfold the law which connects temperature and elastic energy, and it may furnish likewise some useful applications.

Mr. Dalton has examined the subject with considerable care.

My experiments were performed with the apparatus above described, and were verified by frequent repetitions. The following results were noted down during the progress of the experiments.

TABLE

### Table III.

*Elastic Forces of the Vapours of Alcohol, Ether, Oil of Turpentine, and Petroleum or Naphtha.*

| Ether. | | Alcohol sp. gr. 0·813. | | Alcohol sp. gr. 0·813. | | Petroleum. | |
|---|---|---|---|---|---|---|---|
| Temp. | Force of Vapour. | Temp. | Force of Vapour. | Temp. | Force of Vapour. | Temp. | Force of Vapour. |
| 34° | 6·20 | 32 | 0·40 | 193°·3 | 46·60 | 316° | 30·00 |
| 44 | 8·10 | 40 | 0·56 | 196·3 | 50·10 | 320 | 31·70 |
| 54 | 10·30 | 45 | 0·70 | 200 | 53·00 | 325 | 34·00 |
| 64 | 13·00 | 50 | 0·86 | 206 | 60·10 | 330 | 36·40 |
| 74 | 16·10 | 55 | 1·00 | 210 | 65·00 | 335 | 38·90 |
| 84 | 20·00 | 60 | 1·23 | 214 | 69·30 | 340 | 41·60 |
| 94 | 24·70 | 65 | 1·49 | 216 | 72·20 | 345 | 44·10 |
| 104 | 30·00 | 70 | 1·76 | 220 | 78·50 | 350 | 46·86 |
| | | 75 | 2·10 | 225 | 87·50 | 355 | 50·20 |
| 2nd. | Ether. | 80 | 2·45 | 230 | 94·10 | 360 | 53·30 |
| | | 85 | 2·93 | 232 | 97·10 | 365 | 56·90 |
| 105° | 30·00 | 90 | 3·40 | 236 | 103·60 | 370 | 60·70 |
| 110 | 32·54 | 95 | 3·90 | 238 | 106·90 | 372 | 61·90 |
| 115 | 35·90 | 100 | 4·50 | 240 | 111·24 | 375 | 64·00 |
| 120 | 39·47 | 105 | 5·20 | 244 | 118·20 | | |
| 125 | 43·24 | 110 | 6·00 | 247 | 122·10 | Oil of Turpen. | |
| 130 | 47·14 | 115 | 7·10 | 248 | 126·10 | | |
| 135 | 51·90 | 120 | 8·10 | 249·7 | 131·40 | Temp. | Force of Vapour. |
| 140 | 56·90 | 125 | 9·25 | 250 | 132·30 | | |
| 145 | 62·10 | 130 | 10·60 | 252 | 138·60 | | |
| 150 | 67·60 | 135 | 12·15 | 254·3 | 143·70 | 304° | 30·00 |
| 155 | 73·60 | 140 | 13·90 | 258·6 | 151·60 | 307·6 | 32·60 |
| 160 | 80·30 | 145 | 15·95 | 260 | 155·20 | 310 | 33·50 |
| 165 | 86·40 | 150 | 18·00 | 262 | 161·40 | 315 | 35·20 |
| 170 | 92·80 | 155 | 20·30 | 264 | 166·10 | 320 | 37·06 |
| 175 | 99·10 | 160 | 22·60 | | | 322 | 37·80 |
| 180 | 108·30 | 165 | 25·40 | | | 326 | 40·20 |
| 185 | 116·10 | 170 | 28·30 | | | 330 | 42·10 |
| 190 | 124·80 | 173 | 30·00 | | | 336 | 45·00 |
| 195 | 133·70 | 178·3 | 33·50 | | | 340 | 47·30 |
| 200 | 142·80 | 180 | 34·73 | | | 343 | 49·40 |
| 205 | 151·30 | 182·3 | 36·40 | | | 347 | 51·70 |
| 210 | 166·00 | 185·3 | 39·90 | | | 350 | 53·80 |
| | | 190 | 43·20 | | | 354 | 56·60 |
| | | | | | | 357 | 58·70 |
| | | | | | | 360 | 60·80 |
| | | | | | | 362 | 62·40 |

*Remarks on the preceding Table.*

The ether of the shops as prepared by the eminent London apothecaries boils generally at 112°; but when washed with water, or redistilled, it boils at 104° or 105°. It may by rectification, however, be made to boil at a still lower temperature.

Concerning the boiling point of oil of turpentine, curious (may we say ridiculous) discrepancies exist in our systems of chemistry. Dr. Murray, for example, in the table of the scale of temperature at at the end of the first volume of his valuable System, last edition, places the boiling point of oil of turpentine at 560°. Mr. Dalton, vol. i. p. 39, of his new System of Chemical Philosophy, says: "Several authors have it that oil of turpentine boils at 560°. I do not know how the mistake originated, but it boils below 212°, like the rest of the essential oils." I made with much care several experiments on this point, previous to ascertaining the force of its vapour, and found its boiling point to be about 316°. When recently distilled, however, it will boil at 305°. Did it boil below, or even at 212°, as Mr. Dalton asserts, *then*, long before the included portion in the above experiments had reached the 304th degree, it would have acquired such an elasticity as to support a high column of mercury, instead of being barely *in equilibrio* with the atmospheric pressure.

Plunge a phial half filled with fresh oil of turpentine into a metal cup containing any fixed oil. Heat the cup gradually. It will be found that, at the temperature of 316°, the oil remains in steady ebullition, as indicated by a thermometer suspended in the centre of the phial. Prior to this, even at 212°, some small bubbles will be evolved, principally owing to the moisture dispersed in the pores of the oil, from the water originally mixed with the crude turpentine in its distillation. If the heat be very rapidly thrown in, while the upper surface of the oil of turpentine has the area only of a one or two ounce phial, it is possible to heat it to 360° or 370°, in apparent contradiction to the theory of latent heat; for when a liquid boils in an open vessel, according to Dr. Black, its temperature should remain stationary. The true cause of this phænomenon is developed towards the conclusion of this memoir. The specific caloric of the vapour of the volatile oil is so small, compared to that of water, that the heat may readily be quicker introduced than the boiling process can abstract it. Concerning the boiling point of this oil, I have since inquired of a manufacturer; and he states its boiling point at 320°. Essential oil of rosemary, when kept for some time, boils at 270°; recent oil at 212°. To assign the cause of this difference, is foreign to our present object.

The vapour of ether follows nearly the same rate of expansion as water, if we start from their respective boiling points. This was observed also in Mr. Dalton's experiments; and from this single analogy, chiefly, he laid down the general law, "that the variation in the force of vapour from all liquids is the same for the same variation of temperature, reckoning from vapour of any given force."

My experiments on oil of turpentine and petroleum show the fallacy of this generalization, if we reckon the common thermometric scale a tolerably correct index of temperature; but if, with

*Fig. 1*

*Fig. 2*

*Fig. 3.*

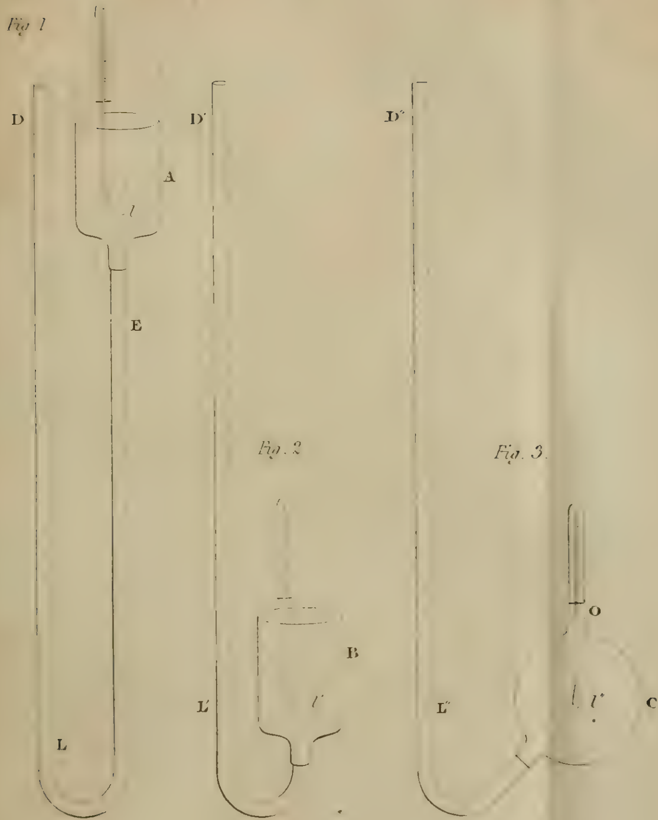



*Fig. A*

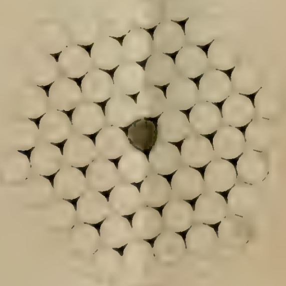
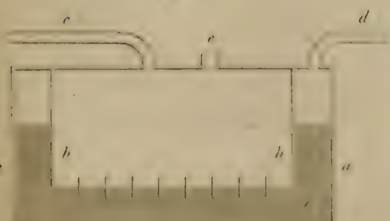


*Fig. B*




S. Porter

at tl
plac
ton,
says
I dc
212
seve
forc
Wh
boil
befo
the
supl
*equ*
P
met
It w
in st
the
bubl
sper
with
rapi
tine
to h
of l
cord
The
conc
the
heat
can
since
at 3
boils
diffe
Tl
as w
was
singl
varia
the s
give
M
falla
metr

with Mr. Dalton, we consider our thermometric scale, as very erroneous, then either itself is an exception to its own law, to use this paradoxical, though just expression. In consequence of his peculiar thermometric ideas, Mr. Dalton has abrogated the above law, which he had himself framed; though it is curious to observe, in some respectable treatises on chemistry, both hypotheses detailed, without indicating their mutual incompatibility. M. Biot, likewise, far from imagining that the law had been repealed for eight or nine years, proposes to judge by its provisions of the total elastic force of every vapour at 100° centigrade, to serve as the basis of the determination of their respective specific gravities at that temperature *.

My experiments show that from 105° to 167°·5 Fahrenheit, ether trebles the tension of its vapour, as water also does from 212° to 272°·7; both containing nearly, but by no means exactly, equal intervals of the Fahrenheit graduation. According to Mr. Dalton's corrected scale of temperature, we have

| | | | |
|---|---|---|---|
| 212° Fah. | = 212° Dalton. | 105° Fah. | = 119° Dalton. |
| 273 F. | = 256·4 D. | 167·5 F. | = 176 D. |

real interval = 44·4 by Dalton. By Dalton 57 = the real interval of temperature.

Thus we see, that while the interval for trebling the tension of ethereal vapour is 57°, that for aqueous vapour is only 44°·4; quantities that are to each other nearly as 100 : 80. Hence, according to this eminent chemist, ether must take for trebling the force of its vapour a fifth part more heat than water does.

I hope presently to be able to adduce satisfactory experimental evidence, that our thermometric indications are not at all so unequable as Mr. Dalton conceives.

Meanwhile, in examining closely the table of the vapour of ether, a beautiful analogy with that of water presented itself. The series of ratios representing the progression of the latter being lowered a single step, will accurately fit the former. At 30 inches of elasticity 1·23 was our initial number for aqueous vapour; for ethereal, it becomes 1·22; increasing or diminishing by unity each time in the second decimal figure, according as we descend or ascend by intervals of 10° of the Fahrenheit scale.

The following is a general view of the results.

* "On peut calculer par la loi de M. Dalton, quelle doit être, pour chacun d'eux, la force élastique totale de sa vapeur à la température de 100 degrés."—*Traité de Physique*, tome i. p. 393.

TABLE IV.

*The observed Tension of ethereal Vapour compared with the Ratios* 1·22, 1·23, *&c. and* 1·22, 1·21, *&c.*

| Temp. | Quotients. | Expert. | Temp. | Product. | Expert. |
|---|---|---|---|---|---|
| 104° | —— | 30·00 | 105° | —— | 30·0 |
| 94 | 24·7 | 24·70 | 115 | 36·6 | 35·9 |
| 84 | 20·2 | 20·00 | 125 | 44·3 | 43·24 |
| 74 | 16·3 | 16·10 | 135 | 53·4 | 51·9 |
| 64 | 13·06 | 13·00 | 145 | 63·6 | 62·1 |
| 54 | 10·3 | 10·3 | 155 | 75·4 | 73·6 |
| 44 | 8·1 | 8·1 | 165 | 88·2 | 86·4 |
| 34 | 6·35 | 6·2 | 175 | 102·0 | 99·1 |
| | | | 185 | 117·3 | 116·1 |
| | | | 195 | 134·0 | 133·7 |
| | | | 205 | 151·3 | 151·3 |

The numbers derived from calculation give a surprising accordance with those observed in the lower range. In the upper range, the correspondence is as good as the delicacy of the experiments at such temperatures could permit us to expect. The experiments have been presented without modification. I must own, that when first the above perfect coincidence appeared, it gave me no small pleasure, as it led me to suppose that I had discovered the hidden chain of nature.

In treating of the vapour of alcohol, Mr. Dalton considers it as irregular in the progress of its elastic force by heat, owing to its not being a homogeneous liquid. He suspects "that the elastic force in this case is a mixture of aqueous and alcoholic vapour." I cannot see the cogency of this argument; for, if the separate bodies have a regular progression, the mixture ought not surely to be anomalous. I believe, however, that if the experiments were made with due accuracy, alcohol would be found as methodical in the elastic march of its vapour as other bodies. The following table will afford satisfactory proofs of the justness of these views. For absolute alcohol, the progression is probably as simple as that of the preceding vapours. But for alcohol, sp. gr. 0·813, which though highly rectified contains not a little water, we should expect it to result from a composition or modification of ratios. After some search on this principle, I accordingly found it. Starting from the boiling point 174°, or, for the convenience of comparison with the table, from the decade 170°, we move not by a unit, as before, but by a unit and a tenth; or the initial ratio 1·26 is affected at each step or term of of 10°, with the number $\pm 0\cdot011$, the signs being employed as in the preceding cases.

TABLE V.

*Elastic Force of the Vapour of Alcohol compared with the Ratios.*

| Temp. | Calcu-lat. | Ob-served. | Temp. | Calcu-lat. | Ob-served. | Temp. | Calcu-lat. | Ob-served. |
|---|---|---|---|---|---|---|---|---|
| 250° | 130·24 | 132·3 | 170° | 28·3 | 28 3 | 90° | 3·41 | 3·40 |
| 240 | 111·13 | 111·24 | 160 | 22 46 | 22 6 | 80 | 2·52 | 2·45 |
| 230 | 93·94 | 94·1 | 150 | 17·7 | 18·0 | 70 | 1·85 | 1·76 |
| 220 | 78·67 | 78 5 | 140 | 15·8 | 13·9 | 60 | 1·35 | 1·23 |
| 210 | 65·29 | 65·0 | 130 | 10 65 | 10·6 | 50 | 0·97 | 0·86 |
| 200 | 53·69 | 53·0 | 120 | 8·16 | 8·10 | 40 | 0·69 | 0·56 |
| 190 | 43·76 | 43·2 | 110 | 6·2 | 6·00 | 30 | 0·49 | 0·38 |
| 180 | 35·35 | 34·73 | 100 | 4·67 | 4·50 | | | |

$$\frac{28\cdot3}{1\cdot26} = 22\cdot46 \therefore 28\cdot3 \times \overline{1\cdot26 - \cdot011} = 35\cdot35$$

$$28\cdot3 \times \overline{1\cdot26 - \cdot011} \times \overline{1\cdot26 - \cdot022} = 43\cdot76 \text{ \&c.}$$

$$\frac{22\cdot46}{1\cdot271} = 17\cdot7, \text{ \&c.}$$

The correspondence here exhibited between the observed and calculated elasticities is remarkable; nor does the difference ever exceed what would be produced by an error of 1° in the construction or reading off of the thermometer. This may fairly be deemed the limit of accuracy in such an experiment.

Oil of turpentine is regulated by the constant ratio 1·122, which converts any elastic force into that 10° above or below, multiplying as usual in the former, and dividing in the latter case. For petroleum the ratio is 1·14; it is also constant.

The following table exhibits a comparative view of theory and experiment.

TABLE VI.

| Oil of Turpentine. | | | Petroleum. | | |
|---|---|---|---|---|---|
| Temp. | Calculat. | Observed. | Temp. | Calculat. | Observed. |
| 310° | | 33·5 | 320° | | 31·7 |
| 320 | 37·7 | 37·06 | 330 | 36·2 | 36·4 |
| 330 | 42·5 | 42·1 | 340 | 41·2 | 41·6 |
| 340 | 47·7 | 47·3 | 350 | 47·0 | 46·86 |
| 350 | 53·5 | 53·8 | 360 | 53·6 | 53·3 |
| 360 | 60·4 | 60·8 | 370 | 61·1 | 60·7 |



The

The whole of the preceding research is closely interwoven with a question of the first importance in chemical philosophy; what are the relative portions of temperature denoted by the graduations of our thermometric scale? Mr. Dalton regards the progressive elasticities of aqueous and ethereal vapour as affording countenance, if not support, to his thermometric innovations. He affirms, that if our instrument for the measuring heat were accommodated to his doctrine, the quantity of expansion of its mercury is as the square of the temperature from its freezing point; then "the force of steam in contact with water increases *accurately* in geometrical progression to equal increments of temperature, provided these increments are measured by a thermometer of water or mercury, the scales of which are divided by the above-mentioned law *."

Were this position true, it would certainly bring a powerful analogy in aid of his theoretical views. We are now furnished with *data* to verify, or refute it. The following tables show the correspondence between that principle and experiment. In the table of aqueous vapour, the *first* column presents his geometrical progression of that vapour, coordinate with his equal intervals of real temperature contained in the *second*. In the *third*, are the coresponding points of the common scale, as given by Mr. Dalton. To these points the elastic forces, as determined by experiment, are placed opposite in the fourth column.

Table second, for vapour of ether, is similarly arranged; the first three columns being Mr. Dalton's; the *fourth*, the faithful transcript of observation.

"The force of the vapour of sulphuric ether," says Mr. Dalton, "in contact with liquid ether, is a geometrical progression, having a less ratio than that of water." "Ether, as manufactured in the large way, appears to be a very homogeneous liquid. I have purchased it in London, Edinburgh, Glasgow, and Manchester, at different times, of precisely the same quality in respect to its vapour †." This shows that no exception can be made to my experiments on account of a supposed difference in the quality of the ether. From the mode of conducting my experiments, there remained always a quantity of liquid ether in contact with the vapour, a circumstance essential to accuracy in this research. The results were verified by frequent repetitions, and discover, in my opinion, the consistency of truth.

* New System, vol. i. p. 11. † Ib. pp. 20, 21.

TABLES

TABLES VII. and VIII.

DALTON'S *Theory of the thermometric Scale compared with the observed Temperatures and Tensions of Vapours.*

| Aqueous Vapour. | | | | Ethereal Vapour. | | | |
|---|---|---|---|---|---|---|---|
| DALTON'S geom. Progression of Elasticity. | DALTON'S new Scale of Temperat. | FAHREN. | Observed Elasticity | DALTON'S Progression of Elasticity. | DALTON'S Scale. | FAHREN. | Observed Elasticity |
| 22·7 inch. | 202° | 199° | 23·1 in. | 6·1 | 32° | 32° | 5·81 |
| 30 0 | 212 | 212 | 30 0 | 9·16 | 52 | 46·6 | 8·67 |
| 39 5 | 222 | 225 | 39·11 | 13·77 | 72 | 62·55 | 12·60 |
| 52 0 | 232 | 238·6 | 50·3 | 20.65 | 92 | 79·84 | 18·40 |
| 69·0 | 242 | 252·6 | 64·5 | 31·0 | 112 | 98·50 | 27·2 |
| 91 0 | 252 | 266 8 | 81·5 | 46·54 | 132 | 118·50 | 37·7 |
| 120·0 | 262 | 281·2 | 103·5 | 69 88 | 152 | 139.9 | 56·8 |
| 158 | 272 | 296·2 | 131 7 | 104·91 | 172 | 162·4 | 83·3 |
| 208 | 282 | 311·5 | 164·8 | 157·5 | 192 | 186·5 | 118·3 |
| | | | | 236·5 | 212 | 212· | 169·0 |

The numbers of the first and fourth column ought evidently to agree, if the theory be just. Their differences, on the contrary, are prodigiously great. At 272° of his scale, for example, equal to 296°·2 of ours, the law of progression makes the elastic force of aqueous vapour amount to 158 inches: experiment gives 131·7; and I am confident, that the latter cannot be in error above an inch or two. Again at 262°, equivalent to 281°·2 Fahrenheit, his theory gives the force of the same vapour at 120 inches; by observation it is only 103·5. Now at this part of the scale, my result is confirmed by the concurrence of those obtained by Betancourt and Robison. I consider this demonstration complete. If we compare these very elasticities of Mr. Dalton, with the table formerly given by the same philosopher *, we shall find discordances which no ingenuity can harmonize. At that time, 225° of Fahr.=222° of the new scale, gave a force of vapour equal to 38·3; it is now 39·5 . 252°·6 F. = 242° D. then coincided with an elasticity of 58·6 inches; above, it is 69. And finally, 281°·2 F.=262° D. were opposite to 90 inches; they have become here 120. And yet no new experiments on the vapour of water have been adduced, to justify such immense alterations.

It may be said, indeed, that these changes arise merely from the substitution of one hypothesis for another; but the deviations from experiment are even more remarkable, since as 282° new scale, correspond to 311°·5 Fahr., the difference amounts to 43 inches, being more than one-fourth of the total elastic force generated at that high temperature.

* Manchester Memoirs, vol. v.

When we turn our attention to ether, we find the discrepancies, if possible, less easy to reconcile. At the temperature of 212°, for example, where the old and new scales meet for the last time, the force of its vapour by the geometrical progression exceeds that found from experiment, by the enormous quantity of 67 inches and a half; amounting to two-fifths of the whole elastic force evolved.

May we venture, then, to conclude, from these multiplied comparisons, that the progressions of elasticity in vapours, taught by Mr. Dalton, are geometrical fictions, intended to quadrate with his notions concerning temperature; but not consonant with the laws or phænomena of nature?

Within a moderate compass, indeed, it is not difficult to suit the ratio of elastic force and the thermometric graduation to each other; but the prosecution of the inquiry into ranges more remote, detects the fallacy of such hypothetical adaptations. My experiments on the vapours of water, alcohol and ether, seem to show, that the ratio of tension decreases in a certain progression as the temperature augments. Were the ratios 1·23, 1·22, 1·21, &c., which are seen to apply so well to aqueous vapour for a considerable range above 212°, to be adopted as representing the progressive march of nature, it would lead to the absurd conclusion, that at 240° above the boiling point, or 452° F., the further influx of caloric would occasion a diminution of elasticity in the steam. The truth however is, that at the 312th degree, indications of a divergence begin to appear between the two lines of experiment and calculation, which had run for so long a space nearly parallel. The curve representing the expansive force of steam, I consider to be logarithmic, in which the ratios, as ordinates, continually diminish, without ever vanishing, or coming to an equality. The axis is an asymptote to the curve, as in the atmospherical logarithmic.

[To be continued.]

---

## XVI. *On Wheel-Carriages and their Effects upon Roads. By Mr.* John Farey *Sen. Mineral Surveyor.*

*To Mr. Tilloch.*

Sir, I am glad to see the important subjects of Wheel-carriages and Roads, brought under the notice of your readers, by the communication of Mr. Benjamin Wingrove, in your last Number; wherein he recommends two important improvements; viz. to prevent or lessen the evils of *dragging waggon wheels* down the hills, and the constructing of *carriages of an uniform breadth,* so that their wheels repeatedly follow in the same tracks, and cut ruts in the

the Road; I have been surprised however to find Mr. W. unacquainted with the circumstance, of the necessity of this latter improvement having been shown, in the Reports of the Committees of the House of Commons on the subject of Roads and Carriages, because in the 1st Report ordered to be printed 11th May 1808, p. 114, Mr. *C. W. Ward*; in the 2d Report ordered to be printed 17th June 1808, p. 176, Mr. *J. F. Erskine;* and in the 3d Report, ordered to be printed 11th June 1809, p. 156, Mr. *J. C. Hornblower*, have distinctly done this; and so have many writers on the subject, particularly Mr. *Robert Beatson* and Mr. *Richard Whitworth*.

In my Derbyshire Report, vol. iii. p. 242, I have related the particulars, of an Act of Parliament obtained in 1808, for a Turnpike Road between Ashover and Tupton, wherein (on the suggestion of Mr. *Joseph Butler*) the Tolls on Carriages, have been apportioned, to several different breadths of their wheel-tracks, for inducing their owners to co-operate in the improvement in question. In p. 241 I have thus expressed myself; viz. "It has occurred to me, from a long and careful attention to Roads, in all situations, and I know numbers of intelligent Travellers and Road Surveyors, who have made the same observation, viz. that nothing is more essential to the goodness and permanence of a Road, than *causing the wheels of carriages continually to change their places on the Road*, by which alone, *Ruts* thereon can be avoided, and a smooth surface be obtained and preserved: this is remarkably exemplified, at the *meetings or turnings* of Roads, in most situations, notwithstanding the *grinding action* of the wheels thereon while turning (which action, Mr. Cummings and others have so greatly magnified, in the use of conical wheels,&c.) and on the slopes of hills of considerable steepness, where the horses, in order to ease the ascent or descent, endeavour to cross continually from one side of the Road to the other: as also in such parts of Roads, as are full of carriages, going different ways and paces, and are consequently obliged often to turn out, and change their tracks."

In the Work mentioned, I have endeavoured to enforce the great importance of obtaining *hard* Materials, for all Roads, which are subject to much wear, at almost any cost; and have pointed out the important aids which the art of Mineral Surveying may furnish, towards the discovery of such materials, in numerous districts, where now, soft and bad materials are used on the great Roads.

I am, &c.

Howland-street, Feb. 1, 1819. JOHN FAREY Sen.

XVII. *Report of the Surveyor-General of the Board of Works, of the Experiments made for the Purpose of ascertaining the Practicability of superseding the Necessity of employing Climbing Boys in the sweeping of Chimneys, by Means of the Employment of Machinery.*

Office of Works, Jan. 14, 1819.

SIR, — I HAVE the honour to acknowledge the receipt of your letter, dated the 14th of March last, directing me, by command of Lord Sidmouth, "to ascertain, by experiment, how far it is safe and practicable to supersede the practice of climbing boys in sweeping chimneys, by the use of machinery;" and I beg leave to acquaint you, for his Lordship's information, that upon the receipt of your letter, I proceeded with as little delay as possible, to secure by every means in my power, a fair and impartial trial of all the different machines that had been collected, for the purpose of sweeping chimneys without the aid of climbing boys.

From the many difficulties I had to encounter at the commencement of this undertaking, I found it necessary, in order to secure a faithful execution of the commands I had received, to appoint Mr. Davis, an active and intelligent clerk in this office, to superintend personally the progress of each separate experiment, and to give such directions and assistance, in the use of the different machines, as circumstances and situation might require.

It will not, I conceive, be necessary for me to enter into a detailed statement of all the numerous trials made by Mr. Davis, to sweep chimneys, without the aid of climbing boys; and I shall therefore only submit, for his Lordship's information, the following list of experiments, where machinery has succeeded in effectually cleaning such chimneys, as presented particular difficulties in sweeping, from the size, situations, and peculiar construction of the flues.

| | Swept by the Machine. | Swept by the Ball & Brush. | TOTAL. |
|---|---|---|---|
| At Kensington Palace .... | 5 | 2 | 7 |
| — the Queen's Palace .... | 43 | 34 | 77 |
| — Windsor Castle .... | 20 | .... | 20 |
| — the Royal Mint .... | 5 | 5 | 10 |
| — The Speaker's house .. | 4 | .... | 4 |
| — Mr. Huskisson's house .. | 13 | 4 | 17 |
| — Mr. Nash's house .... | 1 | 2 | 3 |
| — Lord Liverpool's .... | 9 | 2 | 11 |
| | 100 | 49 | 149 |

This

This statement contains, I believe, with some few exceptions, specimens of nearly every difficult description of chimney that can be met with in the generality of either old or newly-constructed buildings, and will afford, in my humble opinion, sufficient evidence, that even at present by far the greater proportion of the chimneys throughout the country, can be effectually swept by machinery without the aid of climbing boys. There were however many chimneys that, from their very confined and horizontal construction, Mr. Davis could not succeed in sweeping, either with a machine or with the ball and brush; but this difficulty he thinks might be overcome by inserting iron registers or doors in some convenient parts of such flues, where machinery might be used with ease; and, if these registers are properly constructed and fixed, without either danger or inconvenience. The best constructed registers for this purpose, that I have seen, were exhibited here by Mr. Thomas White, of Air-street, Piccadilly, and by Mr. William Feetham, of Ludgate-hill. And the danger to which climbing boys are so constantly exposed when employed in sweeping narrow and intricate flues, would, in my opinion, in a great measure be obviated, were such iron registers or doors directed to be made at proper and convenient distances in every flue of this construction. The machinery that principally succeeded in the above experiments, was the invention of Mr. Smart, and has proved far superior in utility to any that has been submitted for trial upon the present occasion. This machine is simple in its construction, easily worked, can be repaired, when out of order, with little trouble or expense, and may be carried by a single person from place to place without any difficulty. During the progress of these experiments, I have had every possible assistance and advice, that the abilities and experience of Mr. Browne, the assistant surveyor-general, and of Messrs. Nash, Soane, and Smirke, the architects attached to this department, could afford me upon this very interesting subject; and from the information I have obtained from these gentlemen, as well as from the observations I have been enabled to make in attending to several of the trials made with the different machines, I beg leave to offer it to his Lordship, as my most decided opinion, that the total abolition of climbing boys in the sweeping of chimneys, is at present impracticable, and could not be attempted without incurring much risk of danger to the general safety of the metropolis.

I shall beg leave to annex, for Lord Sidmouth's further information, copies of three letters, which I have received from the attached architects, upon the subject of superseding the use of climbing boys in sweeping chimneys; together with a copy of Mr.

Mr. Davis's Report to me, upon the several experiments he has made, to promote this very desirable object;

and have the honour to be, sir,

Your most obedient servant,

B. C. Stephenson.

Dover-street, 31st Dec. 1818.

Sir,—Having attended to several experiments made to sweep chimneys of intricate construction by machines, without the use of climbing boys, I am of opinion, that though it will be difficult, and perhaps impossible, to construct a single machine which will clean every chimney, yet by the use of various machines almost any chimney may be swept clean; and that experience would, in a short time, render the operation quite easy: but I do not think the use of climbing boys can be wholly dispensed with, the pargetting or plastering of flues will require repairing; new buildings will require to have the mortar and knobs of bricks which stick to the plastering cleared away, which I think cannot be done by any other means than boys. I beg also to observe, that till the use of machinery shall by experience be made easy, and the adopting of the most efficacious form of the different machines shall be ascertained, much damage will be done to the plastering or pargetting of the flues, which will require climbing boys to repair. I should advise also, that a clause be inserted in the Building Act, that all chimney funnels hereafter to be built, or old chimneys when taken down and rebuilt, should have the flues made circular in form; there would be then little difficulty in cleaning them with any machine; and if tubes like chimney pots were worked upon the walls as funnels for the smoke, they would be a great security against fire, having few joints and no plastering to require repair.

I have the honour to be, sir, your obedient servant,

*The Surveyor-General of the Office of Works.* (Signed) John Nash.

Lincoln's-Inn Fields, 4th January, 1819.

My dear Sir,—In reply to your letter respecting climbing boys, I beg leave to state, that as far as my experience goes, a very large portion of the chimneys now constructed may be cleaned with machines; but that it will not be possible to do away entirely the service of climbing boys.

I am, dear sir,

Your very obedient and faithful servant,

*B. C. Stephenson, Esq.* (Signed) John Soane.

Albany, November 17th, 1818.

Sir,—In compliance with your desire that I should report to you

you my opinion upon the question of, How far it is practicable to supersede the practice of climbing boys, in sweeping chimneys by the use of machinery, I beg leave to say, that I am not able to give an opinion founded on much personal observation upon the subject; but the result of the very particular inquiries, and of the numerous experiments which you have caused to be made, prove, that machines, upon the principle of Smart's, may be employed with success in all common cases; but that the ball and brush let down from the upper part of the chimney flue is the only process which has answered in every instance.

I have however learnt, from intelligent workmen in Scotland, where it has long been employed, that much injury is often occasioned by this operation at the turning of flues, especially where they are separated only by a thin wall; and I do not think it would be practicable, by any regulation, to provide for the construction of chimney flues in such a way as to obviate this important objection.

I am therefore led to believe, that, although the use of machines may be very generally adopted, there is none hitherto invented which is so far free from objection in all cases, as to render it possible wholly to dispense with the use of climbing boys.

I have the honour to be, sir,

Your obedient and faithful servant,

*Lieut. Col. Stephenson.* (Signed) ROBERT SMIRKE.

Office of Works, 11th January, 1819.

Sir,—In obedience to the instructions, at various times received from you, on the subject of superseding climbing boys by the use of machines, I hereby inclose the result of the experiments made in consequence, with some observations and suggestions naturally presenting themselves in the detail.

It appears, that the whole of the flues at present in use, may be comprised in four classes; the first and most numerous are those which are carried up in a perpendicular stack, the only bend in these flues being just sufficient to clear the opening of the flue above. The second, far less numerous, are those in which the fire-place is in a wall not continued higher than the next floor, and turning off with one bend (making two angles in the elevation) to a partition wall, in which the shaft is continued to the top. The third, still less numerous, are those in which the shaft is at some distance from the fire-place, having at least one angle on the plan, and which of necessity forms two bends in the elevation. The fourth class, which forms a very small proportion of the total number already constructed, are those having more than one angle on the plan, and being, for a part of the length, entirely horizontal.

For

For the first class, the machines already in use are quite efficient; they are also competent to sweep part of the second class; for the remainder of the second class the ball and brush is perfectly efficient, unless any error in the construction has given the only bend in them a dip the contrary way. In the third class, where the ascent is at all preserved, the ball and brush still acts effectually; as it will also do in the fourth class, where there are no parts entirely level. The remainder of the fourth class comprehends those flues, which have several bends, and are frequently horizontal; and in these cases it is alike necessary to let in registers or doors, whether they are swept by boys or machines, there being no other security for the safety of the boys than this measure; which when done, actually presents the means of sweeping by a common machine.

As far as my experience has led me, I consider the proportions of the different classes nearly as under; out of 1,000 flues, 910 of the first class, 50 of the second, 30 of the third, and 10 of the fourth.

For the first and second classes, the machinery has been proved, at Kensington Palace, the Queen's Palace, the Mint, the Speaker's house, Lord Liverpool's, Mr. Huskisson's, Mr. Nash's, and at the Office of Works: but a case has occurred at the Queen's Palace, where a flue of the second class could not be swept by the ball and brush; and upon examining the external part of the chimney, by going between the timbers of the ceiling and lead flat above, that part of the flue was out of a level, the end nearest the shaft being lower than that next the fire-place.

I have not seen a machine that will sweep many flues of the third and fourth classes; but have succeeded with the ball and brush at the several palaces and places above enumerated; and in the last week a chimney was swept at the Tower with a ball and brush in half an hour, which a boy was five hours sweeping a short time since, and in which, I am informed, a boy was once confined 28 hours.

The necessity of putting doors in the remainder of those classes, has been proved at the Speaker's house, where, for want of them, they are obliged to cut out tiles or take down part of the stone work every time the servants' hall chimney is swept by a boy; as well as at Somerset Place, where they have put doors in consequence of accidents occurring. Much has been stated by the parties interested, about the injury done to the pargetting by the use of the machinery and the ball and brush; but so far as the closest observation has enabled me to form an opinion, this is entirely without foundation; for in the use of the common machine less compression is required than is exerted by the boys to sustain their own weight; and with the ball and brush, unless there is a level,

level, and the ball is wantonly thrown down instead of being lowered carefully, there can be no injury done. In the course of my own experience, I have never met with an instance of the necessity of employing a climbing boy to repair the pargetting of a chimney; and with respect to the coring of new chimneys, it requires only a determination on the part of the bricklayers to avoid the necessity of it.

It will appear, that the result of my experiments is, that all the really difficult flues to clean, are met with in large mansions or public offices, and that the middling and lower classes of houses are entirely free from them. The doors introduced in the flues can certainly be constructed to answer, by their locality, all the purposes of convenience, safety, and cleanliness.

The machines I have seen used are Messrs. Smart's, Bean's, Mumford's, Skinner's, Lee's, and the Bath; and these are nearly the same in principle and effect.

Smart's being most used in London, possesses from that circumstance advantages the others have not; practice being required to give confidence to the men employed.

The ball for conducting the brush is susceptible of improvement, inasmuch as making it lighter and larger is found to increase its utility.

The machine from Scotland is not yet ascertained to possess more advantages than the others; but that being different in principle, it may be found capable of improvement.

I have the honour to be, sir,
Your most obedient humble servant,
*B. C. Stephenson, Esq.* (Signed) George Davis.
*Surveyor General*, &c.

---

## XVIII. *New Experiments on the Oxygenized Acids and Oxides.* *By M.* L. J. Thenard.*

I have already announced† that muriatic acid, nitric, &c. are susceptible of being several times oxygenated. As it was of importance that the quantity of oxygen which they were capable of taking up should be determined, I have done this with respect to the muriatic acid. I took liquid muriatic acid, of such strength that when combined with barytes, the solution when slightly evaporated deposited crystals of muriate of barytes, and this acid I saturated with deutoxide of barium reduced, by water and trituration, to a soft paste. By adding the requisite quantity of sulphuric acid I precipitated the barytes; and then treated the oxygenized muriatic acid with deutoxide of barium and sulphuric acid, to oxygenize it anew; and in this way charged it with oxygen fifteen times.

* From *Ann. de Chim. et Phys.* vol. ix. † See our last number, p. 21—25.

For

For the first five or six times this process is performed without the evolution of oxygen gas; especially if the muriatic acid be not completely saturated, and if the muriate be poured into the sulphuric acid: beyond this point it is difficult to avoid losing a little oxygen; but the greater part of this gas remains united to the acid. In this way I obtained an acid containing 32 times its volume of oxygen at the temperature of 68° of Fahr. under a pressure of 29·992 inches of mercury; and only $4\frac{1}{2}$ times its volume of muriatic acid: *i. e.* the volume of oxygen being 7, that of the muriatic acid was 1.

Though the oxygenized muriatic acid prepared in this manner contains a large quantity of oxygen, it is still capable of receiving a new portion. To make it absorb the gas with facility another method must be followed; which consists in putting the oxygenized muriatic acid in contact with sulphate of silver. Immediately there is formed an insoluble chloride of silver, and oxygenized sulphuric acid, which is very soluble. The latter being separated by the filter, muriatic acid is added, but in smaller quantity than it existed in the oxygenized muriatic acid employed at first. Barytes, in quantity just sufficient to precipitate the sulphuric acid, is then added; when the oxygen, quitting the sulphuric acid to unite with the muriatic, instantly brings this acid to the highest point of oxygenation. Thus it is evident we can transfer the whole of the oxygen from one of these acids to the other; and, on reflection, it is equally evident that to bring sulphuric acid to the highest degree of oxygenation, it is only necessary to pour barytes water into the oxygenized sulphuric acid, in such quantity as to precipitate only a part of the acid. These operations, with a little practice, may all be easily performed.

By combining the two methods just described, I obtain oxygenized muriatic acid containing nearly 16 volumes of oxygen for 1 of muriatic acid. It was so weak that I could only extract 3·63 volumes of oxygen gas from 1 volume of acid, under a pressure of 29·922 inches of mercury, and at a temperature of 65°·3.

Oxygenized muriatic acid exhibits several phænomena, new to me, and worthy of being stated.—When recently prepared, it does not give off any air bubbles when filtered; but soon after very small bubbles make their appearance at the bottom of the vessel, ascend, and burst at the surface of the liquid. This is the case even when the acid is only once oxygenized. Suspecting that the action of light had something to do with this slow decomposition, I filled, almost entirely, a bottle with acid, and, after corking it, placed it bottom uppermost in a dark place. After some hours it exploded. This acid contained more than 30 times its volume; and yet when put under the receiver of an air pump, it gave off but a small quantity of the gas which it contained.

I had

I had hitherto believed that the whole of the oxygen was separable from muriatic acid at a temperature below boiling; but after boiling oxygenized muriatic acid for half an hour I still found oxygen in it; which is demonstrated by bringing oxide of silver in contact with it, when oxygen is suddenly disengaged. This oxide enables us, with great ease, to determine the quantity of oxygen contained in oxygenized muriatic acid; and the analysis takes only a few minutes. Take a graduated glass tube, fill it almost wholly with mercury, pour into it a known volume of acid, fill the tube completely with mercury, and then turn it upside down in a mercurial trough. Send up into the acid an excess of oxide of silver suspended in water; and immediately there will be seen disengaged (which may be read off on the tube) the quantity of oxygen which the acid contained. The quantity of chlorine can be estimated; and consequently the muriatic acid, by decomposing a part of the acid itself by means of nitrate of silver: but as in this experiment a portion of the oxygen of the oxide is disengaged, we must take an account of this quantity to obtain an accurate result.

The separation of oxygen from the oxygenized muriatic acid is so rapid that there would be danger in operating with a weak acid, containing 26 to 30 volumes of oxygen; as the tube might escape from the hand of the operator, or might break. Nothing can equal the effervescence which takes place when we immerse a tube containing oxide of silver, and stir it about in some grammes of this acid, which is instantly destroyed, and the oxygen being liberated, escapes with violence, driving the liquid before it.

If the most oxygenized muriatic acid be poured on the sulphate, the nitrate, or the fluate of silver, no effervescence follows. The whole of the oxygen unites with the acid of the salt, while the muriatic acid forms with the oxide of silver water and a chloride.

I made several attempts to ascertain whether the oxygenized acids are capable of taking up so much the more oxygen, the more real acid they contain; or whether the water, by its quantity, has not an influence on the greater or less oxygenizement of the acid; but my attempts have not yet enabled me to answer the questions.

I have likewise tried to oxygenate magnesia and alumina, but without success. I succeeded, however, in superoxygenating several other oxides, viz. oxide of zinc, oxide of copper, and oxide of nickel. We should succeed but very imperfectly, if at all, were we to content ourselves with adding oxygenized acid to the saline solutions of these three metals, and precipitating the liquid by potash. The oxides of these metals must be dissolved in oxygenized muriatic acid three or four times, and then the oxygenized muriate must be decomposed by potash or soda, taking care to add

but

but a small excess of either of these. The formation of superoxide of copper requires another precaution: the deutoxide of copper must be put to the oxygenated muriatic acid in such portions that the acid shall be always in excess; for if the oxide predominate, the greater part of the oxygen will be disengaged. In every case the oxide is precipitated in a gelatinous mass, or in the state of a hydrate: that of zinc is yellowish,—of copper, olive-green,—of nickel, a dirty-looking dark apple-green. The two former allow a portion of their oxygen to be liberated at the common temperature. When boiled in water the liberation of oxygen is still more abundant; but they still retain (especially the superoxide of zinc) a portion of the oxygen which they had absorbed; for if dissolved afterwards in muriatic acid, and heat be applied, a new quantity of gas is given off. The oxide of nickel is likewise decomposed at the boiling temperature; and even below that point its decomposition commences. Treated with muriatic acid it dissolves, like the oxides of zinc and copper, and is deoxygenated by heat without giving off chlorine. These different oxygenated hydrates recover the colours which characterize the common oxides after they have been boiled in water: thus the hydrate of zinc passes from yellow to white,—of copper, from olive-green to dark-brown. It had already been observed by M. Rothoff, a Swedish chemist, that the deutoxide of nickel is decomposed by desiccation.—These new hydrates, as we see, resemble those of barytes, strontian and lime, and form a class analogous to that of the oxygenized acids.—I expect to discover some more of them.

---

XIX. *On the Importance of knowing and accurately discriminating* FOSSIL-SHELLS, *as the means of identifying particular Beds of the* STRATA, *in which they are inclosed: with a List of* 279 *Species or Varieties of Shells, of which the several Stratigraphical and Geographical Localities are mentioned, which seem to require the particular and minute attention of the Collectors and Examiners of Fossil Shells in their natural Deposits. By Mr.* JOHN FAREY *Sen. Mineral Surveyor.*

*To Mr. Tilloch.*

SIR,—ON taking a review of the many particulars regarding the Fossil Shells and other organic remains of Britain, which were published by Edward Lhwyd (or Luid) in 1669, by Dr. Plot in 1686, by *Dr. Woodward* in 1729, by *G. Brander* in 1766, by *Da Costa* in 1776, and by *John Walcott, Rev. David Ure*, and others prior to the time when Mr. *William Smith* began his investigations of the Strata of England, about 1792; it cannot fail of exciting surprise, that these learned and ingenious Writers, and the

the many of our countrymen who wrote on Geology in this period, should have been so little aware, of the important aids which a correct knowledge of Fossil Shells would afford, towards real and untheoretical investigations of *the internal structure of our Country*, and regarding the early history of its Strata.

Mr. *William Martin*, in 1794, began the publication of his "Petrificata Derbiensia," and completed the first volume thereof in 1809, (having previously in the same year, published his "Outlines of the Knowledge of Extraneous Fossils,") yet Mr. M. notwithstanding his industrious search through so many years, for perfect specimens and new species of Fossil Shells, in one of the most distinctly and regularly stratified Districts of England, free from Alluvia, and particularly rich in organic Remains, had but in a very slight and imperfect degree perceived, *the order and regularity*, with which the different species of Shells are almost invariably arranged, in the different beds of the Rocks he had examined, such as Mr. Smith was fortunate enough to perceive, elsewhere, almost from the outset of his investigations.

The works of Mr. Martin which are mentioned above, and his Letter in your 39th Volume, bear ample testimony to the justness of the above remark, which I was particularly enabled to make, on the occasion of paying Mr. Martin a visit at Macclesfield, in April 1809, and on showing and explaining to him my Map of the Strata of Derbyshire, and mentioning to him the discoveries which had been made and communicated to me and many others by Mr. Smith, relative to *the invariableness of the stratigraphical situations of Fossil Shells*, and the important uses which Mr. S. had been able to derive from them, in commencing and carrying on his novel and extensive investigations of the Strata and subficial structure of England and Wales.

Mr. *James Parkinson's* extensive research into the writings of the greater part of the previous authors on Extraneous Fossils, in our own Country and on the Continent, and his industry and judgement in the formation and description of a large Collection of Specimens of such Fossils, are fully shown, in the three volumes entitled "Organic Remains," which he published in 1804, 1808, and 1811; which work fully evinces, until approaching the conclusion of its third volume, the truth of the foregoing remarks, as to the slight and imperfect knowledge which existed of *the Fossil Shells, in relation to, and as the means of identifying particular Strata*, until the discoveries, and the practical applications of the same to the general surface of England, began to be made more generally known, by the communications of Mr. Smith and myself: and in consequence of which, Mr. Parkinson was led to review, to question, and at length to abandon many positions and opinions which had been formed and advanced, in the long progress of preparing his work, with the degree of confidence, which the almost entire concurrence of the numerous authorities he had consulted, was naturally enough calculated to inspire; amongst the most prominent of these changes of opinion, so honourable to Mr. P's liberality, is that which relates to the previously alledged formation of the Strata of Coal and those which intervene, (and of course, of all those which overlie the Coal Series) *during the Noachian Deluge.* See vol. III. pp. 443 and 441.

The early Numbers of Mr. *James Sowerby's* "Mineral Conchology" appeared in 1812, and through them, until near the conclusion of his first volume in 1815, when Mr. Smith's "Map of the Strata of England and Wales" had just appeared, additional evidence is furnished to the same point, in the conflicting opinions and doubts which Mr. Sowerby has therein expressed, as to nearly every inference which follows from the discoveries and labours of Mr. Smith; yet, notwithstanding the almost entire agreement of authors, in his own previously expressed opinions, Mr. S. then liberally took Mr. Smith by the hand, and offered him that assistance, in the bringing out of one of his proposed works on Fossil Shells and other Organic Remains, which has enabled three Numbers of "Strata Identified" to appear, in a state highly conducive to the progress of stratigraphical knowledge, and a fourth Number to be now nearly ready for delivery.

In the mean time Mr. Smith persevered, and by the aid of an ingenious young man his nephew and assistant, Mr. *John Phillips*, (who had made himself enough acquainted with the language and works of some of the best systematic writers on natural history,) was enabled to bring out, in 1817, the first part of his "Stratigraphical System of Organized Fossils:" and since, to complete the manuscript (as I have been informed) of the second and concluding part, of this truly important and nationally creditable work: if fortunately, his publisher's account of the sale of No. 1, had hitherto justified the putting of No. 2 to press!

It is, Sir, from the sincere desire which I feel to remove this impediment to the more rapid diffusion of *the stratigraphical knowledge of Fossil Shells*, which, as far as relates to the lower and most useful part of the British Series, has too long been withheld from great numbers, who, like myself, are anxious to make a more perfect use of this knowledge, in the mineral investigation of our Island for the advancement of Science, and in the practical application of this knowledge to the purposes of mining for the benefit of its inhabitants, that I have to request the favour of your insertion of the foregoing remarks in your Magazine: which remarks might have been spared, if—happily, every writer amongst us would imitate the praise-worthy liberality of the three individuals to whom I have particularly adverted, or would follow the practice

practice of our neighbours on the Continent, who from national feelings, seem to make a point of forwarding the publications of their countrymen : I am sorry however to perceive, that this is not here the case; the article "Conchology," not long published in that respectable work the "Supplement to the Fifth Edition of the Encyclopædia Britannica," intended to bring down the subjects to the time of writing the Supplementary Articles, in the chapter expressly "on Fossil Shells," not only omits all mention of Mr. Martin's works, (whose widow and orphans languish for the comforts which the sale of the copies on hand would produce), but it also totally *omits the mention of Mr. Smith* or his works!; it would have given me pleasure to have added, if I could have done so, that this omission, by the Rev. Dr. John Fleming the writer of the article, might have arisen, from the mention of Mr. Martin and Mr. Smith not having come before him, in the works from which he was quoting at the time : the reverse however is the case, see *Min. Conch.* I. 153, &c.

Whoever attentively examines the great number of Strata, some of them in groups consisting of several successive Strata, of many Beds collectively, and others in single beds, of various thickness, which are as utterly *devoid of Organic Remains*, as any of those more crystalline masses, which inconsiderate Theorists have on these accounts pronounced to be "primitive," that is, of a date antecedent to the first existence of living Beings!; and attentive Persons who at the same time observe, that these Strata without Organic Remains, are interposed between others which abound in such Remains, in nearly an equal degree of plenty throughout every part of the plane which they occupy : such observers of Organic Remains in their natural deposits, can hardly fail I think of concluding (as I have done many years ago) that every individual Shell or Organic Remain, which appears after each of these non-organic Strata or Beds, (or next above such in the Series, especially those of considerable thickness) *must have then begun to exist*, or *they were created* since the deposition of the Stratum which underlies them, and contains no Organic Remains.

The conclusion of such careful observers, will scarcely I think be less certain and undoubted, that Shells of a defined species in a particular Bed, which covers a series of Beds containing none of that defined Species, but other Shells of different species, that such defined Species, as certainly began to exist, or *were created* at that particular era, when the lowest bed in which they are seen, began to be deposited, (and at which period, *the matter of the Stratum itself* imbedding them, also *received its first existence* from the Creator, as I conclude, see Min. Conch. I. 128) : from whence it will follow, that the almost innumerable Species of Organic Beings which existed, prior to the Earth receiving *the same* *dimensions and external form*, which it now exhibits; or in other words, all those Species which *were contemporary with the deposition* (and creation) *of the Strata*, were only of a comparatively limited period of existence, and entirely differed from the subsequent Organic Creation (on the present surface, of which Moses treats), in these remarkable particulars, viz. that very commonly *only one Species was in existence at the same time*; at other times two Species existed, but neither the beginning nor the end of their existences were cotemporaneous, in many instances; during other periods of this series of Creations and vital Extinctions, three, four, five, and frequently greater numbers of Species existed at the same time (as is evinced by their Remains occupying the very same Bed or lamina of the Strata) but often, with different eras, of beginning and ceasing to exist, for almost every particular Species.

Whereas on the contrary, the present series of Organic Beings, or the present Creation as it is commonly called, is extremely diversified, as to *the very great number of Species now existing together*; each one propagating its like !; And experience, history and tradition, concur with just reasoning on the subject, in assuring us, that this always has unvaryingly been the case, ever since Man first began to exist; and that although some few organic Species may have since become extinct, in the progress of bringing whole Districts under the dominion of civilized Man, yet in this latter period, *no new Species have begun to exist*, much less *has any addition been made to the Matter of the Globe*, except perhaps the inconsiderable ones arising from the fall of Masses (containing Iron and Nickel in probably every instance,) which prior to such falls, formed parts of separate and independent *Satellitula*, which from the period of the general Creation had continued to revolve around our planet, with the immense velocity requisite for maintaining such small orbits as *the shooting stars* move in*.

These views on the subject of Organic Remains, which I have long, almost in vain attempted to press on the consideration of observers and writers on Natural History, are nevertheless capable of such abundant proofs, that however long we may have been in arriving at them, they cannot fail I think, of sooner or later, gaining universal assent: but previous to which, a great deal more of research, and of precision and care must be bestowed, *on the discrimination of the extinct organic Species*, than they have yet received, in doubtful cases, even from Mr. Sowerby, who unquestionably takes the lead in this interesting inquiry, in our country, wherein the same originated.

When Naturalists first began to turn their attention to the Or-

* See the Papers of mine on this subject in Nicholson's Journal, vol. 30. p. 285, and vol. 32. p. 269.

ganic

ganicRemains, and while the idea yet almost universally prevailed, that they were but those of individuals, from amongst *the early progenitors of the same stock which yet exists alive*, it was natural enough, that the artificial arrangement of Classes, Genera and Species, into which the followers of Linnæus had divided all the known living Organized Beings, would prove alike sufficient, for comprehending all such Organic Remains: it is however well observed by Dr. Fleming in his Article to which I have referred, that the reluctance felt by the writers who preceded M. Lamarck, to the forming of new Genera, has rendered the descriptions of these writers nearly unintelligible, unless when accurate *figures* accompanied their descriptions. I cannot however think, that the Doctor has displayed equal sagacity, in censuring Mr. Sowerby, in the same paragraph, for a "too great anxiety to constitute Species;" unless indeed, he meant to allude to the giving of personal and arbitrary names, rather than local or descriptive ones, to those individuals which his comparisons shew, to be distinctly different from all the species already named, and from each other.

Notwithstanding the *real differences*, which from my experience I believe that there exists, between the Species of the several successive and distinct Creations above mentioned, reason teaches us, that we are not to expect these differences to be in all cases so great and striking, as at first sight to present themselves; because if this had been the case, the idea could not so long have prevailed, that there were no differences between great numbers of the Fossil and the recent Species: and it will I believe turn out, that as great a further latitude remains to be taken, beyond what Mr. Sowerby has yet done in the constituting and naming of new fossil Species, as Lamarck has so praiseworthily set the example of taking, with regard to the Linnean Genera.

In order to proceed safely, in thus extending the number of Species to an accordance with nature, it will not be right to rely, in doubtful cases, on a single Specimen, even of the most perfect fossil kind, for furnishing the description and selecting the essential characters of the Species; but it will be desirable, that *as many Individuals as possible*, and from as many and as distant Places in the range of the individual Bed to which they belong, should be brought together and compared; carefully excluding from such comparison, all Individuals which belong to higher or to lower Beds, than that particular one, whose organized Remains are under review.

In the present state, of the only general Map of the English Strata which we have published, where, in all instances, a great number of Beds, and often several hundreds of such, are included under one coloured strip across the map, indicating the range of such *assemblages of Strata*, it may to some seem impracticable,

 to

to select many individual Shells from *the very same Bed*, in different Places, as I have recommended above: and if reliance could alone be had on Maps for identifying the Beds, this certainly would at present be a fatal objection to my proposal; but the case is otherwise, because in most instances, the number of organic Species is so considerable, in each of the assemblages of Strata to which Mr. Smith has given Names and Colours on his Map, and amongst these numbers of Species, there are mostly, so many which possess such strikingly distinct characters, as to place them beyond all manner of doubt: and *these characteristic Species*, being first sought for, in the Beds of every Quarry or Cliff which is examined for collecting Specimens for description, the *relative situation* above or below, and often both above and below the Beds, of some of these characteristic Species, may be ascertained, and used as the means of identifying the Bed of an ambiguous or doubtful Species: first through the whole circuit or length of the Quarry or Cliff under examination, next of the nearest adjacent Quarries or Cliffs, wherein the same characteristic and doubtful Species can be traced, and then progressively, to other more distant Quarries or Cliffs, until at length, the greatest range of observation is obtained, which our Island admits.

And besides which, important helps may often be obtained, from *the mineral characters* and qualities of the Beds containing doubtful Species, or from those characters in other Beds, which underlie or overlie them: but until such time as the present fashionable notions of the existence of *universal Formations* or strata composed throughout *of the same precise Mineral Species*, have subsided, I would, from my experience, beg to recommend considerable caution, in making these appeals to the Mineral characters of the Beds, in the consideration of their Organized Remains. Because I mean to maintain, that *the Mineral characters cannot safely be relied on*, without the concurrent support, of *tracing the same individual Bed or Mass*, as has been done in the gross by Mr. Smith in his Map of England, as has more perfectly been done in my large Manuscript Map of Derbyshire, and in others of smaller extent, and as may with ease and certainty be done, through the extent of most Quarries or Cliffs*; or by the concurrence of

* In the doing of which, it will often be perceived, that very great and complete mineral changes take place, in the same bed or mass, within a very small distance: sometimes these changes appear to be abrupt, and at others gradual: for instance, I have lately seen in this town, a moderate sized cabinet specimen, brought from the SSW. side of Shap in Westmoreland, one end of which is Basalt, and the other such highly crystalline and large grained Granite, as if shown detached, could not fail to be pronounced by any Geognost, as part of a *primitive* mass; and such, indeed, the mass whence this specimen was broken, has often been pronounced, yet without this opinion gaining universal assent. See your 50th volume, pp. 361, 362.

*the*

*the alternations* of Beds possessing very different Mineral Qualities (rather than by those qualities themselves); and above all, without the concurrence of such *characteristic organic Remains*, as great numbers of Beds contain, and a still greater number, have such in their vicinity, of which pracitcal Geologists and Naturalists may avail themselves.

I am not sanguine enough to expect to see in my time carried into effect, all which I have been speaking of and recommending, as to the examination and description of the species of Organic Remains, which at present but doubtfully characterize their Beds, owing to the number of other Beds in the English Series, in which *very nearly similar Remains are deposited*; so nearly similar, indeed, that no writer has yet attempted the investigation and mention of their specific differences, in several instances: yet as Mr. Smith has uniformly been heard to declare, that he always could, with regard to Specimens of Organic Remains which he had examined *in situ*, and brought together, perceive differences which directed him in arranging them afterwards on his Stratigraphical Shelves, independent of the name of the Place whence they were brought, which was marked on each; (he has spoken to this purpose in several parts of his works; and I am myself of the same opinion as Mr. Smith on this point) I have been anxious to present to your readers, and to those of Mr. Sowerby and Mr. Smith, as complete a List as I am able, of all the Shells which at the time of compiling it, had been referred to more than one Stratum in the English Series, in the writings of Mr. Sowerby and Mr. Smith, as is mentioned p. 550 (of the last volume).

I am aware that this List, in all probability, contains errors, which I have not had the means of detecting, regarding the localities of some of the Shells, and regarding the Strata from which others of them were obtained by Mr. Sowerby, through the medium of his Friends and Correspondents; Mr. Sowerby as well as myself, will be thankful, that all such errors may be pointed out to Mr. S., in order that they may be corrected in the future Numbers and Indexes of his work.

I beg, in conclusion, to take this opportunity of earnestly soliciting *the co-operation of the Collectors of Fossil Shells* throughout England, with my friend Mr. Sowerby, by the gift or the loan to him of any Shells, *of which they know the precise localities*, which appear to be of any of the Species enumerated in the List which follows: in order, that more extended comparisons may be made, and that distinct Names may be given, in the future numbers of Mineral Conchology, to all such Shells in this List, as shew real marks of distinction, however unusual or minute they may be, provided only, that they are unvaryingly found in the Individuals of the same Bed. I am, yours, &c.

Howland-street, Dec. 21, 1818. JOHN FAREY *Sen.*

*An alphabetical List of such* Fossil Shells *and Coralites, as under the same Name, have by Mr.* Sowerby *or Mr.* Smith, *been referred to more than one* Stratum, *as their stratigraphical Localities. By Mr.* John Farey *Sen. Mineral Surveyor.*

[Note. MC. means "Mineral Conchology," and t. 1 to t. 102 refer to its Plates in vol. I. and t. 103 to t. 203 refer to those in vol. II.: also SS means "Stratigraphical System;" SI means "Strata Identified," and the pages follow: the word "Plate" in parenthesis refers to the Plates of the latter Work; the Names of *Strata*, are those used in Mr. Smith's Map and Works, with an addition or two, which are explained in the Stratigraphical Indexes to Mr. Sowerby's two volumes of MC.]

Ammonites Calloviensis β, in Clunch Clay (Septaria in lower part), Tytherton Lucas (Crook's Farm, see SI p. 22) SS 59, sp. 4 var.

——— α, in Kelloway-stone (Plate, f. 3) near Chippenham, in canal, and Kelloway's Bridge, MC t. 104, SS 59, SI 24.

——— communis β, in London Clay (Plate, f. 11), at Happisburgh-cliff. SS 2.

——— α, in Alum Shale, or Clunch Clay, lower part, near Whitby, MC t. 107, f. 2 and 3, SS 55.

——— γ, in under Oolite, Sherborn, SS 101.

——— δ, in Marlstone, near Bath, Coal-canal, Dundry, and Tucking-mill, SS 115.

——— concavus α, in under Oolite, Dunkerton, Ilminster, and Sherborn, W & NW, MC t. 94, lo. SS 101.

——— β, in Marlstone, Coal-canal, SS 116.

——— elegans α, in under Oolite, Ilminster E, MC t. 94 u.

——— β, in Marlstone, Tucking-mill and Yeovil NE, SS 115 sp. 7.

——— ellipticus β, in Sand, &c. under the Oolites, Yeovil NE, SS 116.

——— α, in Blue Marl, or Lias upper Clay, Charmouth Cliff, MC t. 92, f. 4.

——— Herveyi α, in Cornbrash, Aswarby (not Spalden) MC t. 195 u.

——— β, in under Oolite, Bradford, and Knowles-Hill, MC t. 195, lo.

——— modiolaris α, in Fullers' Earth R, (Plate, f. 2), Dundry, and Rowley-Bottom, SS 88.

——— β, in under Oolite, Lansdown, SS 100.

Ammonites Nutfieldiensis $\alpha$, in Green Sand, Hythe, Nutfield and Stourhead, MC t. 108, SS 27.
—— —— $\beta$, in Portland Rock, Fonthill, and Swindon, SS 39.
—— planicosta $\beta$, in Green Sand, Evershot, and near Exmouth, MC t. 73.
—— —— $\alpha$, in Marston Marble or Marlstone, Craigmouth, Marston-magna, and Yeovil NE, MC t. 73.
—— —— $\gamma$, in under Oolite, Sherborn, E in Park Well, MC 73.
—— splendens $\alpha$, in Chalk Marl, Folkstone NE, MC t. 103.
—— —— $\beta$, in Coral Rag, Westbrook, MC t. 103.
—— striatus $\alpha$, in 4th Derbyshire-peak L, Buxton, Castleton, and Pools-Hole, MC t. 53, f. 1.
—— —— $\beta$, in Coarse Slate or Killas, Filliagh, MC t. 53.
—— tuberculatus $\alpha$, in lower Chalk (Plate, f. 4), Norton, SS 16.
—— —— $\beta$, in Green Sand, Chute-Farm, and Rundaway-Hill, SS 27.
—— Walcotii $\beta$, in Alum Shale, Whitby, MC t. 106, SS 56.
—— —— $\alpha$, in Marlstone (Plate, f. 6), near Bath, and Mitford, SW in Canal, MC t. 106, SS 117.
—— —— $\gamma$, in under Oolite, Mitford, and White Lackington Park, MC t. 106.
—— —— $\delta$, in Coal-measures, Colebrook-Dale, and Trent-River, upper part?, MC 106.
—— —— $\varepsilon$, in Derbyshire-peak L, Devonshire, and Llantrissent, MC t. 106.
—— ...... $\alpha$, in Clunch Clay, Holt, SS 56, sp. 2.
—— —— $\beta$, in Kelloway Stone, Christian-Malford, SS 59, sp. 3.
—— ...... $\alpha$, in Sand, &c. under the Oolites, Enstone, SS 111, sp. 1.
—— —— $\beta$, in Marlstone (Plate, f. 4), Churchill, Coal-canal, Tucking-mill, and Yeovil, SS 115, sp. 4.
—— ...... $\alpha$, in Sand, &c. under the Oolites, Liliput, and Tucking-mill, SS 111, sp. 3.
—— —— $\beta$, in Marlstone, Penard-Hill, and Stone-Farm near Yeovil, SS 116, sp. 8.
Astarte ovata $\alpha$, in Oak-tree Clay, (Plate, f. 8), in North-Wilts Canal, SS 44.
—— $\beta$, in Coral Rag, Bayford S, Kennington, Shippon, and Swindon Canal Well, SS 51.
—— $\gamma$, in Fullers' Earth R, Grip Wood, SS 89.

Astarte ovata $\delta$, in under Oolite (2d Plate, f. 4), Bath, Coal-canal, Fullbrook, Mitford Inn, Northampton NW, Petty-France SSW, Sherborn W. and Tucking-mill, SS 105.

Avicula costata $\alpha$, in Clunch Clay, Dudgrove-Farm, SS 57.
—— $\beta$, in Kelloway Stone, at Kelloway's Bridge, SS 6.
—— $\gamma$, in Cornbrash L, Stoney-Stratford, SS 67.
—— $\delta$, in Clay on Oolite (Plate, f. 8), Bradford (Wilts), Hinton, and Winsley, SS 81.
—— $\varepsilon$, in under Oolite, Petty-France SSW, and Tucking-mill, SS 107.
—— $\zeta$, in Ditto, Sherborn W, SS 107.
—— $\eta$, in Sand, &c. under the Oolites, Enstone, SS 112.
Cardita? deltoidea $\beta$, in Kelloway Stone, Kelloway's Bridge, MC t. 197, f. 4.
—— $\alpha$, in Cornbrash L, Lechlade N, and Peterborough, MC t. 197, f. 4.
—— lirata $\beta$, in Cornbrash L, near Peterborough, Sleaford, Wick-Farm, and Woodford, MC t. 197, f. 3, SS 65 (*c*).
—— $\alpha$, in blue Lias, near Bath W, MC t. 197, f. 3.
—— obtusa $\beta$, in Cornbrash L, (Plate, f. 6), Elm-cross, and Road, MC t. 197, f. 2, SS 65.
—— $\alpha$, in under Oolite, Bath, Chipping Norton, Churchill, Dundry, Northampton NW, Sherborn W, and Writhlington, MC t. 197, f. 2, SS 104.

—— producta $\beta$, in Cornbrash L, Peterborough, MC t. 197, f. 1.
—— $\gamma$, in Fullers' Earth R (Plate, f. 5), Charlton-Horethorn, near Gagenwell, and near Redlynch, SS 90.
—— $\alpha$, in under Oolite, Bath, near Bayeux, and Chapel-House, MC t. 197, f. 1.
Cerithium cornucopiæ $\alpha$, in London Clay upper part, Stubbington beach, MC t. 138, f. 1.
—— $\beta$, in Limestone, with quartz grains, St. Colomby in the Cotentin, MC t. 188, f. 3 & 4.
—— melanioides $\alpha$, in London Clay, lower part (2d Plate, f. 7), Brackelsham-Bay, Charlton, New-cross, New-haven Castle-hill, Southfleet, and Woolwich, MC t. 147, f. 6 and 7, SS 1.
—— —— $\beta$, Chalk Marl, Hamsey, MC t. 147.
Chama digitata $\alpha$, in Green Sand, Long-comb Girts, MC t. 174.

Chama digitata $\beta$, in Kelloway-Stone ?, Huntcliffe, MC t. 174. [SS 45, sp. 1.
——— ...... $\alpha$, in Oak-tree Clay (Plate, f. 5), Bagley-wood Pit, North-Wilts Canal, and Swindon Canal Well,
——— $\beta$, in Coral Rag, Banner's-Ash, Bayford S, Derry-hill ?, Kennington, Longleat-Park ?, Sandford Church-yard, Stilton-Farm, Sunning-well, and Westbrook, SS 52.

Cidaris diadema (*Lin.*) $\alpha$, in Green Sand (2d Plate, f. 11), Chute-Farm, and near Warminster, SS 33.
——— $\beta$, in Coral Rag, Calne, and Hilmarton, SS 53.
——— ...... $\alpha$, in Chalk, Northfleet, SS 19, sp. 1.
——— $\beta$, in Green Sand, Chute-Farm, SS 33, sp. 1.
——— ...... $\alpha$, in Green Sand, near Warminster, SS 33, sp. 2; Strat. Tab. Ech.
——— $\beta$, in Clay on Oolite, Broadfield-Farm, SS 83, sp. 1: Strat. Tab. Ech.
——— $\gamma$, in under Oolite, Tucking-mill, SS 109, sp. 1; Strat. Syst. Ech.
——— ...... $\alpha$, in Coral Rag (Plate, f. 5), Hilmarton, and Swindon Canal Well, SS 53, sp. 3.
——— $\beta$, in under Oolite, Tucking-mill, SS 109, sp. 3.
——— ...... $\alpha$, in Coral Rag, ; Strat. Tab. Ech.
——— $\beta$, in Cornbrash L, Melbury, Norton, and Sheldon, SS 69.
——— $\gamma$, in Clay on Oolite, Farley, and Pickwick, SS 83, sp. 2.

Clavicula cucumerina $\alpha$, in Chalk, Surrey, SS 23.
——— $\beta$, in Coral Rag, SS 54.

Clypeus sinuatus (*Lesk*) $\alpha$, in Coral Rag, SS 54 and 123.
——— $\beta$, in under Oolite (2d Plate, f. 8), Chipping-Norton, Churchill, Fullbrook, Monkton-Combe, near Naunton, Northampton NW, Stow on the Wold, and Stunsfield, SS 109.
——— ...... $\alpha$, in Coral Rag (Plate, f. 6), Hinton-Waldrish, Longleat-Park, and Meggots-Mill, SS 54; Strat. Tab. Ech.
——— $\beta$, in Cornbrash L, Bruham, Sleaford, Trowle, Tellisford SW, Wick-Farm, Wincanton SW, and Wraxhall, SS 69; Strat. Tab. Ech.
——— $\gamma$, in Clay on Oolite, Broadfield-Farm, SS 83; Strat. Tab. Ech.

Clypeus

Clypeus ...... δ, in upper Oolite, Hinton, and Hogwood-Corner, SS 86; Strat. Tab. Ech.
——— ε, in under Oolite, Churchill, SS 110, sp. 2; Strat. Tab. Ech.
Conulus ...... α, in Cornbrash L, Wincanton SW, and Wolverton, SS 70; Strat. Tab. Ech.
——— β, in Fullers' Earth R, Bradford in Canal, SS 94: Strat. Tab. Ech.
——— γ, in under Oolite, Tucking-mill, SS 110; Strat. Tab. Ech.
Ellipsolites funatus β, in Chalk Marl, St. Catharine's Mount, and Steyning, MC t. 32.
——— α, in Derbyshire-peak L, Black Rock SE of Cork, MC t. 32.
Euomphalus catillus β, in Limestone Shale (Derb. Rep. I. 227), Buxton N, MC t. 45, f. 3 and 4.
——— α, in 1st Derbyshire-peak L, Scalebar, Tideswell NE, and Winster, MC t. 45, f. 3 and 4.
*Gryphæa dilatata ε, in Alluvial Limestone, Pakefield, MC t. 149, f. 1.
——— α, in London Clay, lower part, Bennington, Coney-Weston, and Suffolk, MC t. 149, f. 1.
——— β, in Portland Rock, Adlington-Hills?, Bromham (Wilts), Portland Isle, Radipole, and Rude-cliff, MC t. 149, f. 1 and 2.
——— γ, in Clunch Clay (Plate, f. 2 and 3), Bourn, Calne W, Derry-hill, Dudgrove-Farm, Ilminster S, Meggot's-Mill, Sandfoot-Castle, Tytherton-Lucas, Weymouth NNE, and Woburn N, MC t. 149, f. 1, SS 36.
——— δ, in Kelloway Stone (not in the Plate), Bruham-pit, Kelloway's Bridge, Lady-down, Wilts and [Berks Canal, MC t. 149, f. SS 61.
——— ζ, in under Oolite, Carrington, and Farley-Gate, MC t. 149, f. 1.
——— η, in Derbyshire-peak L?, Bramberry-Hill, in Sutherland, MC t. 149, f. 1.
——— incurva β, in Crag Marl, Birdbrook, MC t. 112, f. 2.
——— γ, in Kelloway-Stone (Plate, f. 5), Bruham-pit, Chatley, near Chippenham in Canal, Kelloway's Bridge, and Lady-down, MC t. 112, f. 2?, SI 24.
——— α, in blue Lias, Bath W, Framilode, and Frethern, MC t. 112, f. 1.

* Many localities of Gryphæa, are mentioned in Min. Con. II. p. 22.

Gryphæa ...... $\alpha$, in Marlstone, Newark NE, SS 117.
—— $\beta$, in blue Lias, ; SS 117, sp. 1.
Helix ...... $\alpha$, in Coral Rag, Longleat-Park, SS 49.
—— $\beta$, in Marlstone, Wooton-under-edge, SS 113.
Lima gibbosa $\beta$, in Cornbrash L, Wincanton N, SS 62.
—— $\alpha$, in under Oolite, near Bath, Churchill, Cotswould-Hills, and Taunton, MC t. 152, SS 106.
Mactra gibbosa $\alpha$, in Fullers' Earth R, near Bath, and Mitford, MC t. 42, SS 91.
—— $\beta$, in under Oolite, Mitford, and Tucking-mill, SS 105.
—— ...... $\alpha$, in Fuller's Earth R, Cotswould-Hills, SS 91, sp. 2.
—— $\beta$, in under Oolite, Churchill, and Crewkerne, SS 104, sp. 1.
Madrepora flexuosa $\alpha$, in Coral Rag, Heddington-Common, and Wooton Basset, SS 48.
—— $\beta$, in upper Oolite, Castle-Combe, SS 84.
—— $\gamma$, in Marlstone, Tucking-mill, SS 113.
—— porpites (*Lin.*) $\alpha$, in Clay on Oolite, Broadfield-Farm, SS 77.
—— $\beta$, in under Oolite, Bath, and Churchill, SS 95.
—— $\gamma$, in Marlstone, Tucking-mill, SS 113.
Melania Heddingtonensis $\beta$, in Oak-tree Clay (Plate, f. 1), North-Wilts Canal, SS 41.
—— $\alpha$, in Coral Rag, Bayford S, Heddington (Wilts), Heddington-Common, Shotover, Silton-Farm, Steeple-Ashton, and Swindon Canal Well, MC t. 39, SS 48.
—— striata , in Coral Rag (Plate, f. 3) Banner's-Ash, Bayford S, Calne, Goat-Acre, Silton-Farm, Steeple-Ashton, and Swindon Canal Well, MC t. 47, lo. SS 48.
—— $\gamma$, in under Oolite, Caisson, SS 96.
—— $\beta$, in blue Lias, Limington (Somers.) MC t. 47. u.
Modiola bipartita $\alpha$, in Brick-earth, Osmington, and Parham-Park, MC t. 210, f. 3 and 4.
—— $\beta$, in Derbyshire-peak L, Llantrissent, MC t. 210.

Modiola depressa $\alpha$, in London Clay, upper part, Bognor, and Highgate, MC t. 8, u; SS 2.
——— $\beta$, in Alum Shale?, near Whitby, MC t. 8 m.
——— ...... $\alpha$, in Cornbrash L. (Plate, f. 3) Closworth, Holt, and Wick-Farm, SS 64.
——— $\beta$, in Clay on Oolite, Westwood, SS 79, sp. 3.
——— $\gamma$, in under Oolite, Churchill, and Northampton NW, SS 103, sp. 4.
Murex latus $\beta$, in Crag Marl, Bramerton, Thorpe-Common, and Trimingsby, SS 6.
——— $\alpha$, in London Clay, lower part, Plumstead, MC 35, le. lo.
——— rugosus $\alpha$ & $\beta$, in Crag Marl, Fox-hole, Harwich (Essex-cliff), Holywell, near Malden, and Walton-Nase, MC t. 34, u. and 199, f. 1: SS 7.

——— $\gamma$, in London Clay, lower part, Plumstead, MC 199, f. 2.
Mya ...... $\alpha$, in Fullers' Earth R, Dundry and Sherborn, SS 92, sp. 1.
——— $\beta$, in under Oolite, Dundry, SS 105.
——— $\gamma$, in Sand, &c. under the Oolites, Enstone, SS 112.
Natica glaucinoides $\alpha$, in London Clay, upper part, Highgate, MC t. 5, u.
——— $\beta$, in Crag Marl, Trimingsby, SS 9.
Nautilus intermedius $\beta$, in Crag Marl (perhaps alluvial), Birdbrook and Culford-Hall, MC 125.
——— $\alpha$, blue Lias, Keynsham, MC t. 125.
——— lineatus $\alpha$, in under Oolite, Bath W, and Comb Down, MC t. 41.
——— $\beta$, in Marlstone, Tucking-mill, SS 114.
Ostræa acuminata $\beta$, in Brick-earth, on Woburn Sand?, Withyam, MC t. 135.
——— $\alpha$, in Clay on Oolite, near Bath E, and Bradford, MC t. 135, f. 2, SS 81.
——— $\gamma$, in Fullers' Earth R, Aynhoe, MC t. 135, f. 3.
——— $\delta$, in under Oolite, Churchill, SS 106.
——— crista-galli $\alpha$, in Green Sand, Black Down, Chute-Farm, and Stour-head, SS 29.
——— $\beta$, in Oak-tree Clay, Bagley-wood Pit, and North-Wilts Canal, SS 46.

Ostræa crista-galli $\gamma$, in Coral Rag (Plate 4), Bayford S, Derry-Hill, Longleat-Park, Shotover-Hill, Westbrook, Wilts, [and Wooton-Basset, SS 52.
——— $\delta$, in Forest Marble, Stunsfield, SS 73.
——— $\epsilon$, in Clay on Oolite, Combhay, Farley, and Hinton, SS 81.
——— $\zeta$, in upper Oolite, Petty-France, SS 85.
——— deltoidea $\beta$, in London Clay, lower part, Lopham, and near Paris, MC t. 148.
——— , in Oak-tree Clay (Plate, f. 6) Bagley-wood Pit, Cambridge N, Even-Swindon, Headington-Common (Shotover), North-Wilts Canal, Seend in Canal, Shrivenham in Canal, Swindon Canal Well, and Wooton-Basset, MC t. 148, SS 45.

——— $\gamma$, in Clunch Clay, Sandfoot-Castle, MC t. 148.
——— gregarea $\alpha$, in Green Sand, near Devizes, MC t. 111, f. 1.
——— $\beta$, in Coral Rag, Westbrook, MC t. 111, f. 3.
——— Marshii $\alpha$, in Cornbrash L, Felmersham, Sleaford, and Woodford, MC t. 48, SS 66.
——— $\beta$, in Fullers' Earth R, (Plate, f. 8), Cotswould-Hills, and Monkton-Combe, SS 92.
——— rugosa $\alpha$, in Fullers' Earth R, Frome W, and Monkton-Combe, SS 92.
——— $\beta$, in under Oolite, Sherborn W, and Tucking-mill, SS 106.
Patella latissima $\beta$, in alluvial Limestone, Pakefield Gravel-pit, MC t. 139, f. 5.
——— $\alpha$, in Clunch Clay, Bolingbroke, MC t. 139, f. 1.
Pecten arcuata $\alpha$, in Green Sand, Devizes N in Canal, t. 205, f. 7.
—— $\beta$, in Coral Rag?, Devizes W, t. 205, f. 5.
fibrosus $\delta$, in Coral Rag, Heddington-Common, Kennington, and Longleat-Park, SS 52.
——— $\gamma$, in Kelloway Stone, Kelloway's Bridge, MC t. 13, f. 2.
——— $\alpha$, in Cornbrash L, Chatley, Melbury, Sheldon, Wincanton N and SW, and Woodford, MC t. 136. [f. 2, SS 68.
——— $\epsilon$, in Forest-Marble, Stunsfield, SS 74.
——— $\zeta$, in Clay on Oolite, Farley, SS 81.
——— $\beta$, in upper Oolite, Northleach, MC t. 136, f. 2.

Pecten

Pecten fibrosus $\eta$, in under Oolite, Carrington, and Churchill, MC t. 136, f. 2, SS 107.
quinquecostata $\beta$, in upper Chalk, Emsworth N (perhaps Alluvial ?), and Lewes E, MC t. 56, f. 4 and 5.
———— $\alpha$, in Green Sand, Black Down, Chute-Farm, and Devizes, MC t. 56, f. 3 ? and 6 to 8, SS 30.
———— .......... $\alpha$, in Forest Marble (Plate, f. 5), Foss-Cross and Siddington, SS 73, sp. 1.
———— $\beta$, in upper Oolite, Cotswould-Hills, SS 85, sp. 2.
Perna aviculoides $\alpha$, in Brick-earth, or blue Marl on Portland Rock, Filley-Bridge, Godstone, Osmington, Shotover-Hill, and White-nab, MC t. 66, SS 37.
———— $\beta$, in Alum Shale, near Bedford SE, MC t. 66.
Plagiostoma gigantea $\beta$, in Coral Rag, Banners-Ash, Calne W, Swindon Canal Well, and Westbrock, SS 51.
———— $\gamma$, in under Oolite, Tucking-mill, SS 105.
———— $\alpha$, in blue Lias, (and White ?) near Bath, Cardiff-Castle, and Pickeridge-Hill MC t. 77.
———— spinosa $\alpha$, in upper Chalk Brighton, Northfleet, and Rickmansworth, MC t. 78, f. 1 and 2.
———— $\beta$, in lower Chalk, Guildford, Heytsbury, Lewes N, near Norton-Bavant NE, and near Warminster, MC t. 78, f. 3. SS 16.
———— $\gamma$, in Green Sand, Sidmouth, MC t. 78.
———— ...... $\alpha$, in Clay on Oolite, Farley, SS 80, sp. 2.
———— $\beta$, in upper Oolite, Bradford ? SS 85.
Planorbis euomphalus $\alpha$, in Cowes Rock, Cowes, MC t. 140, f. 7.
———— $\gamma$, in Green Sand, Haldon-Hills, MC t. 140, f. 8.
———— $\beta$, in under Oolite ? near Bath, MC t. 140, f. 8 and 9.
Pleurotoma rostrata $\alpha$, in London Clay, upper part, Barton, MC t. 146, f. 3.
———— $\beta$, in Green Sand, Devizes in Canal, MC t. 146, f. 3.
Productus aculeatus $\alpha$, in 1st Derbyshire-peak L., Bakewell, MC t. 68, f. 4.
———— $\beta$, in 3d Ditto ...., Bakewell, and Buxton, MC t. 68, f. 4.
Rostellaria ........ $\alpha$, in Kelloway Stone (Plate, f. 1), near Chippenham, in Canal, and Kelloway's Bridge, SS 58, SI 24.
———— $\beta$, in Cornbrash L., Melbury, SS 62.

Scaphites obliquus $\beta$, in upper Chalk, Brighton, and E of Warminster, MC t. 18, f. 4 to 7.
——— $\alpha$, in Chalk Marl, Hamsey, MC t. 18, f. 4 to 7.
Serpula crassa $\alpha$, in Landon Clay, upper part, Barton, Highgate, MC t. 30.
—— $\beta$, in Crag Marl, Aldborough, SS 9.
—— $\gamma$, in Fullers' Earth R., Charlton-Horethorn, SS 67.
Serpula ...... $\alpha$, in Oak-tree Clay, Bagley-wood Pit, Brinksworth-Common, Hinton Waldrish, North-Wilts Canal, [and Portland Isle, SS 41, sp. 2.
——— $\beta$, in Clunch Clay, Steeple-Ashton, SS 55.
Spatangus subglobosus? (*Lesk*) $\alpha$, in Chalk, Chittern, and Upton, SS 20, sp. 5; Strat. Tab. Ech.
——— $\beta$, in Green Sand, (2d Plate, f. 14), Chute-Farm, Rundaway, and near Warminster, SI 12, SS 34, sp. 3: Strat. Tab. Ech.
——— ........ $\alpha$, in Chalk, Bubdown, Chesterford, Chittern, Great-Ridge, Guildford, Lexham, near May-Place, Norwich, Pewsey, Smitham-Bottom, Surrey, and Wilts, SS 20, sp. 3; Strat. Tab. [Ech.
——— $\beta$, in Green Sand, Charmouth, and Melbury, SS 34, sp. 1: Strat. Tab. Ech.
Terebratula biplicata $\alpha$ and $\beta$, in Green Sand, Cambridge Castle-Hill, Chute-Farm, Hunstanton-Cliff, Longleat, Rundaway-Hill, and near Warminster, MC t. 90.
——— $\gamma$, in Derbyshire-peak L., Limerick Black Rock? MC t. 90.
——— carnea $\alpha$, in upper Chalk, Devizes, Mundesley, Norwich, Trowse, and NE of Warminster, MC t. 15, f. 5 [and 6, and II. 77, SS 17.
—— $\beta$, in upper Oolite, Cotswould-Hills, MC t. 15, f. 5 and 6.
——— crumena $\beta$, in blue Lias, Pickeridge-Hill, MC t. 83, f. 3.
——— $\gamma$, in 1st Coal Shale? Tees River, upper part?, MC t. 83, f. 2 and 2*.
——— $\alpha$, in 1st Derbyshire peak L, Winster, MC t. 83, f. 3.
——— digona $\alpha$, in Cornbrash L (Plate, f. 9), Chatley, Closworth, Felmersham, Latton, Redlinch, Sheldon, Trowlewick-Farm, and Woodford, MC t. 96, f. 4 and 5, SS 68.
——— $\beta$, in Clay on Oolite, (Plate, f. 9), Bradford (Wilts) Farley, Pickwick, Stoford, and Winsley, MC t. 96, f. 1 to 3, SS 82.

Terebratula digona $\gamma$, in upper Oolite, near Bath, Petty-France, and Tog-hill, MC t. 96, SS 86, sp. 1.
——— intermedia $\beta$, in Green Sand, Chute-Farm, Longleat, and Warminster, MC t. 15, f. 8, and p. 202.
——— $\alpha$, in Cornbrash L., Bruham-Pit, Chatley, Felmersham, Holt, Lullington, Maisey-Hampton, Melbury, Road, and Trowle, MC t. 15, f. 8, and p. 202, SS 68.
——— $\gamma$, in Fullers' Earth R, near Bath, SS 93.
——— $\delta$, in under Oolite, Batheaston, Chipping-Norton, Churchill, Fullbrook, near Lansdown, Sherborn W, and Tucking-mill, SS 108.

——— lateralis $\beta$, in Fullers' Earth R, Aynhoe, MC t. 83, f. 1.
——— $\alpha$, in Derbyshire-peak L, near Dublin, and SE of Cork (Black Rock), MC t. 83, f. 1.
——— obsoleta $\beta$, in Crag Marl, Gunton, MC t. 83, f. 7.
——— $\gamma$, in Green Sand, near Warminster, SS 32. [SS 57.
——— $\alpha$, in Clunch Clay, lower part, Dudgrove-Farm, Felmersham, and Wiltshire, MC t. 83, f. 7,
——— $\delta$, in Cornbrash L, Closworth, Draycot, Wick-Farm, and Wincanton, SW and N, SS 69.
——— $\varepsilon$, in Clay on Oolite, Farley, Pickwick, Westwood, and Winsley, SS 82.
——— $\zeta$, in upper Oolite, Petty-France, SS 86.
——— $\eta$, in under Oolite, Chipping-Norton, Churchill, Fullbrook, and Tucking-mill, SS 108.
——— $\lambda$, in Marl Stone, Churchill, and Wooton-under-edge, SS 118.
——— ornithocephala $\alpha$, in Kelloway Stone, (Plate, f. 6), Chatley, near Chippenham in Canal, Dauntsey-House, Kelloways-Bridge, and Thames and Severn Canal, MC t. 101, f. 1 and 2, SS 61,
——— $\gamma$, in Fullers' Earth R, near Bath, and Bratton, near Toll-bar, SS 93. [SI 24.
——— $\delta$, in under Oolite, Sherborn, and Tucking-mill, SS 108.
——— $\varepsilon$, in Sand, &c. under the Oolites, Enstone, SS 112.
——— $\beta$, in blue Lias Marl, Pickeridge-Hill, MC t. 101, f. 4.
——— subrotunda $\alpha$, in lower Chalk, Horningsham SE, and Suffolk NW part, MC t. 15, f. 1.
——— $\gamma$, in Cornbrash L, Chatley, MC t. 15, f. 1 and 2.

Terebratula subrotunda $\beta$, in blue Lias, Hornton-Quarry, MC t. 15 f. 2. [MC t. 15, f. 7, SS 18.
——— subundata $\alpha$, in upper Chalk (Plate, f. 9), Giles's Gate (Norwich), near Norwich, and Warminster NE,
——— $\beta$, in lower Chalk (Plate, f. 6 and 8), Guildford, Heytsbury, Mazen-Hill, and near Warminster, [SS 17.
Trigonia clavellata $\gamma$, in Crag Marl (Sandstone), Gunton, MC t. 87 u.
——— $\alpha$, in Portland Rock, Boulogne, Portland Isle, and Radipole, MC t. 87 u.
——— $\epsilon$, in Sand Stone, under Ditto (not Green Sand) near Danby-Beacon, SS 28.
——— $\beta$, in Oak-tree Clay, in North-Wilts Canal, and in Oxfordshire, MC t. 87, u. SS 43.
——— $\zeta$, in Cornbrash L, Melbury, and Woodford, SS 65.
——— $\eta$, in Fullers' Earth R, Orchardleigh, SS 89.
——— $\delta$, in under Oolite, Little-Sodbury, MC t. 87, lo.
——— costata $\beta$, in Oak-tree Clay (or blue Clay of Thame) North-Wilts Canal, and Oxfordshire (NE of Ox- [ford ?), MC t. 85, SS 43.
——— $\gamma$, in Coral Rag, Bayford S, and Silton-Farm, SS 51.
——— $\delta$, in Cornbrash L. (Plate, f. 4), Wick-Farm, and Wincanton N, SS 65.
——— , in Forest Marble, Wincanton, SS 72.
——— $\zeta$, in Clay on Oolite, Hinton, SS 79.
——— $\alpha$, in under Oolite (2d Plate, f. 2 and 3), Coal-Canal, Cotswould-Hills, Cross-Hands, Little-Sodbury, Mitford, Petty-France SSW, Tucking-mill, MC t. 85, SS 103.
——— crvirostra , in Ook-tree Clay, in North-Wilts Canal, SS 44, sp. 3.
——— $\beta$, in Coral Rag, Longleat-Park, SS 51.
Trochus ........ $\alpha$, in Oak-tree Clay (Plate, f. 3), in North-Wilts Canal, SS 41.
——— $\beta$ in Coral Rag, Bayford S, and Sandford Church-yard, SS 48, sp. 2.
Anglicus $\alpha$ and $\beta$, omitted in the other Indexes, see MC II. 95.
Turbo ........ $\alpha$, in Oak-tree Clay (Plate, f. 2), North-Wilts Canal, SS 41.
——— $\beta$, in Coral Rag (Plate, f. 1), Bagley-wood Pit, Banner's-Ash, Derry-Hill, Longleat-Park, Steeple-Ashton, and Wooton-Basset, SS 49.

Turrilites costata $\alpha$, in Chalk Marl, Hamsey, St. Catherine's Mount, Earl-Stoke, and near Rouen, MC t. 36.
—— $\beta$, in Green Sand, Chute-Farm, and Horningsham, MC t. 36, SS 27.
Turritella conoidea $\alpha$, in London Clay, upper part, Barton-Cliff, Brackelsham-Bay, Highgate, and Stubbington, [MC t. 51, f. 1 and 4; and II. 239.
—— $\beta$, in Crag Marl, Holywell, MC t. 51, f. 1 and 4.
Unio acutus $\beta$, in Cornbrash L, Melbury, SS 64.
—— $\alpha$, in 9th Coal Shale, near Bradford S (Yorks.), and in Derbyshire, MC t. 33, f. 5 to 7.
—— Listeri $\gamma$, in Crag Marl, Roydon-Green, and in Suffolk, MC t. 154, f. 1.
—— $\alpha$, in Portland Rock, New-Malton, and Seamer, MC t. 154, f. 3 and 4.
—— $\beta$, in blue beds of the yellow Limestone R ?, Durham, MC t. 154, f. 3 and 4.
—— .... $\alpha$, in Fullers' Earth R, Grip-wood ?, SS 89, sp. 3.
—— $\beta$, in under Oolite, Northampton NW, SS 103, sp. 3.
Venus equalis $\alpha$, in Crag Marl, Elmsett, Foxhole, Holywell, Minsmere Iron-sluice, Newborn, Sydenham NW ?, [and Woodbridge, MC t. 21, SS 10.
—— $\beta$, in Green Sand, Black-Down, and Little Teignmouth NW, MC t. 21.
—— ..... $\alpha$, in Cornbrash L, (Plate, f. 5), Sheldon, Trowle, and Wincanton SW, SS 66, sp. 1.
—— $\beta$, in Fullers' Earth R, near Gagenwell, SS 91, sp. 1.
Vivipara fluviorum $\beta$, in London Clay, lower part (Plate, f. 1), Brixton-Causeway Well, Hordle-Cliff, and Wapping Docks, MC t. 31, f. 1, SS 2, SI 3.
—— $\alpha$, in Oak-tree Clay (Sussex Marble), Bethersden, and Farnham SE, MC t. 31 f. 1.

XX. *Ex-*

## XX. *Extract of a Letter from* William Bruce, *Esq. Resident at Bushire, to* William Erskine, *Esq. of Bombay, dated Bushire, 26th March* 1813, *communicating the Discovery of a Disease in Persia, contracted by such as milk the Cattle and Sheep, which is a Preventive of the Small-Pox**.

My dear Sir,—When I was in Bombay I mentioned to you that the cow-pox was well known in Persia by the Eliaats, or wandering tribes. Since my return here I have made very particular inquiries on this subject, amongst several different tribes who visit this place in the winter to sell the produce of their flocks, such as carpets, rugs, butter, cheese, &c. Their flocks during this time are spread over the low country to graze. Every Eliaat that I have spoken to on this head, of at least six or seven different tribes, has uniformly told me that the people who are employed to milk the cattle caught a disease, which after once having had, they were perfectly safe from the small-pox: That this disease was prevalent among the cows, and showed itself particularly on the teats; but that it was more prevalent among and more frequently caught from the sheep. Now this is a circumstance that has never, I believe, before been known; and of the truth of it I have not the smallest doubt, as the persons of whom I inquired, could have no interest in telling me a falsehood; and it is not likely that every one whom I spoke to should agree in deceiving, for I have asked at least some forty or fifty persons. To be more sure on the subject, I made most particular inquiries of a very respectable farmer who lives about fourteen miles from this, by name Malilla (whom Mr. Babington knows very well), and who is under some obligations to me: this man confirmed every thing that the Eliaats had told me, and further said that the disease was very common all over the country, and that his own sheep often had it. There may be one reason for the Eliaats saying that they caught the infection oftener from the sheep than the cow, which is, that most of the butter, ghee, cheese, &c. is made from sheep's milk, and that the black cattle yield very little, being more used for draught than any thing else.

---

## XXI. *On the Atomic Philosophy. By Mr.* Joseph Luckcock.

All matter has been supposed on this hypothesis to be composed of mathematical points, without length, breadth or thickness; and that different arrangements of the same identical

* From the Transactions of the Literary Society of Bombay, vol. i. Though this letter is dated in 1813, the volume in which it appears is only a recent publication.

points, being but one in species, constitute all the various forms of matter in the universe; and, that the same specific matter should compose a guinea or a lock of hair. A mysterious power was supposed to reside in these atoms, or essence of matter, called *repulsion*; in this state of the hypothesis, a question arose,—In an aggregate of these points, what was it that filled up the interstices? It was plain it could not be matter; for although the essence was solid, that could not be the case with an aggregate of these points; the interstices must be occupied with *nothing*. Therefore it was necessary, in order to complete the hypothesis, that this *nothing* should be personified, and from hence arose the invention of a vacuum. I shall pass over the learned disputes whether this *nothing* was created, or whether it possessed the attributes of the Deity, *infinite and eternal*, or merely a local appendage to aggregates of matter, and simply remark, that the parts of this hypothesis are so interwoven, that if any one of them should be removed, the whole must crumble away.

Unfortunately for this system, it admits of no proof; and what is singularly remarkable, its advocates have been principally mathematicians. It has even been called the mechanical philosophy; and yet it is incapable of demonstration. A mathematical point may be imagined; as also the division of a line into an infinite number of parts, but practically we all know these to be among the impossible things. The doctrine of repulsion was necessary to the support of the doctrine of matter consisting of mathematical points, and the moderns have personified it, and say that *caloric* is the great repulsive power. It is easy to conceive a pestle to be a repulsive power, in the operation of pounding a substance in a mortar; but not so easy to suppose a glass of water to have the repulsive power of grinding a lump of sugar into mathematical points, which should remain suspended in it. It appears to me something like arguing in a circle: Matter must consist of atoms, because there is a repulsive power; and a repulsive power must exist, because matter consists of mathematical points. The ancients considered repulsion to be a quality; the moderns, a substance; caloric they conceive to be balls of various dimensions, and tangible matter (as opposed to mathematical points) to consist of these points insinuated into and occupying the centre of the caloric balls, not unlike the apple in a dumpling. And here I cannot help feeling some regret at being compelled to erase from my dictionary, a word of great pith and meaning, *homogeneous;* for surely it never can be said that there is any homogeneity in matter thus compounded.

The personification of *nothing*, or a vacuum, is as necessary to the moderns as to the ancients. To the ancients, it was necessary to fill up the interstices of their mathematical points, and

to

to the moderns it is necessary to fill up the interstices of their caloric balls; and yet a great advocate of this doctrine, in order to clear up a perplexing difficulty, runs into the absurdity, merely to suit the circumstances of the case, of supposing there must have been interstitial caloric, than which a greater inconsistency was never heard of: interstitial heat and interstitial vacuums are incompatible with each other. Both ancients and moderns have asserted the existence of a vacuum with as much confidence as they would assert the existence of water: but it can only be considered as hypothetical; for there never has a fact been brought forward in favour of the actual existence of a vacuum, that can be considered as conclusive. Mr. Dalton supposes the atoms of all gaseous substances, whatever may be the form of the ultimate particle or nucleus, to be perfectly globular, and will be arranged in horizontal strata like a pile of shot. It is easy to demonstrate this to be an error both in number and in form. Mr. Dalton's atom of water is globular, and his atom of steam or aqueous vapour is also globular. It is well known that when water is converted into steam it is increased in bulk 1986 times; or, in Mr. Dalton's language, the atom of water is surrounded by 1985 atoms of caloric. I will exhibit a section of Mr. Dalton's atom of a gaseous vapour; the central ball is water, all the rest are caloric. (See Plate I. fig. A.)

Section of Mr. Dalton's atom of steam or aqueous vapour. The coats or layers of caloric, or the matter of heat, are 6 12 18 24, &c.

The second strata .. .. 3 9 15 21, &c.

And I have shown in my Essays*, fig. 4, Plate I. that the first coat or covering will be 12; from which I have composed the following Table:

| Coats or Coverings. | Number in each. | 1st Difference. | 2d Difference. | Sum of the Coats. | Equal to 12 multiplied by | 1st Difference. | 2d Difference. | 3d Difference. |
|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 36 | | 12 | 1 | 4 | | |
| 2 | 48 | 60 | 24 | 60 | 5 | 9 | 5 | 2 |
| 3 | 108 | 84 | 24 | 168 | 14 | 16 | 7 | 2 |
| 4 | 192 | 108 | 24 | 360 | 30 | 25 | 9 | 2 |
| 5 | 300 | 132 | 24 | 660 | 55 | 36 | 11 | 2 |
| 6 | 432 | 156 | 24 | 1092 | 91 | 49 | 13 | 2 |
| 7 | 588 | 180 | 24 | 1680 | 140 | 64 | 15 | |
| 8 | 768 | 204 | 24 | 2448 | 204 | | | |
| 9 | 972 | | &c. | | | | | |

* Of which see notice in last Number of Phil. Mag.



The

The first column expresses the number of coats; the second column, the number of atoms of the matter of heat in each coat; the fifth column expresses their sum; viz. of the first coat, of the first and second; of the first, second and third, &c. The other columns show how the table may be extended to any definite length.

I will leave Mr. Dalton to take the seventh 1680, or the eighth 2448, which he pleases; one is 305 too little, the other 463 too much. He may be surprised that he cannot find the number 1985 in the table: this number is a multiple of 5, the numbers in the atomical table are multiples of 12: this hypothesis ought to lead to the conclusion that water would unite to the matter of heat in every proportion found in the fifth column of the table, 1 to 12, 1 to 60, to 168, to every number in the table, even to infinity: but this inquiry naturally leads to one of two results; either the atomical philosophers do not follow nature, or nature does not follow the ingenious conceits of the atomical philosophers. I will not attempt to run through all the vagaries of the system, but will only state that atoms are described as solid, hard, and impenetrable; that water consists of the matter of oxygen, of the matter of hydrogen, and of the matter of heat. It is in vain to say that the matter of heat is only an atmosphere to the other two: if one species of matter consists of atoms, so must all; and how can it be possible for one atom to get into the inside of another? If Nature had employed the mechanical philosophers as her journeymen, all gaseous atoms, instead of being globular, would be double hexagonal pyramids. Nature's laws are too simple for the inventive genius of a mechanical philosopher: the chemical combinations in definite proportions, as explained by Sir H. Davy, are clear, intelligible and satisfactory; while the day dreams of the atomic philosophers are clouds that sully the philosophic horizon, which will soon be dispersed and seen no more.

The views which I have developed in my Essay on this subject are very extensive, and will unfold the arcana of nature in a way that I believe has never yet been considered. I have divided all matter which fills all space, into ponderable and imponderable: imponderable matter is the only ethereal substance; it is the same with caloric, matter of heat, specific heat; fire, or light and heat, the electric fluid, the element of fluidity, and which I have called *fluidium*. Instead of being the great repulsive power, it is the operating cause of all chemical attractions, all chemical action: it unites and is united with all ponderable matter, of which it is the life and soul; for without the aid of fluidium, all ponderable matter would be inert and dead. The way in which the sun acts in in the system, is not by emitting or radiating its own substance (a rude unphilosophic idea), but a change it produces in the electrical relations of all ponderable matter, already united with fluidium; which changes always produce heat and light, in proportion to the intensity of the action. This will also account in a satisfactory manner, why the moon should afford us light, but not heat. Fluidium, in its passage from one lunar ponderable substance to another, produces heat and light, the heat is absorbed by the receiving body, and as the cause is perpetual, so will be the effect: we feel no heat, but the light will be without intermission.

### *On the Tides.*

Since my Essays went to press, I have turned over the Asiatic Researches, and had great satisfaction in finding a very remarkable confirmation of my theory; viz. that the tides are not produced by the influence of the sun and moon unitedly or separately, but by the diurnal motion of the earth: see Observations on the Barometer, by Dr. Balfour and Mr. Farquhar, 4th vol. Asiatic Researches, Calcutta 1794.

"1st. That in the interval between 10 o'clock at night and six in the morning, there existed a prevailing tendency in the mercury to fall.

"2d. That in the interval between 6 and 10 in the morning, there existed a prevailing tendency in the mercury to rise.

"3d. That in the interval between 10 in the morning and 6 in the evening, there existed a prevailing tendency in the mercury to fall.

"4th. That in the interval between 6 and 10 in the evening, there existed a prevailing tendency in the mercury to rise.

"That there exists a law in nature, by which the mercury of the barometer, let the standing weight be what it may, is liable to the effects of a constant and regular periodical diurnal fluctuation.

"The periods are evidently connected with the *earth's diurnal motion;* and, if we had no satellite, might easily be explained by the atmospherical tides caused by the sun. But when we find that the barometer is not in the least observable degree affected by the moon's passage over the meridian, or by the united action of the sun and moon at the syzygies, we have absolute proof that this cannot be the cause: neither can the expansion of the mercury, being directly opposite to the phænomena, the greatest degree of heat taking place at 3 o'clock, when the mercury is lowest. The observations were taken every half hour during a complete lunation."

Joseph Luckcock.

XXII. *On*

## XXII. *On the Purification of Coal Gas.*

*To Mr. Tilloch.*

Sir,—The methods recommended by Messrs. Parker and Lowe, in late Numbers of your Magazine, for the purification of coal gas, if they do not fully effect the object proposed, entitle those gentlemen to every praise by making the subject a matter of discussion and inquiry.

It has always appeared to me, that when the various products derived from the destructive distillation of coal are made to pass through an iron tube heated to ignition, the carburetted hydrogen so obtained principally proceeds from the tar; and that that portion of carburetted hydrogen, which had been previously formed from the coal, undergoes another arrangement of its elements by traversing the heated medium. If, for example, coal gas be passed through a red-hot tube *after* the *tar* has been separated, it will be found that the brilliancy of the light from gas so treated falls far short of what it would be, had it received no such treatment.

This being the case (as is shown by experiments) proves clearly the process referred to to be faulty and injurious. I have, sir, been induced to offer these remarks, from recent opportunities I have had, whilst travelling through the country, of visiting several gas establishments, and of witnessing the truly excellent effects of lime when judiciously applied. There are various modes in which lime is employed in the purification of coal gas, and the effect produced is in proportion to its causticity, its quantity, and the extent of its surface.

If the lime be not in a state of causticity or thereabouts, it is certain a larger quantity must be used than is absolutely necessary; and whatever proportion be employed, it is important that as much surface as possible be exposed in the purifying process.

In no lime vessel that I have had an opportunity of seeing, are these advantages so completely combined as they are in the lime-machine of Mr. Clegg. At the Gas-Works lately erected in the city of Chester, there is one of this gentleman's purifiers; and by the obliging assistance of Mr. Leete (a very intelligent young man and superintendant of the works) I was enabled to make some experiments on the gas purified by this machine. Having at other places submitted the gas proceeding directly from the purifier to the action of superacetate of lead dissolved in water, I uniformly obtained a result which indicated the presence of sulphuretted hydrogen, by the test being instantly blackened; but on repeating the experiment at Chester, I could not discover any trace whatever of this combination. Mr. Leete then suggested,

gested, that instead of superacetate of lead, an oxide of that metal be used, which, if any were present, would detect sulphuretted hydrogen with more precision. For this purpose we procured two large ale-glasses and nearly filled them with water; in one some finely-powdered litharge was placed: in the other, dry white lead (*ceruss*); and these substances were well mixed with the water: through each of these mixtures we passed for five minutes large streams of the purified gas; but without changing the original colour of the oxides in the most trifling degree. A brush covered with white paint was then held under the gas tube; but no alteration could be discovered on the paint. Lastly, the gas was passed through lime-water, which was not in any degree clouded. These experiments prove to demonstration, that neither sulphuretted hydrogen nor carbonic acid gases were mixed with the carburetted hydrogen after having passed through this purifier. The peculiar excellence of Mr. Clegg's lime-machine consists in the exposure of a large surface of lime and gas to the action of each other, which is assisted by moderate pressure applied in the safest and most ingenious manner.

The accompanying sketch (Plate I. fig. B) may serve to illustrate its mode of action: *a a* represents the vessel containing lime mixture; *b b* an inner compartment into which the crude gas is conveyed by the pipe *c*; *d* the pipe which conveys the purified gas to the gasometer; *e* an opening through which cream of lime is supplied. When the outer vessel *a a* is first charged with lime mixture, the *level* will be the same in *b b*, as will appear by the dotted line; but the moment gas enters by the pipe *c*, the mixture in the inner department is depressed, and a column about 14 inches raised and supported in *a a*, the gas at the same time not being able to escape until the lime mixture in *b b* is so far lowered as to expose the narrow divisions, which then present a means of escape; and by having yet to pass through the column of fluid raised in the outer vessel, the gas undergoes as complete a purification as can possibly be desired or effected.

I have here merely endeavoured to describe the mode in which coal-gas is purified by the instrument in question. There are several convenient appendages attached to it, which make it not only an important but a handsome piece of machinery, and which I am certain will be found a valuable acquisition to gas establishments in general.

With much respect I am, sir,
Your most obedient servant,

Manchester, Jan. 21, 1819. CH. BOLTON.

XXIII. *No-*

## XXIII. *Notices respecting New Books.*

*Memoirs of the Wernerian Natural History Society.* Vol. II. Part II. For the years 1814, 1815, 1816.

This Part contains:— I. On the Greenland or Polar Ice; by W. Scoresby jun. Esq. M.W.S.—II. On the Mineralogy of the Read Head, in Angus Shire; by the Rev. John Fleming, D. D. F. R. S. E.—III. Description and Analysis of a Specimen of Native Iron found at Leadhills; by Mr. H. M. Da Costa, M.W.S. —IV. Mineralogical Observations in Galloway; by Dr. Grierson. —V. Lithological Observations on the Vicinity of Lochlomond; by Dr. Macnight.—VI. Description of Ravensheugh; by the same.—VII. Hints regarding the Coincidence which takes place in the Pressure of the Atmosphere at different Latitudes and at nearly the same Time; by the Right Hon. Lord Gray, F.R.S. Lond. and Edin. &c.—VIII. An Account of several new and rare Species of Fishes taken on the South Coast of Devonshire, with some Remarks upon some others of more common Occurrence; by George Montagu. — IX. Observations upon the Alveus or General Bed of the German Ocean and British Channel; by Robert Stevenson, Esq. Civil Engineer.—X. Geological Remarks on the Cartlone Craig; by Dr. Macnight.—XI. Account of the Irish Testacea; by Thomas Brown, Esq. F.L.S. M.W.S. M.K.S. —XII. Remarks respecting the Causes of Organization; by Dr. Barclay.—XIII. On the Genera and Species of Eproboscideous Insects; by William Elford Leach, Esq.—XIV. On the Arrangement of Œstrideous Insects; by the same.—XV. Observations on some Species of the Genus Falco of Linnæus; by James Wilson, Esq.—XVI. On the Geognosy of the Lothians; by Professor Jameson.

---

Dr. Bostock, late of Liverpool, now of London, has published an account of the Science of Galvanism. He gives a preference to the chemical hypothesis, and draws the following conclusions:—

"The chemical differs very essentially from the electrical hypothesis with respect to the supposed state of the contiguous metals: the electrical supposes that they can have different states of electricity while they are in contact; the chemical takes it for granted, that, while they are in contact, their electrical states must be similar. The chemical hypothesis satisfactorily explains all the facts that have been observed, respecting the necessity of oxygen for the action of the apparatus; it explains the reason why the metals must differ in their degree of oxidability, and why the fluid must be one that will act differently upon the two metals. The facts that have been noticed respecting the different effects of the interposed fluids may be explained by referring to three circumstances,

stances, which all coincide with the chemical hypothesis, but which seem to have no relation to any electrical action: 1. That the fluid acts only upon one of the metals: 2. That the surface of one of the metals is oxidated with a certain degree of rapidity: 3. That the oxide is removed so as to present a fresh surface to the fluid. If acids be employed, those are the best that dissolve the oxide; or if neutral salts, those which form triple compounds with the oxide which is produced. The chemical hypothesis affords a plausible method of accounting for the different effects of the apparatus, whether we use large or small plates: for it is not unreasonable to suppose that the electricity will become more intense or concentrated at every successive transmission through a new oxidating surface, while its absolute quantity will depend upon the amount of oxide that is formed.

"It will be perceived, that much discordance of opinion still exists upon the subject, and that some strong objections attach to every hypothesis which has yet been proposed. The most important points to ascertain are, the difference between electricity, as excited by the friction of the common machine, and that modification of it which is strictly called galvanism. For this purpose, the nature of electric intensity should be further investigated; for it would appear that, if we were able to attach a more precise idea to this term, a considerable insight would be gained into the cause of this difference. Experiments somewhat similar to those of De Luc should be prosecuted, in which the electrical and chemical effects of the pile are separated from each other; and a more accurate measure of the proper galvanic power should, if possible, be obtained, than any of which we are now possessed. The conducting power of the fluids concerned in the galvanic apparatus should be carefully examined, and the relation of their chemical action to their conducting power should be ascertained."

---

*Recently published,*

The Elements of Natural Philosophy; illustrated throughout by Experiments which may be performed without regular Apparatus. By James Mitchell, M.A. With plates and wood engravings.

A new Edition of Abercrombie's Practical Gardener; or, improved System of Modern Horticulture; adapted either to large or small gardens; designed for the assistance of those gentlemen who manage their own gardens, and as a book of reference for the young professional Horticulturist.

A Compendium of the Theory and Practice of Drawing and Painting, illustrated by the technical terms of art; with practical observations on the essential lines, and the forms connected with them. By R. Dagley, 4to.

*In*

*In the Press,*

The Entomologist's Pocket Compendium: containining an Introduction to the knowledge of British Insects; the Apparatus used, and the best means of obtaining and preserving them; the Genera of *Linné;* together with the modern method of arranging the classes Crustacea, Myriapoda, Spiders, Mites, and Insects, according to their affinities and structure, after the system of Dr. Leach. Also, an explanation of the Terms used in Entomology: a Calendar of the time, and situations where usually found, of nearly 3000 species; and Instructions for collecting and fitting up objects for the microscope. Illustrated with twelve plates. By Mr. George Samouelle, Associate of the Linnean Society of London.

A Treatise on Medical Logic founded on Practice, with facts and observations. By Sir Gilbert Blane, Physician-extraordinary to His Majesty.

A Treatise on Midwifery, developing a new principle, by which, it is said, labour is shortened and the sufferings of the patient alleviated. By Mr. George Power.

A new Edition of Lord Bacon's Works, in twelve volumes foolscap, enriched with portraits, with the Latin part translated into English. By Peter Shaw, M.D.

---

*Preparing for Publication.*

There is now in circulation a Prospectus of a new Work entitled " The Elements of Radiant and Fixed Matter," (ready for the press, and to be published by subscription, in one volume, 8vo, with plates, when a sufficient number of subscribers to cover the required expense shall have been obtained) containing the Direct Evidences in support of the following Theory of Matter, in which are described its presumed original basis, with the laws by which its reciprocal transition to and from the state of radiance and fixation appears to be governed.

*Theory.*—Matter exists in four forms,—the solid, fluid, aëriform, and radiant.—The three first may be denominated inert or passive, and to the agency of the last, aided by caloric, are to be attributed the several changes evinced throughout the universe.

Light is a material compound, composed of the four simple elementary principles, or undecompound constituents of matter, of which all other bodies in nature are formed.

By a prism, light is divisible into four original prismatic coloured rays, which, by obliquity of position, in the act of extended refraction, exhibit three others, which, not being intimate compounds, may be termed laminar intermediates, partaking of partial colorific intensity, as they severally approximate that point in the spectrum, where

where the original rays of which they are composed, are, as to vision, evidently homogeneous.

The first four primary coloured rays possess peculiarly distinct and countervailing qualities, and on the proportions in which they are combined in matter, and the nature of the polarity exercised in their combination, its specific properties are totally dependant.

The red ray, or the first portion of the spectrum, possesses (as has been already proved, by an authority of great eminence) oxydating and acidifying powers, and is here termed the oxygenating ray.

The second, or yellow ray, displays qualities which pertain to the nitrogenous and alkalescent, and is therefore denominated the azotic ray.

The third, or blue ray, is distinguished by its analogy to carbon, and is here considered the carbonic ray.

And the fourth, or violet ray, is admitted to possess the dispositions of hydrogen, which entitle it to the appellation of the hydrogenating ray.

Light combines with inert or fixed matter, not specifically or bodily, but partially by absorption of its individual or separate rays, electively combined, from certain existing laws of attraction, and from the colour of fixed bodies, or that of their solution in menstrua of known constitution, or of their flame in combustion, the predominating original or simple elementary rays in their composition may be defined.

Caloric influences the combination of refracted light with fixed or palpable matter, when at a temperature not exceeding from 800° to 900° of Fahrenheit, but effects the restoration of matter to the radiant state of light, when elevated to 1000° and upwards.

The repulsive power evinced by the particles, or corpuscular atoms of light, towards each other, (when their active poles or those they exercise in the aggregate are paralysed,) is influenced by the peculiar nature of their individual polarity, being quaternary compounds, of a spherical form, combined by one positive and three negative poles at their centre, and therefore exhibiting on their external surfaces, three positive poles at such angles, as to act with repulsion, on liberation from the influence of pressure, or that propelling power which emanates from the radiating point on which the visibility of light depends.

The greater illuminating power of that portion of the spectrum, embracing the lighter green and deeper yellow, may depend on the higher specific gravity of those rays, as by multiplying their given relative qualities, by the specific gravity of the fixed

fixed bodies they represent, they afford from analogy the following data as their comparative intensity of illumination.

Red ray 9·364. Yellow 12·789. Blue 6·593. Violet 1·000. Light orange or deep yellow 11·647. Light green 10·719. The mean of the entire portion 11·076.

The Galvanic phænomena among others support the conclusion, that the transition of matter to the radiant state of light is effected by the combination of one atom of oxygen, by its positive pole, in contact with the negative poles of one atom each, of azote, carbon, and hydrogen, and that the reversion to a fixt state, is produced by a combination of the same atoms in a refracted state principally by their opposite poles with bodies of fixed matter.

The existence of an equilibrium as to such gradual transition and reversion of matter is not less consistent with its indestructibility, than that already admitted in the daily formation of water, and the restoration of that body to its original constituents in the gaseous state.

Light is imperfect in colour and intensity, unless the presence of its four original constituents is evident, and nearly in the following ratio :

| In volume, | | In weight, | |
|---|---|---|---|
| Red ray | 16·250 | Oxygen | 5·5068 |
| Yellow | 25·417 | Azote | 7·5366 |
| Blue | 30·556 | Carbon | 3·6031 |
| Violet | 27·777 | Hydrogen | 0·5880 |
| Parts | 100·000 | Grains | 17·2345 |

Except one, all solids, with which we are familiar, (the metals included,) all fluids, and the whole of the gases, (three only excepted,) are compound bodies.

The colour assumed by bodies in a liquid state, on addition of new constituents, is dependent on a change of position of the visible surfaces of their compound atoms, arising either from an extension of their spheres by the new acquisition, or a diminution in magnitude from abstraction of some portion of their original constituents, by which in either case a direct change as to polarity is effected. This may be elucidated by demonstrating the *nature* of the action of an acid, or an alkali, on the blue colour of vegetable juices.

The health and vigour of vegetative bodies, as well as the colours by which they are adorned, is principally attributable to the transition of radiant matter to a fixed state.

As the crystalline forms assumed by bodies are governed by the number and position of the original constituents in their composition,

position, and as no homogeneous body can consistently exhibit such diversity in its atomical arrangement, the assumption of such forms by the metals is one of the many presumptive evidences in support of their compound nature.

As all bodies, whether of the animal, vegetable, or mineral kingdom, (as here presumed) are compounds, formed of nearly the same constituents, their peculiar properties and qualities are not to be considered as *innate*, but are to be attributed, in addition to variation in proportion, to a modification in arrangement, inducing a *polar* influence by which their passage to other stages of fixity is facilitated or impeded, and they are rendered applicable to appropriate changes.

Thus matter is deleterious alone from an arrangement contrary to that consistent with animal organization, and not from qualities or properties peculiar to its constituents.

The order of polarity observed in the transition of matter from a fixed to a radiant state, is absolute and invariable, while that of its reversion from the latter to the former by combination with bodies of fixed matter is subject to a diversity governed by the nature of those bodies, which are endowed with certain proportionate degrees of fixation, or resistance to resolution, as their poles alone, appropriate to connection in the radiant state, are more or less protected from the influence of caloric in producing a separation of their elements.

As the simple gases, when treated separately and isolated, are individually incapable of combustion; and the only one of them denominated inflammable, extinguishes ignited bodies when plunged into it, and in combination with another gas termed a direct supporter of combustion, forms water, a body the most opposite in its nature to those which possess inflammability, while azote, the only substance described in chemistry as a simple incombustible with a slight acquisition of other matter, produces the most splendid ignition; the humble individual, who with the greatest deference is about to submit the *direct* and presumptive evidences he has collected from experiments in support of this hypothesis, entertains the most sanguine hope to induce a liberal investigation, and thereby to elicit from the more able and efficient efforts of the eminent philosophers who are the ornament of the present enlightened age, the *truth*, of which he is in search, either by the complete confutation, the appropriate modification, or the ultimate establishment of the premises here set forth.

This little work contains, prefixed as a necessary appendage, a condensed review of the opinions of the most celebrated for science, in the earlier and present times, who have expressed their sentiments on the subject; and refers, with due acknowledgements, to the accurate experiments of many authors of the highest authority (particularly of the present day) for corroborating *facts*, as it is hoped, deducible in support of this hypothesis. By a modern Chemist.

---

Mr. Westgarth Forster is preparing by subscription (price 15s.) a second improved and greatly enlarged Edition of his Treatise on a Section of the Strata commencing near Newcastle-upon Tyne, and concluding on the West Side of the Mountain of Cross-Fell; with Remarks on Mineral Veins in general; also Tables of the Strata in Yorkshire and Derbyshire. To which is added a Treatise on the discovery, the opening, and the working of Lead Mines; with the dressing and smelting of Lead Ores. Illustrated with several additional Plates.

---

A History and Description of Lichfield Cathedral, illustrated with sixteen engravings from drawings by Mr. Mackenzie; among which is one representing Mr. Chantrey's famed monument representing the two children of Mrs. Robinson. This work will form a portion of the author's Cathedral Antiquities of England. By Mr. Britton.

---

A Series of Engravings representing the Bones of the Human Skeleton, with the Skeletons of some of the Lower Animals. By Edward Mitchell, engraver, Edinburgh; with explanatory references by John Barclay, M.D.

---

Mr. Wm. Scoresby junior has in the press a work entitled "A Survey of the Arctic Regions."

---

## XXIV. *Proceedings of Learned Societies.*

### ROYAL SOCIETY.

Jan. 14.—A Paper by Sir E. Home on the Corpora Lutea was read. The ovarium is previous to puberty loose and open in its texture; afterwards the Corpora Lutea make their appearance, forming in the cow a mass of convolutions which the author compares to those of the brain. The ova are then formed in the lutea before and independently of sexual intercourse; but, in the author's opinion, impregnation is necessary to their expulsion, on which the Corpora Lutea are burst by extravasated blood, their cavities after the escape of the ova being always found distended with coagulated blood.

Jan. 28. A paper by Captain Webb was read, containing an account of an extensive Trigonometrical Survey made in India by means of astronomical observations. Another paper was read, communicated by the President from Professor Aldini, stating the progress which had been made in the adoption of the art of lighting by by gas on the Continent, accompanied by some remarks on the lighting of London; with suggestions for the improvement and extension of this valuable branch of discovery.

Feb. 4. A paper was read, communicated by the President from Mr. William Scoresby jun. on the Anomaly of the Variation of the Magnetic Needle on board ship. Mr. Scoresby states, as the result of a long series of personal observations, what when the compass is placed in one particular part of a ship, there is no variation, as between north and south; and that when placed in another position, there is no variation, as between east and west. He accordingly suggests, that a medium point between these two lines may probably be found, where the compass will act free from all variation, either as to north or south, or as to east and west.

A paper by Mr. Bain on the same subject was also read at this meeting, showing by a number of examples the great extent of the variations of reckoning occasioned by the local attraction of ships.

Feb. 12. A paper was read, communicated by Dr. Leach, from Mr. Thomas Say of Philadelphia, containing a scientific description of a new species of the genus Ocythoe discovered on the American coasts.

## ACADEMY OF SCIENCES, PARIS.

At the sitting of 5th of October last, was read by M. Thenard a Series of observations on the Oxygenized Acids and Oxides *, which, the author observed, embrace facts so singular that they will excite some surprise. They are as follows:

"I. The oxygenized nitric and muriatic acids dissolve the hydrate of the deutoxide of mercury without effervescence; but if an excess of alkali be afterwards poured into the solution, a considerable disengagement of oxygen ensues, and the oxide of mercury, which at first re-appears of a yellow colour, is quickly reduced.

"II. When this hydrate is brought in contact with the oxygenized nitrate or muriate of potash, it is reduced with equal facility. It passes from yellow to gray, giving off at the same time much oxygen.

"III. Oxide of gold, obtained from the muriate by means of barytes, and containing such a small portion of the base as gave it a greenish hue, being put, while in a gelatinous state, into oxygenized muriatic acid, a strong effervescence instantly followed, occasioned by a disengagement of oxygen. The oxide assumed a purple tint, and was, soon after, completely reduced.

"IV. Oxygenized sulphuric, nitric and phosphoric acids, like

* See M. Thenard's paper in our Number for January; also his paper on the acids and oxides in the present Number, p. 109.

the oxygenized muriatic acid, cause the oxide of gold to assume at first a purple hue; but instead of assuming afterwards the appearance of gold that has been precipitated by sulphate of iron, it becomes dark-brown. These experiments have a tendency to prove the existence of a purple oxide of this metal.

"V. If oxygenized nitric acid be poured on oxide of silver, a strong effervescence ensues, occasioned, as in the preceding cases, by a liberation of oxygen. One portion of the oxide is dissolved. The other is first reduced, and afterwards is dissolved, if a sufficiency of acid be present. If potash be gradually added to the solution, when completed, a fresh effervescence follows, and a dark violet-coloured precipitate is thrown down (such, at least, is always the colour of the first deposit), which is insoluble in ammonia, and, to all appearance, a protoxide of silver, similar to what was observed by an English chemist while examining the action of ammonia on the oxide of silver.

"VI. Oxygenized sulphuric and phosphoric acids likewise reduce partially the oxide of silver, with a strong effervescence.

"VII. Having already noticed that the oxide of silver and oxygenized muriatic acid, by their mutual action, produce water, disengaging oxygen gas and chloride of silver, I now remark that this chloride is of a violet colour: but violet chloride, however obtained, always leaves a metallic residue when treated with ammonia. This phænomenon was observed by M. Gay-Lussac, respecting white chloride turned to violet by the action of light. From this it follows, that when oxygenized muriatic acid is treated with oxide of silver, a small portion of the liberated oxygen is furnished by the oxide itself: therefore, to determine by the process pointed out in my last paper, by means of this oxide, the quantity of oxygen in muriatic acid, we must take into the account the oxygen furnished by the oxide: in order to which a second experiment must be made, in which the chloride of silver, produced and mixed with oxide of silver, must be collected. This mixture being treated with ammonia gives, as a residuum, the portion of the metal that had been reduced; the quantity of which informs us respecting the quantity of oxygen we are in quest of.—With respect to the chloride of silver, it probably corresponds with the protoxide of silver.

"VIII. When a tube containing oxide of silver is dipped into a solution of oxygenized nitrate of potash, a violent effervescence ensues; the oxide is reduced, the silver is precipitated, all the oxygen of the oxygenized nitrate is liberated along with that of the oxide; and the solution, containing merely common nitrate of potash, remains neutral, if it was in that state at first.

"IX. Oxide of silver produces the same effects on oxygenized muriate of potash as on the oxygenized nitrate.

"X. When

"X. When silver in a state of minute division is put into oxygenized nitrate or muriate of potash, all the oxygen of the salt is instantly liberated. The silver is not affected, and the salt remains neutral as before. The action is much less lively when the silver is in a less divided state: and the action is always less violent with the muriate than with the nitrate.

"XI. Iron, zinc, copper, bismuth, lead and platinum, possess, like silver, the property of separating the oxygen of the oxygenized nitrate and muriate of potash. Iron and zinc are oxidized, while oxygen is evolved: the others are not sensibly oxidized.—They were all used in the state of filings.

"The action of gold and of tin was likewise tried. They produced no sensible action on the neutral solutions; or, at most, only a few bubbles were liberated, and these at intervals.

"XII. The peroxide of manganese and that of lead are also capable of decomposing the oxygenized nitrate and muriate of potash. Only a small quantity of these oxides is required to expel the whole of the oxygen from the solution. The effervescence is brisk. I believe that the peroxide of manganese undergoes no alteration. It is not impossible that the peroxide of lead may be reduced to a lower degree of oxidation.

"XIII. Though nitric acid, as is known, has no action on the peroxide of manganese and of lead, the oxygenized nitric acid dissolves both of them with facility, accompanied by a great disengagement of oxygen gas. Potash produces in the manganese solution a black flocky precipitate; and in that of lead, a brick-coloured precipitate. The latter is less oxidized than peroxide of lead; for, treated with nitric acid, it yields nitrate of lead and a flea-coloured residuum. On adding the potash there is instantly a strong effervescence.

"XIV. The oxygenized sulphates, phosphates, and fluates, exhibit with the oxide of silver, with silver, and probably with other bodies, the same phænomena as the oxygenized nitrate and muriate of potash; and the greater number of the oxygenized alkaline salts possess the same properties as the oxygenized salts of potash.—The cause of the phænomena we shall hereafter attempt to resolve.

"With this view, let us recollect the phænomena exhibited by oxide of silver, and silver, with the neutral oxygenized nitrate of potash. Silver in fine powder rapidly liberates the oxygen of this salt. It undergoes, itself, no alteration; while the oxygenized nitrate is reduced to the state of simple nitrate.—The oxide of silver liberates the oxygen of the oxygenized nitrate still more rapidly than does the silver; is itself decomposed, reduced, and the silver entirely precipitated: and in the liquid only common neutral nitrate of potash is found. In these decompositions the

 chemical

chemical action is evidently null. We must therefore ascribe them to a physical cause; but they depend neither on heat nor light. It follows then, that probably they are owing to electricity. I will endeavour to ascertain this—likewise whether the cause, be it what it may, cannot be produced by bringing into contact two liquids, or even two gases; from which, perhaps, we shall derive means for explaining a great variety of phænomena."

## XXV. *Intelligence and Miscellaneous Articles.*

### SUBSTITUTE FOR BORAX.

Sulphate of strontian has been lately discovered in considerable quantity at Carlisle, 34 miles west of Albany, in the State of New York. It is found imbedded in clay slate, forming very extensive strata. A common smith has made a curious discovery respecting this substance: having tried it as a substitute for borax, it proves to be the most useful flux that was ever employed in brazing and welding. By employing a very small quantity of it in powder, instead of clay, he welded with ease the most refractory steel: in brazing it is found preferable to borax, remaining more fixed at a high temperature.

### SAFE COACH.

In a country in which there is so much travelling as England, every improvement calculated to lessen the risks of being overset in stage coaches should be patronized by the public. The vehicle invented, or so improved as to give it all the characters of a new invention, by Mr. H. Matthews of Gretton Place East, Bethnal Green, is precisely of this description. We have inserted a woodcut, which, with a few words of description, will convey to our readers a very correct idea of its advantages.

In coaches of the common construction a great load of luggage is usually carried on the top, and the wheels approach each other so closely, that the towering pillar requires very little inclination to either side, to carry the centre of gravity beyond the centre of the base, and overset the coach. In the new coach the wheels are made to cover a wider base, and the luggage is stowed at the bottom and under the seats, which are so contrived as to allow 5 cubic feet more luggage than can be stowed in all parts of the present coaches: by which means the centre of gravity has only a height of 3 feet 6 inches, instead of 8 feet 9 inches, as in the common coaches, and all the luggage is under lock and key and impervious to wet. The wheels are fastened on with lock and key. That the safety of passengers will be greatly increased by this improvement is quite obvious; but this is not all: the labour


Break Neck Coach
PATENT SAFE COACH

labour of the horses will be lessened; which should always be a matter of consideration with humane minds. The wheel horses are relieved, by this plan, from that unequal vibration which is occasioned by the weight being placed so high as to swing from side to side; sometimes falling to the one horse and sometimes to the other, subjecting them to an equal pace with a jerking unequal pull. The perch, the body and the boot are much nearer the horses, and more at their command, than in coaches of the common construction.

The Patentee, we understand, means to hire out these vehicles to coach masters for the same price at which they now hire their coaches, reserving for himself an additional halfpenny per mile, which he proposes to charge on the *front* outside passengers, to prevent that uncomfortable mixture which is now much complained of—those who ride backward paying the old fare. This bonus he is, however, willing to farm out to the coach-master for a reasonable remuneration. The advantage to the coach-master will be, additional safety to the driver, less wear of cattle, and the carriage of 5 cubic feet more of luggage, which, calculating each foot at 24 pounds, will yield, say at one penny per pound for a distance like that to Brighton, ten shillings. These coaches too may avail themselves of the act, which allows twelve passengers where there is no outside luggage, in place of ten where there is outside luggage. These two extra passengers at 12*s*. yield 1*l*. 4*s*. more.—That is, if we calculate by the 100 miles, the extra profit will be 3*l*. 8*s*. on every 100 miles.

Mr. Matthews has wisely resolved to employ the coach-builders which the coach-masters now employ: this will tend much to prevent that opposition to the introduction of this improvement, which would otherwise arise from interested individuals.

ANTIQUITIES.

The following particulars respecting some discoveries made upon the estate of Ebenezer Hollick Esq. of Whittlesford, at a place called Got Moor, between Whittlesford and Triplow, two miles from Newton, are copied from the Cambridge Chronicle:

Mr. Hollick employed some labourers to level three ancient *tumuli* upon Got Moor, called The Chronicle Hills, vith a view to the improvement of his land. These *tumuli* stood in a line nearly North and South, upon the North side of a brook separating the parishes of Triplow and Whittlesford. The old road from Cambridge to Triplow, through Shelford, crossed this brook; it may have been a Roman way. Upon the left (*i. e.* eastern) side of it were the *tumuli*; and also other sepulchres of a very remarkable nature, as we shall presently show.

The middlemost of The Chronicle Hills was 8 feet high, and it it was 27 yards in diameter ; the others were much lower. They ranged along an ancient wall, constructed of flints and pebbles, which the workmen are now removing. Its length was 4 rods ; its thickness 30 inches, and it had three abutments upon its eastern side. Beyond this *wall*, at the distance of 12 rods to the east, was found an *ancient well* made with clunch, 9 feet in diameter, full of flints and tiles of a curious shape, so formed as to lap over each other. Some of these tiles had a hole in the centre ; and, from their general appearance, it was believed that they had been used in an aqueduct. In this *well* were found two *bucks'* or *elks' horns*, of very large size. Upon opening the *tumuli*, the workmen removed, from the larger one, *four human skeletons*, which were found lying upon their backs, about two feet from the bottom. Some broken pieces of *terra cotta*, with red and with black glazing, were found in opening the *tumuli*, heaped among the earth, which, from the nature of the workmanship, seemed to be *Roman*, but this is uncertain. In opening the northern *tumulus*, and in removing the *wall* upon its eastern side, such an innumerable quantity of the bones of a small quadruped was found, that they were actually stratified to the depth of four inches, so that the workmen took out whole shovels filled with these bones ; and the same were also found near other sepulchres about a hundred yards to the north of The Chronicle Hills. The most singular circumstance is, that there is no living animal now in the country, to which these bones, thus deposited by millions, may be anatomically referred. The bones of the jaw correspond with those of the castor, or beaver, as found in a fossil state in the bogs near Chatteris ; but the first are incomparably smaller. Like those of the beaver they are furnished with two upper and two lower incisors, and with four grinders on each side. Nothing like these minute bones has, however, been yet known to exist in a fossil state. One of the Professors of this University, after a careful examination of the spot, believing them to have belonged to the Lemming, which sometimesdescends in moving myriads from the mountains of Lapland, transmitted several of them to London to Sir Joseph Banks, and to Sir Everard Home, who have confirmed his conjecture. According to these gentlemen, there exists at present a creature of this species called a Shrew Mouse, which is exceedingly destructive to young plantations. About two years ago the Commissioners of Forests wrote to Sir Joseph Banks to know what could be done to get rid of them. A colony of these animals may have been hemmed in by some flood, and, being all of them drowned, were perhaps thus huddled together in one spot.

Before we conclude this article, we have also to add, that about 100 yards from the north of The Chronicle Hills, there were found two

two other *sepulchres*, in which human skeletons were found in *soroi*, constructed of flints and pebbles, put together with fine gravel. These *soroi* were surrounded each by a circular wall 2½ feet thick, and about 3 feet high, 22 feet in diameter. The whole were covered beneath mounds of earth, which rose in hills about 2 feet above the *soroi*, having been probably diminished in height by long pressure and the effect of rains.—In the first *soros* (which was 5 feet square and 8 feet deep, brought to a point with pebbles,) were found *two skeletons*. The uppermost appeared to be of larger size. Under the skull was found the blade of a *poignard* or *knife*. The head of this skeleton rested upon the body of the other. The *soros* was full of dirt; and patches of a white unctuous substance, like *spermaceti*, adhered to the flints. It had an *oak bottom*, black as ink, but stained with the green oxide of copper, owing to the decomposition of an ancient *bronze* vessel, very small parts of which have been removed to this University, and analysed; the composition consisting, as usual in ancient bronze, of an alloy of *copper* and tin, in the proportion of 88 of the former to 12 of the latter. Large *iron* nails, reduced almost to an oxide, were also found here. In the other *soros* (which was 4 feet square within its circular wall, and 8 feet deep,) a human skeleton was found; and another below it in a sitting posture, with an erect spear, the point of which was of *iron*. Nails were found here, but no *wood*, as in the other *soros*. Here the small *quadruped bones* were found in great abundance. The skull of the sitting figure was stolen by one of the labourers, and carried to his own cottage at Whittlesford: it had every tooth perfect. The robbery has given rise to a very amusing instance of superstition; for it is maintained at Whittlesford, that the headless skeleton of an ancient warrior knocks every night at the door of this cottager, demanding the skull sacrilegiously stolen from his grave.

Much more might be added respecting the antiquities of Got Moor, and of The Chronicle Hills. Many gentlemen of the University have resorted to the spot to gratify their curiosity. The mode of burial exhibited by those antient sepulchres, added to the fact of the *bronze* reliques found within one of them, and also that no *Roman* coins have ever been discovered among the other ruins, plead strongly for the superior antiquity of the people here interred; and lead to a conclusion, that The Chronicle Hills were rather *Celtic* than *Roman* tombs.

---

### THE RAINBOW.

According to the Newtonian hypothesis, this phænomenon is occasioned by the refraction of the sun's rays by drops of rain in the quarter in which the bow is seen. Dr. Watt, of Glasgow, has

has suggested a more satisfactory theory, being less at variance with facts; for the rainbow is often seen where no rain is falling. He, like Newton, makes the effect to depend upon refraction: but he ascribes the refraction to the rays coming through the lower edge of a cloud posited between the beholder and the sun, which, acting like the prism, divides the rays of light, and exhibits on the dark opposite sky, as on a curtain, a portion of the solar spectrum. The cause and effect which he points out are so closely connected, that, especially after a little practice, the appearance of the bow may often, from the state of the clouds, be predicted with great certainty.

---

### MAGNETIZING POWER OF VIOLET RAYS.

The discovery of M. Morichini respecting the power which was doubted by many, has been confirmed by Professor Playfair; who gives the following account of an experiment which he witnessed:—

"After having received into my chamber a solar ray, through a circular opening made in the shutter, the ray was made to fall upon a prism, such as those which are usually employed in experiments upon the primitive colours. The spectrum which resulted from the refraction was received upon a skreen; all the rays were intercepted except the violet, in which was placed a needle for the purpose of being magnetized. It was a plate of thin steel, selected from a number of others, and which, upon making the trial, was found to possess no polarity, and not to exhibit any attraction for iron filings. It was fixed horizontally on the support by means of wax, and in such a direction as to cut the magnetic meridian nearly at right angles. By a lens of a sufficient size, the whole of the violet ray was collected into a focus, which was carried slowly along the needle, proceeding from the centre towards one of the extremities, and always the same extremity; taking care, as is the case in the common operation of magnetizing, never to go back in the opposite direction. After operating fifty-five minutes, the needle was found to be strongly magnetic; it acted powerfully on the compass, the end of the needle which had received the influence of the violet ray repelling the north pole, and the whole of it attracting, and keeping suspended, a fringe of iron filings."

---

### THE MISSISSIPPI.

A party of scientific men have built a steam-boat at Pittsburg, for the purpose of exploring the productions of the numerous rivers which empty their streams into the Mississippi. They propose setting out next month (March), and expect to be absent for at least three years.

### AFRICA.

Mr. T. E. Bowditch, whose Travels in Africa were announced in our last Number, is preparing for a second visit to that country, accompanied by Messrs. William and Salmon, surgeons. Being all good Naturalists, we may expect some interesting information respecting the natural history and manners of the interior, from their joint labours.

### EARTHQUAKE.

On the 8th of January several violent shocks of an earthquake were felt at Genoa. Many of the inhabitants quitted their dwellings, and fled into the country. The direction of the shocks was from Port Maurice to Saint Romi. Nothing of the kind was felt either at Nice or at Alassio. In the two former towns the damage was very considerable. From the great agitation of the vessels, it would appear that the shocks were far more violent in the sea than even on the land.

### DIMINUTIVE VOLCANO.

A letter from Jamaica of the 12th December states, that a volcano has been discovered on Prince George's Estate in the neighbourhood of the Indian River, in the parish of St. John; which is represented as one of the greatest curiosities in nature. Its perpendicular height from the base is 6 feet; circumference of the base 49 feet; and that of the crater 2 feet 2 inches.

### THE MAMMOTH.

Accounts from the banks of the Mississippi state, that the mammoth has been discovered actually in existence, in the western deserts of North America. According to the descriptions given of it, this colossus of the animal kingdom is not carnivorous; it lives on vegetables, but more particularly on a certain species of tree, of which it eats the leaves, the bark, and even the trunk. It never lies down, and sleeps leaning for support against a tree. It has rather the shape of a wild boar than of an elephant, and is fifteen feet high. His body is covered by a hairy skin, and he has no horn.

*To Mr. Tilloch.*

35 Berners Street, Feb. 23, 1819.

Sir,—I am sorry to say some inaccuracies have crept into my paper in your last Number, either in my copying it, or in printing:

Page 13, line 22, *for* ·333928, *read* 333928.

—— 14, — 5, $\frac{\overline{390}|^3 y}{68\cdot5}$ *read* $\frac{\overline{390}|^3 x^2 y}{68\cdot5 \times \odot}$.

—— — — 29, in the denominator of the last fraction *for* 1 *read* ☽.

I am, sir, your most obedient servant,

Henry Meikle.

*Meteorological Journal kept at Walthamstow, Essex, from January* 15 *to February* 15, 1819.

[Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *January* | | | |
| 15 | 40<br>49 | 30·00 | SW.—*Cirrostratus* at 7 A.M.; foggy at 8; fine day; cloudy evening; very windy and rain. |
| 16 | 36<br>41 | 30·12 | W.—Windy and clear; fine day; clear and *cirrostratus* and wind; dark and windy. |
| 17 | 47<br>49 | 29·50 | SW.—Showers and wind; at 10 A.M. a great storm; great showers and wind, and sun all day; star-light, and very windy. |
| 18 | 37<br>42 | 29·30 | W.—Sun and stormy, showers; fine day; sun and wind; star-light and windy. |
| 19 | 36<br>41 | 29·70 | W.—Clear, *cumuli*, and windy: fine day; sun and wind. Moon last quarter. |
| 20 | 35<br>40 | 29·49 | W.—Clear and windy; rain in the last night; very fine day; dark and windy. |
| 21 | 34<br>40 | 29·35 | W.—Fine morn; clear and wind; rain in the last night; very fine day; bright star-light. |
| 22 | 34<br>46 | 29·45 | SE.—Clear; windy at 7 A.M., and at 9 foggy; cloudy, windy day; rain and wind. |
| 23 | 33<br>45 | 29·50 | SW.—Clear at 7 A.M.; hazy at 8; fine day; sun and wind and rather hazy; bright star-light. |
| 24 | 40<br>46 | 29·60 | SE.—Gray morn; windy; fine day; some sun, but a *raw* air; windy and star-light. |
| 25 | 36<br>48 | 29·40 | SE.—Clear early; from 10 A.M. to after 3 P.M. stormy and rainy; clear star-light and windy. |
| 26 | 40<br>46 | 29·35 | SE.—Clear and *cirrostratus*, and windy and damp; fine day, but rather hazy, and the air raw; dark and hazy. New moon. |
| 27 | 41<br>48 | 29·40 | SE.—Hazy; dark day; some rain after 2 P.M.; star-light. |
| 28 | 40<br>50 | 29·35 | E.—*Cirrostratus;* fine day; sun, wind and *cumuli;* dark and windy. |
| 29 | 35<br>47 | 29·35 | E.—Clear and *cirrostratus;* very fine sunny day; star-light. |
| 30 | 37<br>42 | 29·35 | NW.—Rainy; rainy day; rain ceased after 2 P.M. for a short time; dark and windy. |
| 31 | 37<br>42 | 29·35 | NW.—Clear and *cirrostratus;* very fine day; a slight shower at 11 A.M.; *cirrostratus* and windy at night. |

*February*

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *February* | | | |
| 1 | 36<br>37 | 29·55 | NW.—Fine morning; white frost and clear; sun through mist at 9 A.M. and windy; very fine day; night dark and windy. |
| 2 | 35<br>35 | 29·45 | NW.—Snow began about 7 A.M., and continued till about 11; fine day; sunshine; ground covered with snow; clear night. Moon first quarter. |
| 3 | 21<br>39 | 29·60 | SW—SE.—Clear high, hazy low; at 9 foggy; fine day; rain after 4 P.M. till after 8 P.M.; starlight. |
| 4 | 35<br>42 | 29·40 | SE.—Clear and *cirrostratus*; raw, cloudy, and windy; some gleams of sun; moonlight; *cirrocumuli* and windy. |
| 5 | 34<br>44 | 29·65 | SE—E.—Windy and hazy at 7 A.M.; rain before 8, and rain all day; dark and rainy at night. |
| 6 | 42<br>49 | 29·60 | SW.—Clear, and clouds; hazy low; fine day; sun and wind; one shower; moon, stars; *cirrostratus* and wind. |
| 7 | 36<br>48 | 29·30 | SW—N.—Fine morn; hazy; fine day; windy; some showers about 3 P.M.; cloudy, but light. |
| 8 | 36<br>43 | 29·70 | W.—Fine morn; fine day; moonlight. |
| 9 | 44<br>49 | 29·90 | SE.—Hazy; rainy day; rainy and windy at 9½ P.M. |
| 10 | 47<br>47 | 29·60 | W.—Windy, *cirrostratus*, and clear; fine day; moonlight. Full moon. |
| 11 | 43<br>51 | 30·00 | W.—Gray morn; very fine day; sun and wind; windy and *light*, but neither moon nor stars visible. |
| 12 | 44<br>44 | 29·70 | W.—*Cirrostratus*, wind and showers; rain and windy till after 2 P.M.; very showery afterwards; fine moonlight night. |
| 13 | 37<br>46 | 29·65 | W—NW.—Fine morn; clear and windy; fine day, some slight showers; star-light. |
| 14 | 31<br>40 | 29·90 | NW.—Clear and *cirrostratus*; fine day; at 9 P.M. Ther. 29; clear starlight. |
| 15 | 32<br>43 | 30·00 | SW.—Clear and *cirrostratus*; hazy; fine day; dark night. |

*Notes of the Phænomena of the early Season.*

Jan. 26, 1819. The Cuckoo (*Cuculus canorus*) heard in the neighbourhood of Bushy Heath, Middlesex, this morning.

Feb. 4. The Snowdrop (*Galanthus nivalis*) in bloom: on the 8th they were vending this flower as well as the Primrose (*Primula Veris*) in London streets. The Thrush and Blackbird have been singing for the last week.

METEO-

METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1819. | Age of the Moon | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| Jan. 15 | 15 | 47·5 | 29·89 | Fine |
| 16 | 16 | 39·5 | 30·22 | Ditto—rain at night |
| 17 | 17 | 47·5 | 29·27 | Stormy |
| 18 | 18 | 41·5 | 29·48 | Ditto |
| 19 | 19 | 38· | 29·80 | Fine |
| 20 | 20 | 39· | 29·60 | Ditto |
| 21 | 21 | 42·5 | 29·42 | Ditto |
| 22 | 22 | 38·5 | 29·48 | Cloudy |
| 23 | 23 | 40·5 | 29·68 | Fine |
| 24 | 24 | 44·5 | 29·60 | Ditto |
| 25 | 25 | 42·5 | 29·40 | Cloudy—rain in afternoon & storm [at night. |
| 26 | new | 40· | 29·53 | Ditto |
| 27 | 27 | 43· | 29·60 | Ditto |
| 28 | 28 | 46·5 | 29·50 | Fine |
| 29 | 29 | 42· | 29·60 | Ditto |
| 30 | 30 | 40· | 29·50 | Cloudy |
| 31 | 31 | 40· | 29·58 | Fine—rain A.M. |
| Feb. 1 | 1 | 36· | 29·60 | Ditto |
| 2 | 2 | 35· | 29·66 | Ditto |
| 3 | 3 | 33·5 | 29·70 | Ditto—rain at night |
| 4 | 4 | 39· | 29·66 | Ditto |
| 5 | 5 | 39·5 | 29·74 | Cloudy |
| 6 | 6 | 47· | 29·60 | Fine |
| 7 | 7 | 42· | 29·43 | Ditto |
| 8 | 8 | 46· | 29·91 | Ditto |
| 9 | 9 | 47· | 29·86 | Rain |
| 10 | full | 45·5 | 29·87 | Stormy |
| 11 | 11 | 51·5 | 29·98 | Ditto |
| 12 | 12 | 46·5 | 29·60 | Cloudy |
| 13 | 13 | 44· | 29·80 | Ditto |
| 14 | 14 | 39·5 | 30·10 | Fine |

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

*For February* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| Jan. 27 | 42 | 49 | 46 | 29·42 | 16 | Foggy |
| 28 | 46 | 54 | 39 | ·32 | 22 | Fair |
| 29 | 37 | 47 | 38 | ·42 | 24 | Fair |
| 30 | 44 | 44 | 40 | ·27 | 0 | Rain |
| 31 | 40 | 44 | 38 | ·40 | 12 | Cloudy |
| Feb. 1 | 28 | 42 | 37 | ·52 | 14 | Fair |
| 2 | 29 | 37 | 38 | ·55 | 0 | Snow Showers |
| 3 | 26 | 40 | 38 | ·54 | 12 | Cloudy |
| 4 | 37 | 45 | 42 | ·60 | 21 | Cloudy |
| 5 | 40 | 47 | 40 | ·56 | 0 | Rain |
| 6 | 44 | 50 | 45 | ·48 | 16 | Fair |
| 7 | 42 | 48 | 37 | ·38 | 23 | Stormy |
| 8 | 37 | 47 | 40 | ·83 | 22 | Cloudy |
| 9 | 45 | 50 | 50 | ·80 | 0 | Rain |
| 10 | 47 | 49 | 46 | ·89 | 29 | Fair |
| 11 | 46 | 52 | 47 | ·92 | 25 | Fair |
| 12 | 47 | 47 | 39 | ·56 | 0 | Rain |
| 13 | 37 | 46 | 38 | ·70 | 22 | Showery |
| 14 | 34 | 42 | 35 | 30·01 | 27 | Fair |
| 15 | 35 | 45 | 45 | 29·92 | 24 | Fair |
| 16 | 45 | 46 | 48 | ·49 | 0 | Rain |
| 17 | 50 | 54 | 50 | ·48 | 27 | Fair |
| 18 | 46 | 49 | 48 | ·49 | 26 | Fair |
| 19 | 50 | 53 | 40 | ·26 | 29 | Fair |
| 20 | 36 | 47 | 42 | ·70 | 27 | Fair |
| 21 | 47 | 47 | 42 | 28·99 | 0 | Stormy |
| 22 | 39 | 46 | 40 | 29·80 | 20 | Showery |
| 23 | 40 | 44 | 34 | ·30 | 0 | Rain |
| 24 | 32 | 41 | | ·36 | 17 | Cloudy |

N.B. The Barometer's height is taken at one o'clock.

## XXVI. *Account of Experiments made on the Strength of Materials. By* George Rennie *jun. Esq. In a Letter to* Thomas Young, *M.D. For. Sec. R.S.** *With Notes by Mr.* T. Tredgold.

London, June 3, 1817.

Dear Sir,—In presenting you the result of the following experiments, I trust I shall not be considered as deviating from my subject, in taking a cursory view of the labours of others. The knowledge of the properties of bodies which come more immediately under our observation, is so instrumental to the progress of science, that any approximation to it deserves our serious attention. The passage over a deep and rapid river, the construction of a great and noble edifice, or the combination of a more complicated piece of mechanism, are arts so peculiarly subservient to the application of these principles, that we cannot be said to proceed with safety and certainty, until we have assigned their just limits. The vague results on which the more refined calculations of many of the most eminent writers are founded, have given rise to such a multiplicity of contradictory conclusions, that it is difficult to choose, or distinguish the real from that which is merely specious. The connexions are frequently so distant, that little reliance can be placed on them. The Royal Society appears to have instituted, at an early period, some experiments on this subject, but they have recorded little to aid us. Emerson, in his Mechanics, has laid down a number of rules and approximations. Professor Robison in his excellent treatise in the *Encyclopædia Britannica*; Banks on the Power of Machines; Dr. Anderson of Glasgow; Colonel Beaufoy, &c. are those, amongst our countrymen, who have given the result of their experiments on wood and iron. The subject, however, appears to have excited considerable attention on the continent. A theory was published in the year 1638, by Galileo, on the resistance of solids, and subsequently by many other philosophers. But however plausible these investigations appeared, they were more theoretical than practical, as will be seen in the sequel. It is only by deriving a theory from careful and well directed experiments, that practical results can be obtained. It would be useless to enumerate the labours of those philosophers, who in following, or varying from the steps of Galileo, have merely tended to obscure a subject respecting which they had no data to proceed upon. It is sufficient to enumerate the names of those who, in conjunction with our own countrymen, have added their labours to the little knowledge we possess. The experiments of

* From the Transactions of the Royal Society for 1818, Part I.

Buffon, recorded in the Annals of the Academy of Sciences at Paris, in the years 1740 and 1741, were on a scale sufficiently large to justify every conclusion, had he not omitted to ascertain the direct and absolute strength of the timber employed. It however appeared from his experiments, that the strength of the ligneous fibre is nearly in proportion to the specific gravity. Muschenbroeck, whose accuracy (it is said) entitled him to confidence, made a number of experiments on wood and iron, which by being tried on various specimens of the same materials, afforded a mean result considerably higher than other previous authorities. Experiments have also been made by Mariotte, Varignon, Perronet, Ramus, Rondelet, Gauthey, Navier, Aubry and Texier de Norbeck, as also at the *Ecole Polytechnique*, under the direction of M. Prony. With such authorities before us, it might be deemed presumption in me, to offer you a communication on a subject which had been previously treated of by so many able men *. But whoever has had occasion to investigate the principles upon which any edifice is constructed, where the combination of its parts are more the result of uncertain rules than sound principle, will soon find how scanty is our knowledge on a subject so highly important. The desire of obtaining some approximation, which could only be accomplished by repeated trials on the substances themselves, induced me to undertake the following experiments.

### *Description of the Apparatus.* (Plate II.)

A bar of the best English iron, about ten feet long, was selected and formed into a lever (whose fulcrum is denoted by *f*). The hole was accurately bored, and the pin turned, which suffered it to move freely. The standard (A) was firmly secured by the nut (*c*) to a strong bed plate of cast iron, made firm to the ground.

* It is true that the subject has been considered by many able philosophers, from Galileo down to the present period: but it is only lately that the proper object of attention has been ascertained; or at least the results of their inquiries had not been brought forward in a practicable form For when Dr. T. Young published his Lectures, there was little on the subject besides the intricate, and I may add unsatisfactory, investigations of Euler and Lagrange. As to the resistance to fracture, which with the greater part of mechanical writers is the only object attended to, it is of very inferior importance.

The laws of flexure constitute the chief guide in the construction of buildings: and the intention of these notes is to call the attention of experimentalists to this part of the subject; and as it is probable the ingenious author of the experiments now before me may be tempted to resume his labours, I feel certain that he will not feel displeased to have his attention called to some interesting points of inquiry, which he has either neglected to notice, or has not given to the public.—T. T.

ground. The lever was accurately divided in its lower edge, which was made straight in a line with the fulcrum. A point, or division (D), was selected, at five inches from the fulcrum, at which place was let in a piece of hardened steel. The lever was balanced by the balance weight (E), and in this state it was ready for operation. But in order to keep it as level as possible, a hole was drilled through a projection on the bed plate, large enough to admit a stout bolt easily through it, which again was prevented from turning in the hole by means of a tongue (*t*) fitting into a corresponding groove in the hole. So that, in order to preserve the level, we had only to move the nut to elevate or depress the bolt, according to the size of the specimen. But as an inequality of pressure would still arise from the nature of the apparatus, the body to be examined was placed between two pieces of steel, the pressure being communicated through the medium of two pieces of thick leather above and below the steel pieces, by which means a more equal contact of surfaces was attained*. The scale was hung on a loop of iron, touching the lever in an edge only. I at first used a rope for the balance weight, which indicated a friction of four pounds, but a chain diminished the friction one half. Every moveable centre was well oiled. Of the resistances opposed to the simple strains which may disturb the quiescent state of a body, the principal are the repulsive force, whereby it resists compression, and the force of cohesion, whereby it resists extension. On the former, with the exception of the experiments of Gauthey and Rondelet, on stones, and a few others, on soft substances, there is scarcely any thing on record. In the memoir of M. Lagrange, on the force of springs, published in the year 1760, the moment of elasticity is represented by a constant quantity, without indicating the relation of this value to the size of the spring: but in the memoir of the year 1770, on the forms of columns, where he considers a body whose dimensions and thickness are variable, he makes the moment of elasticity proportional to the fourth power of the radius, in observing the relations of theory and practice to accord with each other. This was admitted by Euler in his memoir of

* This machine must have had a considerable degree of friction, and Mr. Rennie has not, apparently, attempted to determine the quantity: it must however have been very considerable in the high pressures. The lever turned upon a pin similar to that used by Gauthey. (Rozier's *Journal de Physique*, tom. iv. p. 403), which Perronet found to have much friction and to cause much irregularity. To remedy the defects of this machine another was contrived by Rondelet, in which he attempted, and it appears successfully, to obviate the most material defects of the old machine. The action was more equal on the compressed surface, and a more accurate measure of the strength was obtained. Rondelet's machine is described in his *Traité Théorique et Practique de l'Art de Bâtir*, tome iii. p. 79.—T. T.

1780, in his elaborate investigation of the forms of columns. Mr. Coulomb had however shown before that time, how inapplicable all these calculations were to columns under common circumstances; and you, sir, have repeated the observation in your lectures on natural philosophy. The results of experiments have also been equally discordant; since it is deduced from those of Reynolds, that the power required to crush a cubic quarter of an inch of cast iron is 448000 lbs. avoirdupoise, or 200 tons; whereas by the average of thirteen experiments made by me on cubes of the same size, the amount never exceeded 10392·53 lbs. not quite five tons*. This may be seen by referring to the tables. There were four kinds of iron used, viz. 1st. Iron taken from the centre of a large block, whose crystals were similar in appearance and magnitude to those evinced in the fracture of what is usually termed gun-metal. 2dly. Iron taken from a small casting, close grained, and of a dull gray colour. 3dly. Iron cast horizontally in bars of $\frac{3}{8}$th inches square, 8 inches long. 4thly. Iron cast vertically, same size as last. These castings were reduced equally on every side to $\frac{1}{4}$ of an inch square: thus removing the hard external coat usually surrounding metal castings. They were all subjected to a gauge. The bars were then presumed to be tolerably uniform. The weights used were of the best kind that could be procured, and as the experiment advanced, smaller weights were used.

*Experiments on Cast-Iron in Cubes of $\frac{1}{8}$ of an Inch, &c.*

Iron taken from the block whose specific gravity was 7·033.

| Averages. | | lbs. avoirdupoise. |
|---|---|---|
| 1439·66 | $\frac{1}{8} \times \frac{1}{8}$ .. .. .. .. | 1454 |
| | $\frac{1}{8} \times \frac{1}{8}$ .. .. .. .. | 1416 |
| | $\frac{1}{8} \times \frac{1}{8}$ .. .. .. .. | 1449 |

On specimens of different lengths. Specific gravity of iron 6·977.

| | | |
|---|---|---|
| 2116 | $\frac{1}{8} \times \frac{2}{8}$ .. .. .. .. | 1922 |
| | $\frac{1}{8} \times \frac{2}{8}$ .. .. .. .. | 2310 |
| 1758·5 | $\frac{1}{8} \times \frac{3}{8}$ slipped with 1863 lbs. filed flat, and crushed with .. .. | 2363 |
| | $\frac{1}{8} \times \frac{4}{8}$ ditto, 1495, ditto .. | 2005 |
| | $\frac{1}{8} \times \frac{5}{8}$ ditto, .. .. .. | 1407 |
| | $\frac{1}{8} \times \frac{6}{8}$ ditto, .. .. .. | 1743 |
| | $\frac{1}{8} \times \frac{7}{8}$ ditto, .. .. .. | 1594 |
| | $\frac{1}{8} \times 1$ ditto, .. .. .. | 1439 |

* It is probable that Mr. Reynolds made his experiments on metal cast at the furnace of Maidley Wood, which is of a very strong and superior quality: but this circumstance can have been but of little importance compared to the great disproportion of the results.

April

*April* 23, 1817. *Experiments on Cubes of* $\frac{1}{4}$ *of an Inch taken from the Block.*

| Averages. | | | lbs. avoirdupoise. |
|---|---|---|---|
| 9773·5 | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 10561 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 9596 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 9917 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 9020 |

*Castings, Horizontal. Specific Gravity* 7·113.

| | | | |
|---|---|---|---|
| 10114 | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 10432 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 10720 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 10605 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 8699 |

*Vertical Castings. Specific Gravity* 7·074.

| | | | |
|---|---|---|---|
| 11136·75 | $\frac{1}{4} \times \frac{1}{4}$ | bottom of vertical bar .. | 12665 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 10950 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 11088 |
| | $\frac{1}{4} \times \frac{1}{4}$ | .. .. .. .. | 9844 |
| | $\frac{1}{4} \times \frac{1}{4}$ | full size. Scale broke with 10294; | |
| | | tried again .. .. | 11006 |

A prism, having a logarithmic curve for its limits, resembling a column; it was $\frac{1}{4}$ of an inch diameter by one inch long, broke with .. .. .. 6954

*April* 28*th. Trials on Prisms of different Lengths.*

| | | | |
|---|---|---|---|
| 9414·5 | $\frac{1}{4} \times \frac{1}{2}$ | horizontal .. .. .. | 9455 |
| | $\frac{1}{4} \times \frac{1}{2}$ | ditto .. .. .. | 9374 |
| | $\frac{1}{4} \times \frac{1}{2}$ | ditto, bad trial, 9006 lbs. | |
| 9982·5 | $\frac{1}{4} \times \frac{1}{2}$ | vertical .. .. .. | 9938 |
| | $\frac{1}{4} \times \frac{1}{2}$ | ditto .. .. .. | 10027 |

*April* 29*th. Horizontal Castings.*

| | | |
|---|---|---|
| $\frac{1}{4} \times \frac{3}{8}$ | .. .. .. .. | 9006 |
| $\frac{1}{4} \times \frac{5}{8}$ | .. .. .. .. | 8845 |
| $\frac{1}{4} \times \frac{6}{8}$ | .. .. .. .. | 8362 |
| $\frac{1}{4} \times \frac{7}{8}$ | .. .. .. .. | 6430 |
| $\frac{1}{4} \times \frac{8}{8}$ | or one inch long .. .. | 6321 |

*Vertical Castings.*

| | | |
|---|---|---|
| $\frac{1}{4} \times \frac{3}{8}$ | .. .. .. .. | 9328 |
| $\frac{1}{4} \times \frac{5}{8}$ | .. .. .. .. | 8385 |
| $\frac{1}{4} \times \frac{6}{8}$ | a small defect in the specimen .. | 7896 |
| $\frac{1}{4} \times \frac{7}{8}$ | .. .. .. .. | 7018 |
| $\frac{1}{4} \times \frac{8}{8}$ | or one inch .. .. .. | 6430* |

*Ex-*

* In these experiments the results are so irregular that no practical conclusions can be derived from them. There are many circumstances that affect the results of such experiments, which were observed by Gauthey; such

*Experiments on different Metals.*

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | lbs. avoirdupoise. |
| $\frac{1}{4} \times \frac{1}{4}$ cast copper, crumbled with | .. | | .. | .. | | 7318 |
| $\frac{1}{4} \times \frac{1}{4}$ fine yellow brass reduced | $\frac{1}{10}$ with | 3213· | $\frac{1}{2}$ with | | | 10304 |
| $\frac{1}{4} \times \frac{1}{4}$ wrought copper, | .. | $\frac{1}{16}$ | 3427· | $\frac{1}{8}$ | | 6440 |
| $\frac{1}{4} \times \frac{1}{4}$ cast tin, | .. | .. $\frac{1}{16}$ | 552· | $\frac{1}{3}$ | | 966 |
| $\frac{1}{4} \times \frac{1}{4}$ cast lead, | .. | .. | .. | .. | $\frac{1}{2}$ | 483* |

The anomaly between the three first experiments on $\frac{1}{8}$ cubes, and the two second of a different length, can only be accounted for, on the difficulty of reducing such small specimens to an equality. The experiments on $\frac{1}{8}$ inch prisms of different lengths give no ratio. The experiments on $\frac{1}{4}$ inch cubes, taking an average of the three first in each, give a proportion between them and the three on $\frac{1}{8}$ cubes,

as 1 : 6·096 in the block castings
as 1 : 7·352 in the horizontal ditto
as 1 : 8·035 in the vertical ditto

in several cases the proportion is as the cubes.

The vertical cube castings are stronger than the horizontal cube castings.

The prisms usually assumed a curve similar to a curve of the third order, previous to breaking.

The experiments on the different metals give no satisfactory results.

such as the position of the specimen, the form of its surfaces, and the inequality of the different specimens—which were so extremely small that it would be scarcely possible to obtain any tolerable degree of accuracy.

Gauthey's experiments exhibit a like irregularity, indicating no relation between the height of the piece and its resistance (Rozier's *Journal*, tome iv. p. 407.) It appears probable that when the fracture is of that kind where the body decomposes into pyramids, the length does not influence the result, provided that the piece be long enough to admit of the free motion of the fractured parts. I imagine that hard cast-iron breaks into pyramids, but the nature of the fracture Mr. Rennie has not stated. Probably it was so soft as to break in the manner of flexible bodies, in which, though the forces must act according to some regular law, it is difficult to trace their operation in a continuous solid.—T. T.

* The degree of compression of these bodies having been observed, we might conclude that the height of the modulus of elasticity might be obtained from these experiments. This however is not the case; and so far proves that the strain is not of that simple kind which it has been supposed to be. The reduction of length might be easily measured, even in hard bodies, by an apparatus for multiplying its extent; and it would throw much light on the subject, to reduce pieces of the same length, but of different areas, to a given length. Such a set of experiments would be infinitely more valuable than those on the fracture, and much more easily made, as the apparatus would be easier to manage.

The importance of the laws of stiffness over those of strength has been ably stated by Dr. Young, (Lectures on Natural Philosophy, vol. i.) and what he has stated in favour of stiffness applies equally to the mode of experimenting I now recommend, which could not fail of establishing some important practical rules.—T. T.

results. The difficulty consists in assigning a value to the different degrees of diminution. When compressed beyond a certain thickness, the resistance becomes enormous.

*Experiments on the Suspension of Bars.*

The lever was used as in the former case, but the metals were held by nippers, as indicated in the drawing No. 2. They were made of wrought iron, and their ends adapted to receive the bars, which, by being tapered at both extremities, and increasing in diameter from the actual section (if I may so express it), and the jaws of the nippers being confined by a hoop, confined both. The bars, which were six inches long, and $\frac{1}{4}$ square, were thus fairly and firmly grasped.

| No. | | April 30, 1817. | lbs. |
|---|---|---|---|
| 45 | $\frac{1}{4}$ inch, cast-iron bar, horizontal .. | 1166 | 1193·5 |
| 46 | $\frac{1}{4}$ do. do. vertical .. | 1218 | |
| 47 | $\frac{1}{4}$ do. cast steel previously tilted .. | 8391 | |
| 48 | $\frac{1}{4}$ do. blister steel, reduced per hammer | 8322 | |
| 49 | $\frac{1}{4}$ do. shear steel, do. do. .. .. | 7977 | |
| 50 | $\frac{1}{4}$ do. Swedish iron, do. do. .. | 4504 | |
| 51 | $\frac{1}{4}$ do. English iron, do. do. .. | 3492 | |
| 52 | $\frac{1}{4}$ do. hard gun-metal, mean of two trials | 2273 | |
| 53 | $\frac{1}{4}$ do. wrought copper reduced per hammer .. .. .. | 2112 | |
| 54 | $\frac{1}{4}$ do. cast copper .. .. | 1192 | |
| 55 | $\frac{1}{4}$ do. fine yellow brass .. .. | 1123 | |
| 56 | $\frac{1}{4}$ do. cast tin .. .. .. | 296 | |
| 57 | $\frac{1}{4}$ do. cast lead .. .. | 114 | |

*Remarks on the last Experiments.*

The ratio of the repulsion of the horizontal cast cubes to the cohesion of horizontal cast bars, is 8·65 : 1.

The ratio of the vertical cast cubes to the cohesion of the vertical cast bars, is as 9·14 : 1.

The average of the bars, compared with the cube, No. 16, is as 10·611 : 1.

The other metals decrease in strength, from cast steel to cast lead.

The stretching of all the wrought bars indicated heat *.

The fracture of the cast bars was attended with very little diminution of section, scarcely sensible.

The

* Mr. Rennie's apparatus did not permit of measuring the extension of the specimens. In some experiments made by Mr. Telford, (Barlow's Essay on the Strength of Timber, &c p. 230,) where the extension was measured, it appears to have been greatest at the middle of the length, and to increase

The experiment made by M. Prony (which asserts, that by making a slight incision with the file, the resistance is diminished one half,) was tried on a ¼ inch bar of English iron; the result was 2920 lbs., not a sixth part less.

This single experiment, however, does not sufficiently disprove the authority of that able philosopher, for an incision is but a vague term. The incision I made might be about the 40th part of an inch.

*Experiments on the Twist of ¼ Inch Bars.*

To effect the operation of twisting off a bar, another apparatus was prepared: it consisted of a wrought-iron lever two feet long, having an arched head about 1-6th of a circle, of four feet diameter, of which the lever represented the radius, the centre round which it moved had a square hole made to receive the end of the bar to be twisted. The lever was balanced as before, and a scale hung on the arched head; the other end of the bar being fixed in a square hole in a piece of iron, and that again in a vice. The undermentioned weights represent the quantity of weight put into the scale.

May 30, 1817.

On twists close to the bearing, cast horizontal.

| No. | | lbs. | oz. | |
|---|---|---|---|---|
| 58 | ¼ in bars, twisted as under with .. | 10 | 14 | in the scale. |
| 59 | ¼ do. bad casting .. .. | 8 | 4 | |
| 60 | ¼ do. .. .. .. .. | 10 | 11 | |
| | Average | 9 | 15 | |

Cast vertical.

| | | | | |
|---|---|---|---|---|
| 61 | ¼ .. . .. .. .. | 10 | 8 | |
| 62 | ¼ .. .. .. .. .. | 10 | 13 | |
| 63 | ¼ .. .. .. .. .. | 10 | 11 | |
| | | 10 | 10 | |

On different metals.

| | | | | |
|---|---|---|---|---|
| 64 | Cast steel .. .. .. | 17 | 9 | |
| 65 | Shear steel .. .. .. | 17 | 1 | |
| 66 | Blister steel .. .. .. | 16 | 11 | |
| 67 | English iron, wrought .. .. | 10 | 2 | |
| 68 | Swedish iron, wrought .. .. | 9 | 8 | |

increase from the ends towards the middle in a ratio sensibly proportional to the square of the distance from the end. This fact is at variance with the received opinion respecting this strain.

Dr. Thomson has remarked (Annals of Philosophy, vol. xii. p. 450), that the strengths of English and Swedish iron are not in the same proportion, as is found by comparing Count Sickengen's with that described in the Annals for April 1816. But, if I do not mistake, Sickengen's was made on wire, and consequently would be higher, as the strength is always much increased by forging, wire-drawing, &c.—T. T.

69 Hard

| No. | | | | | lbs. | oz. | |
|---|---|---|---|---|---|---|---|
| 69 | Hard gun-metal | .. | .. | .. | 5 | 0 | in the scale. |
| 70 | Fine yellow brass | .. | .. | .. | 4 | 11 | |
| 71 | Copper, cast | .. | .. | .. | 4 | 5 | |
| 72 | Tin | .. | .. | .. | 1 | 7 | |
| 73 | Lead | .. | .. | .. | 1 | 0 | |

### *On Twists of different Lengths.*

| Horizontal. | | | | Vertical. | | | |
|---|---|---|---|---|---|---|---|
| No. | | Weight in Scale. | | No. | | Weight in Scale. | |
| 74 | $\frac{1}{4}$ by $\frac{1}{2}$ long | 7 | 3 | 77 | $\frac{1}{4}$ by $\frac{1}{2}$ do. | 10 | 1 |
| 75 | $\frac{1}{4}$ by $\frac{3}{4}$ do. | 8 | 1 | 78 | $\frac{1}{4}$ by $\frac{3}{4}$ do. | 8 | 9 |
| 76 | $\frac{1}{4}$ by 1 inch do. | 8 | 8 | 79 | $\frac{1}{4}$ by 1 inch do. | 8 | 5 |

Horizontal twists at 6 from the bearing.

| | | | | | | |
|---|---|---|---|---|---|---|
| 80 | $\frac{1}{4}$ by 6 inches long | .. | .. | .. | 10 | 9 |
| 81 | $\frac{1}{4}$ by do. do. | .. | .. | .. | 9 | 4 |
| 82 | $\frac{1}{4}$ by do. do. | .. | .. | .. | 9 | 7 |

Twists of $\frac{1}{2}$ inch square bars, cast horizontally.

| No | | qrs. | lbs. | oz. | |
|---|---|---|---|---|---|
| 83 | $\frac{1}{2}$ close to the bearing | 3 | 9 | 12 | end of the bar hard. |
| 84 | $\frac{1}{2}$ do. .. .. | 2 | 18 | 0 | middle of the bar. |
| 85 | $\frac{1}{2}$ at 10 inches from bearing, lever in the middle | 1 | 24 | 0* | |

### *On Twists of different Materials.*

These experiments were made close to the bearing, and the weights were accumulated in the scale until the substances were wrenched asunder.

| No. | | Weight in Scale. | | | | | Weight in Scale. | |
|---|---|---|---|---|---|---|---|---|
| 86 | Cast steel .. | 19 | 9 | 91 | Hard gun-metal | | 5 | 0 |
| 87 | Shear steel .. | 17 | 1 | 92 | Fine yellow brass | | 4 | 11 |
| 88 | Blister steel .. | 16 | 11 | 93 | Copper | .. .. | 4 | 5 |
| 89 | English iron, No. 1. | 10 | 2 | 94 | Tin | .. .. | 1 | 7 |
| 90 | Swedish iron | 9 | 8 | 95 | Lead | .. .. | 1† | 0 |

### *Remarks.*

Here the strength of the vertical bars still predominates.

The average of the two taken conjointly, and compared with a similar

* In the resistance to twisting there are some doubts by different writers expressed respecting the effect of the length: these experiments, however, do not appear calculated to remove them, they are so extremely irregular. The angle of torsion was not observed, though it certainly would not have been difficult to have done so in the longer pieces. Some experiments on larger specimens are described in Thomson's Annals for March 1819; but we cannot compare them with these, for want of a more correct knowledge of the nature of this strain.—T. T.

† These experiments are merely a repetition of those in a preceding page, experiments 64 to 73; except that here cast steel is stated to be 19 lbs. 9 oz. instead of 17 lbs. 9 oz.

a similar case of $\frac{1}{2}$ inch bars, gives the ratio as the cubes, as was anticipated.

In the horizontal castings of different lengths, the balance is in favour of the increased lengths; but in the vertical castings, it is the reverse. In neither is there any apparent ratio. In the horizontal castings at 6 inches from the bearing, there is a visible increase, but not so great as when close to the bearing.

*June* 4, 1817. *Miscellaneous Experiments on the Crush of one cubic Inch.*

| No. | | lbs. avoirdupoise. |
|---|---|---|
| 96 | Elm .. .. .. .. | 1284 |
| 97 | American pine .. .. .. | 1606 |
| 98 | White deal .. .. .. .. | 1928 |
| 99 | English oak, mean of two trials .. .. | 3860 |
| 100 | Ditto, of 5 inches long, slipped with .. | 2572 |
| 101 | Ditto, of 4 inches do. .. .. .. | 5147* |
| 102 | A prism of Portland stone 2 inches long .. | 805 |
| 103 | Ditto, statuary marble .. .. .. | 3216 |
| 104 | Craig Leith .. .. .. .. | 8688 |

In the following experiments on stones, the pressure was communicated through a kind of pyramid, the base of which rested on the hide leather, and that, on the stone †. The lever pressed upon the apex of the pyramid. Cubes of one and a half inch.

| No. | | Spec. grav. | lbs. avoirdu. |
|---|---|---|---|
| 105 | Chalk .. .. .. | .. | 1127 |
| 106 | Brick of a pale red colour .. | 2·085 | 1265 |
| 107 | Roe-stone, Gloucestershire .. | .. | 1449 |
| 108 | Red brick, mean of two trials .. | 2·168 | 1817 |
| 109 | Yellow face baked Hammersmith paviors 3 times | | 2254 |
| 110 | Burnt do. mean of two trials .. | .. | 3243 |
| 111 | Stourbridge or fire brick .. | .. | 3864 |
| 112 | Derby grit, a red friable sand-stone, | 2·316 | 7070 |
| 113 | Ditto, from another quarry .. | 2·428 | 9776 |
| 114 | Killaly white freestone, not stratified | 2·423 | 10264 |
| 115 | Portland .. .. .. | 2·428 | 10284 |
| 116 | Craig Leith, white freestone .. | 2·452 | 12346 |

* The experiments on woods are considerably below those of other writers; and it appears singular that the four-inch specimen should be stronger than the shorter length. According to Rondelet's experiments, to crush a cubic inch of oak it required from 5000 to 6000 lbs. avoirdupoise
— — — of fir - - from 6000 to 7000 lbs.
In the former the pieces were compressed 1-3rd of their length; in the latter one-half of their length (Rondelet's *L'Art de Bâtir*, tom. iv. p. 67.) Mr. Rennie has not stated the diminution of length.—T. T.

† It certainly would have been preferable to have placed a hard and rigid substance next the stone, in order to secure equality of pressure.—T. T.

*June*

*June 5th, 6th, and 7th,* 1817.

| No. | | Spec. grav. | lbs. avoirdu. |
|---|---|---|---|
| 117 | Yorkshire paving with the strata | 2·507 | 12856 |
| 118 | Ditto, do. against the strata .. | 2·507 | 12856* |
| 119 | White statuary marble not veined | 2·760 | 13632 |
| 120 | Bramley Fall sandstone, near Leeds, with strata .. .. .. | 2·506 | 13632 |
| 121 | Ditto, against the strata .. | 2·506 | 13632 |
| 122 | Cornish granite .. .. | 2·662 | 14302 |
| 123 | Dundee sandstone or brescia, two kinds .. .. .. .. | 2·530 | 14918 |
| 124 | A two-inch cube of Portland .. | 2·423 | 14918 |
| 125 | Craig Leith with the strata .. | 2·452 | 15560 |
| 126 | Devonshire red marble, variegated | .. | 16712 |
| 127 | Compact limestone .. .. | 2·584 | 17354 |
| 128 | Peterhead granite hard close grained | .. | 18636 |
| 129 | Black compact limestone, Limerick | 2·598 | 19924 |
| 130 | Purbeck .. .. .. | 2·599 | 20610 |
| 131 | Black Brabant marble .. .. | 2·697 | 20742 |
| 132 | Very hard freestone .. .. | 2·528 | 21254 |
| 133 | White Italian veined marble .. | 2·726 | 21783 |
| 134 | Aberdeen granite, blue kind .. | 2·625 | 24556† |

N. B. The specific gravities were taken with a delicate balance, made by Creighton of Glasgow, all with the exception of two specimens which were by accident omitted ‡.

* Gauthey tried the stones in different positions in respect to their natural beds; but from a general view of his experiments it does not appear that he was correct in concluding them to be stronger when "*posées en délit*," because his comparison is made between means that include sections of very different forms. (Rozier's *Journ.* tome iv. p. 406.)—T. T.

† According to Gauthey's experiments a cubic inch

| | | | |
|---|---|---|---|
| of brick, | specific gravity 1·557, | was crushed by | 1562 lbs. avoirdupoise. |
| of Flanders' marble | - 2·628 | - - | 13142 |
| of Genoese do. | - 2·700 | - - | 4856 |
| of porphyry - | - 2·871 | - - | 35568.—T. T. |

‡ Mr. Rennie has of course taken the specific gravity in the usual manner, but certainly not the real specific gravity of the stone in any of the porous ones, though it may be that of the material the stone is composed of. When a stone is porous—and many building stones are very much so—it will be found that the specific gravity as usually obtained, is not the weight of a cubic foot in ounces avoirdupoise, which it certainly ought to be, and particularly where the information is intended for the use of practical men. If Mr. Rennie were to try any of his specimens, he would find the weight of a cubic foot much below the numbers he has given in the case of brick, oolite, and sandstones. The specific gravity of a minute concretion of Portland stone may be 2·432, or as Kirwan has it 2·461, but that of the stone itself is much lower.

Were the real specific gravity of porous stones taken, their comparative heaviness would become a more decisive mineral character than it is according to the present method, and the correction presents no difficulty.—T. T.

*Remarks.*

In observing the results presented by the preceding table, it will be seen that little dependence can be placed on the specific gravities of stones, so far as regards their repulsive powers, although the increase is certainly in favour of their specific gravities. But there would appear to be some undefined law in the connexion of bodies, with which the specific gravity has little to do. Thus, statuary marble has a specific gravity above Aberdeen granite, yet a repulsive power not much above half the latter. Again, hardness is not altogether a characteristic of strength, inasmuch as the limestones, which yield readily to the scratch, have nevertheless a repulsive power approaching to granite itself*.

It is a curious fact in the rupture of amorphous stones, that pyramids are formed, having for their base the upper side of the cube next the lever, the action of which displaces the sides of the cubes, precisely as if a wedge had operated between them. I have preserved a number of the specimens, the sides of which, if continued, might cut the cubes in the direction of their diagonals.

*Experiments made on the transverse Strain of cast Bars, the Ends loose. June 8th,* 1817†.

| | | | Weight of the bars, lbs. | oz. | dist. of bearings. ft. | | lbs. avoir. |
|---|---|---|---|---|---|---|---|
| 135 | Bar of 1 inch square | .. | 10 | 6 | 3 | 0 | 897 |
| 136 | Do. of 1 inch do. | .. | 9 | 8 | 2 | 8 | 1086 |
| 137 | Half the above bar | .. | .. | | 1 | 4 | 2320 |

138 Bar

* A curious circumstance was observed by Rondelet in his experiments; viz. that the blocks from the middle of a stratum of stone were of a higher specific gravity than those taken either from the upper or lower part of the stratum. The stones were from Châtillon, Bagneux, &c. He also observed, that in the same kind of stone the strength was as the cube of the specific gravity. (*L'Art de Bâtir*, tome iii. p 83, *et suiv.*) That any relation should exist between the specific gravity and strength of stones of different kinds was not to be expected, as the strength depends on other properties.—T.T.

† It is in these experiments that we have most to regret the want of observations, and those of a nature that would have added little to the labour which all who make such experiments must undergo. It is however a labour that is to a mind engaged in the search of knowledge, more pleasing than those unaccustomed to such feelings can conceive. But too often it is a pleasure that cannot be pursued, except at an expense and encroachment on the hours of business which a professional man can ill afford to indulge in. The defect of these experiments consists in the want of observations on the flexure produced by given weights, particularly in the first degrees of deflexion; and it is the more to be regretted, because we have very few experiments on cast-iron where such observations have been made. Banks states that his specimens bent about an inch at the time of fracture; and Dr. Young has calculated the height of the modulus of elasticity from this statement, (Nat. Phil. vol. ii. art. 326); but it is well known that the deflexion is not regular when the piece is nearly broken. In Banks's experiments

| No. | | Weight of the bars, lbs. | oz. | dist. of bearings. ft. | | lbs. avoir. |
|---|---|---|---|---|---|---|
| 138 | Bar of 1 inch square, through the diagonal .. | 2 | 8 | 2 | 8 | 851 |
| 139 | Half the above bar .. | .. | | 1 | 4 | 1587 |
| 140 | Bar of 2 inches deep, by $\frac{1}{2}$ inch thick .. .. | 9 | 5 | 2 | 8 | 2185 |
| 141 | Half the above bar .. | .. | | 1 | 4 | 4508 |
| 142 | Bar 3 in. deep, by $\frac{1}{3}$ inch thick | 9 | 15 | 2 | 8 | 3588 |
| 143 | Half the bar .. .. | .. | | 1 | 4 | 6854 |
| 144 | Bar 4 inches, by $\frac{1}{4}$ inch thick | 9 | 7 | 2 | 8 | 3979 |
| 145 | Equilateral triangles with the angle up and down. | | | | | |
| 146 | Edge or angle up .. | 9 | 11 | 2 | 8 | 1437 |
| 147 | ——— angle down .. | 9 | 7 | 2 | 8 | 840 |
| 148 | Half the first bar .. | .. | | 1 | 4 | 3059 |
| 149 | Half the second bar .. | .. | | 1 | 4 | 1656 |
| 150 | A feather-edged or ⊥ bar was cast whose dimensions were | | | | | |
| 151 | 2 inches deep by 2 wide | 10 | 0 | edge up 2 | 8 | 3105 |
| 152 | Half of ditto | | | | | |

N. B. All these bars contained the same area, though differently distributed as to their forms.

ments on curved bars the deflexion is given, but the thickness of the bars is not stated. It is true Rondelet has made some experiments on cast-iron where the successive deflexions were registered, but these experiments are not very regular; besides, it would be desirable to have experiments on British iron.

As I have two experiments by me, I shall take this opportunity of laying them before your readers. A bar of cast-iron, from a Welsh foundry, which did not yield easily to the file, was laid upon supports exactly three feet apart; the bar was an inch square, and when 308 lbs. were put into a scale suspended from the middle of its length the deflexion was found to be 3-16ths of an inch; whence the height of the modulus of elasticity is 6,386,688 feet. The experiment was made by Mr. R. Ebbels, at Garnons, near Hereford. A joist of cast-iron 9 inches deep, resembling in form the letter I, was laid upon supports 19 feet apart, first on its edge, when the deflexion from its own weight was 3-40ths of an inch. It was then laid flatwise, and the deflexion from its own weight was $2\frac{1}{2}$ inches. The castings were from Messrs. Dowson's foundry, Edgware-road. The iron yielded easily to the file. The height of the modulus of elasticity according to the experiment on the joist flatwise is 5,100,000 feet

——— on the edge is 5,700,000 ——.

The deflexion being very small when the joist was on its edge, perhaps it was not measured with the necessary degree of accuracy, as a very small error would cause the difference in the result. The following tablet contains the value of the modulus for cast-iron, according to the experiments above stated.

| | *Height of Modulus in feet.* | *Experimentalists.* |
|---|---|---|
| Cast-iron (Welsh) . . | 6,386,688 | Ebbels. |
| Cast-iron . . . | 3,500,000 | Banks. |
| Cast-iron, gray French, . | 5,095,480 | Rondelet*. |
| Cast-iron, soft do. . . | 4,247,000 | Rondelet*. |
| Cast-iron . . . . | 5,700,000 | By my trial.—T.T. |

* *L'Art de Bâtir*, tome iv. part ii. p. 514.

*Experi-*

*Experiments made on the Bar of 4 Inches deep by ¼ Inch thick, by giving it different Forms, the Bearings at 2 Feet 8 Inches, as before.*

| No. | | lbs. | lbs. |
|---|---|---|---|
| 153 | Bar formed into a semi-ellipse, weighed | 7 | 4000 |
| 154 | Ditto, parabolic on its lower edge .. | .. | 3860 |
| | Ditto, of 4 inches deep by ¼ inch thick | .. | 3979 |

*Experiments on the transverse Strain of Bars, one End made fast, the Weight being suspended at the other, at 2 Feet 8 Inches from the Bearing.*

| | | |
|---|---|---|
| 155 | An inch square bar bore .. .. | 280 |
| 156 | A bar 2 inches deep, by ½ an inch thick .. | 539 |
| 157 | An inch bar, the ends made fast .. .. | 1173 |

The paradoxical experiment of Emerson was tried, which states that by cutting off a portion of an equilateral triangle (see page 114 of Emerson's Mechanics) the bar is stronger than before, that is, a part stronger than the whole. The ends were loose at 2 feet 8 inches apart as before. The edge from which the part was intercepted was lowermost, the weight was applied on the base above, it broke with 1129 lbs., whereas in the other case it bore only 840 lbs.

## *Remarks on the transverse Strain.*

Banks makes his bar from the cupola, when placed on bearings 3 feet asunder, and the ends loose, to bear .. 864 lbs.

Now all my bars were cast from the cupola, the difference was therefore .. .. .. .. 33 lbs.

I adopted a space of 2 feet 8 inches asunder, as being more convenient for my apparatus. The strength of the different bars, all cases being the same, approaches nearly to the theory, which makes the comparative values as the breadths multiplied into the squares of the depths. The halves of tke bars were tried, merely to keep up the analogy. The bar of 4 inches deep, however, falls short of theory by 365 lbs. It is evident we cannot extend the system of deepening the bar much further, nor does the theory exactly maintain in the case of the equilateral triangle by .. .. .. .. 243 lbs.
The diagonal position of the square bar, is actually worse than when laid on its side, contrary to many assertions *.

* That a square bar was weakest in the direction of its diagonal, I had from theory determined some time ago, and the investigation is given in the Phil. Mag. vol. L. p. 418; and it is very satisfactory to find it confirmed by these experiments, and also by those of Mr. Barlow.

It is not an easy task to make accurate experiments on triangular bars, as it is difficult to protect the angle, unless a kind of saddle be used, which must affect the result.—T. T.

The

The same quantity of metal in the feather-edged bar, was not so strong as in the 4 inch bar.

The semi-elliptical bar, exceeded the 4 inch bar, although taken out of it. The parabolic bar came near it.

The bar made fast at both ends, I suspect must have yielded, although the ends were made fast by iron straps. The experiments from Emerson, on solids of different forms, might be made; but the time and trouble these experiments have already cost, have compelled me to relinquish further pursuits for the present. If, however, in the absence of better, they are worthy of the indulgence of the Royal Society, it will not only be a consolation to me that my labours merit their attention, but a further inducement to prosecute the investigation of useful facts, which, even in the present advanced state of knowledge, will yet admit of addition*.

I am, with much respect,

George Rennie.

Since my return to England, I find that a set of experiments have been undertaken by Mr. Peter Barlow, of the Royal Military Academy. They are very interesting, but contain no experiments on the repulsive power of bodies, and consequently, my communication is not altogether superseded, although a space of seven months has elapsed since this was written.

London, Dec. 28, 1817. G. R.

* The science of construction is yet in its infancy, and certainly requires many additions. The first experiments on the strength of materials appear to have been made before the Royal Society; and there can be no doubt that a favourable reception will be given to any others that will tend to elucidate a subject, which is likely to form one of the principal branches of an engineer's education; as he must either proceed on the principle of science, or be directed by a feeling of fitness which is to be acquired only by devoting a life-time to the practice of his art. It is to be hoped, that Mr. Rennie will speedily bring forward some additions to the valuable experiments he has already made, with more detailed descriptions of the phænomena observed in the course of his labours. The example of the chemists ought to be followed, as it is not the number but the accuracy and correct description of experiments that constitute their value. Mr. Barlow has represented some of the fractures in his experiments by engravings, which is certainly an excellent plan.

In Evelyn's *Silva* (Dr. Hunter's edition, vol. ii. p. 227) it is stated that a treatise on duplicate proportion was published by Sir William Petty, in which is "A new hypothesis of elastic or springy bodies, to show the strengths of timbers, and other homogeneous materials applied to buildings, machines, &c." I have never been able to procure the work; but if any of your correspondents could furnish a sketch of this "New Hypothesis," it would be a desirable addition to the history of this branch of science; as, if it should accord with Evelyn's description, our countryman will rank amongst the first contributors to the resistance of solids.—T. T.

XXVII. *Dis-*

XXVII. *Dissertation on the Origin and the uniform Distribution of Animal Heat. By Professor* Van Mons, *of Louvain**.

That union of functions which constitutes animal life can only have effect at a certain degree of temperature. These functions consist in a succession of compositions and decompositions, which take place according to laws modified by the vital influence, whose foundation is in caloric.

Persons have occasionally remarked, that the temperature of their bodies was different from that of the medium in which they lived, and they have sought to discover the cause of this difference.

The philosophers of antiquity touched pretty nearly upon this cause, when they admitted "that by the identification of the air with the blood, this liquid becomes improved, and assumes a spiritous nature, from which result heat and pulsation." These are their own words.

More recent speculators, either losing sight of these opinions of the ancients or interpreting them very badly, have wandered much further from the truth, and given themselves up to systems more or less absurd; one of the most in vogue of which has been, that which attributes the development of animal heat to the friction of the blood against the sides of the sanguiferous vessels.— These systems having no longer any partisans, do not stand in need of refutation.

It was necessary that modern chemistry should shed its light upon the secrets of physiology, in order to give a just idea of the mechanism of respiration, and to deduce from it the true origin of animal heat.

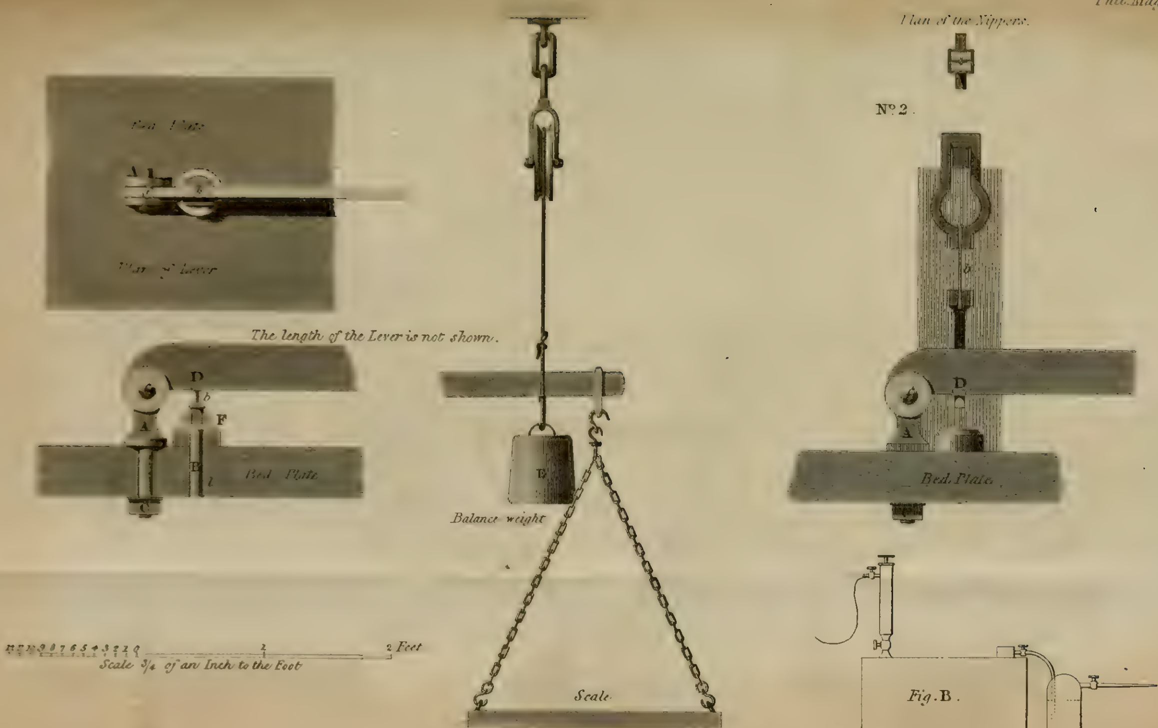
Mayo and other chemists had perceived a strong analogy between the process of combustion and that of respiration; but it was reserved for French chemistry to place the phænomena of this last process in its full light.

The authors of the new theory of respiration believed for a long time, that there takes place in the lungs a direct and complete combustion of carbon and of the hydrogen of the blood by the oxygen gas inspired; and that the caloric disengaged by that combustion, after having gasified the carbonic acid, and evaporated the water, unites itself to the blood in order to be transferred into the circulation and furnish the animal heat.

But on the supposition that matters were thus arranged, the cavity of the thorax would have a temperature much superior to that of other parts of the body, and would serve in some sort as a

* Translated from a communication made by the author.

heating


Plan of the Nippers.
N° 2.
b
D
A
Bed Plate
Plan of Lever
A
The length of the Lever is not shown.
D
b
F
A
B
l
C
Bed Plate
E
Balance weight
Scale
Fig. B.
12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 Feet
Scale 3/4 of an Inch to the Foot

S. Porter sc.

XXVI

*tion*

*vain*

THAT

have e

consist

take p

founda

Pers

their b

lived,

ence.

The

cause,

with t

ritous

their c

Mo

of the

much

more

that w

tion o

These

need o

It w

upon t

mecha

of ani

May

tween

was re

last pr

The

time, t

combu

oxyge

bustio

the wa

the cir

But

cavity

that o

heating stove. It was easy to make sure of the real state of the fact, by introducing a thermometer into the thorax of a living animal. The experiment was made, and scarcely any greater degree of heat was observed.

It was at first endeavoured to explain this contradiction by supposing that all the caloric which is separated from the air is absorbed in order to gasify the carbonic acid and evaporate the water, a supposition which many foreign physiologists still admit, although it is known that carbonic gas becomes condensed with scarcely any elevation of temperature, and may also be gasified without absorbing almost any heat, and that the ordinary temperature of bodies with the aid of the suspending affinity of the air is more than sufficient for the evaporation of water, as is proved by cutaneous transpiration, and other evaporations which are produced by natural heat alone.

Abandoning therefore this theory, which did not besides furnish any reason for the uniform distribution of animal heat, nor explain, any more than the experiments opposed to it, the origin of that heat, another was had recourse to, but equally unsatisfactory—I allude to the theory of changed capacities.

I should have passed over this theory also without observation, if it had not been in our own days revived in all its original purity by men of merit, and if physiologists of the first rank had not united it with the theory of combustion.

This theory supposes between the venous and arterial bloods a great difference of capacity, in virtue of which the latter takes up and combines, without any rise of temperature, the whole quantity of caloric which is set free by the combustion of carbon and the hydrogen of venous blood, and it founds this supposition on the medium of the caloric contained in the two bloods, and of the air inspired and inhaled.

As this difference of capacity depends on the different nature of the two bloods, it ought to change in proportion as by the effect of circulation the arterial blood approaches to the nature of the venous blood, and it ought to resolve itself in the same degree with the caloric which spreads itself uniformly through all parts of bodies.

This theory, which seems to remove the two great difficulties of the theory of direct combustion, the permanence of the temperature of the cavity of the thorax, and the equal distribution of heat, is however contradicted by many facts, as we shall now proceed to prove.

In the first place, nothing establishes this change of capacity which the venous blood is supposed to undergo in becoming arterial blood; and it is far from probable that so slight a change in in the physical nature of blood should lead to a change so considerable in respect of its capacity for caloric.

The measure of this capacity has been taken after a change resulting from a chemical action, while the true capacity is the representation of the quantities of caloric which bodies of different natures require in order to attain an equal temperature without any change of form. The same erroneous sort of estimation has been followed with respect to air inspired and exhaled.

In every change of the capacity of a body, the caloric ought to set itself free at least for some instants; but no such thing occurs in the case of which we are now treating.

We might further object to the supporters of this theory, that that development of caloric which they suppose to result from the adhesion of assimilating principles, is amply compensated by the cold which is produced, as well by the solids which become liquefied as by those liquids which assume the state of vapour, so that, in their final result, these operations ought to be rather a source of cold than heat to animals. Besides, the little heat developed in cold-blooded animals, among whom this solidification of liquids also takes place, proves how little this ought to be considered as an active mean in the production of animal heat.

It is still necessary, then, to return to the theory of combustion, in order to explain the theory of animal heat; but to this theory considered in a point of view different from what has been hitherto done. The oxygen gas condensed in the lungs forms undoubtedly all the caloric which maintains the body at its habitual temperature, and furnishes besides, to the liquids of cutaneous perspiration and other exhalations, the heat which evaporates them; but this condensation takes place by means of a particular mechanism which we shall now explain.

Oxygen gas is the only body of a nature amply provided with caloric chemically combined, and which does not lose by any pressure or diminution of temperature; it does not yield this principle but to the strongest attraction exercised on its base by some other body, and it yields it only by degrees, and on account of the force of that attraction. It becomes therefore decomposed by retaining different portions of caloric, so as to form ternary compounds of combustible substance, of oxygen, and of caloric. It is only by having neglected this property of oxygen gas, so particular and so fertile in its results, that philosophers have not hitherto been able to give a satisfactory explanation of the production and uniform distribution of animal heat.

The venous blood is distinct from the arterial blood in this, that the latter is provided with principles constituted in such a manner as to be able to serve for the nutrition of organs, while the former

former is in some manner a vehicle or exhausted residuum of the same principles. It may, in this respect, be compared to a soil which vegetation has deprived of all its nourishing juice.

In fact, the portion of carbon and of hydrogen put into play by the effect of respiration, appears in the venous blood to be reduced nearly to its last state of composition, at least to a state very near to it. This state is, in respect of these two principles, their combination saturated with oxygen, the first in carbonic acid and the second in water, which forms at the same time the result of their greatest affinity. These principles thus enchained can no longer enter into new combinations.

The arterial blood, on the contrary, is rich in principles slightly compound, or held only by weak affinities; it contains an oxide with a triple base, which, owing its existence to equibalancing affinities, can at every instant be broken in its combination by a slight affinity, and such as can exercise upon it all the power of a kindred composition: thus is the blood destined to furnish nourishment to the organs, and to serve as aliment to natural heat.

But as soil exhausted of its juices only requires to receive the materials proper for the formation of these juices, and to be brought at the same time into contact with the air, in order to resume all its nutritious properties; so in like manner the venous blood charged with chyle and lymph, only requires to receive the same contact in the lungs, in order to become again able to furnish sustenance to all the assimilating functions. I do not know if, except in the case of disease, this blood might not even be considered as an unalterable liquid, the functions of which are confined to serving as a vehicle for the chyle and lymph; so that the carbonic gas and water which disengage themselves from this blood in its passage by the lungs may be the last product of the decomposition of these liquids.

However this last supposition may be, still it appears certain that the venous blood only presents to the air a determined quantity of nutritive juice; that this juice, before entering into the lungs, forms a compound of carbon, hydrogen and azote, which the contact of the air oxidizes, and which, in virtue of its complicated composition, possesses the property of attaching itself to the oxygen gas, while it hardly disturbs its union with caloric. The latter effect takes place in virtue of affinities which counterbalance each other, and which on the one hand have carbon for their agent, and on the other hydrogen united to azote. The effect of this counterbalancing is to prevent the oxygen from combining with either of these agents in particular, keeping it in equilibrio, equally attracted by both, and only sufficiently decomposed to be in a state of condensation.

The fact of this equi-balanced attraction may be easily comprehended in spite of the intervention of a substance, such as carbon, which exhibits in itself so powerful an attraction for oxygen. It is sufficient to reflect that this substance is here destitute of the degree of heat necessary for acting with efficacy on the base of oxygen gas, and that the union of two combustibles, especially when they are both disposed to assume the gaseous state, increases considerably their affinity with that base. I believe even that in this case the carbon requires to be united to a small portion of hydrogen, in order to be assisted in its attraction for the oxygen, and that the azoto-hydrogenous compound requires, on the same principle, a little carbon in order to retain its identity.

It is easy to perceive what ought to be the effect of the circulation of a compound thus constituted, and in which the oxygen remains charged with nearly the whole of its immense provision of caloric. It is unnecessary to state, that the affinity of the assimilating power for one or other, or for the whole of these principles, must very soon destroy that combination, and that the oxygen disengaged from those channels which prevented it from entering into a more solid combination, must either contract a similar union, partly with the hydrogen which only decomposes it partially, and partly with the carbon which extracts from it the greatest possible quantity of caloric, or that it must be itself assimilated; and that in either of these cases it must lose by little and little that caloric which a slighter affinity had permitted it to preserve. This decomposition occurs principally in the extremities of the arterial vessels, and is perhaps continued, though with less energy, and by ways as yet little known, after the arteries are reunited with the veins, and until the return of the blood to the heart.

We may conclude then, that in all those functions which depend on decompositions and compositions by chemical affinity, (and there are few which are not in this situation,) the undecomposed oxygen continues to consume, more or less completely, one or other of the combustible substances which form the base of animal composition. It must be necessary accordingly that there should be a disengagement of caloric every where, or a similar action takes place, either by the oxygen of the oxidized blood, or by that which is separated from the water when that action passes beyond the sphere of circulation.

The action of vegetable life differs from that of animal life in this respect; that in the first the assimilation is effected by the condensation of the carbon and hydrogen with a disengagement of oxygen; and that in the latter every thing is effected by the intervention, and by a more solid condensation, of this principle.

XXVIII. *On*

## XXVIII. *On the Proteus* (*Proteus anguinus*). *By M.* Rudolphi*.

It has been for a long time supposed that this singular animal is only to be found in the lake of Sittich in Carniola, and that it only issues from it in the case of inundations; but M. Rudolphi some time ago discovered it in the grotto of St. Madeleine, about a league from Adelsberg; and it may be also now found in some lakes and ponds, in sufficient numbers to make it a matter of no difficulty to procure specimens.

The manners and the habits of the Proteus have a great affinity with those of the Salamander; and hence has arisen the same prejudice with respect to it; namely, that it announces changes in the atmosphere. When the weather is fine, it is gay and lively, and sometimes protrudes its snout out of the water; while in bad weather it remains tranquil at the bottom of any vase of water in which it may be kept.

Although the eyes of the Proteus are very small, and covered with thick enough eyelids, they are extremely sensible to the light, a strong suffusion of which renders the animal extremely lively in its movements. The veins which present themselves in such numbers to the naked eye, and still more abundantly to a magnifying glass, under the transparent skin of the animal, and whence that secretion of viscous plaster with which they are so profusely covered probably proceeds, seem to be expanded by the action of the light. It may, however, be so accustomed to the light as to become less sensible in this respect. M. Rudolphi mentions the case of a Proteus which had at the time of his writing been kept for six months in a glass vase placed in the window of a house, though partially in the shade.

Although the Proteus will live for several years in water without any supply of food, there have been sometimes found in its stomach, on dissection, the remains of periwinkles and other small animals.

The irritability of the Proteus is not great. M. Rudolphi has in many instances cut off the tail from the trunk, and instantly all motion ceased, even when galvanism was applied to excite it, while the dissevered parts of Salamanders ordinarily preserve their irritability for some hours.

M. Rudolphi is led from this to hope that he may yet be able, as he has still ten specimens of the animal alive, to establish some important results on the reproductive power with respect to which he has already made numerous experiments.

* Extracted from a Letter by M. Rudolphi to M. Linck, inserted in the *Bibliothèque Universelle* of Geneva for April 1818.

The muscles of the Proteus are also very weak, nor is there any animal whose blood presents such large globules. The lungs have a great resemblance to the *natatoire* bladder of fish; whence M. Rudolphi infers that they probably contribute very little to the decarbonization of the blood; and as the globules of the blood, from their large size, and consequently small number, offer necessarily less surface, he is further inclined to think that branches are indispensable.

On dissecting four individuals recently caught, he found in one of them large ovaries communicating with the rectum; and in another of twenty inches eight lines in length, testicles of considerable size with small *epididymæ*.

M. Rudolphi concludes from all these facts, that these animals are not of the species of bull-heads, but perfect animals.

---

## XXIX. *New experimental Researches on some of the leading Doctrines of Caloric; particularly on the Relation between the Elasticity, Temperature, and latent Heat of different Vapours; and on thermometric Admeasurement and Capacity.* By ANDREW URE, *M.D.*

[Concluded from p. 102.]

### CHAPTER II.

### *On thermometric Admeasurement, and the Doctrine of Capacity.*

BEFORE inquiring into the relative quantities of heat contained in different vapours at the same tension, it will be proper to determine the primary and fundamental proposition concerning the measure of temperature. It is singular, that not one experimental fact has been advanced, capable of settling this question, amid the contending opinions of chemical philosophers. Mr. Dalton has, in particular, exerted all the resources of his genius and science to destroy our confidence in the thermometric scale; our sole guide in the vast and intricate province of caloric. While I hope to be able to fix this now indeterminate point, by a new train of investigations, and consequently to prove the entire fallacy of his doctrine of temperature, the key-stone of his system of heat, I do not mean to affirm the absolute uniformity of expansion in bodies, by equal increments of that power. I think it indeed highly probable, that every species of matter, both solid and liquid, follows an increasing rate in its enlargement by caloric. Each portion that enters into a body must weaken the antagonist force, cohesion; and must therefore render more efficacious the operation of the next portion that is introduced. Let 1000 represent the cohesive attraction at the commencement;

mencement; then, after receiving one increment of caloric, it will be become $1000-1=999$. Since the next unit of that divellent agent will have to combat only this diminished cohesive force, it will produce an effect greater than the first, in the proportion of 1000 to 999; and so on in continued progression. That the increasing ratio is, however, greatly less than Mr. Dalton maintains, may, I think, be clearly demonstrated.

According to his table of equal increments of temperature, vol. i. p. 14, New System, we have the following intervals, corresponding to the five successive intervals of 90° on our scale.

| | | | | | |
|---|---|---|---|---|---|
| From 32° to | 122°, to | 212°, to | 302°, to | 392°, to | 482°. |
| Intervals by Fahr. of | 90°, | 90°, | 90°, | 90°, | 90°. |
| True intervals by Dalton, | 102°·4 | 77°·6 | 63°·9 | 55°·7 | 50°·5. |

The relative inequality of these intervals is deduced from Mr. Dalton's law, that "all pure homegeneous liquids, as water and mercury, expand from the point of their congelation, or greatest density, a quantity always as the square of the temperature from that point." He regards the law as resulting from the constitution of liquids, and therefore not applicable to solid bodies. This is indeed implied in its enunciation. In p. 43, after assigning reasons, he states, "that for all practical purposes we may adopt the notion of the equable expansion of solids."

Now I am prepared to prove, either, that the expansion of solids partakes of the above inequability of liquids, which nobody imagines, and for which no reason, even hypothetical, can be assigned; or, which is the only alternative, that homogeneous solids, and mercury, proceed almost exactly, *pari passu*, in their rates of expansion by heat.

The experiments which justify this assertion were made by me about five years ago, and were then exhibited to many of my chemical friends, as also in my public lectures; but a wish to render the series more complete, has induced me to withhold them from the public eye, till requisite leisure could be afforded for this purpose. They were performed with a pyrometer of peculiar construction, in an oblong trough filled with melting ice: a strong bar of Swedish iron was placed, from which projected at right angles four inflexible iron arms, attachable by powerful screws to any part of the bar. The arms nearest the extremities of the bar carried each a fine micrometer microscope, made by that admirable artist Mr. Troughton. The other two arms were incurvated downwards at their extremities, which supported a metallic or other rod. This was fixed by two pinching screws at one end, but lay loose on a friction roller at the other. The loose end bore an elevated index. The curvature of these two arms was such as to allow their extremities, with the attached rod, to be plunged *beneath the surface of oil or water,*

 *about*

*about an inch*, contained in a copper trough. This was placed parallel to the large trough, and a few inches distant from it.

The copper vessel was slowly and equably heated, by a series of Argand lamps placed beneath. One micrometer watched a point projecting from the arm that held the fixed extremity of the rod. The oil was carefully agitated during the application of the heat; and the bulbs of three thermometers, mutually comparable, were immersed into it at regular distances. The micrometers were screened from the influence of the heat. They rendered the $\frac{1}{20000}$ of an inch discernible, and even a smaller quantity, by an experienced eye.

A rod of pure Swedish iron, or of such pure copper as jewellers use for alloying gold, being adjusted to the apparatus, the point on the micrometer scale, that appeared a tangent to the small luminous aperture in the thin index plate of steel, was noted down, when the liquid in the trough was at 32°. The value and truth of the micrometrical indications had been previously ascertained, by viewing through the microscopes a given surface or aperture, moved laterally, so as to make its image successively coincide with the different points of the interior notched scale.

Heat being now applied, the progressive march of the index across the field of view of the micrometer microscope was closely observed, and its position written down at intervals of 10° or 20° of the Fahr. thermometer. But as the pyrometrical details will appear in a separate memoir on the expansions of bodies, I shall state here merely what concerns the present subject.

If we denominate the absolute elongation of the heated metallic rod from 32° to 122°·10, then its elongation from 122° to 212°; from 212° to 302°; from 302° to 392°; from 392° to 482°, was in each successive interval of 90° F. as nearly as possible 10 also. The slight irregularities incident to all delicate experimental investigations being often in opposite directions, in different repetitions of the same experiment, or those which manifested themselves in the ascending or elongating range, were neutralized, so to speak, by others of an inverse nature, which appeared in the cooling retrocession. *Here*, the movements of the liquid mercury and of the solid rod by heat proceeded, *pari passu*, through a very great extent of temperature. Let us now recollect that these five increments, which on our thermometer are equivalent to $5 \times 90° = 450°$, and which altogether produce five times the elongation that the first interval occasions, constitute, on Mr. Dalton's scale, only 350°. If we call the first interval given by this philosopher 1·00, then the four succeeding intervals contain a range of temperature, on his scheme, of only two and a half times the first; and therefore only two and a half times additional

additional elongation should have been produced, instead of four times as found by experiment. "Since for all practical purposes uniform increments of bulk, or expansions of *solids* by heat, correspond to uniform increments of this power;" then each of our old successive intervals of 90° may, for all practical purposes, be held to correspond to equal increments of temperature.

Mr. Dalton's intervals from 32° to 482° Fahr. are as before given, 102°·4; 77°·6; 63°·9; 55°·7; 50°·5=350°·1. Now, if we call the first quantity 1·00, it will produce on a metallic rod a corresponding effect in expansion = 1·00. The next interval of Mr. Dalton's scale (equal always to 90° Fahr.) can produce only $\frac{3}{4}$ of the effect of the first, or as 75 to 100. The third, fourth, and fifth intervals will give the fractional expansions in reference to the first, of $\frac{62}{100}$, $\frac{54}{100}$, and about $\frac{50}{100}$, or merely a half.

No such diminution of effect was observed in the experiments; from 392° to 482° F., the rod elongated as much as from 32° to 122°, or double the quantity compatible with the Daltonian hypothesis. Thus therefore we have a rigid, and I think unanswerable demonstration of the general correctness of the common scale of temperature, and of the extreme inaccuracy and inapplicability of Mr. Dalton's geometrical substitute. Should the preceding statement leave any doubt or obscurity concerning the legitimacy of the inference now drawn, I trust it will be entirely removed, when the details of the experiments are published, with drawings of the apparatus, in my treatise on pyrometry.

Yet though the mercury in the thermometer tube move, *pari passu*, with a metallic rod, deemed uniform in its expansion, it does not prove perfectly equal uniformity of expansion to belong to the mercury. It will seem, no doubt, a paradoxical assertion, that of two bodies marching together, hand in hand, one of them may have an equable pace, while that of the other is regularly, but very slowly accelerated. Yet I think the position just. It proceeds from a circumstance in the thermometer sufficiently obvious, but which seems to have escaped our *systematic* writers. I do not rest the proposition on any imperfection of workmanship, or supposed irregularity in the expansions of the glass.

Let us take a thermometer, the calibre of whose stem is perfectly uniform, and whose scale is exactly divided. Let it have a range from zero to the 656th degree, at which mercury boils, by the accurate experiments of Creighton. At 32°, let the mercury stand at the bottom of the ivory scale, where of course the graduations commence. The bare part of the instrument is consequently the plunging limit, in most chemical researches on the temperature of liquids. Immerse the bulb in common oil, or

oil

oil of vitriol heated to 212°; $\frac{1}{63}$* part of the whole included mercury will now ascend above that part of the stem plunged in the liquid. The part actually exposed to the heat, and by whose expansion the column on the scale is supported, is only $\frac{62}{63}$ of the initial mass. Augment the heat of the oil till the instrument indicate 392°; we know that there remains now, under the immediate influence of the heat, $\frac{61}{63}$ nearly of the original weight of mercury; and finally, at 572°, only about $\frac{60}{63}$ rest in the immersed part of the stem and bulb.

$\frac{3}{63}$ or $\frac{1}{21}$ parts may be considered as no longer subjected to the power of caloric. If the themometer stem were recurved near the bulb, the mercury in the stem placed horizontally would be cold; and this proposition would be almost exactly true.

Now, since the calibre and divisions are uniform, the capacity of the tube from the point marked 212° to that marked 392°, and again from this to that opposite to 572°, is in each equal to its capacity from 32° to 212°. Hence these three equal capacities are filled by the expansions of the three unequal quantities of mercury 62, 61, 60. At the highest station, the column of quicksilver equal on the stem to $3 \times 180°$, is sustained by the expansion of 60 parts; at the middle point, $2 \times 180°$ is supported by that of 61; and at 212° there are 62 parts of mercury to sustain 180° in the tube. Or, to put it in another form, these three successive spaces on the scale are equal; the first portion of mercury is protruded into it by the expansion of 62 parts in the bulb; the second portion by the expansion of 61; and the third by that of 60.

Therefore, if these three thermometric intervals of 180°, each of which holds an equal measure of mercury, contain also equal increments of temperature, as denoted by the equal increments of a metallic rod; then, these three equal effects are produced from the unequal quantities of mercury 62, 61, 60. This liquid, then, must have an increasing rate of expansion, the inverse of these numbers, for every 180° of the scale, or $\frac{1}{62}$, $\frac{1}{61}$, $\frac{1}{60}$. That is to to say, 60 parts at 572° do the same work by the same power of caloric, as 61 at 392°, and 62 at 212°.

I believe this to be the real nature of mercurial expansion, and the true condition of the thermometer; which is an equable measurer of heat, because the mercury possesses the above increasing rate of expansion. Were the mercury, on the contrary, absolutely uniform in its augmentations of volume by equal increments of heat, then for an instrument whose bulb alone in practice can be immersed, the three above ranges should have

* A minute fraction less; but we need not complicate the statement with it.

the

the corresponding parts of the scale shortened in the successive proportions of 62 to 63; 61 to 63; and 60 to 65; quantities taken together nearly equal to 9°, or $=3 \times \frac{1}{62} \times 180 = \frac{540}{62}$.

Whatever reception these speculations may experience, they must not be confounded with the experiments on the expansions of metallic rods, and the corollaries which have a distinct and independent existence.

## § II. *On the Doctrines of Capacity, as connected with the preceding Investigation.*

Dr. Crawford and De Luc tried to verify the justness of the thermometric indications, by mixing together water at 212° and 32°; when the former found 122°, and the latter 119°, to be the resulting temperature. De Luc's number is 3° below the mean; Dr. Crawford's is exact. This ingenious philosopher afterwards sought to confirm the evidence thus given to the accuracy of the scale, by other experiments, which were however of rather an equivocal import. Both of the above results have been condemned and rejected by Mr. Dalton: he states the true mean temperature to be not 122°, nor even 119°, but 110°. For this deviation, the reasons which he assigns appear, independently of all arguments derived from other quarters, to be in themselves inconclusive. He says, "the temperature of the above mixture ought to be found above the mean 122°." "Water of these two temperatures (32° and 212°) being mixed, loses about $\frac{1}{90}$ of its bulk. This condensation of its volume * must expel a quantity of heat, and raise the temperature above the mean." p. 7. Again, p. 50, "that water *increases* in its capacity for heat with the increase of temperature, I consider demonstrable from the following arguments. 1st. A measure of water at any one temperature mixed with a measure at any other temperature, the mixture is less than two measures. Now, a condensatioa of volume is a certain mark of diminution of capacity and increase of temperature †, as in the mixture of sulphuric acid and water; or the effects of mechanical pressure, as with elastic fluids. Second, when the same body suddenly changes its capacity by a change of form, it is always from a less to a greater as the temperature ascends; for instance, ice, water and vapour. Third, Dr. Crawford acknowledges from his own experience, that dilute sulphuric acid, and most other liquids he tried, he found to increase in their capacity for heat with the in-

* That condensation of volume in a liquid, is no proof of the expulsion of heat, is shown in my Essay on Sulphuric Acid.

† For the entire fallacy of this reasoning, see my Essay just quoted; expansion of volume should by Mr. D. increase capacity and diminish temperature. The very reverse is shown in that paper.

crease

crease of temperature. Admitting the force of these arguments, it follows that when water of 32° and 212° are mixed, and give a temperature denoted by 119° of the common thermometer, we must conclude that the true mean temperature is somewhere below that degree. I have already assigned the reason why I place the mean at 110." Now the only reason I can elsewhere find, is derived from his general law, "that all homogeneous liquids expand, as the square of the temperature, from the point of greatest density or congelation." In p. 7, he ventures to assert nothing more than, "that it is not improbable that the true mean temperature between 32° and 212°, *may* be as low as 110° Fahrenheit."

Satisfied from my pyrometrical experiments, that his general hypothesis of the expansion of liquids being as the square of their temperature, is totally inapplicable to mercury, the inference relative to the thermometric mean between 32° and 212° cannot be allowed. But let us examine, on their own merits, the preceding arguments against Dr. Crawford and De Luc's verification of the mean temperature between that of freezing and boiling water.

The reasoning derives its sole force from the assumption, that the capacity of water for heat, increases as its temperature is raised. There is adduced, however, no fact in the least decisive on this main point. What analogy is there between the entire change of form and constitution suffered by an incondensible liquid, on becoming an elastic vapour, and the progressive heating of the liquid itself? Or, although dilute sulphuric acid and other liquids should increase in their specific caloric on being heated, which however has not been satisfactorily demonstrated, are we to assert that water must do so too? It is a matter of surprise to me, that a philosopher of Mr. Dalton's judgement and acuteness should have pressed such inconclusive analogies into his service. He knew well that water is endowed with some curious peculiarities, when compared with other liquids, or anomalies, as we idly style them; for they constitute no anomaly in nature, but wisely fit water for performing the important functions assigned to it in the œconomy of our globe.

In a series of experiments, carefully conducted on the relative capacities for heat, of water, sulphuric acid, oil of turpentine, and spermaceti oil, published in my Essay on hydrochloric acid and the chlorides; it seems to be directly demonstrated that the specific heat of water does not *increase*, but actually *diminishes*, and that very conspicuously, as its temperature rises. It is there proved, that from 210° to 150° Fahr. the specific heat of oil is to that of water as 597 to 1000; and from 150° to 90° as 513 to 1000. The same proportional difference of relation is exhibited

exhibited by the other two liquids. Now, were the phænomenon occasioned by the oil of vitriol, common oil, and oil of turpentine, increasing in *their* capacities for heat in a still more rapid ratio than water, we should undoubtedly expect, from the innate differences between the specific heats of these three substances, to find that they would move independently on each other, or at different rates. But *their* uniform advance together, while water alone varies in this respect, shows distinctly, that in the water resides the cause of the variation. This reasoning may be illustrated in many ways, but by nothing more clearly than the exploded astronomical system of the diurnal and annual movements of the sun and fixed stars; in support of which, very extravagant hypotheses had to be contrived.

The single fact of the motion of the earth once admitted, reduced the Ptolemaic chaos to order. If, in like manner, we should suppose an increasing ratio in the specific heat of water, then we must also suppose a much more rapid increase in the ratios of the above three substances, although their individual specific heats are greatly inferior to that of water. Ought not that body, which has of all others the most decided relation to heat, or highest specific heat, to have also its ratio most decidedly or rapidly augmented? In adopting the increasing specific heat of water, we must further assume, that, however different the initial specific heats of the above three liquids may be, yet, while they possess all the same rate of increase, water alone has a different one; an inadmissible supposition. All these difficulties and contradictions are removed at once by the experimental fact, that water is endowed with a decreasing ratio in its capacity for caloric, as its temperature is augmented.

Since finishing the above researches on specific heat, I have been led to examine attentively the systematic accounts of this subject in our chemical treatises; and I find that Berthollet, with a sagacity peculiar to himself, had anticipated, from the chemical constitution of bodies, such an experimental result as I have recently obtained; though the statements then prevalent all militated against his views. "If caloric obey the usual laws of attraction, when it is in small quantity, relative to the body to which it is united, it will enter into more intimate combination; and hence the elasticity or expansive energy of it, on which temperature depends, may be overcome, and a larger quantity be required to produce a given temperature. Hence, the quantity of caloric contained in bodies in the first stage of temperature, may be greater than it will be higher in the scale."

In the Essay above referred to, I have shown that this circumstance in water, renders it peculiarly qualified for serving as the magazine and equalizer of the temperature of the globe. Since at at our ordinary atmospherical heats, it possesses the greatest capacity for caloric, small variations in its temperature give it a great modifying power over the circumambient air. Although the doctrine of final causes be no safe guide to the discovery of unknown truths, yet when it concurs with experiment, we may deem it an agreeable confirmation. This is finely illustrated by Count Rumford's speculations on the maximum density of water being placed several degrees above its point of congelation; a fact which does not hold with regard to any other homogeneous liquid.

If the specific heat of water, then, diminish as its temperature advances from the freezing to the boiling point, an interval of 10° near 32° will contain more caloric than ten degrees near 122°, and still more than the same intervals near 212°. On this principle we can readily account for the results obtained by Mr. Dalton, in mixing with water at different temperatures a known proportion of ice; though it is remarkable that this able chemist did not see in them any thing inconsistent with his own opposite views upon specific heat.

"176°·5 expresses the number of degrees of temperature, such as are found between 200° and 212° of the old or common scale, entering into ice of 32°, to convert it into water of 32°; 150° of the same scale suffice, he says, for the same effect, between 122° and 130°: and between 45° and 50°, 128° are "adequate to the conversion of the same ice into water. These three resulting numbers (128, 150, 176·5) are nearly as 5, 6, 7. Hence it follows, that as much heat is necessary to raise water 5° in the lower part of the old scale, as is required to raise it 7° in the higher, and 6° in the middle*."

Mr. Dalton, instead of adopting the obvious conclusion, that the capacity of water for heat is greater at lower than it is at higher temperatures, and that therefore a smaller number of degrees of the former should melt as much ice as a greater nnmber of the latter, ascribes the deviation denoted by these numbers, or their differences, to the gross errors of our thermometric graduation; which he considers so excessive, as not only to equal, but greatly to overbalance the real increase in the specific heat of water; which left to its own operation, would have produced opposite experimental results.

That our thermometric scale has no such prodigious deviation from truth, or uniformity of indication, I conceive to be fully established; and therefore the only legitimate inference from these very experiments of Mr. Dalton, is the *decreasing* capacity of water with the increase of its temperature.

* New System, vol. i. p. 53.

It

It deserves to be remarked, that my experiments on the relative times of cooling a globe of glass, successively filled with water, oil of vitriol, common oil, &c. give exactly the same results as Mr. Dalton derived from mixtures of two ounces of ice and sixty of water. This concurrence is the more satisfactory, since, when the Essay on hydrochloric acid was written, I had no recollection of Mr. Dalton's experiments. I found that from 210° to 150° the specific heat of oil bears to that of water the ratio of 597 to 1000; and from 150° to 90°, that of 513 to 1000. Now, at his highest and middle temperatures of 200° and 120°, which come nearest to mine of 180° and 120°, we have by him the ratio of 176°·5 to 150°.

But 597 : 513 : : 176 : 150 exactly, which is a very striking coincidence, and affords the happiest confirmation of the accuracy of both sets of experiments, as well as of the justness of the principles on which they were conducted, and on which, particularly, my reductions were founded. We now see the reason why, when equal weights of water at 32° and 212° are mixed, the temperature may be *below* the mean, as was found by De Luc. The capacity at the middle temperature is greater than the mean capacity of the two extremes, (that is of the ingredients mixed, ice, cold and boiling water,) and therefore the thermometric tension will be lessened, and its mercury will descend on the scale*. This diminution of temperature will cause a corresponding diminution of bulk, which affords a complete answer to Mr. Dalton's first and only plausible argument, formerly quoted against Dr. Crawford's deductions, and the opinions of De Luc. With regard, however, to these experiments, of mixing hot and cold water to find a mean temperature, there are sufficient difficulties to render the result uncertain to two or three degrees. Hence, nothing of moment can safely be inferred from them.

Concerning sulphuric acid in its various states of dilution, I beg to refer the reader to my Essay on the subject, where he will find several peculiarities relative to its volume at different acid strengths, that entirely change its relations to caloric. I have not seen these formerly adverted to by any chemist. They were evidently unknown to Mr. Dalton.

## Chapter III.

### *On the latent Heat of different Vapours.*

What relation is there between the caloric existing in the vapours of different substances, and the temperatures at which they respectively acquire the same elastic force?

* Taking Mr. Dalton's three numbers as correct: then $\frac{176{\cdot}5 + 128}{2} =$ 152°·25. But 150° in the middle are equal to the former mean of the two. Hence, the proposition in the text is demonstrated.

On

On this subject I am not acquainted with any preceding inquiries, though a question of such interest has probably not escaped examination.

In this research I employed a very simple apparatus; and with proper management, I believe it capable of giving the absolute quantities of latent heat in different vapours, as exactly as more refined and complicated mechanisms. At any rate, it will afford comparative results with great precision.

It consisted of a glass retort of very small dimensions, with a short neck inserted into a globular receiver of very thin glass, and about three inches in diameter. The globe was surrounded with a certain quantity of water at a known temperature, contained in a glass basin. 200 grains of the liquid, whose vapour was to be examined, were introduced into the retort, and rapidly distilled into the globe by the heat of an Argand lamp. The temperature of the air was 45°, that of the water in the basin from 42° to 43°, and the rise of temperature, occasioned by the condensation of the vapour, never exceeded that of the atmosphere by four degrees. By these means, as the communication of heat is very slow between bodies which differ little in temperature, I found, that the air could exercise no perceptible influence on the water in the basin during the experiment, which was always completed in five or six minutes. A thermometer of great delicacy was continually moved through the water; and its indications were read off, by the aid of a lens, to small fractions of a degree.

In all the early experiments of Dr. Black on the latent heat of common steam, the neglect of the above precautions introduced material errors into the estimate. Hence that distinguished philosopher found the latent heat of steam to be no more than 800° or 810°. Mr. Watt afterwards determined it more nearly from 900° to 950°; and Lavoisier and La Place have made it 1000°.

It is evident that whenever the water, into which the latent heat is evolved by condensation of the vapour, becomes much hotter than the surrounding air, it will be impossible to ascertain how much of the caloric is dissipated; and consequently, the true quantity contained in the vapour must remain uncertain.

The sources of error in operating with the calorimeter of Lavoisier and La Place were first pointed out by Mr. Wedgwood, and have been since commented on by Dr. Thomson, and other good systematists. It is said to be difficult to obtain precisely uniform quantities of liquefied ice in the repetition of the same experiments, with that celebrated apparatus.

From the smallness of the retort in my mode of proceeding, the shortness of the neck, and its thorough insertion into the globe, we prevent condensation by the air *in transitu;* while the surface of the globe and the mass of water being great, relative

to

to the quantity of vapour employed, the heat is entirely transferred to the refrigeratory, where it is allowed to remain, without apparent diminution, for a few minutes. In numerous repetitions of the same experiment, the accordances were excellent. The following table contains the mean results. The water in the basin weighed in each case 32340 grains. The globe was held steadily in the centre of the water by a slender ring fixed round its neck. The distillation was rapidly performed, so that all the condensation took place in the globe.

*Table of experimental Results on the latent Heat of different Vapours.*

| | | |
|---|---|---|
| 200 gr. of water distilled, raised 32340 gr. water from .. .. .. .. .. | 42°·5 | to 49° |
| 200 gr. alcohol, spec. gravity 0·825 .. | 42 | to 45 |
| 200 gr. sulphuric ether; boiling point 112° | 42 | to 44 |
| 200 gr. oil of turpentine .. .. .. | 42 | to 43·5 |
| 200 gr. petroleum .. .. .. .. | 42·5 | to 44 |
| 200 gr. nitric acid, spec. grav. 1·494; boiling point 165° .. .. .. .. | 42 | to 45·5 |
| 200 gr. liquid ammonia, sp. gr. 0·978 .. | 42 | to 47·5 |
| 200 gr. vinegar . .. sp. gr. 1·007 .. | 42·5 | to 48·5 |

*Calculation from the above Table of the specific or latent Heats of the Vapours.*

1st, Water. $\frac{32340}{200} = 161·7$ = the number of grains of water contained in the refrigeratory to one of steam. This proportion is constant for all the vapours.

From 42°·5 to 212° there are 169°·5; one half of which =84°·75, or in round numbers 84°, is the rise of temperature which would be produced by adding to water at 42°·5 its own weight of boiling water; and $\frac{84}{161·7} = 0·52$, is the elevation which 200 gr. would occasion on 32340 grains.

The water was however in reality heated $6\frac{1}{2}$ degrees, or from 42°·5 to 49°. The difference, $\overline{6°·5 - 0°·52} = 5°·98$, shows the quantity of heat added to each of the 161·7 parts beyond what the same weight of boiling water would have communicated.

And $5·98 \times 161·7 = 967°$, being the latent heat of the steam of water.

2d. Alcohol. Boiling point 175°. Specific gravity 0·825. $\frac{\overline{175-42} \times 66°·5}{2 \times 161·7} = 0·41$. 0·41 multiplied into the specific heat of liquid alcohol 0·65, is 0°·266, which represents the elevation of temperature produced by adding 200 gr. of boiling hot alcohol to 32340 gr. of water. The thermometer in the experiment rose 3°. $3° - 0°{\cdot}266 = 2{\cdot}734$, $2{\cdot}734 \times 161{\cdot}7 = 442°$ = the latent heat of alcoholic vapour in equilibrio with the atmospheric pressure. By a similar process of calculation the latent heat of the other vapours was determined.

*General Table of latent Heat of Vapours.*

| | |
|---|---|
| Vapour of water at its boiling point | 967° |
| alcohol .. .. | 442 |
| ether .. .. | 302·379 |
| petroleum .. .. | 177·87 |
| oil of turpentine .. | 177·87 |
| nitric acid .. .. | 531·99 |
| liquid ammonia .. | 837·28 |
| vinegar .. .. | 875·00 |

From the phænomena exhibited in the mechanical condensation and rarefaction of gases and vapours, as well as from their general constitution, it may be inferred, that an intimate and necessary connexion subsists between their latent heat, elastic force, and specific weight or density.

Hence, when their tension is the same, it appears reasonable to suppose that the product of their densities into their quantities of latent heat will also be the same. Repulsive energy will be proportional to the quantity of heat, the repulsive power condensed or contained in a given space. Thus if the *space* left for its interposition or lodgment be in one vapour a half or a third of the amount of the space in another, we ought to find equal tension produced in the former case, by a half or a third of the latent heat required for the latter.

As the principle, I have reason to suppose, is somewhat new, let us illustrate it by an application to the three vapours in the above list which are most homogeneous, or at any rate best understood; those of alcohol, ether and water.

Aqueous vapour of an elastic force balancing the atmospheric pressure has a specific gravity, compared to air, by the accurate experiments of Gay Lussac, of 10 to 16.

For facility of comparison let us call the steam of water unity, or 1·00; then the specific gravity of the vapour of pure ether is 4·00, while the specific gravity of the vapour of absolute alcohol is 2·60.

But the vapour of ether, whose boiling point is not 100°, but 112°, like the above ether, contains some alcohol; hence, we must accordingly diminish a little the specific gravity of its vapour.

It will then become instead of 4·00 .. .. 3·55

Alcohol

Alcohol of 0·825 sp. gr. contains much water; specific gravity of its vapour .. .. .. .. 2·30
That of water as before, unity .. .. .. 1·00

The interstitial spaces in these three vapours will therefore be inversely as these numbers, or

$$\frac{1}{355} \text{ for ether; } \frac{1}{230} \text{ for alcohol; } \frac{1}{100} \text{ for water.}$$

Hence, $\frac{1}{355}$ of latent heat, existing in ethereal vapour, will occupy a proportional space, be equally condensed or possess the same tension with $\frac{1}{230}$ in alcoholic, and $\frac{1}{100}$ in aqueous vapour.

A small modification will no doubt be introduced by the difference of the thermometric tensions, or sensible heats, under the same elastic force. Common steam, for example, may be considered as deriving its total elastic energy from the latent heat multiplied into the specific gravity + the thermometric tension.

Hence the elastic force of water, or

$$E_w = 970° \times 1·00 + 212° = 1182$$

$$E_e = 302° \times 3·55 + 112° = 1184$$

$$E_{al} = 440° \times 2·30 + 175° = 1185$$

Three equations which yield, according to my general proposition, equal quantities; or of which the differences are inconsiderable, and undeserving of notice.

Neither the specific heats nor specific gravities of the other vapours are ascertained with sufficient precision to enable us to subject them to calculation.

General equation $F - \overline{L \times D} + T = 0$ : L, latent heat, D, density, T, temperature corresponding to F.

When the elastic forces of vapours are doubled, or when they sustain a double pressure, their interstices are proportionally diminished. We may consider them now as in the condition of vapours possessed of greater specific gravities. Hence, the second portion of heat introduced to give double the elastic force need not be equal to the first, in order to produce the double tension. This view now given accords with the experiments of Mr. Watt, alluded to in the beginning of this memoir. He found that "the latent heat of steam is less when it is produced under a greater pressure or in a more dense state; and greater when it is produced under a less pressure or in a less dense state *."

Berthollet thinks this fact so unaccountable, that he has been willing to discard it altogether. Whether the view which I have just opened, of the relation subsisting between the elastic force,

* Phil. Trans. vol. lxxxiv. p. 335.

density, and latent heat of different vapours, harmonize with chemical phænomena in general, I leave to others to determine. It certainly agrees with that *unaccountable* fact. Whatever be the fate of the investigation of the general law now respectfully offered, the statement of Mr. Watt may be implicitly received under the sanction of his acknowledged sagacity and candour.

*Conclusion.*—To the theory of latent heat, which, like the hydrostatic paradox of Archimedes, might have remained for ages a barren, though beautiful proposition, the fertile genius of that philosopher gave all at once its noblest application, and most beneficial influence on human life, by his new steam-engine. After him, many minds of the first order for science and ingenuity have offered schemes of further improvement; but all either frivolous or abortive; with such prophetic judgement had Mr. Watt anticipated the happiest form and structure of which it was susceptible.

Under this conviction, it is with much deference that I draw the following practical inferences from the last train of experiments.

Since the vapour of alcohol, having the same elastic force as the atmosphere, contains $\frac{44}{100}$ of the latent heat of ordinary steam, and since its elastic force is doubled at the 206th degree (6° below the boiling heat of water), with perhaps $\frac{1}{3}$ of additional caloric; might we not, in particular circumstances, employ this vapour for impelling the piston of a steam engine? The condensing apparatus could, I imagine, be so constructed, as to prevent any material loss of the liquid, while more than a quadruple power would be obtained from the same size of cylinder at 212°, with an expenditure of fuel not amounting to one half of what aqueous vapour consumes; or the power and fuel would be as 3 to 1, calling their relation in ordinary steam 1 to 1. A considerable engine could thus also be brought within a very moderate compass. Possibly, after a few operations of the air-pump, the incondensable gas may be so effectually withdrawn, that we might be permitted to detach this mechanism, which, though essential to common engines, takes away one-fourth of their power. In a distillery in this country, or on a sugar estate in the colonies, a trial of this plan might perhaps be made with advantage. While exercising its mechanical functions of grinding, mashing or squeezing the canes, it would be converting ordinary into strong spirit for rectification, or for the convenience of carriage. Might not such an engine be executed on a small scale, for many purposes of domestic drudgery? It would unquestionably furnish a beautiful illustration in philosophy, to make one small portion of liquid, by the agency of fire, imitate the ceaseless circulation and restless activity of life.

XXX. *On*

## XXX. *On Friction in Machinery; and on Wheel-Carriages.* *By Mr.* Henry Meikle.

*To Mr. Tilloch.*

London, Feb. 22, 1819.

Sir, — There are some circumstances affecting friction and several mechanical movements, that seem as yet to have been rather overlooked: and as the diminution of friction and of every unnecessary waste of moving power is undoubtedly of great importance, I shall venture to give my opinion in some cases, hoping that it may excite the notice of others who consider themselves better qualified for the task.

It is now pretty generally understood, that friction remains constant although the velocity varies; and indeed, many experiments are favourable to this notion—but there are certainly some exceptions. Most people, it is presumed, will be ready to admit, that where the greater wear is, there will also, *cæteris paribus*, be the greater friction. But I have often observed, that where one surface passed over another with great velocity and under strong pressure, there was always a tendency to generate heat, which was also followed by a wearing of the parts considerably greater than if the velocity had been small. Indeed I cannot help regarding heat as having a powerful influence on friction. It certainly softens the wearing parts consisting of metal—it tends rapidly to dry up the unctuous substances applied to lessen friction—it probably promotes the tremulous or vibratory motion of the parts of bodies; and besides, it alters even their size and shape.

Such being some of the more obvious effects of heat, we need not be surprised that theories of friction which do not condescend to take notice of such circumstance, should often be at variance with observation; and probably a theory including every anomaly would, from its intricacy, be scarcely intelligible to the framer of it himself.

Another circumstance affecting friction, and often attended with an immediate loss of power, is the application of the moving power in a direction oblique to that in which the body is moved. This, as is well known, takes place on many occasions; often needlessly too; and is particularly observable in the case of wheels acting on one another with teeth that are much tapered towards their extremities. The consequence is, that the mutual action of the wheels not being directed in a line perpendicular to the line joining their centres, they repel each other powerfully, which produces an enormous strain and friction at their axes.

There are various sorts of tapering teeth; but the epicycloidal kind invented by De la Hire, as it has been long celebrated, and



is

is at present much in vogue, is not less remarkable for possessing the fault alluded to in the highest perfection. A person who is at all acquainted with the principles on which such teeth are formed, will readily perceive that wheels of this construction can only work smoothly, when their centres are exactly at a certain distance from each other; and, that if this distance be any how altered, although in a small degree, they must act with great disadvantage. Now there are many causes which may conspire to change this distance; such as the bending of the several parts of the machine—the expansion and contraction of metals by change of temperature. But the grand and fertile source of this misfortune, I presume, is contained in the sudden tapering figure of the teeth themselves, by which an almost irresistible repulsion is introduced between the wheels, in consequence of their mutual action being in a great measure directed to their centres. It is likewise plain, that if the distance of their centres is a very little augmented, the repulsion will be prodigiously increased, and have a tendency to go on increasing *sine limite*, especially when the wheels contain a small number of teeth. It may no doubt be alleged that all wheels have a tendency to repel each other; but certainly the more this is avoided, so much the better; and of course wheels are the nearer to perfection, according as the direction of their mutual action approaches to a coincidence with the perpendicular to a straight line joining their centres, provided the teeth are formed on strict mathematical principles: for it might easily be shown, that such wheels are not so prone to change their distance; nor yet is the smoothness of their motion so soon disturbed, on the event of such a change taking place, as those of the tapering form are.

In fine machinery, this unfortunate repulsion is seldom wanting; for, though often in clock-work the teeth are quite of a superfluous length, yet as two wheels commonly little more than touch with the rounded ends of their teeth, we may rest assured they have their own share of repulsion.

It is a common notion, (though only with the vulgar), that friction is lessened by diminishing the rubbing surface; but the surface may often be augmented with manifest advantage: because ordinarily where the pressure is confined to a small space, it soon creates heat sufficiently intense both to increase friction and also to dry up any unctuous application.

Another vulgar notion is, that a machine moves easier after the wearing parts become heated;—for immediately after the machine has been stopped, it is more easily set in motion than if it had remained at rest for a considerable time. But this seems only to be in conformity with the well known fact, that friction requires time *at rest* to attain its maximum.

It

It has been frequently alleged, that the attraction of cohesion contributes to increase friction. But when both surfaces are of the same sort of metal, it is highly probable that particles or crystals of the one body may often come into that particular position relatively to those of the other body, as to enable them firmly to lay hold of each other; and on the event of the surfaces being again separated by moving along, there may possibly be found some particles which have deserted the surface to which they originally belonged, and gone over as it were to the enemy's standard. The rapidity with which two pieces of iron mutually wear or rather grind each other, particularly after getting hot and free of grease, furnishes a strong presumption in favour of this hypothesis: possibly, even magnetism may claim some little share in the case referred to. The little cohesion which subsists between the surfaces of different metals, is undoubtedly one reason for their having less friction than if the metals were of one sort.

It is truly surprising, after all that has been said against the unfortunate and unscientific contrivance of bending down the extremities of the axles of carriages, that this lamentable practice, so destructive of human lives, should still be continued, even in an age boasting so much of perfection. If, as some suppose, this favourite absurdity took its origin from the legislature's limiting the distance of the wheels below; yet surely contracting the wheels beneath was only a mock obedience to the letter of the law, with a real and substantial breach of it, in spreading them above. For although a carriage had only one wheel in the middle, if it occupied the same extent above as another carriage, where could be the mighty difference in making room on the road?

The numerous disadvantages attending this long-censured contrivance have all been more or less exposed; and so I would just barely mention a few of the most prominent: viz. that such carriages are extremely liable to be overturned, when one wheel goes into a rut or low side of the road; and that this overloaded wheel, sustaining the whole carriage (if a two-wheeled one) in a direction much inclined to the plane of its rim, is apt to be crushed altogether; besides, a wheel constrained to move in such an awkward position experiences an enormous friction, both at the centre, and also where it grinds and twists in contact with the road.

Many of the broad conical wheels of waggons are nothing short of a disgrace to the nation. There is a most provoking perseverance in absurdity exhibited in their perverse construction. Some of these wheels are a foot broad on the edge; and the diameter of one side a tenth part at least greater than that of the other; but still all points of the wheel must obviously revolve in the same time; and of course, while one side alone could roll over ten miles, the other would roll over eleven: from which it is clear, that while one part actually rolls, another must slide. Not satisfied, however, with this degree of absurdity, recourse is had to a most distinguished contrivance—that of fixing nails with gigantic heads projecting beyond the sliding surface; as if there were really a possibility of preventing the sliding altogether. Such a contrivance offers an affront to common sense and an insult to sober reason. Even in the case of narrow-edged wheels, these horrid nail-heads must be viewed as a great incumbrance. They might well be denominated an invention as a universal substitute for rough roads.

It has been justly observed by Mr. Wingrove, that there is no need for continuing in force the act limiting the under distance of wheels. But although this desideratum were denied, wheels need not be spread above, as long as carriages and roads are not limited in length. Granting, however, that the legislature were to repeal this unnecessary restriction, it is not probable that any reformation would soon take place in the construction of carriages; for it is firmly believed with the great bulk of the people, that carriages, but especially the wheels, are at present formed on the most improved and learned principles.

We may therefore reasonably despair of success, in using any remonstrance with the public, so long as the legislature does not again interfere. I do not pretend to dictate in this case; but perhaps something like double toll-duty, when the wheels are more than an inch closer below than above, might in time have its effect. This would be a considerable advantage, not only to the road, but even to the owner of the carriage himself, though against his will; for it has been concluded from experiment, that four horses would do as much with straight axles, as five can with those in common use. I would, however, still approve of having an axle bent just so much that the weight of the load might bring it to the straight. A similar allowance should also be made for the axle bending backward at the extremities, in consequence of the resistance the wheels encounter on the road. For a like reason, it is probable that the wheels of a heavy carriage, whose axle turns with them, are a little wider below than above, and before than behind. But this is certainly nothing worse than the tottering of wheels that turn loosely on a fixed axle.

It has been sometimes thought best to make the axle fast to the carriage, without turning round; as the force to turn the axle is thereby saved. But it should also be recollected, that the weight of a fixed axle adds to the friction at the axle; whereas the weight of an axle turning round does not affect this friction at all. Besides, the force to turn the axle is only needed when the

carriage

carriage begins to move; but in the other case, the increased friction continues during the whole motion. Some have alleged that the improvement of roads, by cutting hills and raising hollows, has sometimes been carried to excess: because, say they, a horse is sooner worn out by constant pulling, though lightly, than if he had now and then to exert himself going up hill, and afterward rested his shoulder going down. But if there is any force in this allegation, it is certainly not of general application; for where two or more animals work together, they might draw and rest by turns:—even a single horse could move rather quicker for a few minutes, and then stand alternately. However, I rather think the main fault of a very level road, is its retaining the water longer in its ruts, so as seldom to be clean and smooth like a hilly one.

Many vulgar notions containing their own refutation might be mentioned. But it deserves also to be noticed, that from the subject's often appearing much simpler than it really is, there is great danger of falling into mistake. A single instance will be sufficient to show the truth of this remark: It has been asserted by high authority, that the use of wheels is only to overcome the inequalities of the road; and, that if the bare axle were to slide on two polished railings of metal, the carriage would be as easily drawn along as if with wheels in the usual way (abstracting from the inequalities of the road). Now were this really the case, even friction-wheels themselves would be altogether useless, or rather a pompous incumbrance. Admitting, however, that friction is not affected by varying the velocity, it would obviously follow, that the friction on the axle is the same in both cases. But still it should never be forgotten that *friction* and *the momentum of friction* are very different things. In the case of the bare axle sliding along, we have the whole friction to contend with; but when wheels are added, we have only to overcome its momentum; which evidently is to the friction, as the radius of the axle to that of the wheel. This being agreeable to what is contained in most books on the subject, it need not be commented on here.

Some further observations may possibly be added at another period. I am, sir, your most obedient servant,

HENRY MEIKLE.

---

## XXXI. *On Shooting Stars.*

*To Mr. Tilloch.*

SIR, — YOUR correspondent Mr. Farey* appears to take it for granted that his theory, or rather hypothesis, respecting the na-

* Phil. Mag. No. 250, p. 116.

ture

ture of *shooting stars* is correct. Perhaps the following consideration may tend to remove such an impression, without entering into a more laboured investigation of this interesting phænomenon, or it may give Mr. F. an opportunity of giving a brief and clear exposition of his notions on the subject, and of the observations on which they are founded.

It is well known that when a body moves with more than a certain degree of velocity it cannot be observed by the human eye: the motion of wheels, of bodies in a sling, the whirling of a fire-brand, and the rapid movements of a dexterous professor of legerdemain, may be cited as instances: but the motion of a body revolving round the earth must be much more rapid, and consequently the body itself must be invisible. Mr. F. states the necessary degree of velocity to be "immense:" and it may be shown that it will require the *satellitula* to move at the rate of about 20,000 feet per second; but it cannot be said of these *satellitula*, as Newton has of the planets, that their "motions may subsist an exceedingly long time *." Therefore Mr. F. must certainly be wrong in assuming them to have been moving within our atmosphere since the creation. Perhaps it may be said their brightness renders them visible, notwithstanding their immense velocity. In that case I should be glad to see the outlines of a hypothesis for heating those bodies, or to explain how they became luminous. Till these points be settled I shall not meddle further with the subject. I am, sir, yours,

Scepticus.

---

XXXII *Plan for establishing, by a Royal or Parliamentary Charter, a Company, with a large Capital, for carrying on the Cultivation of the Waste Lands of the Kingdom, and promoting domestic Colonization; while, by employing the Poor in agricultural Improvements, the heavy Burden of the Poor-Rates will be materially diminished. By the Right Hon. Sir* John Sinclair, *Bart. Founder of the Board of Agriculture.*

There are no circumstances connected with the existing state of this country, which are so peculiarly disgraceful to its internal policy, or so hostile to its most essential interests, as the vast extent of waste lands every where to be met with, and the multitudes of poor who are destitute of employment, and a burden on the community.—That many of these wastes will require much labour and expense to cultivate them, must be admitted; and that many of these unfortunate individuals now unemployed, are

* Principles of Natural Philosophy, book iii. prop. 10.

incapable

incapable of doing much work, more especially in labour out of doors, must likewise be acknowledged: but when the subject is thoroughly investigated, it will not probably be denied by the candid and impartial inquirer, that if a portion of the poor, *who are now in a state of perfect idleness*, were employed in cultivating portions of our waste lands, *now in a barren and useless state*, much public benefit might be expected.

To explain how that can best be accomplished, is the object of the following hints:

Several years have elapsed since the author of this paper was first led to discuss this most interesting subject*. His attention, however, has of late been more particularly called to it, in consequence of an application from the church-wardens and overseers of one of the most populous parishes in London (St. Martin in the Fields), requesting his opinion "on the practicability, and the probable advantage of directing the labour of the poor to the cultivation of the waste lands throughout the country; and whether a considerable number of the able poor might not be profitably employed in carrying on some great agricultural object, so as to render us independent of foreign supplies for subsistence."—(See Appendix.)

In answer to that application, it was briefly stated, that no doubt could be entertained, as a general maxim, that the best source of occupation, for the greater proportion of the idle poor, *is the soil.* That if the poor are employed in manufactures, or in making up manufactured articles, as shoes and clothes, with which the market is already supplied, they must interfere with the industry of other workmen, who would soon be reduced to poverty, and that consequently mischief rather than good would arise from such a system.—Whereas, while there are such extensive tracts of waste land all over the kingdom, and more especially in the neighbourhood of the metropolis, and while we are under the necessity of importing food from other countries, our agriculture cannot be too much extended.

The author then added, "I know that great prejudices are entertained against the employment of the poor in husbandry; but that is altogether owing to the want of information and of experience. Those who have examined *the husbandry of Flanders*, must have seen how much manual labour is there employed in cultivation. Parochial farms are successfully carried on in the neighbourhood of Cranbrook in Kent, an account of which I

* See the History of the Revenue, 3d edition, vol. iii. p. 276, printed an. 1804, where there is a plan for employing the poor, in the cultivation of the waste lands, and in repairing the highways of the kingdom.

transmitted

transmitted to the Select Committee on the Poor Laws *; and if our fields were cultivated in the garden style, the increased produce would amply defray the additional expense."

That in agricultural parishes the poor may be advantageously employed in the cultivation of the soil, seems now to be generally recognised †; but the plan which I propose submitting to the consideration of the public, is of a more extensive nature. The position I wish to establish is this, "that as the poor in the metropolis and in large towns, cannot be advantageously employed in trades and other manual occupations, without injury to others whose subsistence depends upon their labour; hence, it has become a matter of absolute necessity, either to maintain them without employment, or to send the able-bodied to work in the fields, both for raising food, and for producing materials for manufacture (as flax), more likely to interfere with foreign than domestic industry, and in which the more infirm poor might be employed in work-houses, and that by the adoption of such a system, the burden of maintaining the poor will be materially diminished."

In discussing this subject, it is proposed to consider the following points: — 1. To what extent is manual labour applicable to the cultivation of the soil?—2. What is the probable number of persons maintained by the poor-rates in London and its immediate vicinity, who could be usefully employed in carrying on some great agricultural improvement?—and 3. What would be the best plan for carrying such a measure into effect?

1. To what extent is manual labour applicable to the cultivation of the soil?

This is a subject that has frequently been discussed in works on agriculture ‡; but understanding that Mr. Falla, an eminent nurseryman at Gateshead, near Newcastle, had recently paid particular attention to the cultivation of land *by manual labour*, I applied to him for the result of his experience, which he communicated with the greatest readiness. He states, that on an

* See the Report of the Select Committee on the Poor Laws, an. 1817, Appendix, G, No. 2, p. 164.

† "In country parishes, agriculture furnishes the most obvious and useful source of employment; for, though the whole stock of subsistence be thereby increased, yet the cultivator of the land would be more than compensated for any diminution in the value of his produce, by the corresponding diminution of the expense of maintaining his family and labourers, and the more important reduction of the poor-rate."—See the valuable Report on the Poor Laws, an. 1817, p. 19.

‡ See General Report of Scotland, vol. ii. p. 297, where there is an entire section on Trenching Land; also, the Code of Agriculture, p. 151 and p. 232, note.

average,

average, it has been ascertained, that three men and two women or girls, (being about the proportion of the two sexes employed in nursery ground,) taking the year round, will work about ten statute acres, in the proportion of about $2\frac{2}{3}$ acres for a man, and $1\frac{1}{3}$ acre for a woman. But a nursery, in all its operations, takes a great deal more work than ground for agricultural purposes, in which, he thinks, a man may be able to cultivate five acres in a year.

At the rate for digging in the neighbourhood of Newcastle, a man may earn two shillings per day, and the five acres may be done in $82\frac{1}{2}$ days. The same period of time will be required for manuring, sowing and planting his crops, and 148 days may be employed in hoeing, weeding, and other operations, making in all 313 working days in the year. The whole may be done, without any improper degree of exertion, by a man of medium strength.

The profits derived from spade-husbandry are certainly very considerable. By transplanting wheat, there is a great saving of seed, and the ground being in perfect order, from the superior culture it has received, the increase is great. The average produce of wheat, in England, is only at the rate of twenty bushels per acre,—whereas Mr. Falla finds, that trenched land will yield more than double. But, supposing the produce to be only forty bushels, at 10*s*. per bushel, that would amount to 20*l*. per acre, and after amply indemnifying every possible expense, would produce a large profit. The crops of potatoes, carrots, flax, hemp, Swedish turnips, and other articles raised by spade-husbandry, would likewise be very great. The use of the plough was certainly an immense improvement when first introduced; and it must always be applicable to a very large proportion of a country, owing to the scarcity of hands. The advantages derived from it, however, were formerly more considerable, when horses were bought for a trifle, and when their provender was cheap; but since their price has become so great, and their maintenance so very high, it is evident that the expense of horse and of manual labour more nearly approach each other. To bring land into a state for cultivation, trenching will require perhaps 5*l*. and even upwards per acre; but to carry on its cultivation afterwards may be done, even in the neighbourhood of the metropolis, at from 50*s*. to 60*s*. per acre; the ploughing of which would cost from 15*s*. to 20*s*.; but once digging is considered to be equal to two ploughings, consequently the difference of expense is not so material, *while the produce is double*, and in some cases, more than one crop may be obtained in the same year.

There can be no doubt, therefore, that the manual labour may be advantageously employed in the cultivation of the soil.

2. What is the probable number of persons maintained by the poor-

poor-rates in London and its immediate vicinity, who could be employed in carrying on some great agricultural improvements?

This is a question that is not easily solved, and which would require a good deal of investigation accurately to ascertain; but the number must be very great: and when it is considered, that besides able-bodied men, a large proportion of women, and even some children might be employed, there would be no difficulty in finding in London and its vicinity, from fifteen to perhaps twenty thousand persons, who might be employed in various departments connected with the cultivation of the soil, and preparing its productions for use.

Besides mere digging, a variety of operations might be executed by manual labour; as collecting manure, transporting it in barges up the river, conveying it to the fields on portable iron rail-ways, transplanting the crops, hoeing and weeding them, cutting down or reaping them, thrashing by hand-mills, and grinding the wheat by the flour-mills, so strongly recommended by "The Society of Arts." In short, the employments which agriculture furnishes are numerous and unceasing.

In order to employ a greater number of people, if the climate and the soil of the land brought into cultivation were suitable, hops might be raised, which in favourable seasons would be highly productive.

Another material object would be, the culture of flax, in the manufacture of which, the old and the infirm might be employed in work-houses. This plan is successfully carried into effect in the work-house at St. Martin in the Fields, and six or seven others; and if the raw material could be procured in sufficient quantities, the importation of foreign flax or linen would be no longer necessary. Considerable quantities of hemp might likewise be raised.

3. What would be the best plan for carrying such a measure into effect?

There is no doubt, that in so opulent a city as that of London, a large sum might be raised, to carry on such a plan, without any thought of profit or interest. But there is not the least occasion for any individual losing any sum he may be inclined to subscribe for so useful a purpose. On the contrary, if properly managed, it must prove a very beneficial concern. No money can be laid out with more profit than in the improvement of the soil. The author of this paper purchased an estate for 8,500*l.*, and improved so much its value, that it sold for 40,000*l.* He let a farm about twenty years ago for 182*l.* per annum, which was likewise so much improved, under his directions, that it sold lately for 18,200*l.* These are facts which are within his own knowledge, and cannot be controverted. If such beneficial improvements could be effected 700 miles distant from the metropolis,

polis, what may not be accomplished in its immediate vicinity? Any idea, therefore, that the proposed concern may prove a losing one, ought not to be entertained for a moment.

The following heads on the whole are suggested, as a foundation for the proposed institution:

1. That the Society shall be called "The Royal Agricultural Company, for the Improvement of the Waste Lands of the Kingdom, and promoting domestic Colonization;" of which His Royal Highness the Prince Regent be requested to be the patron.

2. That under the authority of parliament, the sum of one million (or any other sum adequate to the purpose) be raised by a joint stock company, in shares of 50*l.* each, or twenty thousand shares in all, for promoting so beneficial an object.

3. That the management of the concern be confided to a president, four vice-presidents, fifteen directors, five trustees, three auditors, a treasurer, an accountant, and such other officers as may be judged necessary.

4. That the sum to be raised, shall be paid by regular instalments, ten pounds at the time of subscribing, and ten pounds every six months afterwards, as the same may be required.

5. That land shall be rented or purchased, either from the crown, or from private individuals, to such an extent as the capital of the company will enable it effectually to cultivate.

6. That convenient accommodation shall be provided in the neighbourhood of the land brought into cultivation, where the directors, and other members of the company may reside when they are desirous of examining the progress of the undertaking.

7. That a regular account of the improvements carried on, shall be drawn up, and submitted to the consideration of His Royal Highness the patron, and of both Houses of Parliament, and likewise printed for the information of the members of the company, and of the public at large.

8. That the accounts of the company shall be annually audited, and open to the inspection of all concerned; and that after the first year of actual cultivation, a dividend of 5 per cent. or whatever other sum the profits of the concern may yield, shall be paid to the subscribers.

9. That a negotiation be entered into with the church-wardens and overseers of the several parishes of London and its vicinity, respecting the number of poor they can respectively furnish, and the various articles they will purchase from the company; and that those parishes be preferred, who offer the most advantageous terms to the company.

10. That a meeting shall be called for taking the above plan into consideration, and for presenting a petition to parliament, for erecting the proposed company into a corporate body.

It

It cannot be too much inculcated in favour of any plan for employing the poor in husbandry, that there is this essential distinction between it and every other mode of occupying them; that by cultivating the soil, FOOD, the great object of human labour, is *directly* obtained; while, by industry of any other kind, it can only be procured *indirectly*, and by means of exchange.

In regard to the minutiæ of the plan;—the district where the land is to be rented or purchased;—the buildings necessary to accommodate the labourers;—the manner in which they are to be paid or maintained;—the nature of the crops to be cultivated; —the manner in which the produce is to be disposed of,—and other minute particulars, it would be in vain to attempt to enlarge upon them at this time, as they must depend on such a variety of circumstances, and can be safely confided to those who are placed in the direction.

*Conclusion.*—There never was a period when such an institution was so loudly called for, nor when there was so favourable an opportunity for carrying it into effect. In fact, unless some great measure be undertaken, to furnish the unemployed poor with a means of subsistence, *by their own labour*, the other classes of the community will not long be able to maintain them, and some fatal convulsion must be the necessary consequence: whereas, if this plan were adopted, an example of successful improvement would be exhibited, which would soon be imitated in every other part of the kingdom, and it would probably spread with a rapidity of which there is no example in history. Its success, however, depends on the skilful application of a large capital; for, in many cases, if only 5*l.* per acre is expended, the money may be lost; whereas, by laying out 15*l.* per acre, the whole expense may be repaid in the course of one year.

On the whole, there is every reason to hope, if no other advantage were to result from the proposed plan, this object, at least, might be obtained; that the poor would soon be enabled to raise provisions for their own sustenance, and no importation of foreign grain would in future be necessary;—even that would be an inestimable advantage. But, if the plan does succeed to the extent that may be expected, a foundation will be laid for improving every acre in the kingdom, capable of yielding any valuable production; and all that floating capital which might otherwise remain either unemployed at home, or might be sent to foreign countries, from the difficulty of placing it out to advantage, might thus be laid out in promoting the cultivation of our own country, and in ameliorating the condition of its inhabitants.

Ormly-Lodge, Ham Common, Surrey, JOHN SINCLAIR.
January 12, 1819.

APPEN-

## Appendix.

### *Letter from the Church-wardens and Overseers of the Parish of St. Martin-in-the-Fields to Sir John Sinclair.*

Sir,—The great attention you have so long paid to the agriculture of the United Kingdoms, induces the overseers of the parish of St. Martin-in-the-Fields to request the favour of your opinion on the practicability, and the probable advantage, of directing the labour of the poor to the cultivation of the waste lands throughout the country.—To find beneficial employment for the parish poor, without interfering, directly or remotely, with established branches of trade and manufacture, is at present exceedingly difficult, and it is impossible to discover any effectual remedy without having recourse to land. Might not a considerable number of the able poor be profitably employed in carrying on some great agricultural object throughout the country, so as to render us independent of foreign supplies for subsistence? Will you have the kindness to communicate to the public your views on this most important and interesting subject?

Your very obedient humble servant,

William Toone,
Clerk to the Church-wardens and Overseers.

*To the Right Hon.*
*Sir John Sinclair, Bart.*
Ormly-Lodge, Ham Common,
Surrey, Nov. 21, 1818.

---

### *General View of the Profit to be derived from the Culture of Waste Lands, under a proper System. By Sir John Sinclair.*

It cannot be doubted, that 10,000 acres of lands, lying entirely waste, may be purchased at a moderate rate. The expenses of bringing them into a state of cultivation may be calculated as follows:

*First Year.*

| | | |
|---|---|---|
| 1. Trenching, 5*l.* per acre | £50,000 | |
| 2. Manure, 15*l.* per acre | 150,000 | |
| 3. Seed, labour, and various other expenses | 20,000 | |
| | £220,000 | |

*Second Year.*

| | | |
|---|---|---|
| 1. Digging, 2*l.* 10*s.* per acre | £25,000 | |
| 2. Manure, 5*l.* per acre | 50,000 | |
| 3. Seed, labour, &c. | 20,000 | |
| | | 95,000 |
| | | £315,000 |

The produce, per acre, where the spade-husbandry is adopted, may be stated at 20*l.* per acre, or, on 10,000 acres, at 400,000*l.* in two years; but if even considerably less, it would produce a surplus sufficient to pay a considerable dividend on the capital expended.

 Under

Under skilful mangement, therefore, the profit would be great; but the whole depends on the expenditure of a large capital, in bringing the land *at once* into a state *of thorough cultivation, and of great fertility*. The latter can easily be effected in the neighbourhood of London, where an offer has already been made of urnishing manure for an extensive tract of country at a very moderate expense.

If any thing like this plan is practicable, why should there be a single acre of waste land in the vicinity of the metropolis, or any able-bodied labourer near it unemployed?

This year (1819) must be employed in making an application to parliament;—in purchasing land;—in various necessary preparations;—and in trying useful experiments;—but the next year will exhibit a scene of industry which has probably never been exceeded in any age or country. J. S.

*** It is particularly requested, that any gentleman who approves of the preceding Plan, will have the goodness to communicate his sentiments on the subject, by a letter addressed to the Right Hon. Sir John Sinclair, bart. Ormly-Lodge, Ham Common, Surrey; or to Mr. J. Bailey, 51, Watling-street, London.

## XXXIII. *Some Particulars of M.* Belzoni's *Discoveries in Egypt.*

In our Number for April of last year (p. 241 of vol. li.) we inserted a letter from M. Belzoni to M. Visconti, dated Cairo, January 9, 1818, mentioning his return from Upper Egypt, and being then engaged in preparing for a third journey to Nubia; and that in his first journey he had succeeded in removing to Alexandria the head known by the name of the Memnon's head,* a colossal bust ten feet in height, formed out of a single block of granite, and about twelve tons in weight. This head, which the French were unable to remove even after blowing off with gunpowder a portion of the back part, M. Belzoni, by the assistance solely of the native peasantry, without the aid of any machine, succeeded in removing from Thebes to Alexandria. The chief difficulty lay in transporting it from Thebes to the Nile, to get it on board a vessel for Alexandria. This labour required a degree of patience and perseverance which few men possess: it took him six months, though the distance to the Nile was only about two miles.

This colossal bust, which reached England last summer, has been recently placed, most judiciously as to light, on a pedestal in the Egyptian room in the British Museum, under the able direction of Mr. Combe.

From Thebes M. Belzoni proceeded to Nubia to examine the great

great Temple of Ybsambul [Ibsambul, Ebsambul, or Absimbul], which lies buried more than twice its height in the sands near the second cataract. On this occasion, however, he was unable to effect any thing, and therefore returned to Thebes, where he employed himself in new researches at the temple of Karnack. Here, several feet under ground, he found surrounded by a wall a range of sphynxes, about forty in number, with heads of lions on busts of women, of black granite, and for the greater part beautifully executed. While absent on his second visit to Ybsambul, Mrs. Belzoni succeeded in digging up at the same place a statue of Jupiter Ammon holding a ram's head on his knees. And on his second journey to Thebes in 1817, M. Belzoni discovered a colossal head of Orus, of fine granite, larger than the Memnon, measuring ten feet from the neck to the top of the mitre with which it is crowned, exquisitely finished and in fine preservation. He carried with him to Cairo one of the arms belonging to this statue. As he succeeded so well in removing the Memnon, may we not hope that he will be encouraged also to attempt the removal of this head, and that we may ere long see it placed beside its colossal brother in the British Museum?

After this, M. Belzoni proceeded again to Nubia, and, in spite of many hindrances and much inhospitality which he experienced, succeeded in opening the celebrated temple of Ybsambul, which no European had ever before entered. In this temple (the largest and most wonderful excavation in Egypt or in Nubia) he found fourteen chambers and a great hall, and in the latter, standing, eight colossal figures, each thirty feet high. The walls and pilasters are covered with hieroglyphics beautifully cut, and groups of large figures in fine preservation. At the end of the sanctuary he found four sitting figures about twelve feet high, cut out of the natural rock and well preserved. Belzoni's labour may be conceived, when we state that on commencing his operations the bed of loose sand which he had to clear away was upwards of fifty feet deep. He carried hence two lions with the heads of vultures, and a small statue of Jupiter Ammon. From the superior style of sculpture found in this temple to any thing yet met with in Egypt, Mr. Salt infers that the arts descended hither from Ethiopia.

M. Belzoni, by a kind of tact which seems to be peculiarly his own, discovered, on his return to Thebes, six tombs in the valley of Biban El Moluck, or the Tombs [or rather Gates] of the Kings, (in a part of the mountains where ordinary observers would hardly have sought for such excavations,) all in a perfect state, not having been viewed by previous intruders, and giving a wonderful display of Egyptian magnificence and posthumous splendour. From the front entrance to the innermost chamber in one of them, the length of passage, cut through the solid rock, is 309 feet: the chambers, which are numerous, cut in a pure white rock, are covered with paintings *al fresco*, well executed, and with hieroglyphics quite perfect, and the colours as fresh as if newly laid on. In one of these chambers he found the exquisitely beautiful sarcophagus of alabaster, mentioned in our fifty-first volume, nine feet five inches long, three feet nine inches wide, and two feet one inch high, covered within and without with hieroglyphics in intaglio, sounding like a bell and as transparent as glass—supposed by M. Belzoni to have been the depository of the remains of Apis. In the innermost room he found the carcase of a bull embalmed with asphaltum, which seems to give some confirmation to his idea. We are happy to learn that this matchless production is now on its way to England, to be placed by the side of the sarcophagus supposed to have contained the remains of Alexander. Mr. Salt, assisted by Mr. Beechey (son of the well-known artist of the same name), has, with much labour and care, copied several of the paintings within this tomb, which will by and by be given to the public. These paintings are quite fresh and perfect. The colours employed are "vermilion, ochres and indigo;" and yet they are not gaudy, owing to the judicious balance of colours and the artful management of the blacks. It is quite obvious [says Mr. Salt] that they worked on a regular system, which had for its basis, as Mr. West would say, the colours of the rainbow; as there is not an ornament throughout their dresses where the red, yellow and blue are not alternately mingled, which produces a harmony that in some of the designs is really delicious.

It is a curious fact, that in one of the Theban tombs two statues of wood, a little larger than life, were found as perfect as if newly carved, excepting in the sockets of the eyes, which had been of metal, probably copper.

We have yet to mention another successful labour of M. Belzoni, perhaps the most singular, because, to all appearance, the most hopeless and unpromising—the opening of the second pyramid of Ghiza, known by the name of Cephrenes. According to Herodotus, (whose information has generally been found correct,) this pyramid was constructed without any internal chambers. M. Belzoni, however, believed the fact might be otherwise; and having reasons of his own for commencing his operations at a certain point, he began his labours, and with so much foresight as actually to dig directly down upon a forced entrance. But even after this success, none but a Belzoni would have had the perseverance to pursue the labour required to perfect the discovery. It was by attending to the same kind of indications which had led him so successfully to explore the six tombs of the kings in Thebes,

Thebes, that he was induced to commence his operations on the north side. He set out from Cairo on the 6th of February 1818, pretending (as he did not wish to be interrupted by visitors) that he was going to a neighbouring village. He then repaired to the Kaia Bey, and gained permission; the Bey having first satisfied himself that there was no tilled ground within a considerable distance of Ghiza. On the 10th of February he began with six labourers in a vertical section, at right angles to the north side of the base, cutting through a mass of stones and lime which had fallen from the upper part of the pyramid, but were so completely aggregated together as to spoil the mattocks, &c. employed in the operation. He persevered in making an opening fifteen feet wide, working downwards and uncovering the face of the pyramid. During the first week there was but little prospect of meeting with any thing interesting; but on the 17th, one of the Arabs employed called out with great vociferation that he had found the entrance. He had in fact come upon a hole into which he could thrust his arm and a djerid six feet long. Before night they ascertained that an aperture was there about three feet square, which had been closed irregularly with a hewn stone: this being removed, they reached a larger opening, but filled with rubbish and sand. M. Belzoni was now satisfied that this was not the real but a forced passage. Next day they had penetrated fifteen feet, where stones and sand began to fall from above: this was removed; but still they continued to fall in large quantities, when after some more days labour he discovered an upper forced entrance, communicating with the outside from above. Having cleared this, he found another opening running inward, which proved on further search to be a continuation of the lower horizontal forced passage, nearly all choked up with rubbish: this being removed, he discovered about half way from the outside a descending forced passage which terminated at the distance of forty feet. He now continued to work in the horizontal passage, in hope that it might lead to the centre, but it terminated at the depth of ninety feet; and he found it prudent not to force it further, as the stones were very loose over head, and one actually fell and had nearly killed one of the people. He therefore now began clearing away the aggregated stones and lime to the eastward of the forced entrance; but by this time his retreat had been discovered, and he found himself much interrupted by visitors.

On the 28th of Februrary he discovered at the surface of the pyramid a block of granite having the same direction as that of the passage of that of the first pyramid, or that of Cheops; and he now hoped that he was not far from the true entrance. Next day he removed some large blocks, and on the 2d of March he entered the true passage, an opening four feet high and three feet and a half wide, formed by four blocks of granite, and continued descending at an angle of about 26° to the length of 104 feet five inches, lined all the length with granite. From this passage he had to remove the stones with which it was filled; and at its bottom was a door or portcullis of granite (fitted into a niche also made of granite) supported at the height of eight inches by small stones placed under it. Two days were occupied in raising it high enough to admit of entrance. This door is one foot three inches thick, and with the granite niche occupies seven feet of the passage, where the granite work ends, and a short passage, gradually ascending twenty-two feet seven inches towards the centre descending commences; at the end of which is a perpendicular of fifteen feet. On the left is a small forced passage cut in the rock, and above on the right a forced passage running upward and turning to the north thirty feet, just over the portcullis. At the bottom of the perpendicular, after removing some rubbish, he found the entrance of another passage which inclined northward. But quitting this for the present, he followed his prime passage, which now took a horizontal direction, and at the end of it, 158 feet eight inches from the above-mentioned perpendicular, he entered a chamber forty-six feet three inches long, sixteen feet three inches wide, and twenty-three feet six inches in height, for the greater part cut out of the rock; and in the middle of this room he found a sarcophagus of granite, eight feet long, three feet six inches wide, and two feet three inches deep inside, surrounded by large blocks of granite, as if to prevent its being removed. The lid had been opened, and he found in the interior a few bones which he supposed to be human: but some of them having been since brought to England by Capt. Fitzclarence, who was afterwards in this pyramid, and one of them (a thigh bone) having on examination by Sir Everard Home been found to have belonged to a cow, we may doubt whether any of them ever belonged to a human subject. The size indeed of the coffin seems better fitted for the reception of a cow than of a man.

On the west wall of this chamber is an Arabic inscription, testifying that this pyramid was opened by the Masters Mahomet El Aghar and Othman, and inspected in presence of the Sultan Ali Mahomet the 1st Ugloch (a Tartaric title, as Uleg Bey, &c.); and on other parts of the walls inscriptions supposed by M. Belzoni to be in Coptic.

He now returned to the descending passage at the bottom of the above-mentioned perpendicular. Its angle is about 26°: at the end of forty-eight feet and a half it becomes horizontal, still going north fifty-five feet, in the middle of which horizontal part there is a recess to the east eleven feet deep, and a passage to the

the west twenty feet, which descends into a chamber thirty-two feet long, nine feet nine inches wide, and eight and a half high. In this room were only a few small square blocks of stone, and on the walls some unknown inscriptions. He now returned to the horizontal part and advanced north, ascending at an angle of 60°; and in this, at a short distance from the horizontal part, he met with another niche, which had been formerly furnished with a granite door, the fragments of which were still there: at forty-seven feet and a half from this niche the passage filled with large stones to close the entrance, which issues out precisely at the base of the pyramid. All the works below the base are cut in the rock, as well as part of the passages and chambers.

By clearing away the earth to the eastward of the pyramid, he found the foundation and part of the walls of an extensive temple, which stood before it at the distance of forty feet; and laid bare a pavement composed of fine blocks of calcareous stone, some of them beautifully cut and in fine preservation. This platform probably goes round the whole pyramid. The stones composing the foundation of the temple are very large—one which he measured was 21 feet long, 10 high, and 8 in breadth.

---

M. Belzoni, to whom the world is indebted for so many discoveries, is a native of the Papal States. About nine years ago he was in Edinburgh, where he exhibited feats of strength, and experiments in hydraulics, musical glasses and phantasmagoria, which he afterwards repeated in Ireland and the Isle of Man, whence he proceeded to Lisbon, where he was engaged by the manager of the theatre of San Carlos to appear in Valentine and Orson, and afterwards in the sacred drama of Sampson. For such characters he was admirably adapted, being in his 25th year, six feet seven inches high, remarkably strong, and having an animated prepossessing countenance. He afterwards performed before the Court at Madrid, whence he proceeded to Malta, where he was persuaded by the agent of the Pashaw of Egypt to visit Cairo. Here he built a machine worked on the principle of the walking-crane, to irrigate the gardens of the Pashaw by raising water from the Nile. Three Arabs with M. Belzoni's servant (an Irish lad whom he had taken with him from Edinburgh) were put in to walk the wheel; but on the second or third turn the Arabs being either frightened or giddy jumped out, and the Irishman had his thigh broken; which put an end to this undertaking. On this failure happening, and while meditating upon trying his fortune in search of antiquities in Upper Egypt, Mr. Salt arrived in Cairo; and on the representation of Sheik Ibrahim, who had witnessed his extraordinary powers, conceived him to be a most promising person to bring the head of the young Memnon to

 Alexandria.

Alexandria. They came to terms; and how well he succeeded in this first work has been proved by the head being now in the Museum.

As an instance of the confidence which his determined perseverance inspires in others, we need only mention, that in his second journey to Nubia Mr. Beechey accompanied him. Having engaged a party of natives, he set about uncovering the temple where its colossal statues showed their heads above the sand. They worked tardily for a few days and then ceased, alleging that the feast of Rhamadan had commenced; nor could any argument persuade them to resume their labour. In this emergency Belzoni, Beechey and the Irishman set to work themselves; but they soon found that by order of the Aga they could not, for money or by entreaties, procure a supply of provisions. The object was to compel them to return the following season to spend more money. Having, however, in their boat a bag of millet, the party pursued their labour, living on this fare and the Nile water; and after twenty-one days severe labour, effected their object, in uncovering and gaining access to the interior of the temple.

We consider Mr. Salt, who has been indefatigable in his own researches, and unsparing in encouraging those of others, as most fortunate in having secured the assistance of so able an explorer as M. Belzoni. By their exertions and those of M. Caviglia, the British Museum is likely soon to become the richest depository in the world, of Egyptian antiquities. Mr. Salt has possessed himself of many gems in this line. Among others he has got down to Cairo the famous stone discovered by the French, with eight sculptured figures; another beautiful head of granite, as perfect and with a finer polish than that named the young Memnon, not quite so large, but perfect; a sitting figure, exquisitely wrought and as large as life; several statues of basalt; thirty rolls of papyrus, and an immense number of smaller articles.

Some time ago, to the great grief of every lover of antiquities or of enterprise, it was reported that M. Belzoni was dead; but we are happy to say that a letter from Naples falsifies this statement. Lord Belmore, who has resided for some time at Naples, where he arrived after a long and interesting tour through Egypt, Palestine, Syria, and to Troy, has received letters from M. Belzoni, dated from Thebes in Upper Egypt, of the 27th of October. He continues his researches in Egypt with the greatest activity, and has lately made many important discoveries. Lord Belmore himself had advanced to 150 leagues beyond the Cataracts into Nubia; he passed six weeks at Thebes, where he every day made some researches with the assistance of a hundred Arabs. His

discoveries

discoveries there are very valuable. His tour will be of great advantage to geographers; for he has accurately determined the longitude and latitude of the greater part of the places through which he passed, having been accompanied by his brother Capt. Corry of the Navy, who had with him an excellent sextant. On his Lordship's return to England he will publish his travels.

## XXXIV. *On the Nautical Almanac.*

*To Mr. Tilloch.*

Sir, — I have just seen the *second edition* of the Nautical Almanac for 1819, which the editors of that work have at length thought proper to publish *without the stamp.* The former price of the almanac was *six shillings;* but the stamp (which was *fifteen pence*) being deducted, it *ought* now to be sold for *four shillings and ninepence.* The price however charged to the public is *five shillings*, being an addition of *three-pence* to the original charge of the work: and, as such, must be considered as an *additional tax* on the public. If the profits of this publication were to go towards increasing the salaries of the computers, and thereby hold out an inducement towards the more perfect conducting of that work, the public need not complain; but it is much to be feared that this additional charge only goes to enrich the indolent bookseller, and not the laborious calculator: and consequently ought to be resisted, as being contrary to the spirit of the new act of parliament.

By that statute it is moreover declared, that all the clauses in former acts relative to rewards for discovering the longitude at sea are *repealed:* and a new scale of rewards is ordered to be made out and advertised in the London Gazette, in lieu of the former ones. Yet in defiance of this injunction, and with *six* additional labourers appointed by the act, for the more perfect conducting of this work, the second edition of the Nautical Almanac above mentioned, has just been published, containing (as usual) the clauses in the aforesaid acts of parliament; which, being repealed, consequently hold out a *false* hope of reward to such as are now disposed to attempt the difficult problem above alluded to. If the new scale of rewards is actually made out, and has received the approbation of the Prince Regent in council, (as provided by the act,) it ought to have been published in this second edition: but on no account ought the obsolete clauses of the former acts to have disgraced its pages, published, as it is, under the authority of the *new* Board of Longitude.

I say that this second edition must be considered as published under the direction, and by the authority of the *new* Board of Longitude;

Longitude; for, by the recent act of parliament, it could not otherwise be exempted from the stamp duty: the editor therefore must have the authority of this *new* Board for its publication, otherwise he would be liable to a penalty for selling it without a stamp. But how are we to reconcile this with the two formal instruments inserted in the beginning of the work, dated the one as far back as June 1815, authorizing Messrs. Bensley to print, and the other as far back as July 1811, authorizing Mr. Murray to sell the present almanac? I mention these facts merely to show how carelessly the new labourers have entered on their arduous duty; and how little improvement is to be expected in the body of the work, if we thus stumble at the very threshold.

Indeed upon a cursory view of the work, it appears to me to be merely a reprint of the first edition, except as to the correction of the numerous errors which existed therein. I observe that the time of the conjunction of $\beta$ *Tauri* with the moon, is now more accurately given in all the different months:—but will these modern Sidrophels be good enough to inform the public why the conjunction of *Pollux* is so carefully noted through all the lunations, since that star cannot in any part of the globe, ever undergo an occultation by the moon.

When this new incorporated body shall think fit to publish the Nautical Almanac under their own avowed authority and direction, it is to be hoped that they will revise and improve the whole work, so as to render it at least equal to the productions of a similar kind published by the other states of Europe, and worthy of the learned names appointed by law for the purpose of conducting it. At present it is smuggled into the world like an illegitimate child, and every one seems ashamed of owning it. First comes the *garbled* preface of Dr. Maskelyne, to make it appear as if ushered in under his auspices: but the only passage which could confirm that fact, and which indeed is the only passage material to be known in any current year, is entirely omitted Then we meet with the *apologetical* advertisement of Mr. Pond, shifting the responsibility from his own shoulders, and endeavouring to make the reader believe that there are but few errors, and those of no moment: which however is, by a strange fatality, opposed, at the end of the Almanac for the present year, by four pages of errata; some of which are not of a trifling nature, and by no means errors only of the press. Lastly, we have now the equivocal authority of the *old* and the *new* Board of Longitude for its publication: and each may thus shift upon the other, with apparently equal justice and as it suits their purpose, any attack which may be made on their ambiguous and ill-favoured offspring.

I am, sir, your obedient servant,

March 15, 1819. PHILASTER.

POST-

Postscript.—March 22. I have just seen the Gazette of last Saturday night, wherein is contained a scale of rewards, approved by the Prince Regent, for *such ships as may arrive at certain points of longitude and latitude therein mentioned;* and which I presume is intended as an additional bounty to the officers and sailors about to be employed in a new expedition towards the North Pole. But in that scale I see no reward, or expectation of reward, held out to such persons as may be induced to attempt any improvement in the method of *discovering the longitude at sea*, the *sole object* for which this body of Commissioners was formed; and which ought certainly to have *first* engaged their serious attention. The *new* Board of Commissioners has existed now about a twelvemonth; a sufficient time, one would suppose, to have matured a plan for the encouragement of this object: but alas! this important subject must yield to the fashionable impulse of the times; and, when the mania for arctic discoveries has ceased, the learned Commissioners may perhaps find leisure to attend to their *duty*.

## *Corrections of the Nautical Almanac for* 1819.

[From another Correspondent.]

Sir,—The inclosed list of corrections of errors in the Nautical Almanac for the year 1819, if printed in The Philosophical Magazine, must be found very useful to all persons who use the Almanac.

March 19, 1819. Astronomicus.

Omissions of the following eclipses:

March 25. Sun eclipsed invisible at Greenwich.

☌ at 11$^h$ 23$^m$ 40$^s$·6; ☽'s long. 4° 29′ 32″·2; ☽'s lat. 1° 26′ 7″·4 S.

Oct. 18th. Sun eclipsed invisible at Greenwich.

☌ at 15$^h$ 55$^m$ 18$^s$·2; ☽'s long. 6$^s$ 24° 55′ 34″·5; ☽'s lat. 1° 14′ 58″S.

*Page*

1. Among other phænomena, for 8$^d$ 11$^h$ 12$^m$, read 8$^d$ 10$^h$ 4$^m$.
2 Column of declination, 2d line, for 23 58 54, read 22 58 54.
2. Do. do. 13th line, for 21 34 10, read 21 34 40.
4. .. .. 6th line, for days, read day.
4 Column 3, .. 12th line, for 6 22, read 6 42.
4 Last line and last column of Venus, for 21 13, read 21 23.
9. Column Noon of Arietis, for 40 35 43, read 40 55 43.
13. Among other phænomena, for 4 7 26 read 4 16 19.
15 Column 2d Satellite, last line but one, for 17 46 38, read 7 46 38.
16. Column 3, 10th day, for 3 40, read 1 40.
16. Saturn, 1st line, 4th column, for 11 6 18, read 11 16 18.
18. Last column, 1st day, for 16 54, read 16 54 N.
18. 5th day, column 6, for 88 44, read 89 44.
18. 19th day, column 5, for 260 27, read 260 24.
19. 14th day, last column, for 5089, read 5012.
20. Last line 4th column, for 39 2 41, read 39 2 14.

*Page*

*Page*

23. 2d line 4th column, for 45 0 56, read 48 0 56.
23. 8th line 7th column, for 59 0 13, read 39 0 13.
25. Among other phænomena, for 4 0 48, read 3 23 41.
25. Do. do. do. add 31 8 47 ☽ β ♉.
27. 1st column, line 10, for 22, read 25.
27. 2d column, line 5 from bottom, for 14 56 59, read 14 59 59.
28. Last column, line 6, for $17^d$ 14, read $17^d$ $14^h$.
28. Day 28, col. 6, for 4 8, read 7 8.
28. 6th column of Jupiter, line 1, for 19 24, read 19 24 S.
Do. .. .. 2, for 19 16, read 19 6.
30. 25th day, 3d column, for 31, read 1.
24th day, 5th column, for 346 10, read 346 18.
31. 9th day, 4th column, for 14 0, read 15 0.
11th day, 5th do. for 55 4, read 55 41.
21st day, last column, for 4709, read 4799.
33. Column $III^h$, for 72 40 4, read 71 40 4.
Do. Pollux 29, for 57 49 11, read 57 49 31.
Do. $XVIII^h$, for 75 6 45, read 76 6 45.
34. Do. $XV^h$, last line, for 61 32 3, read 61 52 3.
Last column, last line, for 65 34 8, read 65 3 48.
35. Column $IX^h$, for 76 58 27, read 75 58 27.
Day column, last line but one, for 51, read 31.
37. Day 28, for Easter Term ends, read begins.
Among other phænomena, last line but five, for 27 17 41, read 27 16 35.

| Page | | | Day | | for | | read |
|---|---|---|---|---|---|---|---|
| 38. | Equation column, | | 4th day, | | for 3 15 0 | | read 3 15 9. |
| | .. | .. | 12 | .. .. | 1 58 0 | .. | 0 58 0. |
| | .. | .. | 13 | .. .. | 1 41 9 | .. | 0 41 9. |
| | .. | .. | 14 | .. .. | 1 26 1 | .. | 0 26 1. |
| | .. | .. | 15 | .. .. | 1 10 6 | .. | 0 10 6. |
| | Col. declination, | | 12 | .. .. | 8 28 19 | .. | 8 28 49. |
| 40. | Mercury, 7th day, | | | .. | 13 15 0 | .. | 15 15 0. |
| | .. | .. | 13 | .. .. | 4 28 79 | .. | 4 28 19. |
| | .. | .. | 25 | .. .. | 19 43 0 | .. | 18 43 0. |
| 41. | .. | .. | 5 | .. .. | 4 46 0 | .. | 4 46 6. |
| | .. | .. | 6 | .. .. | 5 14 6 39 | .. | 5 4 6 39. |
| | .. | .. | 11 | .. .. | 1 18 16 S. | .. | 1 8 16 S. |
| | .. | .. | 30 | .. .. | 3 28 44 9 | .. | 3 23 44 9. |
| 42. | .. | .. | 3 | .. .. | 35 45 | .. | 25 45. |
| | .. | .. | 8 | .. .. | 5 1 | .. | 5 1 N. |
| | .. | .. | 9 | .. .. | 1 10 | .. | 1 10 S. |
| | .. | .. | 22 | .. .. | 6 32 | .. | 6 52. |
| 43. | .. | .. | 12 | .. .. | 58 34 | .. | 55 38. |
| | .. | .. | 13 | .. .. | 58 55 | .. | 56 15. |
| | .. | .. | 14 | .. .. | 59 9 | .. | 56 53. |
| | .. | .. | 15 | .. .. | 59 17 | .. | 57 31. |
| | .. | .. | 23 | .. .. | 4994 | .. | 4991. |
| 44. | .. | .. | 6 | .. .. | 42 52 37 | .. | 42 52 57. |
| 46. | .. | .. | 4 | .. .. | 117 37 50 | .. | 116 37 50. |
| 49. | .. | .. | 17 | .. | Princess of Wales born. | | |

*Page*

| Page | | | | | | |
|---|---|---|---|---|---|---|
| | Among other phænomena, for 99 20 | | | 45 S<br>15 ♀ | read<br>.. | 17 17 N.<br>19 20 15 ♂. |
| | .. | .. | .. .. | .. 25 1 20 | .. | 25 0 14. |
| 50. | .. | .. | 16th day | .. 18 85 22 | .. | 18 58 22. |
| | .. | .. | 30 .. | .. 4 25 42,2 | .. | 4 25 41,2. |
| 52. | Last column, | | .. .. | .. D. M. | .. | H. M. |
| | .. | 6th line, | .. .. | .. Days, | .. | Day. |
| | .. | .. | .. .. | .. | | Inf. ☌ 2ᵈ 16ʰ. |
| | .. | .. | 4 | .. 0 2 | .. | 0 2 N. |
| | .. | .. | 13 .. | .. 12 59 | .. | 22 59. |
| | Jupiter, | .. | 1 .. | .. 16 49 | .. | 16 49 S. |
| | .. | .. | .. .. | .. 18 13 | .. | 18 38. |
| | .. | .. | 13 .. | .. 17 56 | .. | 17 55. |
| | .. | .. | 19 .. | .. 17 32 | .. | 17 33. |
| 53. | .. | .. | 3 .. | .. 4 23 24 27 | .. | 4 27 34 27. |
| | .. | .. | 1 .. | .. 5 3 28 | .. | 5 3 28 N. |
| | .. | .. | 31 .. | .. 3 7 41 39 | .. | 5 7 41 39. |
| 54. | .. | .. | 19 .. | .. 22 12 | .. | 21 12. |
| 55. | .. | .. | 18 .. | .. 4931 | .. | 4913. |
| | .. | .. | 29 .. | .. 14 17 | .. | 14 47. |
| 58. | .. | .. | 1 .. | .. 83 82 46 | .. | 83 32 46. |
| | .. | .. | 3 .. | .. 101 21 3 | .. | 101 23 23. |
| | Pollux, | .. | 6 .. | .. 65 18 14 | .. | 65 18 4. |
| 59. | Antares, | .. | 14 .. | .. 46 21 6 | .. | 46 21 26. |
| 61. | .. | .. | 10 .. | .. .. | .. | Corpus Christi. |
| | Among other phænomena, | | | .. 21 7 48 | .. | 21 6 42. |
| 62. | .. | .. | 5 .. | .. 1 2 2 | .. | 2 2 2. |
| | .. | .. | 28 .. | .. 1 40 0 | .. | 2 40 0. |
| 64. | Mars 19, | | .. .. | .. 11 59 | .. | 12 59. |
| | Saturn 7, | | .. .. | .. 0 29 44 | .. | 11 29 44. |
| 65. | .. | .. | 1 .. | .. 2 29 36 | .. | 2 29 36 N. |
| | .. | .. | 5 .. | .. 3 2 41 | .. | 2 2 41. |
| | .. | .. | 14 .. | .. 2 28 12 | .. | 2 38 12. |
| | .. | .. | 17 .. | .. 0 3 12 54 | .. | 1 3 12 54 |
| | .. | .. | 28 .. | .. 5 10 15 5 | .. | 5 16 15 5 |
| 66. | .. | .. | 27 .. | .. 5 52 | .. | 3 52. |
| 67. | .. | .. | 25 .. | .. 16 44 | .. | 14 44. |
| 70. | Regulus, last line, 1st column, for | | | 4 | .. | 5. |
| 73. | Among other phænomena, | | | 18 13 30 | .. | 18 12 24. |
| 74. | .. | .. | 24 day | .. 21 1 34 | .. | 20 1 34 |
| 75. | II Satellite, | | .. .. | .. 6 day | .. | 9 day. |
| | .. | .. | 31 .. | .. 19 26 33 | .. | 19 36 33. |
| 76. | Mercury | | 25 .. | .. 1 51 | .. | 0 51. |
| | .. | .. | 28 .. | .. 1 27 | .. | 0 27. |
| | .. | .. | 31 .. | .. 1 1 | .. | 0 1. |
| | Georgian ♅ | | 21 .. | .. 8 27 56 | .. | 8 22 56. |
| 77. | .. | .. | 1 .. | .. 0 38 41 | .. | 0 38 41 S. |
| 80. | Aldebaran | | 12 .. | .. 68 20 3 | .. | 65 20 3. |

Page

| | | | |
|---|---|---|---|
| *Page* | | | |
| 82. | .. .. .. .. | for Spica ♏ | read ♍. |
| .. | .. .. .. | .. ntare | .. Antare. |
| 83. | Spica ..29 day, .. | .. 11 32 58 | .. 11 31 58. |
| 84. | 3d line, .. .. | .. At | .. at. |
| .. | .. 4 day, .. | .. $3^h$ | .. ⊙$3^h$. |
| 85. | .. .. 7 .. .. | .. *dele* Princess Amelia born. | |
| .. | 11 .. .. | .. *dele* Duchess Brunswick born. | |
| | Among other phænomena, | 14 19 29 | .. 14 18 23. |
| 86 | .. ..12 .. .. | .. 4 18 52 59 | .. 4 18 52 39 |
| .. | ..21 .. .. | .. 3 9 9 | .. 3 3 9. |
| 87. | ♊ Satellite for .. | .. Immersions | .. Immersion. |
| .. | .. 2 day .. | .. 9 28 46 | .. 9 23 28. |
| .. | .. 4 .. .. | .. 13 3 6 | .. 13 3 48. |
| 88. | Mercury ..28 .. .. | .. 5 27 16 | .. 5 21 16. |
| | Mars ..13 .. .. | .. 2 25 21 | .. 2 15 21. |
| | Jupiter ..25 .. .. | .. 10 54 | .. 10 34. |
| 89. | .. .. 1 .. .. | .. 4 24 11 | .. 4 24 11 S. |
| .. | ..30 .. .. | .. 4 10 41 | .. 5 10 41. |
| 90. | .. .. 6 .. .. | .. 322 28 | .. 332 28. |
| 92. | Sun ..13 .. .. | .. 74 33 50 | .. 78 33 50. |
| 93. | Fromalhaut, 28 .. .. | .. 88 58 56 | .. 80 58 56. |
| 94. | Pegasi, ..13 .. .. | .. 74 40 25 | .. 74 40 28. |
| .. | .. .. .. | .. 76 5 41 | .. 76 5 45. |
| .. | .. .. .. | .. 77 30 48 | .. 77 30 55. |
| 95. | Antares, ..31 .. .. | .. 45 43 5 | .. 46 43 5. |
| .. | .. .. .. | .. 47 34 12 | .. 48 34 12. |
| .. | .. .. .. | .. 49 25 32 | .. 50 25 32. |
| 97. | .. ..29 .. .. | for Duchess read Queen of Wirtemb. | |
| | Among other phænomena, .. | 11 2 35 | .. 11 1 30. |
| 98. | .. ..11 day .. | .. 3 15 0 | .. 3 15 6. |
| 100. | Mercury, 16 .. .. | .. 2 0 30 | .. 1 0 30. |
| | Jupiter, 7 .. .. | .. 10 9 33 | .. 10 8 30. |
| | Saturn, 1 .. .. | .. 11 26 90 | .. 11 26 40. |
| 101. | .. .. 6 .. .. | .. 0 21 48 40 | .. 0 20 48 40. |
| 102. | .. .. 9 .. .. | .. 16 59 | .. 16 50. |
| .. | ..12 .. .. | .. 96 25 | .. 98 25. |
| 107, | last line, last column, | .. 89 19 27 | .. 89 14 27. |
| 109. | Among other phænomena .. | 8 11 2 | .. 8 9 58. |
| 110. | .. .. .. .. | for Declin. North | .. South. |
| 112. | Venus, .. 1 day .. | .. 6 4 17 | .. 6 5 17. |
| .. | ..19 .. .. | .. 6 27 57 | .. 6 27 47. |
| | Mars, ..13 .. .. | .. 20 23 | .. 3 20 23. |
| | Jupiter, ..19 .. .. | .. 26 42 | .. 20 42. |
| | Georgium, 1 .. .. | .. 23 18 | .. 23 18 S. |
| 113. | .. ..10 .. .. | .. 3 13 28 37 | .. 3 15 28 37. |
| .. | ..27 .. .. | .. 10 13 48 1 | .. 10 19 48 1. |
| .. | ..30 .. .. | .. 0 48 10 S | .. 0 48 16 S. |
| 114. | .. .. 3 .. .. | .. 11 18 | .. 12 18. |

*Page*

*Page*

.. ..21 .. .. ..232 28 read 232 38.
... .. 4 .. .. .. after . add 3.
121. .. .. 3 .. .. .. Prs. Sophia born.
Other phænomena, .. .. 4 20 7 read 4 19 4.
124. Head of last column, for D. M. .. H. M.
125. .. .. 1 day, .. .. 1 5 53 34 .. 1 6 53 34.
126. .. ..30 .. .. ..11 7 ..11 17.
133. .. Full moon, .. .. 1 0 11 .. 1 6 11.
.. Other phænomena, 2 4 42 .. 2 3 30.
Add 29 10 22 ☽ β ☋.
134. .. .. .. .. Declin. North .. South.
Last column but one. for add .. subtract.
136, for ☿ Gr. Elong. $5^h$ day read $5^d$.
138. .. ..11 day .. for 191 85 read 191 58.
143. Arietis,..29 .. .. .. 41 25 2 .. 41 2 52.
.. ..30 .. .. .. 59 20 36 .. 59 20 30.
144. .. third line .. .. six .. at VI.
Explanation, &c.
146, line 15 from bottom, insert *if*.
161, line 21, for $\frac{1}{16}^a$ .. read .. $\frac{1}{16}^d$.
.. 22 .. $\frac{7}{128}^a$ .. .. .. $\frac{7}{128}^d$.
*Extract*, &c. line 11 from the bottom, insert *as*.
line 21, for Trial read Trials.

---

## XXXV. *Notices respecting New Books.*

*Philosophie Anatomique: Des Organes Respiratoires sous le rapport de la Détermination de l'Identité de leurs Pièces Osseuses, &c. Par le Chevalier Geoffroy St. Hilaire, &c.*— Anatomical Philosophy: Of the Respiratory Organs in respect to the Determination of their Osseous Parts. By Chevalier G. St. Hilaire, &c.

[ For the following review we are indebted to the pen of M. Cuvier.]

To generalize, to abstract, to reason well or ill—such is the exclusive prerogative of man; such also is the source of his power and of his weakness, of his intelligence and of his errors. It is the principle of these high qualities which is equally the basis of judicial astrology and of astronomy; of the natural systems of ancient philosophers, and of the modern experimental philosophy; of the morals of Socrates, the politics of Machiavel, and the philosophism of Voltaire. To this principle it is owing that we have wandered from experience in the study of the sciences of observation, that we have returned to it, and that we are perhaps wandering from it again.

In these variations there is otherwise nothing which ought to surprise us. They have their origin in the very nature of the sciences, in which observation and reasoning predominate alternately;

nately; observations always precise, exact, important, and which have only for their object facts and their immediate relations; reasoning often uncertain or hazardous, and to which there are no limits; the one a sure guide, which constantly leads to true but confined results; the other, which is faithful to genius alone, and from which spring the highest virtues and the greatest errors.

It is the submission of reasoning to observation which forms the characteristic of modern science. A law is regarded as no further obligatory than when it is supported not only by facts but by an assemblage of facts, the analogy between which may be positive, and which no prejudice can have misinterpreted. Here, however, arises a difficulty.—In what does this resemblance consist? Nature, infinite in its powers, is equally infinite in its productions; it varies them without measure: while observation only comprehends individuals; and hence results the demand for generalization, for principle, and for system. It is thus that all sciences are under the necessity of mixing reasoning with observation, though in different degrees; and it is in the use which each is allowed to make of these two modes of investigation, that their philosophy truly consists.

The objects with which the sciences of observation are occupied, which are possessed of qualities the most various, and whose relations are most extended, are animals; and of all the divisions into which the study of animals divides itself, comparative anatomy is beyond all doubt that in which reasoning is most indispensable.

Until the present day, this important branch of natural science had only admitted a very small number of general laws. Its prudent inductions were never established but upon facts, whose evident analogy does not leave any thing to doubt or uncertainty; and new observations have still been the principal object of its researches—a conduct doubtless most wise in a science so favourable to the love of hypothesis, and where errors are so easy and so seducing.

It is thus that, with the aid of those inductions, physiologists have been led to unite all the animals provided with an osseous frame or skeleton under the name of *Vertebral;* and according to the agreement of their different systems of organs to establish the subordination of their characters, and to class each in respect to the others in a methodical and natural manner; to see an entire analogy between the hand of man, the foot of the horse, the wing of the bird, the pectoral fin of fish, &c. From these facts joined to many others, they have ventured to conjecture, that in the creation of all vertebral animals nature has followed a general plan, which she has only modified in some points, in order to make a distinction of species; and that she has only passed from one

one form to another in the same organs by insensible gradations; —bold conjectures, which, confirmed by a sufficient number of observations, open to the human mind a most extended career.

It is from this elevated point that M. Geoffroy St. Hilaire has descended to new osteological researches. The simple comparison of bones with the view of determining their resemblance in respect of form and attributes, was not, however, alone sufficient to conduct him into the vast career upon which he has entered. Without reasoning he could have ventured but a few steps; and it was necessary that he should make a survey of the whole field of science. What resemblance, for example, could be discovered by the mere comparison of forms and relations between the greatest part of those pieces which compose the skeleton of fishes and those which constitute that of mammiferous animals? Certainly none.—Have not also many of these pieces received the same names; so that vertebral animals which might in one respect be supposed to be formed upon the same model, are in another constituted of parts essentially different?

Professor Geoffroy supposes, with good reason, that this contradiction originates in the influence of human anatomy on comparative anatomy. The study of our species being of all studies the most important, the anatomy of man was first known, and all other anatomical researches became subordinate to it: it became thereby a sort of type, to which the organization of all other animals was compared, in order to characterize and name their different parts—for this comparison was one which related principally to forms. Such a dependence, necessary at first for preventing the anatomist from losing himself in the immense details with which he was surrounded, is no longer necessary now that these details are classed methodically, and every system of organization can be examined in a manner altogether independent of any other.

This just and fertile idea left him at liberty to take for the type of each organ that in which the development had arrived at a fixed point, and to make it thus the true ideal of organization. M. Geoffroy has chosen a medium term which constitutes for him a *normal state*, beyond or within which there is either excess or privation. As this mean term, however, can only be arbitrarily fixed, and as each organ may be regarded as perfect when it has accomplished its end, we are of opinion that the point of greatest development ought to be a point of comparison somewhat better established, and which would lead to relations more extended.

Let this however be as it may, these ideas have led M. Geoffroy not only to trace resemblance in identity of forms, and of the relations of bones to one another, but further, and especially in the identity of their relations with other systems of organs.

Considering, accordingly, osteology in this new point of view, he proceeds to establish, that every time that two organs are *in the same position, in the same relations, and under the same dependencies,* they are similar. In this rests his *principle of connexions;* and in order to confirm this principle in many cases, considering the different parts of which these organs are composed, he shows that they display themselves in every organ of the same number, at least the rudiments of them. It is this sort of demonstration which he designates by the name of *Theory of Analogies.*

Disembarrassed in this manner of the principal obstacles which would have otherwise arrested the course of his inquiry, M. Geoffroy, comprehending in his survey the whole tribe of animals with osseous frames, distinguished that the variable parts of these animals, which he names *abdominal parts,* are directed to the anterior extremity of the vertebral column in fish, to the opposite extremity in birds; that they rest in an intermediate situation in mammiferous animals; and participate of both these systems of organization in reptiles. Hence he possesses, in a great measure, the explanation of all those anomalies which these four groups of animals present when compared to each other, and consequently the means of resolving the problem which he proposed to himself to solve—namely, *to restore the organization of vertebral animals to an uniform type.*

---

*A complete Course of Lithography*; containing clear and explicit Instructions in all the different Branches and Manners of the Art: accompanied with illustrative Specimens of Drawings. To which is prefixed a History of Lithography, from its original to the present time. By Alois Senefelder, Inventor of the Art of Lithography and Chemical Printing. With a Preface by Frederic Van Schlichtegrall, Director of the Royal Academy of Sciences at Munich. Translated from the German by A. S. 4to. pp. 372.

We are sorry that our limits do not allow us to give a fuller detail of the curious matter contained in this interesting volume, than we can now submit to our readers; but we shall seize an early opportunity to present some extracts which we think will induce many of them, especially the professor or amateur of the fine arts, to possess themselves of copies of the work, that they may apply its instructions to practice. The work is divided into two parts: In the first, which is a history of the art from the idea that led to its discovery down to its last and improved state, the author lays before the reader the various plans that he formed and experiments that he tried, and the results with which they were attended. In the second he has communicated in the most unreserved manner, all the knowledge which he himself at present possesses of the practice of the art, giving the most minute and comprehensive instructions for every operation. The volume is embellished with well executed lithographic prints illustrative of the various effects which may be produced by this art, and of its very extensive application.

Dr. T. Forster has just published a pamphlet on the Opinion of the antient Greek and Roman Physicians respecting Pestilential Fevers, &c.

A work has also appeared from the pen of Dr. Granville, on Plague and Contagion, with reference to the Laws of Quarantine.

A small work has just been reprinted at the press of Mr. Valpy, and published by Messrs. Underwood, &c. entitled "*Index Botanicus, sistens omnes Fungorum Species in Synopsi Methodica Persoonii*," &c. It seems to be the completest catalogue of Fungi extant, and has been republished by one of our English botanists on this account, the copies having become scarce in this country.

Mr. Lawrence has just published an octavo volume on the Physiology, Zoology, and Natural History of Man.

Mr. Murray is preparing for the press a translation of Chaussier, on "Counterpoisons, rendered intelligible to those who have not studied the Curative Art," with numerous Notes, the results of Mr. M's researches on poisons.

Mr. William Phillips has in the press a new and greatly improved edition of his "Elementary Introduction to Mineralogy." The most important crystalline forms will be printed on the same pages with the descriptions, and peculiar attention paid to the localities of British minerals. It will be comprised in a volume in small octavo.

Mr. Accum has in the press a fourth edition of his Chemical Amusement; comprehending a series of striking and instructive experiments which are easily performed and unattended by danger. With plates by Lowry.

The purchasers of the third edition of the work will receive the additional matter to be found in the fourth edition, *gratis*, on application to the publisher of the work.

Mr. Richard Taylor of Norwich is preparing to publish Three Maps accompanied by Tables illustrative of the Sites of Religious Houses, &c. in that Diocese, as they existed before the Dissolution of Monasteries.



XXXVI. *Pro-*

## XXXVI. *Proceedings of Learned Societies.*

### ASIATIC SOCIETY.

On Monday evening, August 10, 1818, a Meeting of the Asiatic Society was held at Chouringhee, The most noble The Marquis of Hastings, President, in the chair.

On this occasion, the journal of a survey to the heads of the rivers Ganges and Jumna, by Captain Hodgson 10th regiment native infantry was presented by the President. Captain Webb's Survey, in 1808, having extended from the Doon valley to Cajane near Reital, Captain Hodgson commences his scientific and interesting labours from the latter place, which by a series of observations he found to be in latitude 30 48 28 N. The village of Reital consists of 35 houses which are built of wood, and are two or three stories high. He left Reital on the 21st of May 1817. On the 31st he descended to the bed of the river, and saw the Ganges issue from under a very low arch, at the foot of the grand snow bed. The river was bounded on the right and left by high rocks and snow, but in front over the debouchee the mass of snow was perpendicular, and from the bed of the stream to the summit the thickness was estimated at little less than 300 feet of solid frozen snow, probably the accumulation of ages, as it was in layers of several feet thick, each seemingly the remains of a fall of a separate year. From the brow of this curious wall of snow, and immediately above the outlet of the stream, large and hoary icicles depended. The Gaghoutri Brahmin, who accompanied Captain Hodgson, and who was an illiterate mountaineer, observed, that he thought these icicles must be Mahadeo's hair, from whence, he understood, it is written in the Schaster, the Ganges flows. Captain Hodgson thinks that the appellation of the Cow's mouth is aptly given to this extraordinary debouchee. The height of the arch of snow is only sufficient to let the stream flow under it.—Blocks of snow were falling on all sides, and there was little time to do more than to measure the size of the stream; the main breadth was 27 feet, the greatest depth about 18 inches, and the shallowest part nine or ten inches. Captain Hodgson believes this to be the *first appearance in day-light* of the celebrated Ganges! Zealous in the prosecution of his inquiries, he attempted to proceed forward, but was obliged to return, having frequently sunk in the snow, one time up to his neck, and there being evident marks of hollows beneath.

The height of the halting place, near which the Ganges issues from under the great snow bed, is calculated to be 12,914 feet above the sea; and the height of a peak of the Himalaya, called St.

St. George by Captain Hodgson, is estimated to be 22,240 feet above the surface of the sea.

Captain Hodgson, in his account of the course of the river Jumna, observes, that at Jumnoutri the snow which covers and conceals the stream is about 60 yards wide, and is bounded on the right and left by precipices of granite; it is 40½ feet thick, and has fallen from the precipices above. He was able to measure the thickness of the bed of snow over the stream very accurately by means of a plumb-line let down through one of the holes in it, which are caused by the steam of a great number of boiling springs at the border of the Jumna, the thickness 40 feet 5½ inches. The head of the Jumna is on the s.w. side of the grand Himalaya ridge, differing from the Ganges inasmuch as that river has the upper part of its course within the Himalaya, flowing from the south of east to the north of west, and it is only from Sookie when it pierces through the Himalaya that it assumes a course of about south 20 west. The mean latitude of the hot springs of Jumnoutri appears to be 30,58. Captain Hodgson made his observation April 21, 1817.

## SOCIETY FOR ENCOURAGEMENT OF NATIONAL INDUSTRY (IN FRANCE).

This Society has proposed a prize of 3000 francs (125*l.* English) for the discovery of a metal or composition of moderate price, which shall not be hurtful to animal œconomy, nor oxidizable either by water or by the juice of vegetables, or which shall at least be greatly less so than iron and steel, without imparting any colour or taste to the substances in the preparation of which it is employed.

This metal or composition must possess hardness and tenacity enough to serve for crotchets, for solid files, for instruments to mash, cut, separate and divide pears, apples, beet-root, potatoes, and other vegetable productions in common domestic use.

The Society requires that the inventors shall reveal the nature of the metals which they employ in the case of composition; and that specimens of each of these, along with a model of some known machine by which the necessary experiments for determining the goodness of the principal component parts may be made, shall be deposited with the Society.

The memoirs, specimens, &c. to be lodged with the Society before the 1st of March 1821; the prize to be decreed July 1821.

In order to assist the researches of persons desirous of competing for the prize, the Society have added the following observations:

The employment of iron in a malleable state or converted into steel, in machines which are not regularly worked, occasions a rust which renders them frequently unfit for use after a lapse of time, sometimes very short, according to the nature of the iron or the vicinity of marine vapours. This effect is chiefly felt in the case of machines for mashing fruit and cutting esculent roots. However, these instruments are daily multiplying throughout the country, and it is much to be feared that the rust which affects the quality of the substances on which they are employed, at the same time that it destroys the instruments themselves, may bring them into general disrepute, the result of which would be ruinous to the progress of agriculture and the arts.

The Society of Encouragement invite men of science and artists to remedy this imperfection, either by employing processes already known or to be yet discovered for preserving iron and steel, or by substituting in their place other metallic substances.

Among the metals which may be so employed, it may perhaps excite surprise to find platina mentioned. It is to be regretted that this metal, invaluable for such a purpose from its firmness and unalterability, should be so very dear ; but there is reason to hope that ere long it will become more common, and it is not mpossible that it may then be employed with œconomy, at least for the exposed parts. Besides, instead of subjecting it to long and expensive operations in order to render it malleable, may it not be employed when less pure and ductile, by taking it in a crude state, such as it is found in commerce, and uniting it with other metals which it may protect from oxidation ? It is certain that tin can greatly increase its fusibility, and produce combinations perhaps less malleable but yet harder than iron, sound, and sensibly less liable to oxidation. As much may be said of iron united to tin and platinum ; and there is reason to hope that these compounds, already from five to six times at least more marketable than malleable platinum, may be very usefully employed. The very hard compound of copper, tin and platinum, employed by M. Rochon in the manufacture of telescopes, has been long known.

The other metals which combine chemically—the binary, ternary, quaternary compounds, &c. may they not in varied proportions afford favourable results, which have not hitherto been obtained, only because they have not been examined ? Let us instance a few combinations.

A mixture of tin with iron, without any portion of copper, produces a hard, innocent, malleable, and very resisting compound, which is by no means made use of to the extent it might be, and which

which could be advantageously employed in bars, in plates, or in moulds.

M. Dussaussoy *, who has made known that a mixture of copper, tin and iron, produces a compound of great tenacity, much hardness, easily wrought, and excellent for cannon, indicates many other compositions, which, according to the proportion of the metals and the thickness of the pieces cast, lose or gain, sometimes in tenacity, at others in hardness, qualities which may often be augmented by tempering and hammering. Such compositions have not been adopted into modern use, but may however be of great utility to the arts. It may be sufficient to cite that compound of the ancients, consisting of 14 parts of tin to 100 of copper, which cold-beaten and sharpened produced blades harder than iron, and even preferable to those fabricated with certain varieties of steel.

If the irons and steels employed are further examined one by one, it will be found that the steels are generally less oxidizable; but that there are among them some more so than others, which renders it of consequence that we should be select in our choice—that the parts not exposed to friction may be greatly protected from rust, by smoking them, by giving them a strong varnish, by tinning, or by oxidizing the surface before hand with acids, as is often done with fire-arms; or by a method still better than any of these, by keeping them under water for a certain time, from which they will come out with a sort of varnish less injurable by humidity, and similar to that which the fowling-piece of a gamekeeper acquires after long use.

Iron is in another state naturally much less oxidizable, namely, when fused. From the facility with which it may be then moulded, and from its hardness, it appears capable of being beneficially employed for all the friction parts of instruments, by fabricating with it surfaces covered with sharp points—asperities artfully disposed—so as to form excellent rasps for the grating of fruit and esculent roots. Cast-iron may also be used for the other parts of such instruments, by moulding them with such precision that the file shall not be necessary to adjust them, and the surface of the moulding be thus preserved, which is always harder and much less oxidizable than the interior. When machines of this description are not in use they ought to be deposited in dry places, being first covered with a sort of soap formed of oil mixed with quick lime, and then powdered over with lime, which will serve to absorb the humidity and the acids.

It is to be hoped that by such means advantageously combined, and by others known to or which may be discovered by men of

* *Annales de Chimie et de Physique*, June and July 1817.



science,

science and artisans, instruments in common use may be obtained at less cost than at present, and sufficiently proof against humidity and the juices of fruits.

Foreigners, as well as natives of France, are allowed to compete for the prize; but in the event of its being gained by a foreigner, the Society are to have the property of the process so far as regards its adoption in France.

---

## XXXVII. *Intelligence and Miscellaneous Articles.*

### GAS BLOW-PIPE.

*To Mr. Tilloch.*

Paris, Feb. 15, 1819.

Sir, — When at Florence I had some conversation with the Marquis Ridolfi, on the results of the action of the compressed gases on the earths. I cannot doubt from his assurance, that he has repeated Dr. Clarke's experiments with success. The metallic grains were almost microscopic, yet exhibited an action sufficiently determined for their metallic character, such as effervescence in contact with water, &c.

The Marquis was good enough to show me an improvement he has made in this instrument. I submit a sketch of the appendage to you (Fig. B, Plate II.) The united gases, prior to ignition, pass through *mercury* contained in a small cistern (of iron) exterior to the reservoir. With this arrangement he has never experienced accident, though he has had explosion within the safety cell, even when supplied with folds of wire-gauze and with water.

Numerous experiments have convinced me that the gases before their issue, have in consequence of humidity (from traversing the water in the safety cistern) their intensity attenuated. Allow me therefore to suggest that they should pass a jointed ball supplied with dry *muriate of lime* before they escape from the orifice. I have the honour to be, sir,

Your very humble servant,

(Signed) J. Murray.

---

### DECOMPOSITION OF SULPHATE OF SODA BY IRON.

January 8, 1819.

Sir,—By inserting the following in your valuable Philosophical periodical publication, you will much oblige

Your obedient servant,

*To Mr. Tilloch.* John Charles Pearson.

About three months since, a Mr. Henry Jephson called on me and requested to know if I would sell him, for a friend, a large quantity of bleacher's refuse which was in my possession. (It was

was wanted, I believe, to decompose for the manufacture of carbonate of soda.)

On showing him some that had lain many months in a large old wrought-iron boiler (which formerly belonged to a steam-engine) he was delighted with a beautiful white effloresence which appeared on the sides of the boiler nearest in contact with the refuse, and which he ascertained afterwards to be a carbonate of soda combined with a very small portion of iron.

Last week I was much pleased to hear from him that he had succeeded in obtaining this carbonate, by placing some scraps of iron in contact with crystals of sulphate of soda for six weeks. "It is well known that the bleacher's refuse is principally a sulphate of soda and manganese."

I hear with very considerable pleasure that Mr. Jephson is preparing for publication a work entitled "The Elements of Chemical Analysis;" and if my expectations are realized, it will do him much credit.

*Quere.* Could a manufactory of carbonate of soda be conducted by the above process?

---

## ACID OF INDIGO. BY PROFESSOR VAN MONS.

It has been hitherto believed that in the blue tub the indigo loses its colour by becoming deoxidized; and resumes it on exposure to the air by being reoxidized. M. Doebereiner has ascertained that it experiences this effect by becoming hydrogenated in the tub, by the combined reaction of oxidulate of iron, lime and water, and by being dehydrogenized on exposure to the air, and more rapidly by a weak solution of chlorine. Indigo, which has the same constituents as animal charcoal, viz. thirty-six parts of carbon with three parts and a half of azote, forms in becoming hydrogenized a colourless acid soluble in water. This acid combines in the tub with the lime, and separates itself anew under its ordinary form of indigo, when by the oxygen of the air, or that of the chlorine, its hydrogen is resolved into water. M. Doebereiner has named the acid of indigo *isatanic*, and its combination with lime *isatinate*.

M. Holt has subsequently observed that the filings of iron or of zinc, being put into a solution of indigo in sulphuric acid, discolour that solution; and he thinks that this effect is caused by the hydrogen which these metals detach from the water. It is already known that sulphurated acid, also prussiarated hydrogen, effects a similar discoloration. The indigo here manifests with the hydrogen a stronger affinity than with the sulphuric acid; and this affinity cannot be weak, since it counterbalances that which at the degree of heat which excites it the hydrogen never fails to exercise upon the oxygen of sulphuric acid.

NEW

NEW SALTS CRYSTALLIZED WITHOUT WATER. BY THE SAME.

It was formerly believed that the water of crystallization was essential to the crystalline form of salts ; and it was even thought that all salts were provided with it: now, however, it is known that those salts which in their ordinary crystallization take the most of that water, can be crystallized independently of it, and crystallized even better.

If we dissolve by fire in its water of crystallization some Glauber salt, and add as much of the same salt effloresced as the solution will take, crystals will make their appearance of a form different from that of the Glauber salt, and that even when the solution is still at a temperature of 45° Reaumur. These crystals consist of the Glauber salt totally deprived of water, of which that species of salt contains about one half of its weight. Let a little water then be added, and the whole allowed to cool, when a salt will be crystallized which is a combination in determinate proportions of salt without water and ordinary salt.

Following the same operation with salt of soda, the refrigeration will produce in the mixture some large crystals, which will neither effloresce in the air nor imbibe any water, and which consist of subcarbonate of soda wholly free from this liquid, being formed of 29½ parts of soda and 21 parts of carbonic acid ; and having thus, in the same weight, more than double the real matter, for the crystallized soda ordinarily incloses a third more than the equal of its weight of water. The soda from the coasts of Africa, which are washed by seas holding this alkali in solution, seems to be in the same situation, since it does not effloresce, a change which never fails to take place if it contains water. It is accordingly attended with a profit of more than one half to purchase this salt in preference to the other, when it can be had at the same price. The speculation might even be tried of crystallizing it after having dissolved it in water. It will take for 51½ of this substance 66½ of the liquid, and will augment in that proportion its weight.

Many other salts crystallize without water; and among others, marine salt, saltpetre, and sulphate of potash. Water cannot therefore be considered as essential to this operation, nor ought it to be termed water of crystallization. It is a new body composed of water and salt which is formed, and which ought to receive a particular name. The name of hydrate which has been given to these compounds, and which has been extended to combinations of water with the alkalies, the insoluble oxides and acids, is improper, inasmuch as it presupposes that in these different combinations the water always saturates as an acid, while in those with the acids it evidently saturates as an oxide. In every

case

case where it disengages itself the relations are definite; and a proportion of water with a proportion of barytes, of potash, of soda, of sulphuric acid, of nitric acid, &c., cannot be disunited by fire; and the water is as essential to the composition of these bodies under that form, as oxygen and a combustible are to their composition without water.

---

STEAM FISH-CONVEYING VESSELS.

The application of the power of the steam-engine to navigation is now proposed to be extended to the important object of furnishing the metropolis with a regular and constant supply of freh fish at a cheap price. The variable manner in which the London market is supplied with this valuable article of food—its scarcity at one time, its over-abundance at another, and its dearness at all times—have long been matters of public complaint; and are undoubtedly more the result of those detentions to which the fishing packets are necessarily exposed from their dependence on the winds and tides, than of any combination or artifice (as is vulgarly supposed) among the dealers in the article. A fishing company has accordingly been formed, for the conveyance of fish from the coasts to the metropolis, whose vessels are to be strongly built, sea-worthy, and fast-sailing sloops, with the additional power of proceeding at option by sails or steam separately or united. They are to be fitted up with wells and suitable valves, so that the fish will be brought to Billingsgate alive in pure sea-water, at all seasons of the year, and London thus enjoy a luxury to which it has been hitherto a stranger. The construction of the vessels and engines has been intrusted to Mr. George Dodd, author of a work on Steam-Packets and Steam-Engines.

---

IMPROVEMENT IN STEAM-VESSELS.

Dr. Jeffray, Professor of Anatomy in the University of Glasgow, is reported to have made an important discovery of a new mode of propelling vessels of any description by steam. The principle of the invention has not as yet been made public; but its results, if we may give credit to the anticipations in the Glasgow Courier, in which it has been announced, are altogether marvelous.

---

MARINE BAROMETER.

A correspondent suggests to instrument-makers the propriety of having a small work or treatise published, to accompany the Marine Barometer, with a few concise rules and observations for the management of that instrument so useful to navigators who have not access to the bulky and expensive works and Encyclopædias in which it appears such rules and observations are only to be found, and without which the instrument in question is useless.

DIS-

### DISCOVERY OF AN ANCIENT CITY.

One of the Paris journals announces that a French traveller, now in Egypt, has discovered, at the distance of nine hours journey from the Red sea, an ancient city built in the mountains between the 24th and 25th degrees of latitude. There are still about 800 houses in existence; and among the ruins, temples dedicated to various divinities. There are eleven statues, besides fragments of others. He has also discovered the ancient stations that were appointed on the route through the Desert, going from the Red sea to the valley of the Nile They are at regular distances of nine hours between each. This route was undoubtedly one of those traversed by the commerce of India which flourished at the time of the Lagides, and under the first emperors.

### CELTIC ANTIQUITIES.

A Prussian officer who lately spent some time at Wisbaden, occupied himself in causing excavations to be made, in the hope of rendering his visit to the country of the ancient Celts profitable to science. In the course of his search he discovered a Druidical altar which had been overthrown, and was at first taken for an ordinary tumulus; a vase and a patera for sacrifices, and various arms and rings, all of bronze; a glass vase with a cover; several coloured glass rings; carnelians of various forms; swords and spear-heads of exquisite workmanship; various edge tools of stone, and among them a saw of flint. A vaulted cave was also discovered, containing ashes, calcined bones, and, what is still more curious, several perfect skeletons in Roman dresses: nearone of the skeletons was a *concha veneris* entirely petrified.

### EARTHQUAKES.

On the 2d day of October, about half past one P.M. a very smart shock of an earthquake was felt at Brutenzorg, Batavia. The houses were violently shaken, the windows rattled, the mortar fell from the walls, and the bells rung; people who were standing up became giddy by the motion of the ground. Some houses had the walls rent open. The shock lasted only a few seconds. It was felt in the mountains as well as in Batavia.

It was lately reported that Messina had been entirely destroyed by an earthquake, accompanied with the loss of some thousand lives; but letters of a later date than that mentioned for the catastrophe have been received from that city.

A letter from Palermo of 4th of March announces, that during the fourteen preceding days the weather had been dreadful, during which they had three shocks of an earthquake which had done much mischief on the south-east part of the island (Sicily), throwing down churches and destroying whole villages. Much damage was also done among the shipping. No mischief was done at Palermo.

*Meteoro-*

*Meteorological Journal kept at Walthamstow, Essex, from February 15 to March 15, 1819.*

[Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *February* | | | |
| 15 | 32<br>43 | 30·00 | SW.—Clear and *cirrostratus;* hazy; fine day; dark night. |
| 16 | 42<br>46 | 29·65 | SE.—Fine, wind and *cirrostratus;* rainy from before 9 A.M. to about noon, and slight showers afterwards; dark and windy. |
| 17 | 47<br>51 | 29·39 | W.—Clear and *cirrostratus* and windy; fine day; sun and wind; showers and windy.—Moon last quarter. |
| 18 | 42<br>48 | 29·41 | W—NW.—Cloudy morn; very fine day; dark and windy. |
| 19 | 40<br>50 | 29·25 | S by W—SW.—Cloudy and windy; showers; fine day; a shower about 3 P.M.; star-light. |
| 20 | 33<br>45 | 29·85 | SW.—White frost and hazy; fine day; sun and wind; dark night; rain in the night. |
| 21 | 44<br>47 | 29·19 | S.—Clear and cloudy; showers and wind; rain and wind. |
| 22 | 39<br>44 | 29·16 | NW.—Clear, *cirrostratus* and windy; fine day; some showers; star-light. |
| 23 | 37<br>49 | 29·65 | SE.—Very rainy and windy; rainy day; stormy; some sun and wind; very windy and star-light. |
| 24 | 30<br>40 | 29·50 | W.—*Cirrostratus* and wind; sun and windy; fine day; snowing from 2½ P.M. to about 5 P.M.; ground and trees white; star-light. New moon. |
| 25 | 29<br>38 | 29·64 | NW.—Snowing fast at 7 A.M.; sunshine; fine day; very windy; star-light. |
| 26 | 29<br>40 | 29·65 | W.—Fine rain; clear at 7 A.M., at 8 A.M. hazy; sun through mist; snow; rain; rain and wind. |
| 27 | 35<br>47 | 29·36 | SE.—Cloudy; fine day; some sunshine and wind; night cloudy. |
| 28 | 39<br>40 | 29·30 | SE.—Cloudy and windy; slight rain; very cold and windy; and *cirrostratus;* fine day; showers and wind. |
| *March* | | | |
| 1 | 35<br>39 | 29·23 | NW.—Showers and windy; snowing began after 7 A.M.; rain afterwards; frequent rain; dark night. |

*March*

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *March* | | | |
| 2 | 39<br>41 | 29·20 | S.—Stormy, wind and rain; very rainy till about 5 P.M.; light, but neither moon nor stars visible. |
| 3 | 36<br>39 | 29·42 | N—NE.—*Cirrostratus* and windy; fine gray day; fine night; *cirrostratus*, and wind. Moon first quarter. |
| 4 | 35<br>46 | 29·80 | N.—Gray morn; wind and showers (slight); fine day; cloudy, and windy at 9 P.M., and bright star- and moon-light at 11 P.M. |
| 5 | 37<br>46 | 29·92 | N.—Clear, and *cirrostratus;* showers all day, and a little sunshine; cloudy night. |
| 6 | 43<br>49 | 29·88 | N.—Cloudy and windy; fine day; sun and wind; cloudy; very windy. |
| 7 | 39<br>42 | 30·00 | NE.—Wind, *cirrostratus*, and clear; fine gray day; wind and *cirrostratus;* night dark. |
| 8 | 39<br>44 | 30·09 | NE.—Clear, *cirrostratus* and wind; fine gray day; sunshine after 3 P.M.; cloudy and windy. |
| 9 | 37<br>47 | 30·02 | N—S.—Hazy morn; hazy and sun; cloudy and windy. |
| 10 | 36<br>47 | 30·02 | SW—NW.—Foggy morn; fine gray day; windy; cloudy night. |
| 11 | 40<br>49 | 30·00 | W—NW.—Clear and clouds; fine gray day; windy; cloudy early; at 11 P.M. clear and *cirrostratus*. Full moon. |
| 12 | 44<br>53 | 30·00 | NW.—Clear and *cirrostratus;* fine sunny day; cloudy night. |
| 13 | 43<br>48 | 30·20 | W—NW.—*Cirrostratus;* fine gray day; cloudy night. |
| 14 | 43<br>48 | 30·19 | SE.—Gray morn; fine day; sun and wind; star-light. |
| 15 | 32<br>48 | 30·20 | NE—SW.—Clouds and *cirrostratus*; very fine day; star-light. |

*** Draba verna, Veronica agrestis, Lamium purpureum, Alsine media, &c. in flower.—Whitlow grass, Wild germander, Dead nettle, Common chickweed.

N. B. Though the very early part of this spring was forward, the season at present is not far advanced; on the contrary, it is rather backward. By a reference to journals for upwards of forty years back, I find that mild winters have generally been followed by rather late springs.

METEORO-

## METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1819. | Age of the Moon. | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| Feb. 15 | 15 | 40·5 | 30· | Fine |
| 16 | 16 | 43·5 | 29·60 | Rain |
| 17 | 17 | 49·5 | 29·50 | Cloudy—rain A.M. |
| 18 | 18 | 46· | 29·66 | Ditto |
| 19 | 19 | 50· | 29·33 | Ditto |
| 20 | 20 | 47· | 29·90 | Fine |
| 21 | 21 | 46· | 29·08 | Cloudy—heavy rain and stormy [A.M. |
| 22 | 22 | 41·5 | 30· | Ditto |
| 23 | 23 | 35· | 29·60 | Snow |
| 24 | new | 39· | 29·50 | Cloudy |
| 25 | 25 | 40·5 | 29·84 | Fair—snow A.M. |
| 26 | 26 | 41· | 29·66 | Cloudy |
| 27 | 27 | 38· | 29·46 | Rain |
| 28 | 28 | 44· | 29·46 | Cloudy |
| Mar. 1 | 1 | 40·5 | 29·46 | Ditto—rain A.M. |
| 2 | 2 | 42·5 | 29·60 | Ditto |
| 3 | 3 | 41·5 | 29·84 | Ditto—hail A.M. |
| 4 | 4 | 44·5 | 30·04 | Ditto |
| 5 | 5 | 47· | 30·10 | Ditto |
| 6 | 6 | 48·5 | 30·06 | Ditto |
| 7 | 7 | 47· | 30·23 | Ditto—rain A.M. |
| 8 | 8 | 46·5 | 30·22 | Ditto |
| 9 | 9 | 49· | 30·20 | Fine |
| 10 | 10 | 50·5 | 30·22 | Cloudy |
| 11 | full | 53· | 30·14 | Ditto |
| 12 | 12 | 51· | 30·24 | Fine |
| 13 | 13 | 47· | 30·35 | Cloudy |
| 14 | 14 | 49· | 30·40 | Ditto |

METEORO-

## METEOROLOGICAL TABLE,

## By Mr. Cary, of the Strand,

## *For March* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| Feb. 24 | 32 | 41 | 28 | 29·36 | 17 | Cloudy |
| 25 | 31 | 41 | 35 | ·65 | 10 | Fair |
| 26 | 30 | 40 | 36 | ·45 | 12 | Cloudy |
| 27 | 37 | 47 | 41 | ·30 | 24 | Fair |
| 28 | 40 | 41 | 37 | ·25 | 10 | Cloudy |
| March 1 | 35 | 40 | 40 | ·20 | 0 | Rain |
| 2 | 42 | 44 | 40 | ·36 | 0 | Rain |
| 3 | 40 | 40 | 40 | ·55 | 22 | Cloudy |
| 4 | 37 | 45 | 42 | ·82 | 25 | Fair |
| 5 | 42 | 46 | 40 | ·90 | 10 | Showery |
| 6 | 44 | 48 | 40 | ·85 | 27 | Fair |
| 7 | 41 | 46 | 40 | 30·00 | 25 | Cloudy |
| 8 | 40 | 46 | 40 | ·01 | 30 | Fair |
| 9 | 42 | 47 | 40 | ·02 | 29 | Fair |
| 0 | 40 | 47 | 40 | ·01 | 21 | Cloudy |
| 11 | 41 | 48 | 46 | ·04 | 28 | Cloudy |
| 12 | 46 | 50 | 40 | ·10 | 29 | Cloudy |
| 13 | 44 | 47 | 42 | ·23 | 27 | Cloudy |
| 14 | 42 | 49 | 39 | ·24 | 29 | Cloudy |
| 15 | 37 | 55 | 40 | ·09 | 35 | Fair |
| 16 | 46 | 56 | 50 | 29·94 | 30 | Fair |
| 17 | 44 | 47 | 40 | 30·12 | 31 | Cloudy |
| 18 | 37 | 52 | 40 | ·09 | 30 | Fair |
| 19 | 47 | 51 | 44 | 29·52 | 47 | Showery |
| 20 | 44 | 44 | 39 | ·62 | 25 | Showery |
| 21 | 40 | 47 | 40 | ·87 | 41 | Fair |
| 22 | 40 | 49 | 40 | ·85 | 40 | Fair |
| 23 | 41 | 50 | 42 | ·78 | 22 | Cloudy |
| 24 | 47 | 56 | 46 | ·73 | 36 | Fair |
| 25 | 46 | 52 | 40 | ·70 | 30 | Showery |
| 26 | 41 | 53 | 45 | ·70 | 39 | Fair |

N.B. The Barometer's height is taken at one o'clock.

## XXXVIII. *On the Question "Whether Music is necessary to the Orator,—to what Extent, and how most readily attainable?"* *By* Henry Upington, *Esq.*

[Continued from p. 86.]

*To Mr. Tilloch.*

Blair's Hill, Cork, March 11, 1819.

Sir, — In your late Journals for January and February I stated at considerable length the method which, at my suggestion, was adopted by the *Speaker* for the subversion of his original habits, and the substitution of superior habits in their stead. I also stated in that paper, the very simple operations by which any gentleman may almost instantly acquire a sufficiency of music for oratorical purposes: it now therefore remains that I circumstantially relate what subsequent exercises—whether of actual recitation, of intervals, of time or forte—were deemed expedient for the *Speaker*, as the ground-work of his elocutionary proceeding.

The passages with which I began this novel undertaking were, as already mentioned, the *Exordiums* of Virgil's first Eclogue, of the Æneid, and of the Iliad. In these, as well as in the exordium of Ovid's Metamorphoses which succeeded, both accent* and quantity were attempted in the prescribed manner; and the result was highly beneficial. Passages from the Epithalamium on Helen, by Theocritus, then followed†; and in *this* hexameter

* The *circumflex* was omitted by me in the Latin. My general method of *classically accentuating* this language will appear from the Eclogue. The short and long *quantity* is known to every scholar.

Títyre, tù pátulæ récubans sùb tégmine fági,
Sylvéstrem ténui músam meditáris avéna;
Nòs pátriæ fínes èt dúlcia línquimus árva,
Nòs pátriam fúgimus—tù, Títyre, léntus in úmbra
Formósam resonáre dóces Amarýllida sýlvas.

This accentuation, even when really executed, has no modern peculiarity. It is the *universal* language of the superior gentleman, not the *local* dialect of either English, Scotch or Irishman. I notice this circumstance for the guidance of those gentlemen whose opinions may unheedingly have been influenced by the "Elements of Elocution" or "Rhetorical Grammar" of Mr. Walker. Indeed from the whole tenor of these works which I have perused much more carefully than they deserve, I feel persuaded that if he (Mr. W.) had been taken to an instrument, his ear must have been found incapable of distinguishing the higher from the lower of any two contiguous or nearly contiguous notes, as C from C sharp, or even from D, or perhaps from E minor. It would certainly be well if all oratorical empirics were tried by some such test. Their capability of distinguishing *slides* should also be ascertained by the pitch-pipe—the stopper of which should, in such essay, be moved up and down very gradually.

† The selections from this beautiful Epithalamium were

Ἐν ποκ' ἄρα Σπάρτα down to δῶμ' ὑμεναίῳ.
Οὕτω δὴ πρωΐζα ...... νυὸς ἤδη.
Χαίροις ὦ νύμφα ...... πάλιν ἔλθῃ.



more

more licenses than usual were taken with the quantity—such licenses indeed as the now *newly-formed* ear did at any time suggest,—the *accurate* observance of the Dactylic and Spondaic proportions sometimes appearing rather too heavy for the subject. Regulated in this manner, it may safely be affirmed that this Epithalamium, when judiciously modulated, exhibits more grace, more elegance and melody than in all probability were ever yet presented to our countrymen. It possesses (in modern estimation) an almost intermediate character between poetry and prose, partaking however much more of the former than of the latter; and is admirably calculated for the improvement of either the genteel comedian or the orator.

The Orations of Demosthenes were now taken up: and without over-nice attention to the sense, the exordium of his first Philippic was practised, merely as a lesson of prosaic melody; the etas, omegas, diphthongs and circumflexed syllables obtaining all warrantable extension of their quantities. Appropriate emphasis* (or expression as we term it) was afterwards delicately introduced, and the general features of this passage were in a sufficient de-

* There is not perhaps any subject less understood in these countries than that of *emphasis*. The generality of people, including a vast number of self-taught critics, imagine that nothing more is necessary than *Gothic violence* to which some unfortunate syllable must by all means be devoted; whereas *this* species of emphasis should, in all practicable cases, be avoided. Interval or degree of rise or fall in the musical scale,—tone or quality of the voice,—time, quicker or slower,—pause,—forte,—nay, piano itself—all enter into the definition of emphasis; and of these the judicious speaker will employ such and only such as are most applicable to the occasion.

The old well-known sentence "Do you ride to town to-day?" is exceedingly well calculated to try the talents of a reciter. Quere then—how shall this sentence (ill constructed as it is for the purpose) be delivered, so as to express not only *religious disapprobation* at journeying on the *sabbath* DAY, but likewise *serious apprehension* at visiting the TOWN in which a malignant fever is prevalent;—while, at the same time, no other answer shall be intended by the querist than a simple *yes* or *no* with regard to *riding*, in opposition to any other mode of travelling?

If Mr. Sheridan in his "Art of Reading" had thus investigated the *general* character of his subject, instead of partially searching out some *little points*, and barbarously degrading to the rank of enclitics an infinity of important words—much reason had been found (in the present state of intelligent opinion) to approve rather than condemn our clerical delivery of the Church service—so shamefully misrepresented by this uncandid writer.

Neither, in my mind, is the stage modulation at all suited to the solemnity of the temple. Every thing has its own proper place. Hence it appears extremely probable that the greatest actor ever produced by our nation would have been found incapable of filling with becoming dignity either the seat of justice or the pulpit. As for my own part, whenever I discover anything theatrical in the gesture, countenance or delivery of a clergyman; I set him down, at least in this instance, as a defective orator, who, in place of enchaining my imagination in the house of God, conducts it, in opposition to my best intentions—to the Play.

gree

gree *modernized.* Its ultimate character was peculiar: *sweet gravity* was its main constituent.

Our *native* composition was next essayed. Improvement was striking and decided, although certain vestiges of original associations were still perceptible. For the perfect obliteration then of all these, a *finishing* exercise appeared desirable—and for this purpose the accentual or muscular signs were evidently the most effectual.

Some eighty or a hundred lines from "Leland's Demosthenes" and "The Spirit of Patriotism," together with the "Apostles' Creed*" were therefore accented; not regularly indeed and according to ancient method, but rather in an arbitrary manner—these English exercises having but two objects in view; namely, the changing of original associations, and accustoming the Speaker to unusual attempts at elevation, depression and repetition, even with temporary *rant,* which imperfection the judicious practitioner should however, as much as possible, avoid. The exordium of the first Philippic will serve for an example.

### *Philippic the first.*

[For the definite application of the accentual signs, see Magazine for January.]

" Had wé been convèned Athénians upòn sòme nẽw súbject of débate, I had wáited untìl mòst óf the úsúal† pérsons had declãred their opínions. If I hád appròved of ány thìng próposed by′ them, I shoúld have contínued sílent: íf nòt, I hád thèn attémpted to exprèss my` sentíments. Bùt sìnce those véry põints upòn which thèse spéakers have óftentìmes been hèard ãlréady, àre at thìs tìme tó be consídered; thò I háve arísen first, I presũme I máy expèct your párdon; fòr if thèy, on fórmer occãsions had ádvised the necéssary méasures, you wóuld not have fõund it néedful tó cónsult át présent."

During the prosecution of these latter exercises, *Music* was once more introduced. The *Speaker,* as I have elsewhere observed, was, notwithstanding his almost incredible improvement, still too unchaste and even too monotonous in his modulation to satisfy the discriminating judges by whom he was occasionally

* This Creed was chosen for its supposed susceptibility of superior modulation. Of this hereafter.

† The general incapacity of the *Speaker* to sustain the letter *u* occasioned these consecutive acutes on "*úsúal.*" [In words like "*usefulness*" &c. this defect was highly detrimental.] The several *almost-consecutive* acutes towards the conclusion of the period, were also intended as preventives of precipitation.

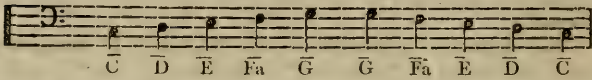
With regard to the word "*põints,*" it was intentionally circumflexed—to destroy that *contemptible affectation,* now growing into custom, of genteelly *squeezing to death* the noblest of our diphthongs.

 examined:

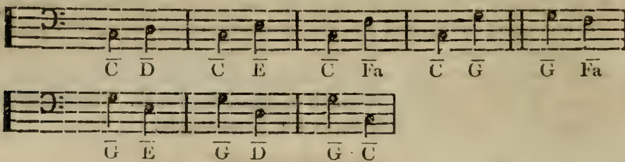
examined: and suitable exercises in this art were therefore recommended.

He began with the Major Diapente, Minor Diapente, and the General Diapente called by Dr. Burney the “Venetian Solfay,” thus,

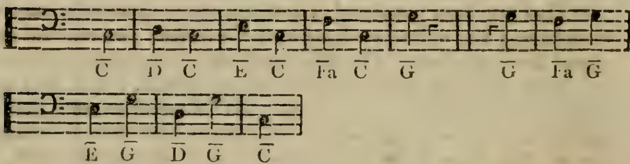
No. 1. *Major Diapente.*




No. 2. *The same adjusted* for the more effectual attainment of Intervals.

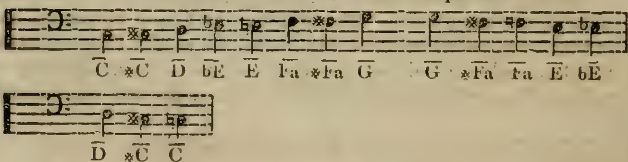



No. 3. *The same with reversed Emphasis*; to destroy all Associations between Tone and Forte.




Nos. 4, 5, 6. *Minor Diapente.* On similar Plan as the Major; E flat or minor being substituted for E major.

No. 7. *General or Venetian Diapente.**

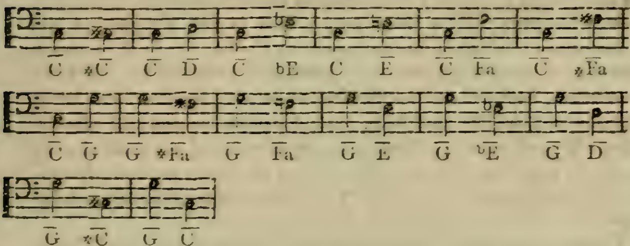



[It need not be expected that this difficult chromatic exercise shall

* This solfay has been strongly recommended in Dr. Burney's History of Music: and should the oratorical practitioner discover that his ear is sufficiently good for the *mensuration of distances* (which by the way is no contemptible acquisition), I know not any method so well suited for the attainment. The musician, in particular, will find it a most advantageous lesson

shall be executed by any ordinary ear when detached from the piano. No more then is intended than that the practitioner shall execute these intervals while assisted by the instrument. To preserve more certainly a recollection of the fundamental note, it may even be necessary, for some time, to sound the lower octave of that note (suppose c) during the performance.]

No. 8. *The same*, for the purpose specified in No. 2.




No. 9. *The same, with reversed Emphasis.*

[Unnecessary to note down. No. 3 will explain the reason of this lesson, and the method.]

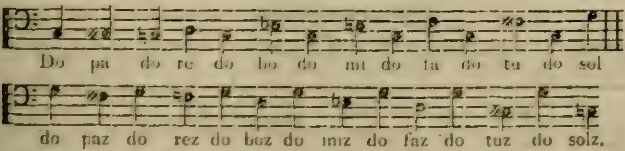
Such are the very simple lessons beyond which (unless some pieces of recitative were composed for the occasion by a first-rate master) much doubt was entertained by my judicious musical

---

lesson for his pupils, the vast majority of whom are left by their masters most egregiously ignorant of intervals.

In this solfay, every semitone of the octave is comprehended by the words Doparè Bomifa Tusoldè Lanosi; the syllables of which should, in my opinion, be disposed not merely in the Venetian manner, but in a manner significant of *immediate distance*, so that the practitioner shall sing the interval itself by the agency of its name. I shall exemplify the Diapente by the first eight syllables Doparè Bomifa Tusol: let the remaining four be added by the musician.

*Descent* is implied by the termination *z*.




Here the syllable "*do*" is always the mensuration standard.

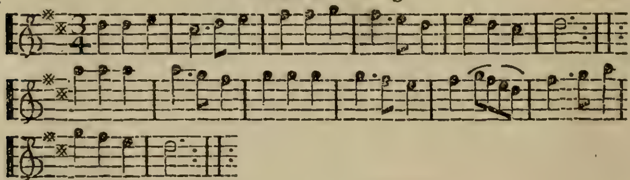
*pa* implies a semitone,
*re* . . . a tone,
*bo* . . . a minor 3d,
*mi* . . a major 3d,
and so of the rest.

 friends

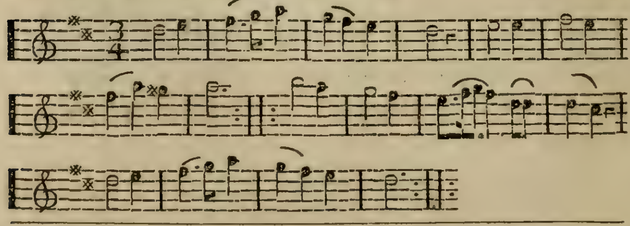
friends whether the orator could with any prospect of utility, proceed. All the *songs* within their recollection, or to which recourse could in any way be had, were decidedly rejected—with the exception of those two so frequently mentioned, " God save the King " and " Hope, thou Nurse." Even these were considered by no means faultless; and yet, as examples of extremely chaste modulation, and containing the sub-semitone of their respective keys, they were nevertheless hazarded—and fortunately with advantage. The *time* too, which is the simplest of our $\frac{3}{4}$, and most analogous to the imperfect Cretic − ◡ ⏓ so common in our language, was an additional inducement. For the prevention, however, of inarticulate or ranting habits, these songs were in some degree modified: and, for accustoming the *Speaker* to an elevated command towards the closing of his periods, the triplet or grace on the penultimate bar of " God save the King," though objectionable in every other sense, was reluctantly introduced.

These two pieces being composed in triple time and in the major mode, a *minor* exercise* in *common* time was also suggested. Of this nature not an eligible *song* could be procured. Our sacred melodies were therefore examined; and one which the *Speaker* had frequently heard sung in one of our churches (and most sublimely indeed) was chosen for the purpose. The time and intervals of these three pieces, in their original form, ran thus,

*God save the King.*

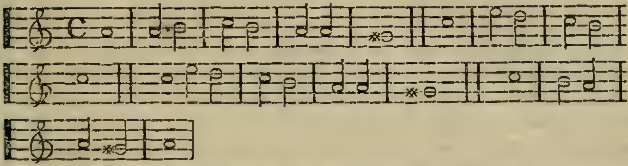


*Hope, thou Nurse.*



* For the excitement of the softer passions, the *minor* mode is infinitely superior to our national one the *major*. In chaste recitation it is also less monotonous,

4th Psalm.



But in their modified form, for execution by the *Speaker*, thus—prosodial characters (as I already noticed) being in each instance substituted for the musical ones, viz.

For the Minim =*
Crotchet —
Quaver ◡

*God save the King.*

[The *words* of this air were sung.]

d d e | *c d e | *f *f g | *f e d | e d *c | d |

a a a a g *f | g g g | g *f e | *f g *f e d | *f g a | b a g *f e | d |

*Hope, thou Nurse*†.

[The *letters* of this air were substituted for the words, in consequence of the *slurs* which having been found too difficult were omitted.]

d e | *f g a | g *f e | d | e e | *f e | *f a *g | a ||

b a | g *f | e *f g *f e d | d *e | d e | *f g a | g *f e | d ||

*4th Psalm*‡.

[The *words* of *this* melody were sung. They are placed in the usual manner under the music] thus,

A | A B | c B | A A | *G || c | e d | c B | c ||

Oh Lord that art my righteous Judge, to my complaint give ear.

monotonous, in consequence of what I shall call the *natural semitone* which is found between every fundamental and its minor third. The minor mode likewise, as being more serious than the major, is better calculated, in general, for the solemnity of the pulpit.

* The same signs are equally employed for the Semibreve, Minim and Crotchet. The proportions 1, 2, 4, not the slowness or quickness of the movement, are the main object.

† It is worthy of observation that, in this exquisite air, the *Diapente* is twice solfayed. This circumstance alone must render it an eligible lesson.

‡ Although it was thought adviseable that the *Speaker* should exercise his

 voice

— c | c d | c B | A A | *G — || — c | B A | A *G | A — ||

Thou still redeem'st me from distress; have mercy Lord and hear.

Inexplicable as it may seem, why our early habits, when connected with certain associations, should with extreme difficulty be removed—the fact is nevertheless incontrovertible. Never did there appear a stronger instance of this truth than was exhibited by the *Speaker*. His periods, during recitation, were originally ill-sustained; and notwithstanding all the subsequent advantages of muscular and musical exercise, his primary associations were so deeply imprinted that all the efforts of art seemed ineffectual, on certain occasions, for their obliteration. Success was almost despaired of—when, fortunately, a most simple and I believe novel expedient was suggested by an ingenious friend—an expedient equally applicable to any intermediate part as well as to the conclusion of a sentence; viz. practising for a few moments the *terminating* portion as though it were the *commencement*, and adding some auxiliary words to assist the imagination. As thus with the period "*for all are ready to confederate with those whom they see prepared and resolved to exert themselves as they ought.*" Let the reciter suppose himself *beginning* a sentence in the following manner, annexing the imaginary part which is printed in small capitals; *To exert themselves as they ought* IS THE ONLY METHOD OF ENSURING OUR OBJECT, BECAUSE, &c. &c.: and after having practised *this* reading for three or four times, let him return to the original.

Now simple as this contrivance may appear, it was always, even in the most cumbrous sentence, found eminently efficacious: nay, it produces even in the most untutored reciter an instantaneous change; and compels him, in defiance of himself, to an exceedingly close approximation towards that species of *level* of which I treated in this Journal for last September. In short, this operation may be considered by the orator, of more practical advantage with regard to periods than all the individual or collective rules with which our modern writers upon elocution have swelled their pages.

Our attention, which was hitherto chiefly occupied by the various lessons that were judged necessary for improving the *Speaker* in the sustentation of his voice and the command of intervals—must for a short time be turned to the subject of *time* and *forte*. The command of *these*, under all circumstances even the most difficult, was by no means lightly appreciated; nor did the result

voice on the higher keys, yet this Psalm has perhaps been set *rather too* high. Should the *orator* employ for his improvement those keys which carry him beyond his *speaking* compass? I think not.

in

in any manner disappoint our expectation. Uncommon energy, ease, distinctness and expression, not merely in the delivery of emphatic words or emphatic syllables, but throughout all the individual parts of the most complicated sentences, were acquired; and by a method equally prompt as efficacious; viz. "the mere practice of an arranged table, with diversified forte of the simpler *feet*; to the greater part of which so arranged, extensive exercises in the Greek or Latin—but which the *Speaker* was too impatient to encounter—must of themselves have habituated his ear and enunciative organs.

These feet, as the reader will discover, are inclosed or barred in the natural or *truly classical*, not in our artificial or musical [*called* "classical."] manner. The latter, or musical manner, which rejects in many instances the *here*-prescribed order of forte; and unduly lengthens, beyond the written duration, the *commencing* or emphatical note of its respective bars, while it shortens the *succeeding* one*—is contrary to the intention of this lesson, whose object is *relative proportion:* wherefore, for example, although our *second* and *third* tribrachs [see *table*, for the cause of numbering them] may appear to the musician as equivalent to the *first*, when those tribrachs shall be thus barred do | do do do | or do do | do do do; yet nothing can be further from the fact—nor should they be so practised by the orator. On the contrary, he must aim at the *equalization* of the length of every such syllable, no matter in what situation it shall be found; while the three syllables, in aggregate, within the written boundary, though completely united with each other as a word of three syllables, shall be nevertheless detached both from the last syllable of the preceding and from the first syllable of the succeeding measure, as thus | do—do—do | do—do—do | do—do—do | ; even approaching in some slight degree, by the agency of the almost imperceptible boundary-pauses, to what the unskilful musician will possibly set down as *common time.*

Perhaps, above all other exercises, this excellent one of the tribrach, as regulated in the table, is the best calculated for enabling the orator to annihilate at pleasure that despicable *jigging* quality of our *triplet*—with which, from the musical habits of our country, our very language itself would appear almost

* *This* (accompanied by more or less forte) is the true definition of the term "*musical accent*" which has been ingeniously introduced by our writers on music, in the mysterious garb of "*pressure!*" Call it accent, pressure, forte, or what we please, it is certainly subversive of all *relative proportion*, and constitutes one of the essential differences between the Grecian music and our own: and from such practice results the general incapacity of our musical world for the mensuration of relative time.

inseparably

inseparably connected. Let the orator therefore persevere; in a few days every apparent obstacle will be sufficiently surmounted.

### *Exercises of Time and Forte.*

[Although the first syllable of our musical solfay, "*do*," (the *o* whether long or short being always sounded as in "*no*") is invariably used in these examples; yet the orator should exercise himself in *all* the long sounds of our language, viz. *a* (as in *all*), *a* (as in *father*), *e* (as in *deign*), *e* (as in *meet*), *i*, *o*; *o* (as in *move*), *u*, *oi*, *ou*. Our *short* vowels too, as well as the long ones, may be exercised in their proper places.]

Note—The *forte*, or more properly the *comparatively* forte syllables of the following table are printed in *italics:* and according to the *local* situation of these, the feet are uniformly *numbered.*

*Dissyllable Feet.*

| | | | | | |
|---|---|---|---|---|---|
| Pyrrhic | 1st. | *dŏ*—dŏ | Iambus | 1st. | *dŏ*—dō |
| | 2d. | dŏ—*dŏ* | | 2d. | dŏ—*dō* |
| Trochee | 1st. | *dō*—dŏ | Spondee | 1st. | *dō*—dō |
| | 2d. | dō—*dŏ* | | 2d. | dō—*dō* |

*Trisyllable Feet.*

| | | | | | |
|---|---|---|---|---|---|
| Dactyl | 1st. | *dō*—dŏ—dŏ | Molossus | 1st. | *dō*—dō—dō |
| | 2d. | dō—*dŏ*—dŏ | | 2d. | dō—*dō*—dō |
| | 3d. | dō—dŏ—*dŏ* | | 3d. | dō—dō—*dō* |
| Anapæst | 1st. | *dŏ*—dŏ—dō | Cretic | 1st. | *dō*—dŏ—dō |
| | 2d. | dŏ—*dŏ*—dō | | 2d. | dō—*dŏ*—dō |
| | 3d. | dŏ—dŏ—*dō* | | 3d. | dō—dŏ—*dō* |
| Amphibrach | 1st. | *dŏ*—dō—dŏ | Bacchic | 1st. | *dŏ*—dō—dō |
| | 2d. | dŏ—*dō*—dŏ | | 2d. | dŏ—*dō*—dō |
| | 3d. | dŏ—dō—*dŏ* | | 3d. | dŏ—dō—*dō* |
| Tribrach | 1st. | *dŏ*—dŏ—dŏ | Antibacchic | 1st. | dō—dō—dŏ |
| | 2d. | dŏ—*dŏ*—dŏ | | 2d! | dō—dō—dŏ |
| | 3d. | dŏ—dŏ—*dŏ* | | 3d. | dō—dō—dŏ |

[If the ordinary practitioner should find these lessons too difficult, let him consult some intelligent musician. They *can* and *must* be executed without whine or drawl.]

[To be continued.]

---

## XXXIX. *Observations on three British Species of Warblers; with a view to a more accurate Discrimination of them, and the consequent Elucidation of Calendars of Natural History. By* T. Forster, *M.B. F.L.S.*

This numerous family is divided into a great variety of kinds, many of which differ so much from each other as to justify us, in the artificial arrangement of Natural History, if we should regard them

them as constituting several separate genera. Under the general description of *a small head, a slender bill beset with bristles, small and depressed nostrils; and an outer toe joined to the middle one by a membrane, &c.* naturalists have imperfectly depicted the character, and have overlooked the less obvious but not less essential differences to be found in the forms of the brain, the mode of feeding, and other habits and manners of the several genera and species of Warblers. I have endeavoured by observation to found a division of genera on these differences, and submit them in the following pages.

### Genus FICEDULA.

I have adopted for the division (*Muscivoræ*) of some continental writers this term from Aldrovandus, and have used it here to designate the three species of Willow Wren known in this island, in preference to *Trochilus* (which I have formerly used), as this latter term is already (though I believe erroneously) applied to the Humming Bird.

The great confusion which has prevailed among ornithologists with respect to the Willow Wrens, has induced me to be very minute in the description of them, in order to convey clear ideas of the characteristic marks of distinction which each species may possess. Their great resemblance in many particulars has led to the abovementioned confusion in the description of them.

The description of *Sylvia Trochilus*, or the Willow Wren, by Latham, seems to answer to that of the *Sylvia Hippolais*, or Least Willow Wren, of Montagu's Ornith. Dict.—Temminck has recently fallen into a similar mistake. Bewick has mistaken the names; and, in short, almost all writers have mixed part of the description of one species with that of another. The infinity of names also used by various writers renders necessary a copious table of reference, in order to identify species by their descriptions.

#### Species 1. Ficedula Sylvicola.

Synonyms:

*Sylvia Sylvicola*, Montagu Ornith. Dict. and Linn. Trans. iv. 35.
*Sylvia Sibilatrix*, Temminck Man. Orn. 123. and Beckstein iii. 561.
*Trochilus major*, Synopt. Catal.* 116.

This is the *Yellow Willow Wren* of Bewick; the *Wood Wren* of Linn. Trans. ii. 245. tab. 24; the *Largest Willow Wren* of White's Nat. Hist. Selborne; and the *Green Wren* of Albin, vol. ii. tab. 86. 6.

* Synoptical Catalogue, &c. by T. Forster. Nicholls and Co. London, 1817.

Some

Some German writers call this bird *Grüner Sänger*; and Bechstein has called it *Lambrolchen* and *Laubvolchen.*

This bird is apparently figured in Nillson's *Ornithologia Suecica*, vol. i.

*Description.*— Length about five inches: bill dusky: irides hazel. The upper part of the head, back, scapulars and coverts are dusky yellowish green. Over each eye there is a bright brimstone-coloured streak. The cheeks, throat and breast are yellow, palest on the breast and inclining to white; the lower part of the breast, belly and under-tail coverts white.

The plumage of the female is like that of the male; but she appears somewhat larger, and weighs three drachms.

This bird has been confounded with the species next described (*S. Trochilus*). But it may be easily distinguished by its colour and habit. The upper parts are of a brighter greenish colour; and it is found in more wooded situations than the *Sylvia Trochilus.*

This species is migrative like the other two: it arrives very early in May, and departs in September.

Species 2. Ficedula Salicum.

Synonyms:

*Sylvia Trochilus* of Latham.
*Motacilla Trochilus*, Linn.
*Asilus*, Briss. iii. 479. and Ray, p. 80.
*Le Pouillot*, Buff. v. 344.
*Le Figuier brun et jaune*, Buff. v. 295.

This is the *Yellow Wren* of Edwards; the *Middle Willow Wren* of White in Hist. Selborne; the *Scotch Wren* of Pennant and Latham; and the *Willow Wren* of Bewick.

The provincial names for it are Ground Wren, or Ground Huckmuck.

This bird weighs two drachms and almost three quarters, and is five inches in length, being somewhat smaller than the last. It is to be distinguished from that bird by the upper parts of the plumage being more of a greenish yellow olive, the under parts being whitish tinged with yellow; quills dusky edged with yellow; over the eye a yellow line; legs light brown: eggs spotted with dark rust colour. This species is more frequently found about willows and osiers than the other two are.

Species 3. Ficedula Pinetorum.

Synonyms:

*Sylvia Hippolais*, Lath.
*Motacilla Hippolais*, Linn.
*Ficedula Septima*, Aldrov.

This

This is called *Chifchaf*, or Lesser Pettichaps; it is the *Least Willow Wren* of White and Bewick.

Its length is four inches and a half, and it weighs two drachms. It is to be distinguished from the last species by its smaller size, by the under parts being less tinged with yellow and the upper parts rather browner, by its legs being dusky instead of brown, and by its song. The eggs are white speckled with purplish red.

The Chifchaf is frequent in gardens and orchards, particularly where larch and fir trees abound: it arrives in March and departs in November. This bird as well as the last may be easiest found in still rainy days, when they may be seen running nimbly about the boughs and hedges. It is generally to be found flitting about the branches of the pine trees in pursuit of its prey, and where trees of this genus abound, we are rarely disappointed in finding it during summer.

The head of this kind is somewhat more depressed than the last.

I have given the above descriptions to prevent mistakes when the species are occasionally noticed in the journals of the weather, &c. as the times of the appearance of migratory birds are interesting appendages to calendars of the seasons.

I am, &c.

Walthamstow, March 18, 1819. T. Forster.

[To be continued.]

---

## XL. *Discoveries made in Egypt by Mr.* Caviglia; *with Remarks on the probable Reason for the principal Entrances into the Pyramids having been constructed descending in an Angle of* 26° *or* 27° *to the Horizon.*

In our Number for February 1817 (see our fifty-first vol.) we announced that some important discoveries respecting the sphynx and the principal pyramid had been made by a Captain C. and Mr. Salt; that by excavating round the sphynx they had ascertained that it is cut out of the solid rock; that they had entered the chamber immediately over that containing the sarcophagus, and which had been discovered by Mr. Davison in 1765, as described in his Journal published in Walpole's Memoirs, the existence of which had since been doubted; and that they found that the descending passage at the entrance of the pyramid, instead of terminating where there is an ascent to the two chambers, continues in a straight line, till it joins the bottom of what has been hitherto called the well, but does not there terminate, but proceeds onward to a well, or rather, as we now find, another chamber exactly under the apex of the pyramid. The Capt. C. there

there alluded to, and to whom Mr. Salt ascribes the entire merit of these and other important discoveries which we shall briefly notice, is Mr. Caviglia, the owner and master of a Mediterranean trader, enthusiastically fond of such pursuits.

Mr. Caviglia's first object was to examine the well in the chamber of the great pyramid, neither he nor Mr. Salt being then aware that Mr. Davison had been at the bottom of it forty years before. With a rope round his body, his friends remaining above to secure the other end, he descended the shaft twenty-two feet in depth: from this a passage of about eight feet, led to a second shaft of only five feet in depth; and four feet ten inches from this was another well somewhat tortuous twenty-nine feet deep, where there is a grotto about fourteen feet long and five wide, and about the height of a man: here a new shaft, somewhat inclined, commences of ninety-nine feet in depth, where all further progress was prevented by dirt and rubbish. He found but little difficulty in reaching the bottom, but the heat was excessive and the air very impure. Dissatisfied with this first attempt, he afterwards hired some Arabs, and absolutely set to work to clear away the rubbish from the bottom of the well; but which he was obliged to abandon, the air being so bad that a candle would not burn in it. Disappointed in this object, he next proceeded to clear out the principal entrance of the pyramid; and now he discovered that this passage, instead of terminating where it had hitherto been supposed, continues in the same inclination downward, of the same dimensions, and having its sides worked with the same care as the entrance, though filled nearly to the top with earth and stones. At the length of 150 feet the foul air became again very troublesome: however, he persevered; and having penetrated 200 feet, he found a door-way on the right, from which having cleared the rubbish, he found himself in the bottom of the well, and there his baskets and implements which had been left on his recent attempt to clear it out. The opening of this passage to the well had the effect to produce a free circulation of air, and enabled him to pursue his researches without any further hindrance from that cause. The new passage did not terminate at the opening into the well: twenty-three feet beyond this, in the same angle of inclination, it became narrower, and then proceeded horizontally about twenty-eight feet further, where it opened into a chamber sixty-six feet long and twenty-seven broad, but of unequal height—the floor which is cut out of the rock, having never been levelled. The half of the length from the east or entrance end is fifteen feet between floor and ceiling: in the middle it is five feet lower, presenting the appearance of the commencement of another well; and from this it rises towards the west end, where

where it is hardly the height of a man. No sarcophagus was found in this apartment. On its south side is a horizontal passage just wide enough for a man to creep in, which terminates abruptly at the end of fifty-five feet. Another passage commences, with a kind of arch, at the east end of the chamber, which runs about forty feet into the solid body of the pyramid.

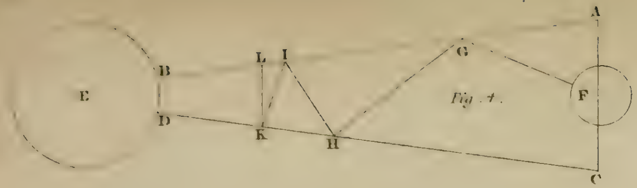
The next enterprise of Mr. Caviglia was that of entering the upper chamber, to which we have already alluded. The sides and roof are of red granite highly polished; the floor is composed of the large stones which form the roof of the sarcophagus room. No antiquities were found to reward all this labour.

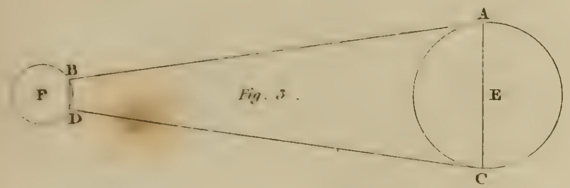
In another undertaking Mr. Caviglia met with a rich harvest, in the success which followed his exertions to explore the contents of several of the ruined edifices and tumuli which, when viewed from the top of the great pyramid, appear in countless numbers scattered among the pyramids, extending on the left bank of the Nile north and south as far as the eye can reach. They have been mentioned by travellers, but never examined before with the attention they merit. The stone buildings to which he gained access, by freeing them from the sand and rubbish with which they were choked, and which Mr. Salt supposes to be mausoleums, are generally oblong, with their walls slightly inclined inward from the perpendicular, flat-roofed, with a parapet rounded at top and rising about a foot above the terrace. Their walls are constructed of large masses made nearly to fit with each other, though rarely rectangular. Some have door-ways ornamented above with a volute, covered with hieroglyphics; others only of square apertures, gradually narrowing inward. The doors and windows are all on the north sides—perhaps, because least exposed to the wind-carried sands from the Libyan desert. The inside of the walls of the first he examined, was stuccoed and embellished with rude paintings, one of which represented the sacred boat, another a procession; and in the southern extremity were found several mouldering mummies laid one over the other in a recumbent position. Many of the bones were entire, and on one skull was part of its cloth covering inscribed with hieroglyphics. The second which he examined had no paintings, but contained several fragments of statues—two of which, composing the entire body of a walking figure, almost the size of life, with the arms hanging down and resting on the thighs. Mr. Salt thinks this was intended as a portrait, the several parts of which were marked with a strict attention to nature, and coloured after life, having glass eyes or transparent stones to improve the resemblance. A head was also discovered which Mr. Salt describes as a respectable specimen of art. Many of the fragments of granite and alabaster sculptures give a higher idea of Egyptian art than has

has usually prevailed, much attention being shown to the marking of the joints and muscles. In another of these buildings was a sculptured boat of a large size with a square sail, different from any now in use on the Nile. In the first chamber were bas-reliefs of men, deer and birds, painted to resemble nature;—the men engaged in different mechanical occupations. In the second apartment there were similar productions—a quarrel between some boat-men, executed with great spirit—men engaged in agricultural pursuits, ploughing, hoeing, stowing the corn in magazines, &c.—vases painted in vivid colours—musicians with a group of dancing women: another chamber was without embellishment: a fourth had figures and hieroglyphics; and in a fifth were hieroglyphics executed on white plaster, as it would appear, by means of stamps. In all the mausoleums which were opened, fragments of mummy cloth, bitumen and human bones were found; but what is perhaps most singular of all, in one apartment or other of all of them was a deep shaft or well. One that was cleared out by Mr. Caviglia was sixty feet deep; and in a subterranean chamber a little to the south, at the bottom of the well, was found without a lid, a plain but highly-finished sarcophagus; and from this it may be inferred, that in each mausoleum such a chamber and sarcophagus may be found at the bottom of the well. Mr. Salt mentions that all the mausoleums consisted of different apartments, some more some less in number, variously disposed and similarly decorated, and that the objects in which the artists have best succeeded are animals and birds: the human figures are in general out of proportion, but the action in which they are engaged is intelligibly, and, in some instances, energetically expressed. In many of the chambers the colours retain all their original freshness. The bas-reliefs and colouring after nature, in these early efforts of art, serve, he says, to embody the forms, and to present a species of reality that mere painting can with difficulty produce.

Mr. Salt considers these edifices as anterior to the pyramids. The Quarterly Reviewer, with more reason, we think, concludes on the contrary, that they were constructed from the dilapidated casing of the pyramids, which had on them an immense number of hieroglyphics; and a fact mentioned by Mr. Salt, namely, that one of the stones bearing an inscription and figures was built into the wall in which he saw it, upside down, furnishes evidence that it had previously formed a part of some other edifice.

But the most brilliant of Mr. Caviglia's labours was that of uncovering the great Andro-sphynx in front of the pyramid of Cephrenes, which we noticed in our fifty-first volume. The labour, which was immense, is described pretty fully in the Quarterly Review, No. xxxviii. It cost him three months incessant exertion with


E
B
D
L
I
K
H
G
A
F
C
Fig. 4.


F
B
D
Fig. 3.
A
E
C

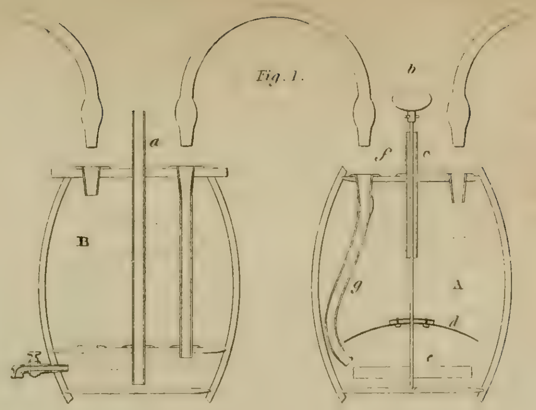
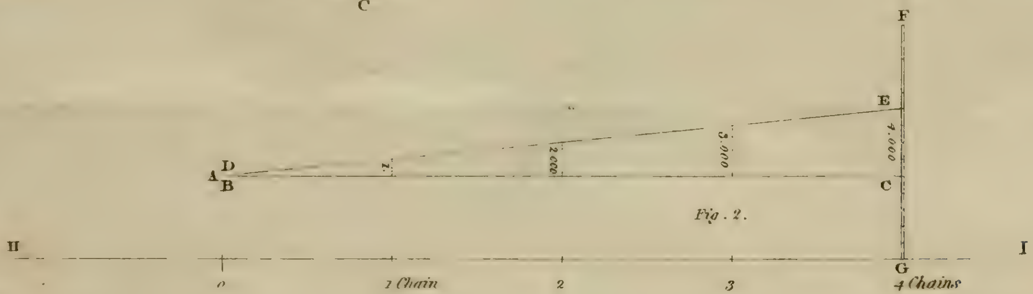


Fig. 1.
a
B
b
f
c
g
A
d
e


F
E
4.000
3.000
2.000
1.
D
A
B
C
Fig. 2.
H
I
G
0
1 Chain
2
3
4 Chains

S. Port…

has usu
ing of t
a sculpt
any nov
liefs of
men en
apartm
some bo
cultural
gazines,
group o
lishmen
were hi
pear, by
opened,
were fo
apartme
that was
subterra
well, wa
phagus;
leum su
tom of t
sisted o
variousl
in whic
the hum
tion in
stances,
colours
colourin
to emb
mere pa
Mr. S
The Qu
on the c
casing o
of hiero
that one
into the
that it h
But t
covering
phrenes,
which v
Review,

with the assistance of from 60 to 100 persons every day to lay open the whole figure to its base, and expose a clear area extending 100 feet from its front—a labour in which they were greatly impeded by the moveable nature of the sand, which by the slightest wind or concussion was apt to run down like a cascade of water and fill up the excavation. This colossal figure is cut out of the rock, the paws, and some projecting lines where perhaps the rock was deficient, or which may have been repaired since its first construction, being composed of masonry.

On the stone platform in front, and centrally between the paws of the sphynx, which stretch out fifty feet in advance of the body, was found a large block of granite two feet thick, fourteen high, and seven broad. It fronts the east, as does the face of the sphynx, is highly embellished with sculptures in bas-relief, representing two sphynxes on pedestals and priests presenting offerings, with a well executed hieroglyphical inscription beneath: the whole covered at top, and protected as it were with the sacred globe, the serpent and the wings. Two other tablets of calcareous stone, similarly ornamented, were conjectured, with the former, to have constituted part of a temple, by being placed one on each side of the latter at right angles to it. One of them was in its place, the other thrown down and broken, the fragments of which are now in the British Museum. A small lion *couchant*, with its eyes directed towards the sphynx, was in front of this edifice. Several fragments of other lions and the forepart of a sphynx were likewise found, all of which, as well as the sphynx, the tablets, walls and platform on which the little temple stood, were covered with red paint, which would seem here, as in India, to have been appropriated to sacred purposes —perhaps as being the colour of fire. A granite altar stands in front of the temple, one of the four horns being still in its place, and the effects of fire visible on the top of the altar. On the side of the paw of the great sphynx and on the digits of the paws are Greek inscriptions, as also on some small edifices in front of the sphynx, inscribed to the Sphynx, to Harpocrates, Mars, Hermes, to Claudius, (on an erasure in which can be traced a former name, that of Nero,) to Septimius Severus (over an erasure of Geta), &c. Several of these inscriptions are given in the Quarterly Review.

We are concerned to add, that in consequence of Mr. Caviglia's great exposure to the sun during ten months which he occupied in these researches, he had an attack of ophthalmia, which compelled him at length to desist, and to return to Alexandria. By these operations an expense was incurred of about 18,000 piastres, of which Mr. Salt contributed a share, as did also two or three

 other

other English gentlemen, who liberally engaged that whatever might be discovered should be left to the disposal of Mr. Caviglia; and he on his part generously requested "that every thing might be sent to the British Museum, as a testimony of his attachment to that country, under the protection of whose flag he had for many years navigated the ocean."

An incidental remark of Caviglia, that "one ceases to see the pole-star at the spot where the main passage ceases to continue in the same inclination, and where one begins to mount," has suggested to the Quarterly Reviewer the idea that possibly these passages were intended to answer some purpose in astronomy, whatever might be their other purposes; and we think the idea is deserving of consideration. In the six pyramids that have been opened at Gizeh and Saccara, the entrance has been found at or near the centre, on the northern face, and the passage in all inclined downward. Greaves makes that of Cheops 26°, and Caviglia 27°, which he says is common to all the sloping passages in this pyramid. He found the same angle on opening the small pyramids to the south of that of Mycerinus, at the end of the passage of which were two chambers leading one out of the other, which were both empty. Belzoni [see our last number] estimates the angle of the sloping passages in the pyramid of Cephrenes at 26°. "Now," says the Reviewer, "it is quite impossible that this coincidence could have been accidental; it must have been the work of design, executed for some special purpose ....... All the learning of the Egyptians was vested in their priests. Their knowledge of astronomy is not merely hypothetical ..... When we find that all the learning of Thales, by which he was enabled to calculate eclipses and determine the solstitial and equinoctial points, was acquired from the Egyptians, 600 years before the Christian era; that, at a later period, Eratosthenes, under the sanction of the Ptolemies, was enabled to measure the length of a degree of the meridian, and from it to deduce that of the circumference of the earth, to an extraordinary degree of accuracy, by the unerring principles of geometry; and that the day of the summer solstice was then, and probably much earlier, so nicely observed by means of a well dug at Syene, from whose surface (on that day) the sun's disc was reflected entire,—we are compelled to concede to the ancient Egyptians a very high degree of astronomical knowledge." To this we may add, that there had been a period when with them *Apis* [*i. e.* Taurus] was the leader of the heavenly host, though, at the period when the Greeks first became acquainted with their astronomy, *Ammon* [The Ram] performed that office; and from this it appears they must have been acquainted with the precession of the equinoxes, and, when the vernal

vernal equinox passed into the latter sign, had then adopted the practice of counting the signs from Aries. Had more modern astronomers adopted the same procedure, the nominal commencement of this equinox would have been transferred to Pisces when the equinox passed from the stellar Ram into that of the Fishes.

Astronomical utility, the Reviewer conceives, might have been in contemplation when the main passages leading from the northern faces were constructed. They "are invariably inclined downwards, in an angle of about 27°, more or less, with the horizon, which gives a line of direction not far removed from that point in the heavens where the north pole-star now crosses the meridian below the pole. The observation of the passage of this, or some other star, across this part of the meridian, would give them an accurate measure of sidereal time—a point of the first importance in an age when no other instruments than rude solar gnomons, or something still more imperfect, were in use. Indeed (continues the Reviewer) we know not of any method that could more effectually be adopted for observing the transit of a star with the naked eye, than that of watching its progress across the mouth of this long tube; and some one or more of these luminaries, when on the meridian below the pole, must have been seen in the direction of the angular adits." From Mr. Caviglia's statement it is to be inferred that he actually saw the pole-star when at the bottom of the main passage: "and if so, we have not yet got the true measure of the angle which these passages form with the horizon. This would be very desirable, as it might lead to most important results; especially if it should be found that the difference in the angles of the adits of the pyramids of Gizeh, Saccara, and Dashow corresponded with the difference of the latitudes of those places; for we might then be almost certain that they were intended to observe the passage over the meridian, of some particular star, whose altitude, when below the pole, was equal to the angle of the adit. If this suggestion be well founded, it would not be difficult, by calculation, to determine which of the stars (in Ursa Major most probably) might be seen to pass across the mouth of the shafts about the supposed time of building the pyramids, and thereby fix with more precision the period at which these stupendous edifices were erected." That the pyramids were intended in some way for astronomical purposes has long been suspected; but we have never before met with the rational suggestion offered in the Quarterly Review, to account for the inclination given to the principal passages.

## XLI. *On Calorific Radiation.* *By Mr.* Henry Meikle.

*To Mr. Tilloch.*

London, April 1, 1819.

Sir, — The nature of heat, like that of light, is still in darkness; for although many of its effects are pretty familiar to us, yet the nature of the cause is wholly unknown. Our ignorance in this respect does not arise from want of diversity of opinion on the subject, since almost every author entertains his own favourite notions. But to enumerate all the wild speculations that have from first to last been let loose on the public, would be an endless as well as an useless task. Suffice it to say, that whatever discordance apparently prevails among the different hypotheses, it is some consolation, that they generally agree in the main point—their grand common tendency being only to fortify more strongly the impenetrable barrier that has hitherto defended the nature of heat. Indeed it may be fairly questioned, if even the most capacious and enlightened human mind be in any degree adequate to comprehend the nature of heat, although it were fully unfolded to view. The same may be said of many other things. Like the unlettered child fondly handling the mysterious page, he would gape, and gaze, and wonder, in vain. Be this as it may, the little success that has uniformly attended the numerous attempts to explain this hidden principle, indisputably proves they were premature. For the present it is surely of infinitely more use, carefully to register the observed effects.

No simple hypothesis has ever been framed satisfactorily to explain all the different phænomena. The more common one—that heat is a substance and cold the absence of it, does not quite account for every appearance. The difficulty of giving a sufficient reason, on this hypothesis, for the apparent reflection of cold, has even induced some to create a system of frigorific rays to operate as a deserved check on the capricious anomalies of heat, which have so wantonly derided every honest effort to explain them.

The supposed inexplicable case alluded to is, that when a truncated hollow cone of metal, A B C D (fig. 3, Plate III.) open at the ends, with its inner surface polished, has a spherical vessel E, containing a freezing mixture, placed at the wider end, and the ball of an air-thermometer F at the narrower end, it is found that the thermometer is more cooled, or ascends higher, in this state of things, than when it and the cold body mutually change places.

Passing some whimsical explanations as foreign to the subject, this effect is usually ascribed to the concentration of the rays of cold

cold upon the thermometer by means of the conical reflector; because it was readily concluded, that were cold merely the privation of heat, the result ought to be just the reverse; for in that case it was supposed, that when the thermometer was placed at the wider end, mostly all the heat which flowed from the one-half of its ball, behoved to be collected to the narrow end by reflection; whereas, in the other position, a much less portion of heat would be conducted to the cold body. To a superficial inquirer, this afforded a very excellent demonstration of the existence of frigorific rays.

However, upon a more careful examination of the subject, founded upon principles generally received, it may easily be shown, that a conical reflector can only collect rays which are but little inclined to its axis; and consequently, that most of the rays of heat flowing from the thermometer when placed at the wide end, are either thrown out at that end or fall again upon the thermometer.

For let the cold body E, five inches in diameter, be now placed at the narrow end of the cone, whereof the diameter is one inch (see fig. 4), and let F, the ball of the thermometer of two inches diameter, be stationed at the wide end, of which the diameter is five inches; the inclination of A B to C D being 16°: we shall also suppose at first, that the heat issues from the ball of the thermometer in lines perpendicular to its surface:

Then a ray F G falling upon the reflector so as to make the angle F G A = 30°, will be reflected to H, making I G H also = 30°; but angle G H C will evidently be 30° together with 16° the inclination of A B to C D, in all 46°. For a like reason, angle H I G = 62°, I K H = 78°, and K L I = 94°: always increasing by 16°. Further than this it cannot go; for at the next reflection the ray will fall back between K and H, and finally return to the wide end. This will obviously be the fate of the greater part of the radiation; much of it, no doubt, falling again upon the thermometer.

Now it is evident, by thus tracing out the true paths of the rays, that all the radiation that is more inclined to the axis of the cone than about 12°, will return again to the wide end, if not to the thermometer; and therefore, the radiation of the surface of a spheric segment 24° in breadth, which is only 1-46th of the surface of the entire hemisphere, is all that can reach the cold body. But when the thermometer is at the narrow end, it is evident that that end embraces a space of the ball's surface 60° in breadth, which is about 2-15ths of the hemisphere; and that all the radiation from this portion of the ball can readily find its way to the cold body.

Thus it appears, that the quantity of caloric which arrives at


the

the cold body placed at the wide end, will be six times as great as in the reverse position.' This, it is true, much exceeds what is wanted for our purpose; but we must make some allowance for rays which are lost by reflection, or which do not emanate perpendicularly from the surface of the ball; and besides, it is a current though doubtful notion, that in the reflection of heat, the angle of incidence is less than that of reflection. At all events, it is hoped that by means of the foregoing explanation the paradox may be solved without the sorry aid of frigorific rays, which certainly deserve no encouragement in our northern climate. How soon they might be followed by a kindred system of *tenebrific rays*, it is not easy to say. I am, &c. HENRY MEIKLE.

[For a P.S. sent by the author, but which came to hand too late for insertion in this place, see *Miscellaneous Intelligence* at the end of the present Number.]

---

## XLII. *On the Purification of Coal Gas; on the ammoniacal Liquor of Coal Gas; and on some singular Products obtained from the ammoniacal Liquor. By Mr.* GEORGE LOWE, *of Derby.*

*To Mr. Tilloch.*

SIR, — HAVING just read in your truly scientific and interesting Magazine for last month, Mr. Bolton's communication on the popular subject of coal-gas, in which he honours me with the meed of praise in connexion with Mr. Parker for our humble endeavours at perfecting this national source of light—thus far I can have no objection that Mr. Bolton should unite us; and for myself, I beg to return him many thanks for a communication which evinces laborious research, judgement, and liberality. But when at one fell swoop he condemns the practice of passing gas through heated surfaces as "faulty and injurious," the credit due to my former communication, and to your pages of last December which record it, demands that I should set Mr. B. right respecting the strange error he has fallen into, when he thus identifies my plan with Mr. Parker's. If he will have the goodness to refer to it, he will find that the chief view with which it was written, was to show in what we agreed and in what we differed; and that the *modus operandi* of mine was the very *reverse* of his! inasmuch as Mr. Parker applies the medium of heat to his gas *after* it has passed the condenser; but in mine *before!*

This difference, which Mr. B. has unfortunately overlooked, he will find, constitutes the sole cause why the former method deteriorates the illuminating power of the gas, whilst the latter materially increases it. After this process of hyper-carbonizing the

the gas, if I may so term it, I do now, as I then stated, "pass it through lime-water." Having explained thus much, I can with pleasure proceed hand-in-hand with Mr. Bolton in the flowery path of experiment. We all have, or are likely to have, our *hobbies*. Chemistry has been the one which from early youth has filled up and rendered both pleasant and profitable the hours of relaxation from more weighty concerns. Like Mr. Bolton, I have visited many gas concerns, both great and small, and can bear witness with him to their often total want of skill, and to the consequent impurity of their gas; to say nothing of the immense expense of outfit, and wear and tear. In some establishments I have seen retorts worn out in three days; some in three months; and others, though in constant work, (as at a friend's in Birmingham,) not in three years! This speaks volumes as to the necessity of a good plan, and to the effects of the want of it.

It puts me in mind, Mr Editor, of the pledge which I gave in my former letter, of troubling you with a sketch of the plan of the apparatus we were then setting up, to light our brewery, offices and house. It is now complete, and that in every sense. The gas is brought to a red heat, in connexion with oxidizeable surfaces, or not, at pleasure, *before* leaving the retort, and its quality is as above described: it then passes through a condenser; and lastly, through lime-mud into the gasometer.

I am fully convinced with Mr. B. that there is nothing so cheap, so simple, and so effectual, as lime for purifying. The lights of two Argands by which I am writing, have been burning at least five hours, and the room is as free from any unpleasant smell as if two wax-lights had been burning!—Among other chemical tests, the nose is not a bad one.—But it is a great point that the lime-washer should be furnished with an agitator to stir up the thickest and most serviceable part of the lime, which otherwise will form a stiff inert mass at the bottom. This appendage seems to be wanting in the sketch of Mr. Clegg's washer. The washer we have adopted, you will, I trust, consider as combining in some degree the main requisites of exposure of surface with moderate pressure, united to simplicity and cheapness of structure, as well as being *portable;* which, on the small scale of a private gas apparatus situated near a dwelling, will be found a great desideratum; as thereby the nuisance which invariably takes place at recharging with fresh lime, is removed to a distance. The accompanying sketch A A (Plate III. fig. 1.) represents the section of an eighteen-gallon cask, which may be had for a few shillings, as it does not require that it shall be a sweet one, though a sound one in point of leakage.

This cask contains the lime mud; *b* is the handle of the agitator, which is made to take off and on, and is fastened with a pin or cotter to the iron rod of the agitator, which passes through the copper tube *c*, which acts both as a water joint to prevent the escape of gas, and as a safety-tube (supposing any stoppage to take place between the washer and gasometer); *d* is an inverted copper dish, made fast to the iron rod and pierced (except in the centre for the diameter of about six inches) with holes an eighth of an inch in diameter, and at intervals of about an inch. This divides the gas into streams of small bubbles, thereby exposing a greater surface to the caustic lime, as well as keeping a quantity of gas under the dish, or shelf, equal to its diameter. *e* is a strap of iron likewise made fast to the perpendicular rod, which acts as an agitator when the handle *b* is turned round or forced up and down; *f* is a brass plug and socket of an inch and quarter internal diameter, to which is soldered the inch and quarter copper pipe *g*, which conveys the gas under the shelf *d*. The brass plugs which convey the gas in and out of the washer, as well as the pipe *c*, are fastened into the cask-head with resin cement.

The condenser will, I trust, explain itself; it is also a cask having a head and bottom, and also an interposed disc a little above the latter, forming a tar chamber, to the bottom of which the tube of safety *a* descends within half an inch. The top of this cask or refrigerator is open to introduce water, except a staff across the middle, just to steady the brass sockets and safety-tube. The communication pipes are of light inch-lead pipe, to which the plugs are soldered. I have never found them leak when well pushed down, and they are well adapted to facilitate the putting any part of the apparatus in or out of connexion in a moment.

You will perhaps be inclined to smile, and say "This smells of the brewery." I am happy however to say, The brewery never smells of it; which is more than some gas concerns can boast.

The peculiar construction of our retort, and the improved plan of setting it up, will shortly come before the public, through the medium of the Society for the Encouragement of Arts, Manufactures and Commerce, should they think it worth their notice.

I have read in a late number of the Journal of Science and the Arts, a short notice that Professor Stromeyer has obtained from coal a new acid, a new gum, and a gum resin, which have the properties of dyeing various colours. But as the method by which he obtains them is not even hinted at, perhaps the following experiments which I have been making, may not be unacceptable to some of your readers.

## *On the ammoniacal Liquor of Coal Gas.*

Having long been surprised that this product of the gas manufactory should find such difficulty of being disposed of to advantage, I began a set of experiments to ascertain its constituents,

ents, and the quantity of ammonia it contained. Having evaporated some of the clear ammoniacal liquor from the tar-tub to dryness, I was surprised to find so little crystallizable salt, and that enveloped in a black mass of carbonaceous and oily matter, highly impregnated with sulphuretted hydrogen. This not being at all satisfactory, I next proceeded to rid it of its sulphuretted hydrogen by oxidizing the sulphur. To this end I poured gently into some ammoniacal liquor some muriatic acid, which caused a blackish precipitate, and kept stirring the liquor as I added the acid: at length a strong effervescence took place, and sulphuretted hydrogen was liberated. I kept adding acid till it caused to effervesce. This I presumed would at the same time neutralize the ammonia and form a muriate of it, or sal ammoniac. Having let it precipitate its black matter, which seems to be a compound of sulphur and carbon, I resumed the evaporating of some of it; when, to my surprise, after it had been over the lamp some time, it let fall another precipitate, which I collected and washed, and found it possessing a waxy nature, insoluble in water, but readily so in alcohol; imparting to it a reddish brown tint. When rubbed on the finger moistened with alcohol, it gave a permanent brown dye. The evaporation of the remaining portion of liquor was going on, when I was still more surprised to observe amongst the crystals forming at the edge of the evaporating basin, minute globules of a beautiful red, or rather lake colour, floating smartly about, till at length by the heat at the edges they boiled, and seemed to undergo a partial decomposition, giving out a very peculiar aromatic smell, but still preserving their bright colour.

After it was evaporated to dryness, I left it for a day or two, at intervals making experiments upon the remaining portion of liquor I had not submitted to heat. If into a test glass full of this a piece of linen be dipped, it will soon become red; but instantly, if a solution of sub-carbonate of potash be dropped upon it, or if a few drops be added to the liquid in the test-glass, it turns of a reddish-brown hue, which partly deposits its colouring matter by standing. By this time the lake-coloured crystals were all deliquesced, and the beautiful colouring matter was floating on the top like oil. This I also collected. It will not unite with water, but readily so in alcohol. Besides the difference of colour, it possesses properties different from the brown deposit which at first took place: it permanently stains the fingers; has a peculiar astringent taste, not unlike tannin; but is not in the least altered by sulphate of iron. If a portion be pressed upon filtering paper, a colourless *oil* will spread all round it; or if a small bit be placed upon the tongue, after a minute or two an intense sensation of burning will be felt, just like that produced by any

of

of the essential oils; and if chewed, it sticks to the teeth like resin. Whether this is the new resin, and the other the gum resin, which M. Stromeyer has mentioned, it is impossible for me to say, or whether his experiments were made with the coal-tar which contains them. Whether essential oil may be obtained in sufficient quantity to render it worth extracting, I am not prepared to say. But that the ammoniacal liquor will yield sal ammoniac so as to pay for the labour and expense, I have no doubt:—but more of this on some future occasion. Suffice it for the present to say, that if any of the foregoing hints shall in the least help, or stir up others who may have more ability and opportunity for deeper research than myself, I shall rest satisfied that I have neither wasted my own time, nor your pages.

With great respect I remain yours, &c.

Derby, March 15, 1819. GEO. LOWE.

P. S. Having read the discovery of a new combination of oxygen, hydrogen and carbon, called lampic acid, have any of your correspondents observed the peculiar ethereal smell arising from the slow combustion of coal gas when issuing from an Argand, the cock of which is turned on so little as only to give a *blue flame* about a quarter of an inch high; will the cause of one account for the other?

*** We beg to add, for the information of our correspondent, that the principal consumption of the ammoniacal liquor at present is by the sal ammoniac makers. Mr. Lowe put on the margin of the communication he sent to us, several pencil dashes of the two colours described in the foregoing paper: they appear to be pretty solid, and may possibly possess other properties which may add to their value. The suggestion in his P.S. is ingenious, and we doubt not will soon be put to the test of experience.

---

## XLIII. *Formula for calculating the Force of Steam. By Mr.* W. CREIGHTON.

*To Mr. Tilloch.*

SIR, — IN your Number for February, Dr. Ure having given some formulas for calculating the elasticity of aqueous vapour, I am induced to communicate one formed some years ago to suit Mr. Dalton's experiments, especially as it is simple, and the results frequently nearer Dr. Ure's numbers than his own calculations.

Let the degrees of Fahrenheit $+85=D$, and the corresponding force of steam in inches of mercury $-0{\cdot}09=I$. Then

$\text{Log. } D-2{\cdot}22679\times 6=\text{Log. } I.$

*Example.*

*Example.* $212°+85=297$, Log. $=2{\cdot}47276$

$$\begin{array}{r l}
 & 2{\cdot}47276 \\
- & 2{\cdot}22679 \quad \text{a constant number.} \\
\hline
 & 0{\cdot}24597 \\
\times & 6 \\
\hline
\text{Log.} & \bar{1}{\cdot}47582 = 29{\cdot}91 = \text{I.} \\
 & + \quad {\cdot}09 \\
\hline
 & 30{\cdot}00 \text{ inches.}
\end{array}$$

*Comparative Table.*

| Temp. | Dr. Ure's | | Dalton's Exp. | By Formula. |
|---|---|---|---|---|
| | Exp. | Calcul. | | |
| ° | inches. | | | |
| 310 | 161·30 | 157·25 | | 165·61 |
| 300 | 139·70 | 137·94 | | 142·01 |
| 290 | 120·15 | 119·95 | | 121·27 |
| 280 | 101·90 | 103·41 | | 103·13 |
| 270 | 86·30 | 88·39 | | 87·31 |
| 260 | 72·30 | 74·91 | | 73·57 |
| 250 | 61·90 | 62·95 | | 61·68 |
| 240 | 51·70 | 52·46 | | 51·44 |
| 230 | 43·10 | 43·36 | | 42·66 |
| 220 | 35·54 | 35·54 | | 35·17 |
| 212 | 30·00 | 30·00 | 30·00 | 30·00 |
| 210 | 28·88 | 28·90 | 28·84 | 23·81 |
| 200 | 23·60 | 23·50 | 23·64 | 23·44 |
| 190 | 19·00 | 19·00 | 19·00 | 18·94 |
| 180 | 15·16 | 15·20 | 15·15 | 15·18 |
| 170 | 12·05 | 12·07 | 12·13 | 12·07 |
| 160 | 9·60 | 9·50 | 9·46 | 9·52 |
| 150 | 7·53 | 7·42 | 7·42 | 7·43 |
| 140 | 5·77 | 5·75 | 5·74 | 5·74 |
| 130 | 4·37 | 4·42 | 4·34 | 4·39 |
| 120 | 3·30 | 3·37 | 3·33 | 3·32 |
| 110 | 2·46 | 2·55 | 2·53 | 2·49 |
| 100 | 1·86 | 1·92 | 1·86 | 1·84 |
| 90 | 1·36 | 1·43 | 1·36 | 1·34 |
| 80 | 1·01 | 1·06 | 1·00 | ·97 |
| 70 | ·73 | ·77 | ·72 | ·69 |
| 60 | ·52 | ·56 | ·52 | ·50 |
| 50 | ·36 | ·40 | ·37 | ·35 |
| 40 | ·25 | ·28 | ·26 | ·26 |
| 32 | ·20 | ·20 | ·20 | ·20 |
| 30 | ·19 | ·19 | ·19 | ·19 |
| 20 | ·14 | ·14 | ·13 | ·13 |

Again; Saussure's barometer on Mont Blanc stood at 16·075 French

French inches; temperature supposed 10° of De Luc's thermometer, or 17·141 English measure at 60 F.; water boiled at 68·993°, which, as 80° was the boiling point for 27 French inches, is equal to 185·51° Fahrenheit.

Now 17·141 — ·09 = 17·051 = I. Log. = 1·23175

$$\begin{array}{lr} \div 6 & = 0{\cdot}20529 \\ + & 2{\cdot}22679 \\ \hline & 2{\cdot}43208 = 270{\cdot}45 - \end{array}$$

85 = 185·45°, which corresponds nearly with observation. A few more comparisons with experiments on mountains may be made;

| | | *Inches.* | *Exp.* | *Calc.* |
|---|---|---|---|---|
| On Buet, | by De Luc | 20·964 | 194·87° | 194·72° |
| Grenairon, | De Luc | 21·765 | 196·60 | 196·48 |
| Mt. Cenis, | Saussure | 23·776 | 200·71 | 200·67 |
| Near Geneva, | Shuckburgh | 26·000 | 204·91 | 204·98 |

As little dependance can be placed on any theorem for calculating the force of steam much beyond the range of experiment, it is only an object of curiosity to examine what pressure would confine red hot water: suppose the heat 1000° F. and calculating as before, gives 71,000 inches of mercury, or above 2300 atmospheres, approaching to six miles of granite, which may perhaps be two or three miles too much. Steam of 2300 atmospheres would be more dense than water.

I am, &c.

Soho, Staffordshire, March 1819. Wm. Creighton.

---

## XLIV. *On Aphlogistic Phænomena and the Magnetism of Violet Light. By Mr.* J. Murray.

*To Mr. Tilloch.*

Paris, March 24, 1819.

Sir, — In my Elements of Chemical Science, second edition (published by Messrs. Underwood of Fleet-street), I have, in common with others, considered the aphlogistic phænomena discovered by Sir Humphry Davy, peculiar to the metals platinum and palladium; and assigned their relations to caloric as the cause, though I had early observed and pointed out the feeble phosphorescent flame which accompanied other metals, charcoal, glass, &c. when heated, and plunged into inflammable media in contact with air. The opinion there given, I beg now to revoke.

When at Naples, Professor Sementini informed me that *silver* and *copper* manifested the phænomena in question, and he was so good as to repeat these experiments, among others, before me. The light exhibited by the *copper* is less brilliant than that of of platinum, while the *silver* yields a *bright light*, sufficiently intense to *read by*. The diameter of the wires employed is 1-100th, and that of the ring about 1-4th of an inch. The wick of the spirit-lamp is spread out and flattened, and the spiral contaning *say* twelve rings is supported upright by a pin. The lamp is then ignited, and carefully extinguished by the momentary application of the cap. The light emanating from the silver is more beautiful than that from platinum; and moreover, the experiment is less difficultly performed.

I beg to add, that I have succeeded in obtaining aphlogistic phænomena by using silver wire and *camphor*. For this purpose I use a slice of camphor a little larger than the diameter of the wire cylinder. The metal is then fixed by a pin passing through the camphor into a bit of cork, so that the pin may not fall when the camphor fuses. By this light I could distinctly *see to read a letter.*

In every experiment it is necessary to have the wire incandescent prior to extinction of the flame, which in consequence of the *hollowness* of flame (already pointed out in one of my former papers) can only be obtained when the wires come in contact with the *outer fringe* of the cone.

There is another very interesting discovery on which I have expressed a degree of surprise, since amply removed. I advert to the communication of *magnetic powers* to a steel bar by *violet light*, announced by Dr. Morrichini of Rome. On my return from Naples, I had the pleasure of seeing the Professor. He has succeeded in magnetizing no less than *seventy-four* steel bars, and was so good as to present me with one so treated. It is attractive of iron filings, and possesses a high polarity. The following is recorded on the wrapper, descriptive of the circumstances which accompanied the experiment. — "Adi 1 7bre 1812. Num. 3, Essendo il tempo nuvolo ed umido non è seguita l'esperienza, anzi l'ago perdette quella piccola virtù magnetica che avea acquistata il giorno precedente. Avendolo posto alle solite prove il giorno dopo, si è calamitato al solito."

It is by no means necessary (as Professor Playfair has stated) that the needle rest in the magnetic plane; for Professor Morrichini assured me that he had succeeded with the needle in various positions on the horizontal level, and even vertical and more or less inclined. The bright solar beam admitted by a convenient aperture is received by the prism. The prism is then turned upon its axis so as to insulate the violet light, and the ray is then projected on the needle by means of a lens possessing considerable convexity, and about three inches diameter. For the rest I beg to give you a few abridged extracts from Professor Morrichini's memoir, entitled "*Secondo Memoria sopra la forza magnetizante*

*netizante del lembo estremo del raggio violetto*," &c. &c. *not published.* The *red* ray of the spectrum does *not magnetize*, nor the light of combustible bodies, inflamed. The violet light of the lunar beam has given in twelve hours magnetic properties more decisive than the solar *red* in seven hours and a half. The duration of the experiments in December 1812, and February, March and April 1813, with violet light, varied from 23 to 120 minutes, nor seemed to have any relation to the range of the barometer, thermometer, or hygrometer; for on 1st of March 1813, when the duration was only 23′, Reaumur's thermometer was 7·25, barometer 28·2,20, and the hygrometer of Retz 41·65; and on 4th of April 1813, when 120′ were required to produce the magnetic effect, the thermometer was 11·70, barometer 28·0,50, and hygrometer of Retz 28·90, but this last was in a cloudy sky and moist at intervals; though on 23d of March while the thermometer was 10·15, barometer 28·2,15, and hygrometer of R. 31·25, the duration of the experiment was 30′, and the magnetism most intense. For the three preceding days the sky had been very variable.

Experiments were made on the chemical rays of the spectrum on the 15th, 16th, and 18th of April 1813. On the 15th, with a cloudy sky, and hygrometer of R. at 32·25, weak magnetic signs were manifested in 30′. On the 16th of April, a cloudy sky, hygrometer 28·85, the magnetism was intense in 70 minutes, and on the 18th, hygrometer 29·10, also intense, in 60′. On the 27th, 28th and 29th of March and 1st of April 1813, experiments were made on the *red* light of the spectrum, but no magnetic signs were exhibited. On the 2d of April a feeble and equivocal repulsion was shown. None were manifested with two experiments on *green* light: in one however slight signs were given, but the magnetism was feeble and incomplete. On the 14th of April with undecomposed light a little magnetism was acquired in 120′. In the first experiment with lunar violet light no magnetic effect was produced; in the second, there was an indecisive tendency to the magnetic meridian: the same was shown in the third, fourth and fifth experiments which succeeded; and in the two last a superior attraction. On the 15th, 16th, and 19th of April, with the *red* ray there was no effect produced in 60 minutes; but with red light on the 21st of April and 16th and 20th of May, an indecisive tendency to the magnetic plane was discovered in 90′, 30′, and 90′. Experiments made on the 10th, 11th and 12th of May with the violet light of the flame of olive oil gave no magnetic signs in 240′, 120′, and 120′.—Dr. M. told me he did not use a reflector for the lamp in this experiment.

We cannot therefore withhold what the Professor claims as confirmed, page 31, " le nuove sperienze che ho avuto l'onore di esporvi

esporvi in questa memoria confermano sempre piu l'esistenza di un potere magnetizante nella luce, principalmente nel lembo estremo del raggio violetto, e la probabilità che questo potere appartenga piuttosto ai raggi chimici o disossidanti, che allo stesso raggio violetto."—Dr. Morrichini thus concludes, page 32, his interesing memoir: "The chemical and violet rays are never separated, and the intensity of the violet rays may proportionally announce those of the chemical. Terrestrial bodies may absorb from the solar rays the magnetic fluid as they absorb light and caloric, which two fluids are concerned in their decomposition and recomposition. Iron then may be with regard to the magnetic fluid what pyrophorus is with regard to caloric, and natural phosphori with respect to light." This beautiful discovery may be said to throw *a new light upon light.* I regret that from previous arrangements I had to leave Rome, before I could witness the repetition of the experiment, on the first favourable day, and to which Professor Morrichini was so good as to invite me. Dr. Morrichini informed me, as the result of a series of very delicate experiments, that he had constantly found the violet ray *positive*, and the red ray *negative*, with respect to electricity.

From a series of experiments now in progress by the Professor of Botany at Rome, it would seem that violet light possesses a considerable influence in vegetation.

I have the honour to be, sir,

Your very obedient and most humble servant,

J. Murray.

---

## XLV. *Method of ascertaining Distances from one Station to another (in Levelling or Surveying) on Level and variously inclined Surfaces, to their exact Length of Horizontal Base, by the Addition of an angular Bubble attached to the Telescope of a Spirit Level. By Mr.* John Hughes, *of Walworth*.*

### *Mode of adjusting the Bubble.*

Suppose A (fig. 2, Plate III.) to be the spirit level. H I, a quay, a wall, or any other level plane chosen for this purpose, on which are measured with great precision (say) four chains. B C, a horizontal line or visual ray, pointing from the telescope to the five-foot mark on the levelling-staff F G, and corresponding in height with the fine wire, or spider's fibre, within the telescope. DE is a visual ray also pointing to nine feet on the staff (the telescope being thus elevated by means of the thumb screws); and while in that direction, the angular bubble must be screwed and so adjusted that it may stand exactly horizontal without re-

* Communicated by the Author.

gard

gard to the bubble by which the line BC was ascertained; and then the instrument is fit for use. For the visual ray at four chains distance points four feet higher on the staff, by the angular bubble being brought level, than it does by the horizontal one being brought so: consequently the variation of the observations taken upon the staff, will be always more or less at any further or intermediate distance, as may be seen on reference to the figure.

*Operation.*—If at any distance or station from the instrument the horizontal ray points to (say) 3·754 on the staff; elevate the telescope as before until the angular bubble stands horizontal; then if the visual ray points to (say) 9·568, the difference is 5·814, or five chains, 81 links and 4-10ths in distance, according to this adjustment, which I have preferred, because unity, or 1·000 feet variation of the rays upon the staff, gives one chain in distance, and therefore 1-100dth of a foot gives one link,—and so on *vice versâ*.

*Remarks.*—It is necessary here to observe, that the staff F G has a sight or sliding vein with a nonius upon it, by means of which every foot is divided into 1·000 equal parts. But other staffs may be divided into feet and inches, or any other equal parts, and the angular bubble may be adjusted so that any number of inches or other parts on the staff shall be made to answer for any desired distance, at the convenience or discretion of the engineer. I presume it will be readily admitted by all engineers, that a distance of twenty miles may be levelled to within three inches, or less, of truth; and it is even possible it may be performed correctly true. Now, supposing, in taking levels across a country, the greatest probable error to take place, viz. three inches: then as this mode of ascertaining distances has only the same chance of varying from truth, as the operation of taking levels has, the greatest probable error that may occur, will only amount to one pole or five yards and a half in twenty miles. But if, as before stated, the art of levelling can be performed true (of which no reasonable doubt does exist), the distance can by this means be ascertained true also. It is much to be doubted if any engineer or surveyor has ever measured a distance of twenty miles on the various inclined surface of the earth, to within twenty perches of truth, by the usual mode of chain dragging, subject as that method is to so many unavoidable inaccuracies. Therefore, if *truth* can be approached by this mode *nearer* than by any other *now used*, in the proportion of 20 to 1, it cannot fail being an object of some consideration to the practitioner, and his employers in general.—This method was applied to practice in 1804, but not published. John Hughes.

XLV. *On*

## XLVI. *On the Respiration of Oxygen Gas, in an Affection of the Thorax.* *By Professor* Silliman*.

It is not extraordinary that when oxygen gas was first discovered, and found to be the principle of life to the whole animal creation, extravagant expectations should have been formed as to its medicinal application. Disappointment followed of course, and naturally led to a neglect of the subject; and, in fact, for some years pneumatic medicine has gone into discredit, and public opinion has vibrated to the extreme of incredulity. Partaking in a degree in this feeling, we listened with reluctance to a very pressing application on this subject during the last summer. A young lady, apparently in the last stage of decline, and supposed to be affected with hydrothorax, was pronounced beyond the reach of ordinary medical aid. As she was in a remote town in Connecticut, where no facilities existed towards the attainment of the object, we felt no confidence that, even if oxygen gas were possessed of any efficacy in such cases, it would *actually* be applied, in this case, in such a manner as to do any good. Yielding, however, to the anxious wishes of friends, we furnished drawings for such an apparatus as might be presumed attainable, and also written and minute directions for preparing, trying, and administering the gas. It was obtained from nitrate of potash (saltpetre), not because this was the best process, but because the substance could be obtained in the place, and because a common fire would serve for its extrication. The gas obtained had, of course, a variable mixture of nitrogen or azote; and, probably, on an average, might not be purer than nearly the *reversed* proportions of the atmosphere—that is, 70 to 80 per cent. of oxygen to 20 or 30 nitrogen; and it is worthy of observation, whether this circumstance might not have influenced the result.

Contrary to our expectations, the gas (as we have since been informed on good authority) was skilfully prepared and perseveringly used. From the first, difficulty of breathing and other oppressive affections were relieved; the young lady grew rapidly better, and in a few weeks entirely recovered her health. A respectable physician, conversant with the case, states in a letter now before us, "that the inhaling of the oxygen gas relieved the difficulty of breathing, increased the operation of diuretics, *and has effected her cure*. Whether her disease was hydrothorax, or an anasarcous affection of the lungs, is a matter, I believe, not settled."

Should the revival of the experiments on the respiration of oxygen gas appear to be desired, it would not be difficult to sim-

* From the American Journal of Science, No. I.

plify the apparatus and operations so as to bring them within the reach of an intelligent person, even although ignorant of chemistry.

This interesting class of experiments ought to be resumed, not with the spirit of quackery nor of extravagant expectation, but with the sobriety of philosophical research; and it is more than probable that the nitrous oxide, which is now little more than the subject of merriment and wonder, if properly diluted and discreetly applied, would be productive of valuable effects.

## XLVII. *Description of the American Tar and Water Burner invented by Mr.* Samuel Morey *of the United States* *.

The inventor, not unskilled in chemistry, and aware of the attraction of oxygen for carbon, conceived it practicable to convert the constituents of water into fuel, by means of this affinity.

Whatever may be the fact, chemically considered, the operation in various experiments promises to afford a convenient method of applying to use several of the most combustible substances not hitherto employed as fuel. By the process which I shall briefly describe, *all carbonaceous fluids* may be conveniently burnt, and derive great force from their combination with the oxygen and hydrogen gases of water or steam, before or at the moment of ignition.

" A tight vessel, cylindrically shaped, and placed horizontally, was first employed, containing resin, connected with a small boiler by a pipe which entered one of its ends near the lower side, and extended nearly its length, having small apertures, over which were two inverted gutters one over the other; the upper one longer than the other, intended to detain the steam in the resin in its way to the surface. The resin being heated, *carburetted hydrogen gas* issued from the outlet or pipe inserted near the upper part of the vessel, and, being ignited, afforded a small blaze about as large as that of a candle; but when the steam was allowed to flow, this blaze instantly shot out many hundred times its former bulk to the distance of two or three feet. It is presumed the steam was decomposed, and that carburetted hydrogen and carbonic oxide or carbonic acid were produced as the steam passed, very near the hot bottom of the vessel.

" Another apparatus was constructed, consisting of two vessels one within the other having a cover common to both; the inner one to contain *tar* (as a more convenient substance than resin), the

* In our 247th Number (vol. lii.) we gave a brief notice of this invention. The present account is copied from Professor Silliman's American Journal of Science, No. I.

the outer vessel to contain water, which surrounds the other and lies under its bottom; or, in other words, this part of the apparatus consisted of a vessel of tar set into a vessel of boiling water. The tar vessel being riveted to the cover, holes are made through its sides near to the cover, to allow the steam to pass in and to act on its surface. The cover being secured on, a safety-valve is provided for the steam vessel; and two cocks, one over the tar, the other over the water (but both having communication with the eduction pipe), are fixed contiguously; the first has a tube, or is elongated to reach nearly to the bottom of the tar, which ascends this pipe when pressed on by the steam, and is driven forward into the eduction pipe, when the cock over the tar vessel is opened for its escape. When both cocks are opened, both tar and steam are emitted at once, and in mixture, through the eduction pipe. In this tube (which is for convenience furnished with two joints) is placed a large wire or metallic rod, which about fills the tube, and is perforated obliquely or zigzag, to increase the length of the passage, and to mingle the tar and steam more intimately. The gases or vapours issue from a small orifice at the end of the pipe; and being ignited by a little fire into which it is directed, an intense and voluminous blaze is produced, and continues as long as the materials remain unexhausted. A hot brick instead of the fire answers the same purpose.

"The apparatus contained but about one quart of tar (which must always be nicely strained), and it lasted an hour and a half; and the flame was sufficient to fill a common fire-place, if not allowed to escape by its violence up the chimney. Its force will be according to the elasticity of the steam. Probably a form of stove may be devised wherein it may be used for the purposes of warmth, light, and cooking; and another apparatus to light streets. But this invention will be of more special use *as fuel for steam engines applied to navigation.*"

---

## XLVIII. *A Letter to Professor* Jameson, *by Mr.* John Farey *Sen.**

Sir, — I beg to take the liberty of mentioning to you, that I have this day read, in vol. II. part ii. of the "Memoirs of the Wernerian Natural History Society," your Introductory Paper to an account of "the Geognosy of the Lothians," which was read before that Society on the 17th of December 1814, and now lately has been published: in which Paper, at the top of p. 621, occur these words, viz. "Mineralogists, in general, distinguish two

* Communicated by Mr. F., with a request that it should be inserted in the Phil. Mag.—Editor.

red Sandstone formations: one, the oldest, rests immediately on transition or primitive rocks: the other, and newer, rests on beds of magnesian limestone, coal, and mountain Limestone, which are superimposed on the oldest formations."

My object in the present address, is, respectfully to request the favour of you, to mention in an early Letter to Mr. Tilloch, for insertion in the "Philosophical Magazine," the names of two or three of the English Mineralogists (and the volumes and pages of their Writings) to which you appear to me to refer, in the passage above quoted, who were, prior to December 1814, *generally* agreed, in considering the *newer red Sandstone* formation, as resting on beds of *magnesian* limestone?: or else inform me, wherein I may have misunderstood this passage.

You will likewise do me additional favours, if you will inform me in such Letter, whether the term "newer red Sandstone," alluded to in the above extract, was intended for *the same formation*, as was mentioned in one of your Lectures in April 1815, as it has been quoted, or referred to in substance, in vol. xlv. p. 381, of the Philosophical Magazine, by a Gentleman from Bristol, who was understood, to have been then some months studying in your College at Edinburgh?: and, whether from the middle of page 622 to the end of your Paper above referred to, you mean to be understood, when speaking of "the red Sandstone," as intending *only the oldest* of the two mentioned, or "old red sandstone"?

I am, sir, your obedient servant,

*To Mr. Jameson,* JOHN FAREY Sen.

Professor of Natural History in the University of Edinburgh, and President of the Wernerian Society, &c.

---

## XLIX. *On Wheel-Carriages, and the Incapacity of most Roads to sustain the Wear of very heavy Loads.* *By Mr.* JOHN FAREY *Sen., Mineral Surveyor and Engineer.*

*To Mr. Tilloch.*

SIR,— THE subject of Wheel-Carriages being at the present time, one of some interest, from there being a Committee of the House of Commons now sitting, to inquire into the state of the Highways, and to report on any matters which may conduce to their improvement and better management, I am induced to notice some points in the Letter of Mr. Henry Meikle in your last Number. Mr. M. in pages 199 and 200 (as well as Mr. Wingrove in p. 14) mention, that the Legislature have restricted it to a uniform distance, at which the Wheels of Carriages should run

run on a Road, and recommend the repeal of this law; without seeming to be aware, that very soon after this most absurd Law was enacted (in 1773), *it was repealed:* but that deep *Ruts* on all the Parish Roads (and on too many of the Turnpike Roads, also) had, in the interval, become *so universal*, and the difficulty of drawing Carriages, but in these Ruts, so great, that the custom thus fatally introduced, of making all Axletrees of similar lengths, has scarcely ever since been deviated from; nor will this be done to any extent, I believe, until inducements have for some years been held out, to the making of new Carriages, or applying new Axletrees, such, that the Wheels of different Carriages may run *in divers tracks*, as I have mentioned in p. 103; until at length, the Legislature can go the full length, of enacting the very opposite of what they did in 1773!

It was (as I have fully shown in my Derbyshire Report) a not less absurd mistake in legislating for the public Roads (in 1773, or earlier) than that to I which have above alluded, which encouraged the introduction of wheels *of greater breadth of rim, than about six inches*, by granting great and mischievous indulgences, in weights and numbers of Horses and in easy Tolls, to the Waggons with Wheels 9, 12, and 16 inches broad, and at the same time, so loosely and improperly defining these broad Wheels, that the exemptions might, and have to the present day been claimed, by the owners of Waggons, which in no degree comply with the mistaken intentions of the framers of the act alluded to: while *the excessive weights* which these "stone-crushing machines" carry (to use the words of Sir Joseph Banks, regarding the Waggons on the Hounslow Road), contribute more than any other circumstance, to the great expense and bad state of the main Roads: particularly where *brittle* gravel or *soft* stone are the Road Materials.

It is the rounded or *barreled form of the rims* of these broad Wheels, and the use of a thick streak of Tire in the middle (with the addition mostly of projecting Nail-heads) occasioning them to run on surfaces *considerably narrower than* 6 *inches*, in most instances, which causes them, now, to be so very mischievous: and were these gross evasions to be restrained, and flat horizontally-rolling rims, of 9, 12 and 16 inches, to be really enforced, (whether as cones or cylinders,) even the impolitic indulgences granted to these Broad Wheels, or greater ones, as to Horses and Tolls, would not be able to keep them for many weeks upon the Roads: so true is it, that *Road-Rollers*, and *Carriages for transporting Loads*, are altogether different things. I cannot avoid adding my conviction, that the late Mr. Cummings, from totally over-looking *the brittle and crushable nature of Road Materials*, (a property not confined to these, but extending *to all*

*Materials*, even to Iron, as the experiments of Mr. George Rennie in the beginning of your present Number amply testify) did a great deal of mischief 12 years ago, by his experiments and writings, having the tendency, to mislead thousands into the very same errors, which were acted on in 1773, in supposing that *great* weights could pass, on any wheels (however truly cylindrical) *without crushing brittle Stones*, such as those undoubtedly are which alone are procurable, on nine-tenths of the lengths of all the main British Roads.

The sooner Men of science *cease to notice* the absurd objections raised against adopting, in most instances, the least possible degrees of *ascent* in the laying out new Roads; however much this may occasion the lengthening of the ascents, it will be the better I think: let the objectors be referred to the example of a well-contrived Rail-way, as the only argument likely to prevail with such Persons. I beg to call the attention of my friend Mr. Tredgold (the author of the first Paper of the present volume) to the beginning and concluding parts of Mr. Meikle's ingenious Letter,

And I am, yours, &c.

Howland-street, April 2, 1819. J. FAREY Sen.

P. S.—I beg the favour of *Scepticus*, in p. 202 of your last Number (after consulting his *Cyclopædia*, in order to gain some idea of the important distinctions there are, between *real* and *apparent* Motions) that he will *read my Papers* in Mr. Nicholson's Journal, which are referred to in the page on which he has commented: it would be too much, for me to request of you, to reprint matters, already on the imperishable *records* of science.

---

## L. *Notices respecting New Books.*

*A Voyage of Discovery made under the Orders of the Admiralty, in H. M. Ships Isabella and Alexander, for the Purpose of exploring Baffin's-Bay, and inquiring into the Probability of a North-west Passage.* By John Ross, K.S. Capt. R.N. 4to. With 32 coloured Plates, Maps, &c.

Our readers have already been made acquainted with several particulars respecting this voyage, in our preceding numbers and through the medium of the daily newspapers: they will not, however, be displeased that a few of the most prominent particulars should yet have a place in our pages. On the voyage, generally, we may observe that it serves to confirm, in all the leading features, the accuracy of the observations of the voyager from whom the sea explored by Capt. Ross has its name; but which had by many been consigned to a place among the records of fiction. So far this voyage has been useful; and we have only to to regret the haste, from whatever cause this may have arisen, with which the exploration was abandoned.

The most prominent novelty recorded by Captain Ross, is the discovery of a race of men in Baffin's Bay, never before visited by civilized Europeans, and so totally unacquainted with the rest of the world, as to believe that to the *southward* of their place of residence there was nothing but eternal frost!—no country in which it would be possible for human creatures to exist! On this occasion Sacheuse, the Esquimaux who accompanied the expedition, was found very useful as an interpreter.—We shall give the account in Captain Ross's words:

"Aug. 10, 1818.— Lat. 75 deg. 55 min. N., long. 65 deg. 32 min. W.—About 10 o'clock this day we were rejoiced to see eight sledges, driven by the natives, advancing by a circuitous route towards the place where we lay. They halted about a mile from us, and the people alighting, ascended a small iceberg, as if to reconnoitre. After remaining apparently in consultation for nearly half an hour, four of them descended, and came towards the flagstaff, which, however, they did not venture to approach. In the mean time, a white flag was hoisted at the main in each ship, and John Sacheuse dispatched, bearing a small white flag, with some presents, that he might endeavour, if possible, to bring them to a parley. This was a service in which he had most cheerfully volunteered, requesting leave to go unattended and unarmed—a request to which no objection could be made, as the place chosen for the meeting was within half a mile of the Isabella. It was equally advantageous to the natives, a canal or small chasm in the ice, not passable without a plank, separating the parties from each other, and preventing any possibility of an attack from these people, unless by darts.

"In executing this service, Sacheuse displayed no less address than courage. Having placed his flag at some distance from the canal, he advanced to the edge, and taking off his hat, made friendly signs for those opposite to approach, as he did; this they partly complied with, halting at a distance of 300 yards, where they got out of their sledges, and set up a loud simultaneous halloo, which Sacheuse answered by imitating it. They ventured to approach nearer, having nothing in their hands but the whips with which they guide their dogs; and after satisfying themselves that the canal was impassable, one of them in particular seemed to acquire confidence. Shouts, words, and gestures were exchanged for some time to no purpose, though each party seemed in some degree to recognise each other's language. Sacheuse, after a time, thought he could discover that they spoke the Humook dialect, drawling out their words, however, to an unusual length. He immediately adopted that dialect, and holding up the presents,

sents, called out to them *Kahkeite*, 'Come on!' to which they answered, *Naakrie*, *naakrieai-plaite*, 'No, no; go away;' and other words, which he made out to mean that they hoped we were not come to destroy them. The boldest then approached to the edge of the canal, and drawing from his boot a knife, (represented in an engraving,) repeated, 'Go away;' 'I can kill you.' Sacheuse not intimidated, told them that he was also a man and a friend, and at the same time threw across the canal some strings of beads, and a checked shirt; but these they beheld with great distrust and apprehension, still calling 'Go away, don't kill us.' Sacheuse now threw them an English knife, saying, 'Take that.' On this they approached with caution, picked up the knife, then shouted and pulled their noses. These actions were imitated by Sacheuse, who in return called out, 'Heigh, yaw!' pulling his nose with the same gesture. They now pointed to the shirt, demanding what it was; and when told it was an article of clothing, asked of what skin it was made. Sacheuse replied it was made of the hair of an animal which they had never seen: on which they picked it up with expressions of surprise. They now began to ask many questions: for by this time they found the language spoken by themselves and Sacheuse had sufficient resemblance to enable them to hold some communication.

"They first pointed to the ships, eagerly asking 'What great creatures those were?' 'Do they come from the sun or the moon?' 'Do they give us light by night or by day?' Sacheuse told them that he was a man, that he had a father and mother, like themselves; and, pointing to the south, said that he came from a distant country in that direction. To this they answered, 'That cannot be, there is nothing but ice there.' They again asked, 'What creatures these were?' pointing to the ships: to which Sacheuse replied, that 'they were houses made of wood.' This they seemed still to discredit, answering, 'No, they are alive, we have seen them move their wings.' Sacheuse now inquired of them what they themselves were; to which they replied, they were men, and lived in that direction, pointing to the north; that there was much water there; and that they had come here to fish for sea unicorns. It was then agreed that Sacheuse should pass the chasm to them, and he accordingly returned to the ship to make his report, and to ask for a plank.

"During the whole of this conversation, I had been employed with a good telescope in observing their motions, and beheld the first man approach with every mark of fear and distrust, looking frequently behind to the other two, and beckoning to come on, as if for support. They occasionally retreated, then advanced again, with cautious steps, in the attitude of listening, generally keeping

keeping one hand down by their knees, in readiness to pull out a knife which they had in their boots; in the other hand they held their whips with the lash coiled up; their sledges remained at a little distance, the fourth man being apparently stationed to keep them in readiness for escape. Sometimes they drew back the covering they had on their heads, as if wishing to catch the most distant sounds; at which time I could discern their features, displaying extreme terror and amazement, while every limb appeared to tremble as they moved. Sacheuse was directed to entice them to the ship, and two men were now sent with a plank, which was accordingly placed across the chasm. They appeared still much alarmed, and requested that Sacheuse only should come over: he accordingly passed to the opposite side, on which they earnestly besought him not to touch them, as if he did they should certainly die. After he had used many arguments to persuade them that he was flesh and blood, the native who had shown most courage ventured to touch his hand, then pulling himself by the nose, set up a shout, in which he was joined by Sacheuse, and the other three. The presents were then distributed, consisting of two or three articles of clothing, and a few strings of beads: after which Sacheuse exchanged a knife for one of theirs.

"The hope of getting some important information, as well as the interest naturally felt for these poor creatures, made me impatient to communicate with them myself; and I therefore desired Lieut. Parry to accompany me to the place where the party were assembled, it appearng to me that Sacheuse had failed in persuading them to come nearer the ships. We accordingly provided ourselves with additional presents, consisting of looking-glasses and knives, together with some caps and shirts, and proceeded towards the spot, where the conference was held with increased energy. By the time we reached it, the whole were assembled; those who had originally been left at a distance with their sledges, having driven up to join their comrades. The party now therefore consisted of eight natives, with all their sledges, and about 50 dogs, two sailors, Sacheuse, Lieut. Parry, and myself, forming a group of no small singularity; not a little also increased by the peculiarity of the situation, on a field of ice, far from the land. The noise and clamour may easily be conceived —the whole talking and shouting together, and the dogs howling, while the natives were flogging them with their long whips, to preserve order.

"Our arrival produced a visible alarm, causing them to retreat a few steps towards their sledges: on this Sacheuse called to us to pull our noses, as he had discovered this to be the mode of friendly salutation with them. This ceremony was accordingly performed

performed by each of us, the natives, during their retreat, making use of the same gesture, the nature of which we had not before understood. In the same way we imitated their shouts as well as we could, using the same interjection, *heigh, yaw!* which we afterwards found to be an expression of surprise and pleasure. We then advanced towards them while they halted, and presented the foremost with a looking-glass and a knife, repeating the same presents to the whole as they came up in succession. On seeing their faces in the glasses their astonishment appeared extreme, and they looked round in silence for a moment at each other and at us; immediately afterwards they set up a general shout, succeeded by a loud laugh, expressive of extreme delight, as well as surprise, in which we joined, partly from inability to avoid it, and willing also to show that we were pleased with our new acquaintances.

"Having now at length acquired confidence, they advanced, offering, in return for our knives, glasses, and beads, their knives, sea-unicorns' horns, and sea-horse teeth, which were accepted. They were then instructed by Sacheuse to uncover their heads, as a mark of good will and respect to us; and with this ceremonial, which they performed immediately, and of which they appeared to comprehend the meaning, our friendship became established.

"One of them having inquired what was the use of a red cap which I had given him, Sacheuse placed it on his head, to the great amusement of the rest, each of whom put it on in his turn. The colour of our skins became next a subject of much mirth, as also the ornaments on the frames of the looking-glasses. The eldest of them, who was also the one that acted as leader, addressing himself to me, now made a long speech, which being ended, he appeared to wait for a reply. I made signs that I did not understand him, and called for Sacheuse to interpret. He thus perceived that we used different languages, at which his astonishment appeared extreme, and he expressed it by a loud 'Heigh, yaw!' As Sacheuse's attempt to procure the meaning of this oration seemed likely to fail, and we were anxious to get them to the ship as soon as possible, I desired him to persuade them to accompany us; they accordingly consented, on which their dogs were unharnessed and fastened to the ice, and two of the sledges were drawn along the plank to the other side of the chasm, three of the natives being left in charge of the two dogs and the remaining sledges. The other five followed us, laughing heartily at seeing Lieut. Parry and myself drawn towards the ship on the sledges by our seamen. One of them, by keeping close to me, got before his companions; and thus we proceeded till we arrived within 100 yards of the ship, where he stopped. I attempted

attempted to urge him on, but in vain, his evident terror preventing him from advancing till his companions came up. It was apparent that he still believed the vessel to be a living creature, as he stopped to contemplate her, looking up at the masts, and examining every part with marks of the greatest fear and astonishment. He then addressed her, crying out in words perfectly intelligible to Sacheuse, and in a loud tone, 'Who are you? what are you? where do you come from? is it from the sun or the moon?' pausing between every question, and pulling his nose with the utmost solemnity. The rest now came up in succession, each showing similar surprise, and making use of the same expressions, accompanied by the same extraordinary ceremony. Sacheuse now laboured to assure them that the ship was only a wooden house, and pointed out the boat, which had been hauled on the ice to repair; explaining to them that it was a smaller one of the same kind. This immediately arrested their attention, they advanced to the boat, examined her, as well as the carpenter's tools, and the oars, very minutely; each object, in its turn, exciting the most ludicrous ejaculations of surprise. We then ordered the boat to be launched into the sea, with a man in it, and hauled up again, at the sight of which they set no bounds to their clamour. The ice-anchor, a heavy piece of iron, shaped like the letter S, and the cable, excited much interest; the former they tried in vain to remove, and they eagerly inquired of what skins the latter was made.

"By this time the officers of both ships had surrounded them, while the bow of the Isabella, which was close to the ice, was crowded with the crew; and certainly a more ludicrous, yet interesting scene, was never beheld, than that which took place whilst they were viewing the ship: nor is it possible to convey to the imagination any thing like a just representation of the wild amazement, joy, and fear, which successively pervaded the countenances and governed the gestures of these creatures, who gave full vent to their feelings; and I am sure it was a gratifying scene which never can be forgotten by those who witnessed and enjoyed it.

"Their shouts, halloos, and laughter, were heartily joined in, and imitated by all hands, as well as the ceremony of nose-pulling, which could not fail to increase our mirth on the occasion. That which most of all excited their admiration was the circumstance of a sailor going aloft, and they kept their eyes on him till he reached the summit of the mast; the sails, which hung loose, they naturally supposed were skins. Their attention being again called to the boat, where the carpenter's hammer and nails still remained, they were shown the use of these articles; and no sooner were they aware of their purposes, than they showed a desire

desire to possess them, and were accordingly presented with some nails. They now accompanied us to that part of the bow from which a rope ladder was suspended, and the mode of mounting it was shown them; but it was a considerable time ere we could prevail on them to ascend it. At length the senior, who always led the way, went up, and was followed by the rest. The new wonders that now surrounded them on every side caused fresh astonishment, which after a moment's suspense, always terminated in loud and hearty laughter.

"The most frequent ejaculation of surprise was *Heigh, yaw!* and, when particularly excited by any more remarkable object than the rest, they pronounced the first syllable of the interjection many times with peculiar rapidity and emphasis, extending wide their arms, and looking at each other at the end of the exclamation with open mouths, as if in breathless consternation.

"Their knowledge of wood seemed to be limited to some heath of a dwarfish growth, with stems no thicker than the finger, and accordingly they knew not what to think of the timber they saw on board. Not being aware of its weight, two or three of them successively seized on the spare top-mast, evidently with the view of carrying it off; and as soon as they became familiar with the people around them, they showed that desire of possessing what they admired, which is so universal among savages. The only thing they looked on with contempt was a little terrier dog, judging, no doubt, that it was too small for drawing a sledge; but they shrunk back, as if in terror, from a pig, whose pricked ears, and ferocious aspect (being of the Shetland breed) presented a somewhat formidable appearance. This animal happening to grunt, one of them was so terrified, that he became from that moment uneasy, and appeared impatient to get out of the ship. In carrying his purpose into effect, however, he did not lose his propensity to thieving, as he seized and endeavoured to carry off the smith's anvil; finding that he could not remove it, he laid hold of the large hammer, threw it on the ice, and following it himself, deliberately set it on his sledge, and made off. As this was an article I could not spare, I sent a person to recover it, who followed him, hallooing, and soon got pretty near him. Seeing that he must be overtaken, he artfully sunk it in the snow, and went on with the sledge, by which we were convinced that he knew he was doing wrong. The seaman, on finding the hammer, left off the pursuit, and returned, while he went off, and was seen no more that day. Shortly after, another of them, who had received a present, consisting of a small hammer and some nails, left the ship also, and putting his acquisition upon the remaining sledge, dragged it away with him, and disappeared.

"Among other amusements afforded to the officers and men on on board, by their trials on the inexperience of the natives, was the effect produced on them by seeing their faces in a magnifying mirror. Their grimaces were highly entertaining, while, like monkeys, they looked first into it, and then behind, in hopes of finding the monster which was exaggerating their hideous gestures. A watch was also held to the ear of one, who supposing it alive, asked if it was good to eat. On being shown the glass of the skylight and binnacle, they touched it, and desired to know what kind of ice it was. During this scene, one of them wandered to the main hatchway, and, stooping down, saw the serjeant of marines, whose red coat produced a loud exclamation of wonder; while his own attitude and figure did not less excite the surprise of our tars, who, for the first time, discovered some unexpected peculiarities in the dress of the natives.

"The three men remaining were now handed down to my cabin, and shown the use of the chairs, which they did not comprehend, appearing to have no notion of any other seat than the ground. Being seated, we attempted to take their portraits, in which Lieut. Hopner, Mr. Skene, Mr. Bushnan, and myself were at the same time employed. During this attempt, fearful it might alarm them, we amused them with questions, collecting from them at the same time the information we thought it desirable to obtain, and directing Sacheuse to ask those questions which the hurried nature of this visit permitted us to recollect as most essential, and of which the result will appear hereafter. Our drawings being completed, and interrogatories ended, they began to be very inquisitive, asking the use of every thing in the cabin; we showed them paper, books, drawings, and various mathematical instruments, which produced only the usual effect of astonishing them; but on being shown the prints, in Cook's Voyage, of the natives of Otaheite, they attempted to grasp them, evidently comprehending that they were the representations of human beings. The sight of a writing-desk, a bureau, and of other wooden furniture, also excited their astonishment, but apparently from the nature of the materials only, as they seemed to form no idea of their uses.

"They were now conducted to the gun-room, and afterwards round the ship, but without appearing to distinguish any thing particularly, except the wood in her construction, stamping on the deck, as if in evident surprise at the quantity of this valuable material. In hopes of amusing them, the violin was sent for, and some tunes played; they, however, paid no attention to this, seeming quite unconcerned, either about the sounds or performer—a sufficient proof that the love of music is an acquired taste, and that it requires experience to distinguish between that and other similar noises. A flute was afterwards sounded for them, which

which seemed to excite somewhat more attention; probably from resembling more nearly in shape the objects to which they were accustomed; one of them put it to his mouth and blew it, but immediately threw it away. On returning to the cabin, some biscuit was produced, and a piece eaten by Sacheuse before presenting it to them. One of them then took a piece also into his mouth, but almost immediately spat it out with apparent disgust. Some salt meat that was afterwards offered produced the same effect. We now also ascertained their names, that of the eldest being Ervick, and that of the two others, who were his brother's sons, Marshuick and Otooniah. Some juggler's tricks were afterwards exhibited by Mr. Beverly, which seemed to disconcert them, as they became uneasy, and expressed a wish to go on deck. We accordingly accompanied them, and, by pointing to the pieces of ice that were alongside, attempted to discover to what extent they could count, for the purpose of ascertaining the numbers of their nation. We found, however, they could only reckon to ten; and on inquiry, therefore, if their country possessed as many inhabitants as there were pieces of ice, they replied 'Many more:' a thousand fragments were, perhaps, then floating round the ship.

"The knives had by this time been examined by the armourer, who thought they were made from pieces of iron hoop, or from flattened nails; we therefore asked if any plank or wreck had formerly been driven on their shore; to which they replied, that a piece of wood with some nails had come on shore, and been picked up. We therefore concluded that the knives which they had left with us had been formed from this iron, and consequently made no further inquiries.

"They were now loaded with various presents, consisting of some articles of clothing, biscuit, and pieces of wood, in addition to which the plank that had been used in crossing the chasm was given to them. They then departed, promising to return as soon as they had eaten and slept, as we had no means of explaining to them what tomorrow meant. The parting was attended with the ceremony of pulling of noses on both sides.

"After they had reached and crossed the chasm, they were observed by some men who had been sent to accompany them, throwing away the biscuit, and splitting the plank, which was of teak, into small pieces, for the purpose of dividing it among the party. Soon after this, they mounted their sledges, and drove off in a body hallooing, apparently in great glee."

The ships had subsequently some further intercourse with the natives, in which it was discovered that the iron of the knives of the natives, which were composed of small pieces from three to six in number, each about the size of a silver groat, inserted in a slit in a piece of bone, was obtained from two masses at some distance;

stance; one of which (the largest) was about the size of the cabin sky-light. To obtain this iron seemed to be one of the objects of their present journey: they contrived by much labour to detach small pieces which they afterwards extended by beating them between stones, and when sufficiently extended for the purpose, employed them in the manner just described, riveting in the piece at the extremity of the knife, but not the others. These masses are believed to be meteoric.

Our readers have also been informed that our voyagers had met with red or rather crimson-coloured snow. It was on the face of the cliffs on the shore, and in several parts it was seen at a distance of at least six miles from the sea, but always on the face or near the foot of a mountain. Captain Ross considers the matter which communicated this colour to be of vegetable origin. Some of it brought home in bottles, has been examined by chemical gentlemen: the following is Dr. Wollaston's statement respecting it:

"With respect to the exact origin of that substance which gives redness to the snow, I apprehend we may not be able to give a decided opinion, for want of sufficient knowledge of the productions of those regions in which it was found; but from all the circumstances of its appearance, and of the substances which accompany it, I am strongly inclined to think it to be of vegetable origin. The red matter itself consists of minute globules from 1-1000th to 1-3000th of an inch in diameter; I believe their coat to be colourless, and that the redness belongs wholly to the contents, which seem to be of an oily nature, and not soluble in water, but soluble in rectified spirits of wine; when the globules are highly magnified, and seen with sufficient light, they appear internally subdivided into about 8 or 10 cells. They bear to be dried by the heat of boiling water, without loss of colour. By destructive distillation, they yield a fetid oil, accompanied with ammonia, which might lead to the supposition that they are of animal origin; but since the seeds of various plants also yield this product, and since the leaves of fuci also yield ammonia by distillation, I do not discover any thing in the globules themselves which shows distinctly from what source they were derived. I find, however, along with them, a small portion of a cellular substance, which not only has these globules adherent to its surface, but also contained in its interior; and this substance, which I must therefore consider as of the same origin with them, appears by its mode of burning to be decidedly vegetable, as I know of no animal substance which so instantly burns away to a white ash as soon as it is heated to redness. The first conception I formed as to their nature was, that they might be the spawn of a minute species of shrimps, which is known to abound in those seas, and

and which might be devoured by the myriads of water-fowl observed there, and voided with their dung; but, in that case, they should undoubtedly be found mixed with the exuviæ of those animals, which is not that fact, but they are found accompanied solely by vegetable substances, in one of which they are actually contained. If they are from the sea, there seems no limit to the quantity that may be carried to land by a continued and violent wind; no limit to the period during which they may have accumulated, since they would remain from year to year, undiminished by the processes of thawing and evaporation, which remove the snow with which they are mixed. I regret that the scantiness of our information does not enable us to come to any satisfactory conclusion, and can only hope that future navigators may have an opportunity of collecting materials to elucidate so curious a phenomenon."

---

*The American Journal of Science, more especially Mineralogy, Geology, and the other Branches of Natural History, including Agriculture and the ornamental as well as useful Arts.* Conducted by Benjamin Silliman, M.D. Professor of Chemistry, Mineralogy, &c. in Yale College.

We have received the first and second Number of this new Journal, which is to be published quarterly, and, judging by the contents of these two, promises to be serviceable to the cause of science, not only in making us acquainted with the geology, mineralogy, and general natural history of the western hemisphere, but by furnishing early notices of all new discoveries in the different branches of physics, made in that quarter of the world. We have given several extracts in our present Number.

---

*A Letter to the Farmers and Graziers of Great Britain, to explain the Advantages of using Salt in the various Branches of Agriculture, and in feeding all Kinds of Farming Stock.* By SAMUEL PARKES, F.L.S. M.R.I. F.S.A. E. &c. &c.

This little pamphlet of 98 pages cannot be too strongly recommended to the attention of those to whom the author addresses himself. It contains a preliminary advertisement of six pages; the Letter occupies twenty; and the remaining pages are filled with extracts from ancient and modern writers on the employment of salt in agriculture, in promoting the health of horses, cattle, sheep, bees, &c.; and from the minutes of evidence before, and the Report of, the Select Committee of the House of Commons, on the use of salt and on the salt-duties, &c.; with directions for enabling farmers to procure this best of all articles for the improvement of their land and live-stock at the reduced price, &c. &c.—We are sorry that our present press of matter prevents our now laying Mr. Parkes's Letter before our readers.

*Just*

*Just published*, A Treatise on Spinning Machinery, illustrated with plans of different machines made use of in that art, from the spindle and distaff of the ancients to the machines which have been invented or improved by the moderns. With some preliminary observations, tending to show that the arts of spinning, weaving and sewing, were invented by the ingenuity of females. And a postscript, including an interesting account of the mode of spinning yarn in Ireland. By Andrew Gray.

Facts and Observations towards forming a new Theory of the Earth. By William Knight, LL.D. Belfast.

Two Essays, one upon single Vision with two Eyes, the other upon Dew; a Letter to the Right Hon. Lloyd Lord Kenyon; and an account of a female of the white race of mankind, part of whose skin resembles that of a negro, with some observations on the causes of the differences in colour and form between the white and negro races of men. By the late W. C. Wells, M.D., with a memoir of the author's life written by himself.

---

## LI. *Proceedings of Learned Societies.*

### ROYAL SOCIETY.

Feb. 11. A PAPER was read, presenting arithmetical investigations upon the Extraction of Roots, by Lewis Francis Bastard, Esq., of Geneva: and one on the Variation of the Compass, by Captain John Ross, R. N.

Feb. 18. A paper by Captain Edward Sabine of the Royal Artillery, On the Irregularities of the Compass-needles of His Majesty's ships Isabella and Alexander, caused by the attraction of iron contained in the ships.

Feb. 25. A paper by Sir H. Davy was read, relating to the Formation of Mists in particular situations. The fall of the Thermometer is greater after sun-set on land than on water. The author considers the known fact of the expansibility of water at temperatures below 40°, as the cause which preserves at a superior temperature both the water and the superincumbent air. When the cold, and comparatively dry land-air annexes with the moister and warmer air resting on the water, the diminished temperature that results from this mixture, has a tendency to separate a part of its moisture in the form of mist.

A paper by Captain Edward Sabine was also read, containing Observations on the Dip and Variation of the Magnetic Needle, and on the Intensity of the Magnetic Force, made during the late voyage in search of a N.W. passage. The Dipping-needle was so adjusted, that, on reversing the poles, the dip remained unaltered; and was kept in the direction of the magnetic meridian by means

 of

of another compass. The intensity of the magnetic force was determined by employing a magnet to draw the needle to a horizontal position; which being then removed, the needle was left to oscillate till the arcs became too small to be observed, and at every tenth vibration the arc and the time were noted. The observations were generally made upon the ice, to avoid the irregularities produced by the iron of the ship.

March 4. A paper on the Action of Crystallized Surfaces upon Light, by Dr. Brewster, was read; also a paper by Sir E. Home on the Fossil Skeleton of an Animal, on parts of which he had before presented three separate papers to the Society. Sir Everard has been enabled to correct and amplify his former details by means of a more perfect skeleton since discovered, in which the only parts wanting are some of the bones of the pelvis and the lower parts of the sternum.

March 11. A paper was read, On the Pressures which sustain a heavy body in equilibrio, when the points of support are more than three, by Charles Bonnycastle, esq.

March 18. A letter was read from Dr. Granville, which had for its object to correct a mistake in his paper published in the last volume of the Society's Transactions, and which had been pointed out to him by Dr. Maton.

March 25.—Observations on the Peculiarity of the Tides between Fairleigh and the North Foreland, and on the supposed meeting of Tides near Dungeness, by James Anderson, esq. R.N. —On the Ova of the Opossum Tribe, by Sir Everard Home, bart.

April 1.—Results of Observations made at Trinity College, Dublin, for determining the Obliquity of the Ecliptic, and the Maximum of the Aberration of Light, by Dr. Brinkley.—Additional Remarks on the Skeleton of the Proteorrhocius, by Sir Everard Home, bart.—On some new Methods of investigating the Sums of several Classes of infinite Series, by Charles Babbage, esq.

### SOCIETY OF ANTIQUARIES OF LONDON.

On April 23 (St. George's Day) the Society of Antiquaries met at their apartments in Somerset-place, in pursuance of their Statutes and Charter of Incorporation, to elect a President, Council, and Officers of the Society for the year ensuing; whereupon

George Earl of Aberdeen,
Right Hon. Sir J. Banks,
F. A. Barnard, esq.
W. Bray, esq.
Nicholas Carlisle, esq.
T. Combe, esq.
H. Ellis, esq.
H. Leycester, esq.
Samuel Lysons, esq.
Matthew Raper, esq.
Robert Smirke, jun. esq.

(eleven

(eleven of the Council) were re-chosen of the NewCouncil;—and

| | |
|---|---|
| Charles Bicknell, esq. | Daniel Moore, esq. |
| Michael Bland, esq. | Sir Gore Ouseley, bart. |
| Henry Dealtry, esq. | John Delafield Phelps, esq. |
| Bowyer Edward, Lord Bishop of Ely, | William Walton, esq. |
| Sylvester Lord Glenbervie, | Roger Wilbraham, esq. |

(ten of the other members of the Society) were chosen of the New Council, and they were severally declared to be the Council for the year ensuing. And on a Report made of the Officers of the Society, it appeared that

George Earl of Aberdeen was elected President.
William Bray, esq. Treasurer.
Taylor Combe, esq. M.A. Director.
Nicholas Carlisle, esq. Secretary, and
Henry Ellis, esq. B.C.L. Secretary for the year ensuing.

The Society afterwards dined together at the Freemasons' Tavern in Great Queen-street, according to annual custom.

---

### HUNTERIAN SOCIETY.

A Society has been established in London bearing the designation of the "Hunterian Society." It professes the most friendly feeling towards all similar existing institutions, and is founded principally, but not exclusively, for the accommodation and benefit of medical men residing in the eastern parts of the metropolis.

Its objects are to concentrate the zeal and experience of a large number of respectable practitioners, whose places of residence are at a distance from professional associations already existing; and to receive and discuss communications on medical and surgical subjects. It aims particularly at the cultivation of a spirit of liberal and friendly intercourse among the members of the profession within the sphere of its influence.

It consists of honorary, corresponding, and ordinary members, and already the Society is honoured by the names of a considerable number of men of character and talent. The Hunterian Society holds its meetings every alternate Wednesday evening throughout the year, at No. 10, St. Mary-Axe.

The following is the list of the Officers and Council for the present year:

*President:*—Sir William Blizard, F.R.S.

*Vice Presidents:*—James Hamilton, M.D.; George Vaux, esq.; John Meyer, M.D.; Lewis Leese, esq.

*Treasurer:*—Benjamin Robinson, M.D.



*Secretaries:*

*Secretaries:*—John T. Conquest, M.D. F.L.S.; Thomas J. Armiger, esq.

*Council:*

| | |
|---|---|
| Thomas Addison, M.D. | James Alexander Gordon, M.D. |
| Thomas Bell, esq. F.L.S. | William Kingdon, esq. |
| Henry James Cholmley, M.D. | Benjamin Pierce, M.D. |
| Thomas Calloway, esq. | James Parkinson, esq. |
| William Cooke, esq. | Henry Richard Salmon, esq. |
| George Edwards, esq. | Frederick Tyrrell, esq. |

ROYAL ACADEMY OF SCIENCES, PARIS.*

In the public sittings of 22d March, was read a Notice on the continuation of the labours undertaken to determine the figure of the Earth, and upon the results of the operations of the Pendulum, made in 1817, at the Shetland Islands, by M. Biot.

The paper commenced by a reference to a notice read last year before the Institute, detailing the birth and progress of the great system of astronomical observations, undertaken a century and a half ago by the Academy of Sciences, and followed up, without interruption, since that epoch, in all parts of the world, to determine the figure of the earth, and, what is perhaps more surprising, to discover that law of density, according to which, matter is distributed in the beds which form the interior of the mass of the earth.

The author then proceeded to remark that, " if a century and a half of experiments were necessary to develop and to perfect all the means which the solution of this great physical question required, now that those means have been acquired, our progress will be more rapid. The short space of a year has been sufficient to add to the results already obtained new elements, which both confirm and enlarge them. These recent acquisitions we now propose to submit to you.

" The figure of the earth may be determined by two methods, the results of which will be found to agree, though the processes are different. In the first, which is purely geometrical, the observer measures in reality the length of an arc of the terrestrial meridian,—that is to say, let him measure, provided he can do it immediately on the earth, the whole of that arc, in a straight line, as was done in Pennsylvania 50 years ago; but if the configuration of the ground, and if the habitations which cover it, do not permit him to extend his operations, as is commonly the case, he measures, first of all, a line of four or five thousand toises, with the utmost precaution and accuracy: then, upon

* From the *Moniteur* of April 5.

this

this line, as upon a base, he erects, in the direction of the meridian, a series of triangles, whose sides are successively connected, so that he can find the whole length of the arc of the meridian which crosses them. Having found the length of this arc, by whatever method he chooses to adopt, he then determines, by astronomical observations—not by a few, but by many thousands, the stars, or, to speak with more precision, the points in the heavens, towards which the two verticals produced to their two extremes are directed. But, since the earth is absolutely a mathematical point, when compared to infinite space, the arc of the heavens, intersected by the produced parts of the verticals, is the same as that which might be observed from their point of concourse. He thus measures the angle which they include, and the instruments give the number of degrees, minutes, seconds, and even fractions of seconds, which correspond to it: for it is necessary to observe the most scrupulous precision, when we are measuring an object so immense by means so diminutive. Similar observations, repeated on various points of the same arc of the meridian, discover how the verticals produced to these points incline mutually in given distances: but the law of these inclinations is precisely the geometrical character which specifies the curvature, and the degree of curvature of the earth's surface, in the direction of the meridian, which has been taken. Operations analogous to this will also give this curvature in other directions, —for example, from east to west, by following the course of the same parallel, as is done at present from Brest to Strasburgh: and the united results so obtained, in different countries, completely determine the form of the earth.

"The other method, founded upon observations of the pendulum, is more circuitous, and appears, at first view, to have no connection with the proposed object. In this method we have nothing to do with bases, triangles, or with any geometrical or actual measurement of the earth's surface, the observer not having even the necessity to cast his eyes upon the surface at all. He merely brings with him a small metal ball, quite round, some metal wire, a clock, an astronomical circle, and a small iron rule. When arrived at one of the stations which he has chosen, he shuts himself up in some strong secluded building, where he is free from any exterior motion or noise. Then taking his metal ball, he suspends it to one end of his wire, by means of a small round leather cap, so exactly fitted to the ball, that contact alone shall be sufficient to make them adhere. He attaches the other end of the wire to a steel fulcrum, like the fulcrum of a balance, which he sets upon a plane of agate stone, exceedingly smooth, firm, and made perfectly horizontal; he then puts the pendulum in motion, counting the number of vibrations which it makes in any given time—a day for instance; or rather he does not count them, for it would be an endless task, but ascertains them by his clock; and lest the time-piece should deceive him, he most minutely compares it with the movements of the heavenly bodies—the great invariable clock, infallible at all times and in all places. Having determined how his pendulum goes, he measures its length with accuracy by his rule. He repeats these trials a great number of times, in order to be sure of their exactness. That done, he carefully puts up his ball and his rule and betakes himself to make the same proofs elsewhere. These being gone through, are sufficient to enable him to calculate with the utmost exactness, and perhaps more exactly than by actual measurement, the curvature of the terrestrial meridian, on which there have been so many observations made. In effect, the vibrations of the pendulum are caused by the gravity which tends to make bodies fall towards the earth. In the operation which has been just described, the metal ball, in returning to the vertical point in each of its vibrations, does no more than fall towards the earth, as much as the length of the wire to which it is suspended will permit. It is then seen, that the rapidity of the vibrations of the pendulum, or of its fall in any place, according to the given length of the wire, must depend on the energy, more or less powerful, of its gravity in that particular place: so that the operator may compare, by this means, the intensities of gravity in different places. But, according to the theory of universal gravitation, this intensity is found connected with the form of the earth's surface, and with the law of density in the inner beds of the earth, by mathematical analogies. Thus, then, we see that it is only necessary for the observer to have one of these elements, in order to be able to determine analogically with regard to the other. It is thus that, by means of impressions left upon trees and upon sand, the philosopher Zadig determined the form, height, and even the colour of the king of Babylon's beautiful horse. In our case, the method is the same, though the results are only a little more serious. The sciences, indeed, afford innumerable examples of those indirect methods, which conduct much further than any one could expect to go by means apparently more direct; a sort of stratagem of inquiry which takes by surprise the secret of nature, just as the arts of a skilful general discover to him those points where the enemy is most assailable.

"The two methods which we have just explained have been almost always used together, in order that their results might reciprocally confirm each other: and as endless perfectibility, however doubtful in morals, is quite certain in the physical sciences, it has naturally happened that the most perfect operations belong to the latter. Thus, at first, it was merely known that the earth

was

was of a round figure, and that was easily ascertained by the circular form which its shadow presents when projected on the moon's disc during an eclipse. Newton discovered afterwards by his calculations, that it was not completely round, but was somewhat flattened at the poles and distended at the equator. The methods of observation, yet imperfect, after great difficulty, have established this truth. It has been at last obtained by measuring the terrestrial degrees under the most distant latitudes, namely, at the equator and at the poles. The flatness of the poles was thus put beyond doubt. The operations undertaken for the last fifty years in France, England, Sweden, America, and India, have succeeded in determining its precise quantity. It has been imagined, therefore, that a great idea conceived a long time since, might be realized upon these results,—that of forming a system of national measures adapted for universal use, which might have for its base the extent of the earth itself. The measurement of the arc of the meridian comprehended between Dunkirk and Barcelona, and accomplished with infinite precision by Messrs. Mechain and Delambre, was the principle of all these conclusions: better could not be selected. The desire of communicating to these results, not greater precision, for it would have been difficult to hope for it, but a new assurance, and a base not so peculiar to France, has caused this first arc to be prolonged across Spain as far as the *Pithiuse* Isles. Contingently, it became a part of an immense triangle above the Mediterranean. In fine, the same motive has still caused to be seized with extreme anxiety the opportunity which was offered, two years ago, of seeing this operation, already so grand, extend itself towards the north, to nearly equal extent, in uniting with a portion of the same meridian which stretches from the southern coasts of England as far as the Shetland Isles to a higher latitude than St. Petersburgh—a portion which the learned men of England have been now twenty years occupied in measuring. In order to terminate this immense arc, which comprehends almost the fourth of the distance from the equator to the pole, and which unites to this extension all the exactitude of mental observation, there remained nothing, last year, but to erect some triangles between the Shetland Isles and Scotland, by the medium of the Orkneys, and to connect the operations of the English and the French at the point of junction, consequently at Dunkirk, by means of a system of combined operations in which instruments of a very different nature, employed by the observers of the two nations, would be made to co-operate. This last labour was executed in the preceding autumn. M. Arago and I went to receive, at Dunkirk, the English observers, MM. Mudge, Coleby, and Gardner. They brought with them the grand astronomical sector con-

 structed

structed by Ramsden, which they had made use of in all their preceding operations, and we, on our part, brought one of our repeating circles. These circles, in themselves, are instruments of small dimensions, and of a price comparatively moderate; but their precision is founded on a principle independent of their size, and which consists in the angles of observation being repeated, and replacing each other on the same circular limb, so that the errors which might embarrass them combat each other, (if we may be allowed the phrase,) and mutually destroy each other. A sector, on the contrary, is an expensive instrument, and of considerable size; it is, properly speaking, a long telescope, placed vertically, and which is capable of deviating some degrees to the north as well as to the south of the vertical point, in following a circular limb whose divisions measure its deviation. Such stars as pass to the meridian near the zenith, may thus be observed, and also the quantity which are both north and south of the vertical point may be ascertained. This observation being repeated on the same stars and on a great number, at the two extremities of an arc of the *terrestrial* meridian, gives the breadth of the celestial arc, included between the verticals, produced to these two extremities; or, what is the same thing, it gives the mutual inclination of these two vertical *lines;* which may be then compared to the length of the terrestrial arc, which they confine. We know what art is necessary in the construction to establish thus the exact verticality of a telescope twelve feet long, and to maintain it invariably either in this position, or in the vertical plane which it ought to describe in following its limb. But what we cannot conceive without seeing it, is the infinite multitude of precautions, cares, and we may say atttentions, which the English artist has employed to render the observations more exact, and a circumstance of more importance than one might imagine more easy. In the old sectors,—in that, for example, which Clairault, Lemonier, and Maupertuis employed in the operation of Laponie—the observer was obliged to be horizontally above the telescope, his face turned towards the heavens, and in this constrained posture had to wait the transit of the star. In the sector of Ramsden, a little mirror, placed at the lower end of the telescope, reflects the image of the star in a horizontal direction; and the astronomer, conveniently seated, observes it with much ease. Moreover, the steadiness of the instrument is estimated by the aid of a plumb-line suspended from the top, the higher extremity of which should always correspond to a mark finely traced by the artist at the centre of the rotation of the glass.—The proof of this coincidence, which must often be made, was very inconvenient in the ancient sectors, the observer being obliged, in order to effect this purpose, to mount on a scaffold to to an elevation equal to the top of the instrument. In this instrument the artist has avoided this inconvenience also; he has traced the point of coincidence on a little shell of mother-of-pearl; a lamp placed behind this shell illuminates it; and a concave mirror, receiving the illuminated image from the point and from the plumb-line, reflects both at the bottom of the instrument, where the observer beholds them distinctly. In a word, that the observations may be made every where, the entire apparatus is fixed in a great portable tent, which shelters it, and the top of which admits the light by a kind of window, which opens for the observations. At Dunkirk this fine instrument, by the desire of the observers, was placed within the marine arsenal. The English brig the Investigator, which had conveyed it thither, was also to bring it by the docks to the place where it was to be employed, and was to remain there ready to take it back with the same facility, the same care, and the same respect as they would have paid to a vessel of our marine. We placed our little repeating circle at a short distance off, in a shed which the Administration of Marine had directed to be constructed for us; for it may be conceived, without our mentioning it, that the French government had given the necessary orders that the united observers should find all the assistance which they could desire. There, owing to a continuation of good weather, which proved extremely harassing, so little time did it leave us for relaxation, all the observations were completed in fifteen days, to which, properly speaking, we may add as many nights. By a confidence, which would not deserve to be noticed if it were as common as it is proper and useful, we reciprocally accommodated each other with our apparatus; and when we were completely satisfied with our observations, we made a full and entire communication of them to each other. They were found to agree in a surprising manner, if the different nature of the processes be considered; and what is still more fortunate, they were found also to accord perfectly with those which M. Delambre had formerly made in the same place, in the commencement of his operations; whence results the double assurance, that the arcs of France and England are thus perfectly connected with each other; and that, moreover, the observations made on the other points of the two arcs, by processes similar to those which we had proved together, afford all the precision which can be desired. It gives one unfeigned satisfaction to recognise as certain, results that have cost so much trouble. It is a great encouragement for science, to see that it can at length calculate on the methods which it practises. Though instability, in this particular, is infinitely less dangerous than in politics, it is still an evil, because it is an acknowledgement of imperfection. Happily, the learned ought to take less pleasure in in politics than other men, because their curiosity finds food enough in things totally unknown, just as we are accustomed to think little of revolutions among people who have still to discover new worlds, in which they may extend themselves.

"The operations which had re-united us being thus happily accomplished, the brig that had conveyed the English observers set sail, and departed from Dunkirk. I could not see this vessel depart with indifference, in which I had been so obligingly received the preceding year, in passing to the Isles of Shetland, and the officers of which had afforded me such assistance in my observations. The captain, on quitting the port, hoisted the French flag, saluted us with fifteen pieces of cannon, and, while he could render himself audible, or we could see him, continued to testify to us every mark of friendly recollection. As it was expedient that the point of junction of the English and French operations might always be re-ascertained, M. Arago and I thought proper to erect some lasting monument. The city of Dunkirk freed us from this care in a manner too honourable to them not to call here for our gratitude. A little marble column, surmounted with a spire, is to be erected in this place, and a short inscription will record the object of the operation, with the names of the observers of the two countries. At the Shetland Isles, the extremity of the great arc has been marked in like manner, in the garden of Mr. Edmonston, by a little monument which he has caused to be erected in the place where we had made our observations. In Spain, in the Isles called *Pithiuse*, the southern extremity of our arc is consecrated by a cross. Thus, in the most distant countries, and under the most opposite forms of government, those institutions which are calculated to preserve order in society, tend to the same object, whether their beneficent influence be founded on morality, on politics, or on religion.

"The operations of which we have spoken refer to the first of the methods by which the figure of the earth may be determined. The other method, which employs the measure of a pendulum, had been practised, together with the preceding, on all the points of our arc. We had given an account, last year, of a tour made in England, Scotland, and the Shetland Isles, to carry our apparatus of the pendulum over the whole extent of the English arc. The English government, which had favoured this operation with great kindness, naturally desired that it should be executed, in like manner, by an observer of their own nation. Captain Kater, Member of the London Society, an experimentalist singularly exact, and author of an excellent Memoir relative to the measure of the pendulum, upon the principle of seconds, has been deputed for this purpose. He conveyed, with much precaution, to Edinburgh and the Shetland Islands, a solid pendulum, of of an invariable form, the diurnal motion of which he had previously determined at London; and the oscillations of which he had also observed in these different places. It is the same operation which, among many others, our countryman Capt. Freycinet is executing, at this moment, in his Voyage round the World, with pendulums constructed by the direction of M. Arago. Captain Kater was received at the Shetland Islands by the same Mr. Edmonston who had received me with such obliging hospitality two years ago. He has made observations in the same place where I did, with the same assistance, and the same accommodations; for, after so many services received from this excellent man, the obligation, in his opinion, is still due by him, and not by us, for having penetrated into these remote islands, and connected with the rest of the world, by the permanent operations of science, the obscure and peaceable corner of the earth in which Providence had placed him. I have the pleasure of being able to announce, that the observations of Captain Kater are found to accord almost identically with mine, as he himself has assured me, in sending me a view of his results in exchange for mine, which I addressed to him. Having thus the lengths of the pendulum measured by an uniform process upon the same meridian from Formentara, the most southern of the *Pithiuse* islands, to Unst, the most northern of the Shetland Islands, and not only in these two islands, but in a great number of intermediate points, the flatness of the earth can, by these lengths, be determined with great exactness. But the amount that results from it is found to be exactly the same that is drawn from the lunar inequalities, or from the comparison of terrestrial degrees measured at very distant latitudes; so that all these methods, so different in their progress, so distinct in their processes, definitively concur, and terminate in this one result—the flatness of the earth; namely, the excess of the radius of the equator above the radius which extends to the pole is between *——and —— of the latter radius. The difference between these extreme amounts, betwixt which the truth is now found to be comprised, will produce but one hundred toises either more or less on the length of the semi-axis, which passes by the poles of the earth; and after the correctness of the observations which established this fact, as well as from their number and their different natures, it can be no longer a subject of discussion.

* These quantities, expressed in vulgar fractions, are so indistinctly printed in our copy of the *Moniteur*, (and, we suspect, in the whole impression, for we have taken the pains to see several copies) as to be quite illegible. If any of our friends have been so fortunate as to meet with a legible copy, or can, from any other source, furnish us with them, we shall gladly insert them in a future number.

In

In general, we can state with satisfaction, that the sciences have at present attained a point, in which the successive results may still surpass each other in precision, but cannot be opposed to each other. Differences are found, and ever will be found in them, because there is nothing absolutely perfect in what man observes with his senses. But these differences will be henceforth very trifling, comprised in very narrow limits, and such that the elements of the great physical theories shall no longer experience but trifling modifications.

*Sitting of March* 24.

*Papers read.*—Extract from a Memoir on the physical and mathematical Theories of Heat, by Baron Fourier. Historical Notice on the Life and Works of M. Perier, by Chevalier Delambre, Secretary of the Academy. Continuation of the Labours relative to the Determination of the Figure of the Earth, and Results of Observations on the Pendulum made during last year at the Shetland Isles by M. Biot *. Memoirs on Insects painted or sculptured on the ancient monuments of Egypt. By M. Latreille.

*Prizes awarded.*—1. To M. Fresnel, for the best Memoir of Experiments made for determining the effects of the refraction of luminous rays, direct and reflected, when they pass separately or simultaneously near the extremities of one or more bodies of an extent either limited or indefinite, having regard to the intervals of these bodies, as well as to the distance of the luminous focus whence the rays emanate; and mathematical inductions from these experiments of the movements of rays in their passage near bodies. Prize of 300 francs.

2. To M. Jules Cloquet, for the best Anatomical Description of the intestinal members known by the name of *Ascaris Lumbricalis* and *Echinorynchus Gigas*. A gold medal of the value of 300 francs.

3. To M. Moreau de Jonnes, one of the correspondents of the Society, for a Statistical Account of the French West India Colonies viewed with relation to their political œconomy. A gold medal of the value of 530 francs.

4. To M. Pons, Assistant Director of the Observatory of Marseilles, for the three comets which he discovered in 1818, the medal founded by M. Lalande. These comets were very small, and without any appearance of tails; so that except for the extreme vigilance and ability of M. Pons, assisted by the great clearness of the heavens at Marseilles, it is probable that two of these comets would have wholly escaped observation. It was not even without a good deal of difficulty that they were discerned at

* Inserted in Phil. Mag. for August 1818.

Paris.

Paris. In spite of these obstacles, and notwithstanding the few observations which could be collected, M. Nicollet has already calculated the parabolic orbits, some particularities of which are sufficiently remarkable. The first comet passed its perihelion Feb. 26, 1818. Its inclination varied little from 90°; it is the greatest which has been yet observed. The second did not reach its perihelion till the 24th January 1819. It presented at first some resemblance to the comet of 1805. The third was at its perihelion on the 5th December 1818, and on the 13th of the same month its distance from the earth was only twelve hundredth parts of the distance of the sun. This last comet is retrograded; the two others are direct.

## LII. *Intelligence and Miscellaneous Articles.*

### POSTSCRIPT TO MR. MEIKLE'S PAPER ON CALORIFIC RADIATION.

*To Mr. Tilloch.*

Sir, — In perusing my paper in your last number, I find I have inadvertently made a mistake in accusing the epicycloidal teeth of tapering suddenly. In so doing, I meant that kind of teeth which have the form of the involutes of the circles beyond which they project. These, there can be no doubt, have an enormous friction. When a certain force applied perpendicularly to the radius of a wheel, is just sufficient to turn it round, it is clear, that if the force act in any other direction, the pressure on the teeth must be augmented in the ratio of radius to the cosecant of the angle which the direction of this pressure makes with the radius of the wheel; and of course, the friction not only on the teeth, but likewise at the centre of each wheel, must be augmented in the same ratio.

By glancing at Mr. Rennie's experiments, I am disposed to agree with Mr. Tredgold—that most experimentalists have been rather remiss in not carefully measuring the degree of flexure. When a bar resting loosely on two props becomes bent by the action of a weight on its middle, the strain will be increased in the ratio of radius to the secant of the angle which the bar makes with the horizon at the point where it rests on the prop. But the arm of the lever, between the weight and prop, will also be lengthened. Allowance for these should therefore be made, before any conclusion can be drawn with accuracy.

This seems to be the reason of what Buffon has remarked in his experiments—that in beams differing only in length, the variation of strength did not exactly follow the inverse ratio of the lengths; the real strengths seeming to fall a little short of the computed;

computed; and the more, the longer the beam. In some of his experiments, the angles which the beams made with the horizon must have been very considerable. H. M.

HERCULANEAN MANUSCRIPTS.

Sir Humphry Davy has turned his attention to this subject, and seemingly with much promise of success. It occurred to him that a chemical examination of the nature of the MSS. and of the changes they have undergone might offer some data as to the best methods to be attempted for separating their leaves, and rendering their characters legible. Some fragments having been submitted to experiment, he was soon convinced that they had not been carbonized by the operation of fire, but were in a state analogous to peat or Bovey-coal, the leaves being cemented together by a substance formed during the fermentation and change of the vegetable matter of which they were composed. Having ascertained the nature of this substance, the next desideratum was to discover means to destroy the cementing substance without injury to the characters or destroying the texture of the MSS.; and in this he happily succeeded. After the chemical operation, the leaves of most of the fragments perfectly separated from each other, and the Greek characters were very distinct. He found however in one fragment the leaves easily separated, but the characters defaced on the exterior and partially so in the interior folds: in another, though the characters were legible on the leaves that separated, yet an earthy matter, a species of tufa, prevented their separation in some parts—circumstances that were clearly the results of agencies to which the MSS. had been exposed, during or after the volcanic eruption by which they had been covered. An examination of the excavations that still remain open at Herculaneum, confirmed the opinion that the MSS. had not been acted on by fire. These excavations are in loose tufa, composed of ashes, sand, and fragments of lava, imperfectly cemented by ferruginous and calcareous matter; and from the manner in which this tufa is deposited in the galleries of the houses, there can be little doubt that it was the result of torrents laden with sand and volcanic matter, accompanied with showers of ashes and stone. From the state of the buildings, it appeared evident to Sir Humphry that they had never been exposed to any degree of heat capable of converting vegetable matter into charcoal: from the state of the MSS. it is inferred that they were probably on shelves of wood, which were broken down when the roofs of the houses gave way to the superincumbent mass; and hence many of them were crushed and folded in a moist state, and some pressed in a perpendicular direction. They must all have been acted on by water; and as the ink was composed of finely

finely divided charcoal suspended on a solution of gum or glue, wherever the water percolated continuously the characters were more or less destroyed. Vegetable matter becomes decomposed by moisture, first brown, then black; and by long continued action of air, the charcoal itself is at last destroyed, leaving nothing but the earths which entered into the constitution of the vegetable substance: when not exposed to air or moisture, still the decomposition goes on, but more slowly, and in the course of ages the carbonaceous matter only remains.

Of the MSS. the greater part are brown, and still contain some of their volatile substance, or extractive matter, which occasions the coherence of the leaves; others are almost entirely converted into charcoal, and their leaves (when not too much crushed) may be readily separated by mechanical means. Of a few, little remains except the earthy basis, and the charcoal of the characters, that of some of the leaves being destroyed.

The number of MSS. and of fragments originally brought to the Museum at Naples, where Sir Humphry examined what remained, was 1696; of these 88 have been unrolled, and found in a legible state; 319 more have been operated upon, and found not to be legible; and 24 have been presented to foreign potentates. Among the 1265 that remain, the greater number consist of small fragments, or of mutilated or crushed MSS., presenting but little hope of being separable in distinct leaves; from 80 to 120 are in a state much more promising, and to which Sir Humphry's chemical process is applicable. The process he has not yet published.

Of the 88 MSS. that have been unrolled, excepting a few fragments in which some Latin verses were found, the great body consists of works of Greek philosophers, or sophists: 9 are of Epicurus, 32 bear the name of Philodemus, 3 of Demetrius, 1 of Colotes, 1 of Polystratus, 1 of Carniades, and 1 of Chrysippus: and those whose authors' names are unknown are upon natural or on moral philosophy, medicine, criticism, arts, life and manners.

Sir Humphry suggests that a systematic attempt should be made to examine in detail all the MSS. that contain legible characters. The name of the author has generally been found in the last leaf unrolled; but two or three columns at the beginning would enable a scholar to judge of the nature of the work, and by a single fold it might be ascertained whether it was prose or verse, history, physics, or ethics. He thinks that by employing one enlightened Greek scholar to direct the undertaking, one to superintend the chemical part of the operation, and 15 or 20 persons for the mechanical labour of unrolling and copying, there is every probability that in a year, and at an expense of from 2500*l*.

2500*l.* to 3000*l.*, every thing worth preserving in the collection would be known, and the extent of the expectation that ought to be formed be fully ascertained.—At all events, an acquaintance with the contents of the remaining rolls would afford much curious and even useful information, respecting the state of society, literature, science, and the arts, among the ancients; particularly in the Greek colonies of Magna Grecia and Sicily.

---

## GALLIC ACID.

M. Braconnot has published the following improved processes for obtaining this acid. Eight ounces of pounded gall-nuts were infused for four days in a little more than two pints of water, and agitated occasionally, at the end of which time they were thrown on a cloth and the residue was strongly pressed: the liquid thus separated was filtered, and set aside in a glass bottle covered with paper for two months, during which time it deposited much gallic acid in crystals. The mould was removed from the surface, and the fluid being then passed through a cloth subjected to pressure, the mass left in the cloth was found to be principally gallic acid. The liquid was then evaporated to the consistence of a syrup, and in twenty-four hours more crystals were deposited, which were again separated by a cloth and pressure. The solid refuse of the first infusion, which, having been moistened, had been left to ferment during the two months that the infusion had been set aside, also yielded, by the action of boiling water, a portion of crystallized acid. The whole quantity of crystals obtained by these means was nearly two ounces, but mixed with an insoluble powder. To get rid of this they were boiled in 18 cubic inches of water: the liquid being filtered, 154½ grains of a peculiar substance remained on the filter, and fawn-coloured crystals were deposited on cooling, which when pressed and dried weighed 617 grains: 154½ grains more were got by evaporating and crystallizing the mother liquor.

M. Braconnot's second process is still better. He exposed moistened gall-nuts for a month to a temperature of from 68° to 77° of Fahrenheit, moistening them now and then with water. They swelled, became mouldy, and formed a whitish paste. A coloured liquid which it contained being separated by pressure, the mass was treated with boiling water to dissolve the acid: the fluid when separated by pressure and cooled gave a crystalline magma of gallic acid.

To purify his gallic acid M. B. employed animal charcoal (common ivory black) washed in muriatic acid: 100 parts of the coloured acid, 800 parts of water, and 18 parts of the charcoal (moistened before mixture with the acid and water) were put into a bottle, which was then kept for 15 minutes in boiling water. The

The filtered liquid left to cool, but now and then shaken, became a mass of white gallic acid, from which the redundant fluid was separated by pressure. The acid thus obtained was as pure and white as other crystallizable vegetable acids: its solution does not affect a solution of gelatine; and it crystallizes from hot water in needles as white as snow. *Annales de Chim.*

---

### PYROMUCOUS ACID.

This name is given by M. Hauton Labillardiere to a new acid which he has procured, by distilling mucous acid till nothing remained in the retort but charcoal. A brown liquid came over, and a few crystals attached themselves to the upper part of the retort: these were put together, and about four times as much water was added: the solution was then filtered, and evaporated to a pellicle; the crystals were separated, and the mother liquor was again evaporated to obtain the rest of the acid. The crystals thus obtained are yellow and impure, and must therefore be distilled in a small retort at a temperature of 266° of Fahrenheit; then melted, and again distilled. A slight portion of charcoal is left in the retort, and the distilled acid still appears yellow; but when crystallized it becomes white and pure. It is inodorous, of a strong acid taste, melts at 266° of Fahr., volatilizes above that heat, and condenses into a liquid which on cooling becomes solid. It reddens vegetable blues, is not deliquescent, is more soluble in alcohol than in water, and in hot water than in cold. Analysed by oxide of copper, its constituents appear to be carbon, 52·118, oxygen 45·806, hydrogen 2·111. It combines with the various metallic oxides, yielding neutral salts, the greater part of which are crystallizable.

---

### STARCH-SUGAR FERMENTED.

Our readers know that sugar has been made artificially by the action of sulphuric acid on starch. Sugar thus made is found to be fermentable like any vegetable saccharine matter. Dissolved in water, boiled with hops, and treated like malt worts, it yields a light, brisk, pleasant beverage, and of a strength proportioned to the solution employed.

---

### POTATOE SUGAR.

Late accounts from Sweden state, that in many parts of that kingdom "they now extract sugar from potatoe starch. It is calculated that 240 pounds yield forty of moscovado sugar."

---

### WODANIUM.

In our number for January we announced the discovery of this new metal by M. Lampadius. The mineral from which he obtained it was not English, as first stated, but from Topschan in

 Hungary;

Hungary: it was considered as an ore of cobalt, but was found to be composed of sulphur, arsenic, iron, nickel, and 20 per cent. of this metal. Its colour is bronze yellow; specific gravity 11·470; it is malleable, has a hackly fracture; is as hard as fluor spar; is strongly attracted by the magnet; does not tarnish in the common temperature, but does when heated, forming a black oxide. It yields colourless solutions, but its oxide hydrated by ammonia is deep blue. Neither alkaline arseniates, nor phosphates, nor infusion of galls, produce any precipitate in its solutions. Prussiate of potash gives a pearl-gray precipitate, and a plate of zinc a black metallic one from its muriatic solution.

---

### NATIVE COPPER.

A remarkable piece of native copper was recently found near the town of Wallingford, and twelve miles from Newhaven, United States. It was turned up in ploughing. The country is of the secondary trap formation, and the rocks at the place where it was found are of the old red sandstone of Werner, which here occupies the plains and runs under the trap. The piece weighs almost six pounds; it is beautiful virgin copper with rudiments of large octohedral crystals of native copper upon its surface, which is more or less incrusted with green carbonate of copper and ruby oxide very much resembling that of Cornwall; the ruby oxide is particularly remarkable in the cavities of the piece. Another piece of nearly ninety pounds weight was found in the same neighbourhood several years ago.—See Bruce's Mineralogical Journal, vol. i. p. 149.—*Silliman's Journal*, No. I.

---

### TRIPHANE.

Triphane has been recently found by Dr. MacCulloch in the granite of Glen Elg.

This mineral has also been observed in Ireland, but not as yet in any other part of the British dominions with which we are acquainted.

---

### PURE NATIVE CARBONATE OF MAGNESIA.

This substance has been lately discovered by Mr. James Pierce, on the Western or New-Jersey bank of the Hudson, at Hoboken, opposite the city of New-York, in horizontal veins of nearly two inches in breadth, and of unknown depth, in precipices of serpentine.—*Silliman's American Journal*, No. I.

---

### AMIANTHUS.

Mr. Pierce, the gentleman who discovered the carbonate of magnesia mentioned in the preceding article, has found straw and rose coloured amianthus of a very fine quality in Staten Island. It is not found in veins, but attached to rocks; breaks

up

up like flax, and in fibres which measure from 12 to 15 inches in length, as soft and flexible as fine human hair; and may be spun and wove without the aid of moisture.—*Silliman's Journal*, No. I.

---

SUBTERRANEAN GARDEN AND NATURAL HOT-BED.

A curious account of a subterranean garden formed at the bottom of the Percy Main Pit, Newcastle, by the Furnace Keeper, was communicated to the last General Quarterly Meeting of the Caledonian Horticultural Society, in a letter from Mr. Bald, Coal Engineer of Alloa. The plants are formed in the bottom of the mine by the light and radiant heat of an open fire constantly maintained for the sake of ventilation.—The same letter contained an account of an extensive natural hot-bed near Dudley in Staffordshire, which is heated by means of the slow combustion of the coal at some depth below the surface. From this natural hot-bed a gardener raises annually crops of different kinds of culinary vegetables, which are earlier by some weeks than those in the surrounding gardens where the subterranean heat does not operate.

---

TAME SEALS.—CARNIVOROUS HORSE.

A gentleman in the neighbourhood of Burntisland has completely succeeded in taming a seal: its singularities daily continue to attract the curiosity of strangers. It appears to possess all the sagacity of the dog, lives in its master's house, and eats from his hand: he usually takes it with him in his fishing excursions, upon which occasion it affords no small entertainment. When thrown into the water, it will follow for miles the track of the boat; and, although thrust back by the oars, it never relinquishes its purpose. Indeed it struggles so hard to regain its seat, that one would imagine its fondness for its master had entirely overcome the natural predilection for its native element.—*Edinburgh Weekly Journal.*

The above paragraph corroborates the account of a Newfoundland dog having suckled two young seals, which fact (from a gentleman of the strictest veracity, the owner of the dog,) was sent to the Editor of the Monthly Magazine by the writer. When mentioned to some persons, who seem to consider animals as mere machines incapable of imbibing new habits, an incredulous expression of countenance has mortified the relater; and another instance was so questioned, that it was quite suppressed, till corroborated by a similar case so notorious as to enforce belief.

Five and-thirty years ago the writer frequently saw a young horse which preferred roasted or boiled meat to grass and corn. His dam was killed by an unfortunate accident, when the foal was five weeks old: he was fed by the dairy maid with cow's milk, and soon familiarly followed her to the kitchen. He began to

 gnaw

gnaw bones in mere playfulness: but his carnivorous taste was not suspected, till the remains of a piece of roast-beef set to cool in the pantry-window was carried away. Nobody imputed the theft to the colt; and the housekeeper, determined to convict the pilferer, watched while another bit of meat was left in the same spot from whence the beef was taken. She soon saw the colt stretch his fore feet up, till they rested on the outside of the window, take out the fragment, and gallop to a wood at some distance. She afterwards offered him slices of beef, mutton, veal, or lamb, which he accepted like a dog: he did not like pork, but all kinds of fowl or game were highly agreeable to him.

To confirm this statement by parallel evidence, permit me to remind your readers, that in different parts of India the horses in an encampment are served with boiled sheep's heads, as a mess more nutritive than grain, when they have any extraordinary fatigue to undergo. May not the whole account admit of practical application? When grain and fodder are scarce, the worst cattle might be killed, and boiled into strong soup, cutting the flesh small, among straw, hay, or other vegetable provender? During scarcity the cattle of Iceland go to the shores, and feed on fish.

---

## INTERIOR OF AFRICA.

Advices have been received of Major Gray's having succeeded in penetrating into the interior of Africa to a considerable distance. When parted with, the gentleman, a French naval officer, who brought these advices, says, he had advanced 300 leagues. Major Gray left the River Gambia in the month of April 1818. On the following 1st of November he was at Bondou, a Negro country, situated near the river Senegal, where he was detained, by the evil disposition of the inhabitants and from the want of trading articles, till the 15th of the same month, when he proceeded with his expedition to the village of Bakel in the Serracolet country. He there put himself under the protection of the French Government brig Argus, which vessel was to stop a year in that country. At this period Major Gray received no news for a whole month from the Surgeon-major of the expedition, whom he had sent to Sego to solicit the protection of the king of Bambarras. Mr. Adrian Partarieux, a man of colour, and interpreter to Major Gray, who had gone to St. Louis, Senegal, for trading articles, left it the beginning of last month to join the expedition. On the 18th of Nov. last Major Gray was in very good health, though he had unfortunately lost the greater part of his white men, and all the animals of burden; but he had not abandoned all hopes of succeeding in his mission.

The subjoined paragraphs are from a private letter dated St. Louis (Senegal) Jan. 19th, received by a gentleman at Caen, and published in a Paris journal. "A

" A great number of ships have arrived here from Europe, and several others are expected, exclusive of those forming the expedition. The colony is encumbered with merchandise, and nothing is selling.

" The arrival of the expedition is anxiously looked for, to see what course things will take. It is hoped that the projects of Government will open fresh resources to trade. Some millions of pounds of cotton have been shipped for exportation. It is very fine, and from its amelioration by the care of its cultivation, it perhaps cannot be excelled. It is worth 45 sols a pound when shredded; but this new branch of industry wants encouragement, and I do not perceive that any thing has been done to promote it. We find here cotton of a nankeen colour, which grows, like the other, without cultivation, and which may be advantageously used in our manufactures.

" Our Galam expedition has not been attended with all the success which we anticipated. It left this on the 17th August 1818, to the number of nine vessels, under convoy of three Royal brigs of war; they were three months in proceeding up the river about 300 leagues. The navigation is dangerous, because it must be attempted during the hottest and worst part of the season. This flotilla, with the exception of the Argus Royal brig, and a merchant vessel, destined to pass the year at Galam, returned about the middle of December.—They effected nothing, except bringing away some grain. The most grievous part is, that all the Europeans, to the number of 30, were taken sick, and 15 of them died. Fears are entertained for those who remain. An express, just received, announces the death of the governor, M. Chatellux, geographical engineer.

" The English expedition under Major Gray, which set off last year from Gambia to explore the Niger, has been detained at Galam by the rains which prevail during the months of August, September, and October, and also by other unforeseen obstacles. However this may be, it is now united to ours, which is not established at the ancient fort St. Joseph, but at a few leagues below the river Faleme.—Major Gray dispatched Adrian Partarieux, a mulatto, of St. Louis, attached to his suite, to bring him a supply of men and effects from Gambia: they will join him by land; the journey is 21 days. An English officer has arrived with an escort of blacks at Sego, where Major Gray is desirous of constructing a galliot, with which he purposes to ascertain the course of the Niger."

## PARK THE TRAVELLER.

The death of Mr. Park, the enterprising traveller in the interior of Africa, seems now to be placed beyond a doubt. The following information of that event corroborates, in part, the statement given by Amadi Fatouma, who was dispatched in quest of Mr. Park from the Gambia, some years since, but is at variance with the circumstances attending it. Mr. Bowditch, who conducted a successful mission from Cape Coast Castle to the King of the Ashantees, obtained, while at Coomassie, the summer before last, the following account during one of his visits to Baba, the Chief of the Moors. A Moor, who had just come from Timbuctoo, was sent for the purpose of seeing Mr. Bowditch: he did not express the surprise that was anticipated on seeing a *white* man, and accounted for it from having before seen *three white men* at Boussà. This naturally created a desire of being informed of the particulars, and Baba interpreted to Mr. Bowditch the following relation which the Moor gave:—"That some years ago, a vessel with masts suddenly appeared on the Quolla, or Niger, near Boussà, with *three white* men, and some *black*. The natives, encouraged by these strange men, took off provisions for sale, were well paid, and received presents besides: it seems the vessels had anchored. The next day, perceiving the vessel going on, the natives hurried after her (the Moor protesting, from their anxiety to save her from sunken rocks with which the Quolla abounds); but the *white* men mistaking, and thinking they pursued for a bad purpose, deterred them. The vessel soon after struck; the men jumped into the water and tried to swim, but could not for the current, and were drowned. He thought some of their clothes were now at Wanwaw, but he did not believe there were any books or papers." This story was afterwards repeated to Mr. Bowditch by another Moor, but who was not, like the former, an eye-witness of the transaction. An Arabic manuscript was also obtained by this gentleman, which corroborates the fate of Mr. Park and his companion Lieutenant Martyn, and adds, that one of the bodies had been found and buried. There is, however, reason to hope that some further information may be obtained. Mr. Hutchison, who was left as Resident Agent at Coomassie, learning from Baba, the person before mentioned, that a Moor was about to depart for Jenne, sent a letter to two Europeans who resided there, and who he supposed were some belonging to Park's expedition, as seven of the soldiers are yet unaccounted for, who were in good health when separated from their commander. There were also, it seems, two *white* men at Timbuctoo, who have been there for several years. The Moors assured Mr. Hutchison that there was no doubt of the letter reaching its destination, and that gentleman accompanied it with two notices in English and Arabic, offering a reward for information.

ANTI-

ANTIQUITIES.

A Monk at Rome, in the course of exploring the traces of one of the 12 Monasteries of St. Benedict, has discovered a large edifice which is supposed to have been built by Nero. He has opened a length of 260 feet, and found 12 chambers square and circular, besides an aqueduct of 200 paces.

Numerous packages, containing statues and other antiquities from Upper Egypt, collected by the zeal and encouragement of Mr. Saltz, were lying at Grand Cairo and at Rozetta, at the end of December, when our letters came away, waiting for a vessel to transport them to England.

The English are much respected in Egypt; many of them have made parties and gone to Upper Egypt; and never were circumstances more favourable for excursions of this nature, the Pacha affording them every kind of countenance and facility.—The Countess of Belmore, who is with one of these parties, has been further up the Nile than was ever before effected by any European female.

ROMAN ANTIQUITIES.

Letters from Rome of the 12th of February state, that the enterprise formed to draw from the bed of the Tiber the statues and other wrecks of antiquity which it is supposed are deposited there, appears to obtain success. Already the sum of 60,000 scudi is almost completed. This sum is deposited in the hands of the Papal banker, the Duke of Torlonia. All the objects which it is hoped will be drawn from the bed of the river, by means of a machine invented for the purpose, will be formed into one mass, and valued by *connoisseurs*. The Pope's chamber will receive a sixth, and will also have the right of priority to purchase the rest. A Papal commissioner is appointed to superintend the enterprise. The operation will last two months, and will be terminated before the beginning of September. Should it succeed, the director of the enterprise, M. Varo, promises to each shareholder a premium of 200 scudi, besides the interest of his money. The English display much zeal in subscribing for every enterprise useful to the arts.

The steps before the Temple of Peace are now clearing, and the side of it towards the Golden House, that the world may at length know which way the Via Sacra turned.

EXCAVATION IN TAURIS.

In the course of some recent diggings, near Fanagoria in the government of Tauris, a vault in the form of a tomb was discovered, containing a human body of prodigious size in a state of high preservation. It is presumed that the body has lain there since a remote period of antiquity, for it is well known that Tauris formed one of the colonies of ancient Greece. The head was encircled with a laurel wreath in gold; on the forehead was a gold medal, with a head, and the initials P. P. (Philip.) On each side of the body were vases of silver and porcelain, chains of gold, and ear-rings. On one of the fingers was a gold ring, with a precious stone, on which were engraven two figures, the one male and the other female, admirably executed.

## ASTRONOMY.

*To Mr. Tilloch.*

Sir,—Permit me to solicit the attention of your astronomical readers to a subject on which some information seems desirable. I mean the works of the celebrated German astronomer Schroeter relative to the moon's disc. Dr. Brewster* says "the most accurate and complete" drawings of the moon "that have yet been published are those of the celebrated Schroeter, who has given highly magnified views of *most parts* of the moon's surface." Now the only work of whose existence I am aware, is entitled "*Selenotopographische Fragmente*, 4to, Gottingen, 1791;" and the editors of the Monthly Review†, in giving an account of that work, say, "The present volume contains the result of the author's observations, with respect to the *northern parts* of the lunar disc." Again; the work just mentioned contains only forty-three plates, yet Dr. Brewster has references to Plates LIV. LV. and LVII. If any of your correspondents can explain these circumstances, it will no doubt gratify many persons who are in the same situation with, yours, &c. *ΑΣΤΡΟΦΙΛΟΣ.*

March 31, 1819.

## FIRE-BALLS.

M. de Humboldt in his "Personal Narrative of Travels to the Equinoctial Region," (vol. iii.) gives an account of a series of most remarkable atmospheric phænomena witnessed at Cumana in lat. 10° 27′ 52″, long. 67° 59′, by his fellow-traveller M. Bonpland. On the 7th of Nov. 1799, the atmosphere, after an earthquake, had returned to its former purity, and the sky near the zenith exhibited the blue tint peculiar to tropical climates. At half past 2 A.M. on the 12th, thousands of bolides (fire-balls) and falling stars succeeded each other during four hours. Their direction was very regular from north to south; and they filled a space of 60° in the sky, from 30° N. to 30° S. of the true E. The meteors rose above the horizon at E.N.E. and at E. describing arcs more or less extended, and were never seen to fall towards the S. after having followed the direction of the meridian.

* Ferguson's Astronomy, by Brewster, vol. ii. p. 217.

† Vol. vii. p. 162.

Some

Some attained an elevation of 40°, and all above 25° or 30°. The wind was from E., but little was moving in the lower regions of the atmosphere. No clouds were visible. The observer, from the beginning of the phænomena, could not perceive a space in the firmament equal in extent to three diameters of the moon, that was not at every instant filled with fire-balls and falling-stars—the latter in greatest number. All left luminous traces, from 5° to 10° in length, as often happens in equinoctial regions, visible for seven or eight seconds; and many of the falling-stars exhibited a distinct nucleus, as large as the disc of Jupiter, darting out vivid sparks of light. The bodies seemed to explode; but the largest, which were from 1° to 1½° in diameter, vanished without scintillation. The light was white, not reddish, owing probably to the transparency of the air.

In their journey from Caraccas to Rio Negro, the travellers made inquiry at every place, whether the meteors of the 12th of November had been seen there. They had been seen at Fernando de Apuva in lat. 7° 53′ 12″, long. 79° 20′; and at Marao in lat. 2° 42′, distant 174 leagues from Cumana. The observers compared the phænomenon to a beautiful fire-work, which lasted from 3 to 6 A.M. At the southern extremity of Spanish Guiana, Portuguese missionaries assured M. de Humboldt that the phænomenon had been seen in the Brazils, as far as the equator, or over a line of 230°: "but what was my astonishment," he says, "when, on my return to Europe, I learnt that it had been seen on an extent of the globe of 64° of latitude, and 91° of longitude—at the equator, in S. America, at Labrador, and in Germany?" They were not seen south of the equator. Mr. Ellicot, astronomer to the United States, saw them in the Gulf of Florida in lat. 25°, long. 81° 30′. To him they appeared to move in all directions in every part of the sky, some seeming to fall perpendicularly, so that it was expected they would drop into the vessel. The same phænomenon was seen in America, in lat. 30° 42′; in Labrador at Nain, lat. 56° 55′; at Hoffenthal, lat. 58° 4′; in Greenland at Lichtenau, lat. 61° 5′; and at New Herrenhut, lat. 64° 14′, long. 52° 20′. "The Esquimaux were frightened at the enormous quantity of bolides that fell during twilight, towards all parts of the firmament, some of which were a foot broad. It was also seen in Europe at Weimar, lat. 50° 59′, long. 9° 1′, between six and seven in the morning, when it was half past two at Cumana."

M. de Humboldt observes, that some meteors have not more than five leagues of elevation, and the highest do not appear to exceed thirty. They have often more than 100 feet diameter; and their velocity is such, that in a few seconds they dart over a space of two leagues. Some have been seen to rise upwards, forming

forming an angle of 50° with the vertical line. "This remarkable circumstance has led to the conclusion, that falling-stars are not aërolites, which, after having hovered a long time in space, take fire on entering accidentally into our atmosphere, and fall towards the earth."

### COMET.

A comet was lately discovered at the Observatory of Konigsberg, in the Swan. It is not visible without the aid of the telescope.

### EARTHQUAKES.

On the night of the 29th of January two shocks of an earthquake were felt at Teflis in Georgia. They were preceded by a tempest and a subterraneous rumbling. At ten o'clock the shocks grew so violent, that even the inhabitants, though such phenomena are familiar to them, were struck with terror. They were the more terrified, as every shock was followed by tremendous rendings, as if the earth were opening her bowels. Several old buildings were destroyed.

On the 26th of February an earthquake was felt at Rome, Frescato and Albano. Its direction was from S. E. to N. E.

### STEAM BOAT.

A trial was made at Milan on the 19th of February, with a boat on a new construction, which moves either with or against the stream, by means of machinery, without the aid of oars or steam, moved by the power of six men, carrying a load of one and a half its own weight, which is stated to have answered every expectation. We cannot, for want of sufficient data, make any proper estimate of the supposed advantages gained by this construction, being neither informed of the load moved nor of the velocity, but of the power applied—six men.

### LIGHT-HOUSES.

New light-houses have recently been erected: one at the point of Ayre, at the northern extremity of the Isle of Man; and two others at the southern extremity of the same island. They were lighted for the first time on the 1st of February, and are to be kept burning from evening till morning.

### VOYAGES OF DISCOVERY.

The Russian Government is fitting out two expeditions for scientific researches in remote seas. Each will consist of two ships; one of them is designed to make discoveries towards the North Pole. Above sixty officers of the Imperial Navy have applied to the Minister of the Marine requesting to be employed on this service.

STATIS-

## STATISTICS.

By the latest estimate, the population of the Danish States is now 1,862,000 souls, viz. in Denmark 1,100,000; in the Duchies of Sleswick and Holstein 680,000; in Lauenburg 30,000; in Iceland and the Faroe Islands 52,000.

## ON THE WEATHER-COCK OF VARRO, BEING THE FIRST ON RECORD.

So many important phænomena are connected with the direction and changes of the wind, that philosophers have in all ages paid particular attention to this branch of meteorology, as well as to the making of instruments to indicate it.

The earliest instance, however, which we have on record of a regularly formed wind-vane appears to be that of Varro, which he caused to be made and put up in his garden. The fan and point turned on a pivot, and seem to have been constructed like our modern weather-cocks; but it had the addition of a moving index, which went round a circle divided into eight equal divisions answering to the eight winds. This circle seems to have been placed horizontally on the post whereon the vane was fixed. Though it is highly probable, from the interest which wind and weather must always have excited, that there were more simple vanes before the time of Varro; yet we have no accurate account of them. Leaves of trees and afterwards flags may have suggested the first weather-cocks.

## LECTURES.

On the 22d of May Dr. Davis will commence his next Course of Lectures on the Theory and Practice of Midwifery and on the Diseases of Women; and Mr. Taunton his Course of Lectures on Anatomy, Physiology, Pathology and Surgery.

## LIST OF PATENTS FOR NEW INVENTIONS.

To William Hazledine, of Shrewsbury, Salop, iron-founder, for his improved method of casting certain kinds of cast-iron vessels.—15th Jan. 1819.

To John Roberts junior, of Llanelly, Carmarthenshire, merchant, for certain apparatus for preventing stage coaches and other wheeled carriages from overturning.—15th Jan.

To Urbanus Sartoris, of Winchester-street, London, for improvements in the construction and use of fire-arms.—23d Jan.

To Joseph Hall, of Paulton, Somerset, for a machine or top for the cure of smoky chimneys.—23d Jan.

To James Fox, of Plymouth, for a method or methods of diminishing the loss, in quantity and quality, of ardent spirits and other fluids, during distillation or rectification.—28th Jan.

To

To Matthew Thomas, of Greenhill's Rents, Middlesex, for an improved plough, and a propelling power applicable to ploughs and to other implements and machines. Communicated to him by a foreigner residing abroad.—28th Jan.

To Henry Ewbank, of London, for machinery for cleaning or dressing paddy or rough rice, so as to fit it for culinary purposes. —9th Feb.

To James Simpson, of Edinburgh, for a method or methods of conveying gas used for illumination to burners, and at the same time suspend the burners, lamps or lustres or other frames wherein the burners are placed.—9th Feb.

To Edwards Heard, of Brighton, for certain processes, means or methods of hardening and improving tallow, and other animal fats and oils, so as to manufacture therewith candles of a superior quality to those at present made from tallow.—12th Feb.

To Robert Willis, of Upper Norton-street, Mary-le-Bone, for an improvement or improvements on the pedal harp.—13th Feb.

To Thomas Brocksopp, of Fore-street, Cripplegate, London, for the application of certain machinery to the purpose of breaking or crushing of sugar.—23d Feb.

To Professor Jeffray, of Glasgow, for certain combinations of and improvements in machinery to be moved by wind, steam, and animal strength, water or other power, by means of which boats, ships and other floating vessels may be propelled or moved in water, and applicable to other useful purposes.—4th March.

To William Millward, of Eton, Bucks, for an improvement on skaits, and in fixing the same on the feet.—4th March.

To Samuel Haycraft, of Birmingham, for certain improvements in manufacturing spoons, forks and other articles of iron, silver, or other suitable metal, by the application of certain machinery hitherto used for that purpose, and improvements in such machinery.—4th March.

To William Tyror, of Liverpool, for certain improvements in the construction of pumps, and in the machinery for working the same —13th March.

To William Neale, of Birmingham, for combinations of machinery calculated to increase power, to be worked by manual labour or other suitable means.—13th March.

To Æneas Morison, of Glasgow, for a combination of certain processes and manufactures, whereby animal and vegetable food may be preserved for a great length of time.—23d March.

To John Outhett, of Vauxhall, for improvements in the construction, arrangement and combination of the series of apparatus used for the production of gas from coal and other substances, and for purifying, storeing, and delivering for the purposes of illumination; and for the application of certain parts of the said improved apparatus to other useful purposes.—23d March.

To Thomas Morton, of Leith, for a method of dragging ships out of water on dry land.—23d March.

To William Robinson, of Saffron Walden, for certain new or improved apparatus to be attached to all sorts of doors, and door-jambs, and hanging stiles, for the purpose of preventing, when shut, the admission of external air into rooms or other places.—25th March.

To William Bundy, of Camden Town, Middlesex, for certain machinery for breaking hemp and flax.—1st April.

To Paul Slade Knight, of Lancaster Moor, for his new and improved kind of fire-engines, pumps, and other engines in which are used pistons working in barrels or cylinders.—3d April.

To John Seaward, of Kent-Road, St. George's, Southwark, for his new or improved method or methods of raising or producing steam for the purpose of working steam-engines and other apparatus.—3d April.

To Henry Peter Fuller, of Piccadilly, for his improvement in the method of producing or preparing sulphate of soda, soda, subcarbonate of soda, and muriatic acid.—5d April.

To Augustus Siebe, of Crown-street, Soho, Middlesex, for an improved weighing-machine.—5th April.

To Philip Pindin, of Farningham, for his improvement on single and double trusses.—20th April.

To John Smith, of Bermondsey, for improvements in making arms or axle-trees for coaches, carts, waggons, and all other descriptions of carriages.—20th April.

---

*Meteorological Observations kept at Walthamstow, Essex, from March* 15 *to April* 15, 1819.

[Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *March* | | | |
| 15 | 32<br>48 | 29·20 | NE—SW.—Clouds and *cirrostratus*; very fine day; star-light. |
| 16 | 44<br>47 | 29·95 | SW—W.—Hazy morn; very fine day; dark and windy. |
| 17 | 47<br>47 | 30·02 | NW.—Clear and *cumuli* and windy; fine day, but wind cold; star-light. |
| 18 | 31<br>45 | 30·19 | NW.—White frost, and very fine; fine windy day; star-light. |
| 19 | 49<br>48 | 29·60 | SE—NW.—Morn hazy and windy; showers, sun and wind; cloudy and windy. Moon last quarter. |
| 20 | 41<br>47 | 29·31 | NW.—Showery and windy morn; and the same all day; Star-light and windy. |
| 21 | 39<br>47 | 29·70 | NW.—Sun and wind; fine day, but cold wind; dark and windy. |

*March*

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *March.* | | | |
| 22 | 37 47 | 29·70 | S—NW.—Cloudy; very fine day; dark night. |
| 23 | 37 47 | 29·70 | SE.—Cloudy and hazy; fine day; windy and dark. |
| 24 | 45 59 | 29·50 | SW.—Very rainy early; fine day; very dark night. |
| 25 | 45 55 | 29·59 | SW—W.—Clear and *cumuli;* hazy, showers and wind and sun; star-light. New moon. |
| 26 | 34 53 | 29·70 | SW.—Fine morn: clear and *cumuli*; fine day, but some slight showers; star-ligaht. |
| 27 | 44 54 | 29·90 | SW.—Hazy morn; day cloudy and windy; rain and wind. |
| 28 | 48 55 | 29·70 | SW.—Rainy morn, and rather hazy: day fine, but night very dark. |
| 29 | 49 50 | 29·75 | S.—Clear high, hazy low; sun and great storms of wind, hail and rain; night star-light. |
| 30 | 49 58 | 30·00 | SW.—Gray morn; slight showers in the day; night cloudy and windy. |
| 31 | 52 59 | 30·00 | NW.—Gray morn; showery day; night cloudy and windy. |
| *April* | | | |
| 1 | 49 62 | 30·00 | W.—Morn gray and windy; fine day; Lady Bird and a Butterfly first seen; moon and star light. |
| 2 | 48 66 | 30·10 | W.—Very fine morn and day; moon and star light; moon in a *corona.* Moon first quarter. |
| 3 | 43 62 | 29·99 | NE.—SW.—Sun and hazy; fine day; moonlight. |
| 4 | 48 57 | 30·10 | SE.—Clear and *cirrostratus*; very fine day; night light, but neither moon nor stars visible. |
| 5 | 45 57 | 30·00 | N.—E.—*Cirrostratus* and clear; fine day; moon light and windy. |
| 6 | 40 51 | 29·92 | SE.—Very fine morn and day; moonlight. |
| 7 | 46 66 | 29·60 | E.—Clear and *cirrostratus*; fine day; windy; a slight shower about 7 P.M.; cloudy night. |
| 8 | 51 53 | 29·75 | SE.—NW.—Hazy morn and very rainy all day; light, but neither moon nor stars visible. |
| 9 | 45 60 | 30·00 | NW.—Very fine morn and day; moonlight night. |
| 10 | 40 59 | 30·00 | W. by S.—Fine morn and day; moonlight. Full moon. |
| 11 | 48 59 | 29·40 | S.—Hazy morn; fine day; moonlight night. |
| 12 | 42 47 | 29·30 | E.—Very rainy morn and day till 6 P.M.; night dark and windy. |
| 13 | 51 51 | 29·20 | E.—*Cirrostratus* and rain; showers and sun; starlight. |
| 14 | 45 58 | 29·45 | SE.—Clear and *cumuli*; fine day; dark night. |
| 15 | 40 60 | 29·35 | W.—S.—Rain early; clear and *cirrostratus* at 7 A.M.; very fine day; cloudy at 8 P.M. |

METEORO-

METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1819. | Age of the Moon. | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| Mar. 15 | 19 | 50· | 30·20 | Fine—rain at night. |
| 16 | 20 | 55· | 30·03 | Fine |
| 17 | 21 | 44·5 | 30·13 | Cloudy |
| 18 | 22 | 43·5 | 30·26 | Fine |
| 19 | 23 | 47·5 | 29·50 | Cloudy—hail and rain A.M. |
| 20 | 24 | 44·5 | 29·57 | Ditto—rain A.M. |
| 21 | 25 | 44· | 29·89 | Ditto |
| 22 | 26 | 48·5 | 29·85 | Ditto |
| 23 | 27 | 50· | 29·80 | Ditto |
| 24 | 28 | 53· | 29·62 | Fine—hail storm in the evening. |
| 25 | new | 53·5 | 29·61 | Ditto |
| 26 | 1 | 51·5 | 29·90 | Ditto |
| 27 | 2 | 52· | 29·85 | Rain |
| 28 | 3 | 57· | 29·77 | Cloudy—rain in the morning. |
| 29 | 4 | 58· | 29·72 | Ditto |
| 30 | 5 | 58·5 | 30· | Ditto |
| 31 | 6 | 61· | 30·15 | Ditto |
| April 1 | 7 | 61·5 | 30·20 | Ditto |
| 2 | 8 | 57·5 | 30·20 | Fine |
| 3 | 9 | 62· | 30·10 | Very fine |
| 4 | 10 | 56·5 | 30·20 | Cloudy |
| 5 | 11 | 54·5 | 30·17 | Fine |
| 6 | 12 | 53·5 | 29·99 | Ditto |
| 7 | 13 | 61· | 29·80 | Ditto |
| 8 | 14 | 58·5 | 30· | Ditto—rain A.M. |
| 9 | 15 | 56·5 | 30·10 | Ditto |
| 10 | full | 60· | 29·93 | Ditto |
| 11 | 17 | 55· | 29·44 | Cloudy—rain A.M. |
| 12 | 18 | 52·5 | 29·48 | Rain—lightning at night. |
| 13 | 19 | 61·5 | 29·30 | Cloudy |
| 14 | 20 | 55·5 | 29·60 | Showery |

METEORO-

## METEOROLOGICAL TABLE,

## By Mr. Cary, of the Strand,

### For *April* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| March 27 | 47 | 54 | 46 | 29·96 | 26 | Showery |
| 28 | 47 | 54 | 45 | ·88 | 10 | Small rain |
| 29 | 49 | 56 | 47 | ·77 | 27 | Showery |
| 30 | 47 | 59 | 49 | 30·06 | 30 | Showery |
| 31 | 51 | 58 | 50 | ·20 | 31 | Cloudy |
| April 1 | 50 | 62 | 52 | ·24 | 46 | Fair |
| 2 | 52 | 65 | 54 | ·20 | 62 | Fair |
| 3 | 53 | 66 | 47 | ·07 | 63 | Fair |
| 4 | 47 | 56 | 49 | ·22 | 41 | Fair |
| 5 | 47 | 56 | 42 | ·14 | 45 | Fair |
| 6 | 44 | 50 | 49 | 29·81 | 47 | Fair |
| 7 | 49 | 62 | 51 | ·78 | 40 | Fair |
| 8 | 52 | 53 | 47 | 30·00 | 0 | Rain |
| 9 | 47 | 53 | 42 | ·10 | 32 | Fair |
| 10 | 43 | 62 | 47 | 29·84 | 40 | Fair |
| 11 | 52 | 58 | 44 | ·43 | 38 | Fair |
| 12 | 46 | 47 | 46 | ·36 | 0 | Rain |
| 13 | 52 | 52 | 44 | ·37 | 25 | Rain |
| 14 | 49 | 57 | 47 | ·54 | 55 | Fair |
| 15 | 51 | 59 | 51 | ·49 | 39 | Fair |
| 16 | 52 | 57 | 49 | ·27 | 41 | Fair |
| 17 | 50 | 55 | 46 | ·50 | 45 | Stormy |
| 18 | 49 | 55 | 44 | ·77 | 38 | Stormy |
| 19 | 46 | 55 | 50 | ·74 | 30 | Showery |
| 20 | 54 | 59 | 55 | ·70 | 27 | Small rain |
| 21 | 54 | 58 | 44 | ·72 | 30 | Cloudy |
| 22 | 46 | 51 | 45 | ·90 | 18 | Small rain |
| 23 | 46 | 51 | 44 | ·77 | 16 | Small rain |
| 24 | 51 | 48 | 44 | ·67 | 0 | Rain |
| 25 | 46 | 46 | 42 | ·86 | 10 | Cloudy |
| 26 | 46 | 51 | | 30·16 | 33 | Fair |

N.B. The Barometer's height is taken at one o'clock.

## LIII. *Memoirs of the Life of* Lewis Brugnatelli, *M.D. Professor of Chemistry in the University of Pavia, Member of the Imperial-royal Institute of Science, Literature and Arts of Milan, &c. &c.*

Modern Italy has produced few men whose lives have been more useful to society, or more interesting not merely to their own country but to the civilized world, than that of Dr. Lewis Brugnatelli, who presents an illustrious example of talents and industry attaining eminence in science, although unsupported either by personal wealth or powerful patronage. In any other country than Italy, the number and immense sale of his literary works on science would have procured him additional means of making chemical researches; but unfortunately for writers in the Italian language, a work of merit is no sooner published in any of the principal cities, than it is reprinted in all the adjoining states, and (in the commercial phrase) the market is often supplied with editions so shamefully incorrect, as to injure not merely the interest but also the honour of the original author. It is necessary to consider well the fatal consequences of this state of things, in order to appreciate more adequately the zeal and indefatigable exertions of the late chemical professor.

Dr. Lewis Brugnatelli was born in Pavia in 1761; his parents, not being in very affluent circumstances, had destined him for a mercantile life before he had received the rudiments of a literary education: observing, however, the strong bent of his mind, they afterwards thought of making him an engineer; but this study, although scientific, was little congenial to his feelings, and he immediately applied himself with the most indefatigable zeal to the study of medicine and chemistry, in which his progress was so rapid, notwithstanding the extreme scantiness of his means, that he not only obtained the degree of Doctor of Medicine in Pavia, 1784, but was shortly after elected repeater of chemistry in the same university. By the death of Professor Leopoli he became pensioned repeater in the College of Ghislieri, and in 1787 he was elected assistant to the chemical chair of Professor Leopoli, and afterwards to that also of Professor Brusati. During this interesting period he had given the most unequivocal evidence of his talents and skill both in chemistry and medicine. The science of analytical chemistry had just come into existence; curiosity and enthusiasm were awakened towards every thing that could be subjected to chemical action: a few chemical reagents had been discovered, and our juvenile professor eagerly availed himself of their aid to investigate the nature and properties of the gastric juice. His experiments were made and published the

the very year in which he graduated (1784), when he discovered that the gastric juice had invariably an acid character in carnivorous animals, while in herbivorous it was uniformly alkaline and putrescent. He was led to these experiments by the circumstance of Professor Carminati being engaged in making physiological researches on the gastric juice at the same period in the hospital. It was then ascertained that the gastric juice of carnivorous animals hád great curative powers when applied to foul ulcers or wounds, but that of herbivorous was destitute of this pròperty. Professor Brugnatelli continued his researches; and combining the effects of the different kinds of gastric juice with that acid which he had also discovered in the stomach of all carnivorous birds, he succeeded in determining their solvent powers in the corrosion not only of metals but calcareous stones; and even pieces of rock-crystal and agate introduced into the stomach exhibited signs of its consumptive powers. These experiments were followed by an examination of the action of nitric acid on cork, in which the Professor discovered that a new and peculiar acid was developed, and which has since been called the suberic acid. At the same time he discovered a method of preparing fulminating silver, which he improved and extended to other substances; and which is esteemed preferable to the process of Howard, being that now generally used for making fulminating balls, &c. The consequence of these discoveries led him to make new experiments on the salts (particularly nitrats) which had the property of detonating when mixed with a combustible body, and exposed to friction or a blow of a hammer, in order to demonstrate the quantity of caloric which might exist in bodies even in the solid state. He extended his ideas to the various kinds of combustion, proving the necessity of determining the difference between them; some being cold and obscure, others accompanied with the most vivid development of caloric and light,—circumstances which must have a very great influence on the properties of a body that was united to oxygen. In the case of cold and obscure combustion, the body continues capable of presenting the detonating phænomena of caloric and light when brought in contact with other combustible bodies; but it loses entirely this property if the caloric and light were disengaged previous to its union with oxygen. Of these facts and observations Thomson availed himself in his System of Chemistry, article *Combustion*, which is chiefly derived from the luminous researches and ingenious observations of the Pavian Professor. On these facts was founded the hypothesis respecting the constitution of oxygen, modifying the principles of Lavoisier, according to which many phænomena of combustion are very plausibly explained.

Among the ingenious researches and observations of Professor

Brugnatelli must be noticed his opinion respecting the chemical action of the electric fluid, which he published so early as 1800, in his 'Memoir on oxyelectrics,' inserted in his *Annali di Chimica*, vol. xviii. In his 'Galvanic observations' published in the same work and in the Memoirs of the Italian Institute, he opposed decidedly the supposed formation of muriatic acid at the expense of water as observed by Pacchiani, remarking that this acid depended on other substances preexisting in the water. By these and other observations he made some progress towards those discoveries which have immortalized the name of Davy, who on his part did not fail to cite with great care and merited approbation the previous experiments of the Pavian chemist.

Professor Brugnatelli being at Paris in 1801, and in company with Volta, he mentioned the fact that various substances are transported by the electric fluid, in presence of the French chemists and philosophers, all of whom smiled, saying, "The thing is impossible, that an imponderable body should transport ponderable substances." So far had the Italian chemist, as usual, anticipated the knowledge of the progress of chemical discovery, even in the French capital, where his experiments and discoveries were so novel and singular that they were boldly and thoughtlessly disbelieved, instead of being investigated, verified or disproved. The Pavian Professor, however, had previously proposed a modification or a reform of the new chemical nomenclature; and as the greater part of the nomenclaturists were then living, it was the easiest and most effectual mode of avoiding difficulties by totally disbelieving both the chemical and literary novelties. In 1806 he read a Memoir in the hall of the University 'On the decomposition of salts effected by electricity,' which was afterwards printed in the first volume of his *Giornale*.

To detail with sufficient accuracy his numerous discoveries in pneumatic, vegetable and animal chemistry, would greatly exceed the limits prescribed to this brief memoir: to those pursuing similar inquiries, the subjoined list of his original works, copied from the *Giornale di Fisica*, (edited by his son Dr. Caspar B.) may be useful. It may likewise be proper to notice here that he discovered uric acid in the excrement of silkworms, free lime in rhubarb, and carbonate of lime in the urinary calculi of hogs, and more recently in those of men. His numerous experiments and researches appear in a posthumous 'Memoir on urinary calculi,' which is just published, and which abounds in new facts and observations, the result of great industry and extensive knowledge, derived from a vast collection of calculi, designs of which accompany the work. Among his researches in vegetable chemistry should be recorded his Experiments on Coffee-berries, which being steeped some time in a solution of soda, displayed a beautiful

 emerald

emerald green; this colour, the same as occurs in ammoniure of copper, is dissipated in close receivers, but immediately reappears when brought in contact with atmospheric air. He also discovered several new sympathetic inks, some hygrometric colours, reagents to detect poisonous substances; and greatly improved many pharmaceutical and chemical processes, introduced various new amalgams and paints, and obtained a very pure gum from the variegated aloes and various other vegetable products. His electric and galvanic experiments were equally numerous: and the curious fact of carbon becoming capable, by means of galvanism, of being oxygenated and hydrogenated, and when in this state a powerful electric, may contribute to facilitate further experiments of the like nature. The medical labours of Professor Brugnatelli would have given him celebrity, had his chemical fame been less conspicuous. His experiments with chlorine in the cure of hydrophobia are too recent to require further notice; but whatever may be the final effects of this medicine, either in curing or mitigating a hitherto incurable disease, the merit of Brugnatelli in recommending it to the public must ever remain unimpaired. In such a calamity, every truly scientific medical practitioner will gladly avail himself of a medicine, which presents even the slightest hope of arresting the hand of Death, and which is so easily procured as to deprive either indolence or ignorance of a pretext for not promptly administering it. The observations and statements of the Pavian Professor have been translated into almost all the European languages; and should any obstinate or wilfully incredulous practitioner omit its application, he will necessarily expose himself to the censure of friends.

Finally, Brugnatelli was appointed professor of general chemistry applied to the arts in the University of his native city (Pavia) in 1796; and he filled this chair with equal honour to himself and advantage to the numerous students from all parts of Italy and the Levant who attended his lectures, till his death on the 24th of October 1818, in his fifty-eighth year. The following list of his published writings is principally taken from the catalogue printed in the *Giornale* edited by his son. Original works:—'Elements of chemistry;' four editions of this work have been sanctioned by the author, how many have been pirated it is impossible to tell. 'A General Pharmacopea;' of this, five editions have been printed, and it has been translated into other languages. 'Materia Medica,' a supplement to the preceding, in one volume. The periodical works which he edited were:—*Biblioteca Fisica d'Europa*, from 1788-91, 20 volumes. *Giornale Fisico Medico*, afterwards continued under the title of *Avanzamenti della Medicina e Fisica*, 1792–96, 20 volumes. *Annali di Chimica*, 1790–1805. *Commentari Medici*, edited in company with Brera,

Brera, 1797, one volume. *Giornale di Fisica, Chimica e Storia Naturale*, 1808–18; the first eight volumes were edited by Brugnatelli alone, the remainder in company with Brunacci, Configliachi, and his son.

His detached memoirs and papers must be enumerated in their chronological order. In 1784 appeared his 'Letter on the means of preserving various insects, and chemical analysis of the gastric juice,' in the *Oposculi scelti* of Milan, vol. 7. In 1785, 'Letter on the solvent power of the gastric juice of certain animals,' *ib.* vol. 8; and 'On the peculiar properties of vitriol of iron,' published in Crell's Annals. In 1786, 'Memoir on the nature of cork,' *Opus. scelt.* Milan, vol. 9. In 1787, 'On the action of turnsole upon animal matter 'On the sediment of urine, On the corruption of animal matter in different kinds of acid, and Experiments on the constituent parts of alcohol, of gall,' &c. all published in Crell's *Annals.* In 1788, 'Fructification of the rose, and analysis of the saliva,' Rozier's Journal, vol. 33; 'New sympathetic inks, method of restoring ancient writings, and discoveries respecting vegetable substances,' *Biblioteca,* vols. 3 and 4. In 1789, 'New method of obtaining acid from concentrated vinegar,' *ib.* vol. 10. In 1790, 'Method of rendering paper and ink indestructible by fire, new mode of bleaching wax,' *ib.* vols. 14 and 17. 'Singular property of certain substances to move themselves upon water,' *Ann.* vols. 1 and 22; 'On oxygenated muriatic acid used as a photometer, and easy mode of discovering nitrous in vitriolic acid,' *ib.* In 1791-2 and -3 appeared 'A new mode of preserving and concentrating citric acid, a new neutral salt, observations on some insects, and chemical reagents for the use of travelling naturalists,' *ib.* vol. 4. In 1794, 'Easy mode of impregnating water with the acidulous carbonat of potash, on the perennial heat of the tepid water of St. Pellegrino, and chemical analysis of the vegeto-mineral mire of Trescore,' *ib.* vols. 5 and 6. In 1795, 'Letter on animal electricity, on caloric and light, medical observations, and proposals for reforming the new nomenclature,' *ib.* vols. 7 8, 9, 10, and 13. This latter work excited considerable attention to the chemical and literary labours of the Pavian Professor: the nomenclature which he proposed has been generally adopted by Italian chemists, and it is perhaps well suited to the genius of the language. Although subsequent discoveries have not sanctioned the principles which it favours, it has nevertheless been extremely useful in Italy, in a country where numbers read and speak of chemistry and chemical subjects without any practical knowledge; where there are very few practical, but many theoretical and critical chemists, who, being amused with literary subtleties and refinement of terms, have disseminated a taste for chemical studies which may ultimately lead to practical expe-

 rience,

rience, and consequently useful discoveries. In 1796 and two following years he published his 'Researches on combustion, the action of medicines on the animal body, on phosphorus, and fulminating bodies, saccharic acid considered as a reagent, convenient apparatus for making carbonated and other mineral waters, on fulminating gold, on the difference between oxygen and termoxygen, process for making mosaic gold, on urinary calculi, description of a compound still to obtain brandy and alcohol at the same time; on ammoniure of cobalt, and an acid in zaffre, method of obtaining crystallized oxymuriate of lead and of calomel without corrosive sublimate, on ethers, albumen, ammoniures of mercury and zinc,' *Ann.* vols. 10–22. In 1800, he again published 'A table of the modern chemical nomenclature,' which occasioned some controversy: but his principal exertions were directed to galvanic experiments during this and the two following years. Among the papers, however, which he published during this period, may be mentioned his 'Observations on vesicular vapours suspended in air at the freezing temperature, on the conversion of fixed oils into wax, sensibility of plants, a detonating oxymuriate of lead, and on the phosphorism of animal bodies.' In the Memoirs of the Italian Institute for 1806, appeared his 'Observations on the identity of some new characters of carbon with those of the metals,' which have since been so amply illustrated. Many other memoirs and translations of chemical and medical works issued from his pen; and his countrymen now begin to appreciate more justly his merits as a philosopher, when they can no longer enjoy his amiable character as a man. Fortunately for them and the friends of science, his son and successor pursues with success the noble career of his father; and Brugnatelli's Journal, almost the only scientific periodical work at present published in Italy, may continue to be the vehicle of new discoveries in the arts and sciences, to enlighten and instruct some of the most ingenious, friendly and good-natured people in the world.

---

## LIV. *On the Fallacy of the Experiments in which Water is said to have been formed by the Decomposition of Chlorine. By Sir* H. Davy, *LL.D. F.R.S.**

Some experiments have been lately communicated to the Royal Society of Edinburgh, from which it has been inferred, that water is formed during the action of muriatic acid gas on certain metals, and consequently, that chlorine is decomposed in this operation.

* From the Philosophical Transactions for 1818, Part I.

In

In repeating those experiments, I have ascertained, that the water is derived from sources not suspected by the authors, and that their conclusions are unfounded. To take up the time of the Society by long experimental details and theoretical speculations on such an occasion, will be unnecessary; I shall therefore only transiently mention the sources of error, and demonstrate their operation by two or three examples.

When muriatic acid gas is passed through flint glass tubes heated to redness, a small quantity of water is formed by the action of the gas on the oxide of lead in the glass, and a smaller quantity by its action on the alkali of the glass: the process being one of double affinity, the hydrogen of the muriatic acid unites to the oxygen of the oxide, and the chlorine combines with the metals.

A copious dew was formed by passing muriatic acid gas through flint glass tubes red hot, and a less copious dew, by passing it through green glass tubes. In the first instance, the glass became opaque, and gained a pearly lustre, and a combination of chlorine and lead sublimed from the hotter into the colder part of the tube. In the second, the surface of the tube became slightly opaque, but no sublimate was formed.

When fine clean iron wire was introduced into such tubes, and made red rot, and muriatic acid gas passed over it, no particular precautions being taken to free the tubes from common air, much more water appeared; but this excess of water principally owed its existence to the combination of hydrogen disengaged from the muriatic acid gas by the iron with the oxygen of the common air. I say, *principally*, because an inappreciable quantity must have been deposited from the vapour of hydrated muriatic acid in the muriatic acid gas. This was proved by filling the whole apparatus with hydrogen in another experiment, and generating the muriatic acid gas in a retort filled with hydrogen, when the water produced was no more than might have been expected from the action of the muriatic acid gas on the oxide of lead and alkali in the glass. I give the details. Above twenty-one grains of the first combination of chlorine and iron were formed; the quantity of moisture collected by bibulous paper, and which was a strong acid solution of the proto-muriate of iron, amounted to less than half a grain, and of this not more than two-thirds could have been water. Now, if chlorine had been decomposed in this operation, the quantity of water ought to have been at least ten times as great.

I have shown by numerous experiments, that in the action of muriatic acid gas upon metals, hydrogen, equal in bulk to half the volume of the gas, is produced; it is therefore evident, that if water had been generated by the action of muriatic acid gas on metals,



it

it must have been the *chlorine*, or the *metal*, or both, that were decomposed. As chlorine can be freed from much of its aqueous vapour by dry muriate of lime, which is not the case with muriatic acid gas, it offers a much more unexceptionable substance for experiments of this kind. I passed 23 cubical inches of chlorine slowly through dry muriate of lime into a flint glass tube red rot, containing a green glass tube full of iron wire; the chlorine combined with this iron wire with intense heat; the bright sublimate formed was passed through more iron wire heated to redness, so as to form a considerable quantity of the first compound of chlorine with iron, which, when examined, was found exactly the same as that produced by the action of muriatic acid gas on iron. All the products were heated strongly, and the end of the glass tube kept very cool; but *not the slightest appearance of moisture was perceptible.*

In all these experiments I was assisted by Mr. Faraday of the Royal Institution.

Muriate of ammonia is not altered by being passed through porcelain or glass tubes heated to redness; but if metals be present, it offers similar results to muriatic acid gas. In one experiment, in which muriate of ammonia recently sublimed was used, instead of muriatic acid gas, the appearance of moisture was less than in the experiment on muriatic acid gas, which has been just detailed, and yet there was a considerable action on the oxide of lead in the glass, not only by the muriatic acid, but likewise by the free hydrogen of the decomposed ammonia.

---

## LV. *Observations on a Species of* Limosella *recently discovered in the United States, by Dr.* Eli Ives, *Professor of Materia Medica and Botany in the Medical Institution of Yale College**.

This small plant was observed in flower in July 1816, by Mr. Horatio N. Fenn (now of Rochester, state of New-York), in company with Dr. Leavenworth. The plant and the seeds have been preserved by me in a flower-pot from that time to the present. The plant was taken a few rods south of Mr. Whitney's gun-manufactory, on the margin of the river, where it was covered by every tide. I have since observed the plant in great abundance on the margin of the Honsatonuc in Derby, and in those small streams in East Haven, Branford and Guildford, which empty into Long Island Sound.

A specimen of the *Limosella* (with some specimens of the *Tillea*) was sent to Z. Collins, esq. of Philadelphia, who wrote me that Mr. Nuttal had found the same plant a few days previous to

* From the American Journal of Science, No. I.

to the receipt of my letter, and that they had no question on the subject of the generic character, but that it would probably prove to be a new species.

In the Transactions of the Medico-Physical Society of New-York, p. 440, it is described under the name of *Limosella subulata*. A description of the plant was published about the same time, by Mr. Nuttal, in the Journal of the Academy of Natural Sciences of Philadelphia, (see vol. i. No. VI. page 115.) In the paper written by Mr. Nuttal, is the following query: "Does this plant, with a lateral mode of growth and alternate leaves, germinate with two cotyledons?"

The following observations were made in answer to this question. In the winter of 1816-17, this plant was kept in a situation exposed to severe frost; yet whenever the weather became warm for two or three days it became quite green, but for the last winter there was no appearance of life in the plant. In March 1818, the vessel in which the *Limosella* had been preserved for two summers preceding, and in which there were a great quantity of seeds, was exposed in a warm situation to the sun. There was no appearance of vegetation till the last day of March, when were observed several cylindrical leaves; some of them evidently arose from bulbs, which had formed last summer on account of the dryness of its situation, which frequently occurs when plants are removed from a moist to a dry situation. In other instances single cylindrical leaves arose from the earth where no bulbs were to be found; these cylindrical leaves were thought to arise from seeds; which, if it was a fact, would prove that the plant vegetated with but one cotyledon. In a short time the vessel was crowded with the seeds of the *Limosella* raised by the cotyledons.

These were carefully observed, and in every instance when the coat of the seed was cast off, two linear cotyledons were observed; soon a cylindrical leaf arose from the centre of the cotyledons; and when this leaf had grown to the length of half an inch, a leaf of a similar kind arose laterally to a line made by the first leaf and the cotyledons.

From the facts above stated, it is thought to be proved that the *Limosella* vegetates with two cotyledons. This was the fact in every instance where the husk of the seeds was obviously attached to the cotyledons; and in the few instances where the plant appeared to vegetate with one cotyledon, it is probable it arose from a bulb or some portion of the old plant in which life had not been extinguished during the past winter, which was made more probable by the fact that several of the leaves arose obviously from bulbs. This *Limosella*, with its congeners, hence will take its place in the natural order of Jussieu, *Lysimachiæ*.

LVI. *On*

## LVI. *On the urinary Organs and Secretions of some of the Amphibia.* By John Davy, M.D. F.R.S. *Communicated by the Society for the Improvement of Animal Chemistry.**

Colombo, March 25, 1817.

The urinary organs of the amphibia have been imperfectly described by authors; but I am not aware that any account has hitherto been published of the urinary secretion of any of this class of animals.

Since I have been in Ceylon, both subjects have excited my attention, and on both I have had favourable opportunities of gratifying my curiosity. It may not be uninteresting to the Society to know the results of my observations. I shall briefly state them, confined as they are at present to a few animals of four natural families.

### 1. *Of the urinary Organs and Urine of Serpents.*

The kidneys of the different kinds of serpents I have examined, resemble each other generally; though in each kind there are minute and trifling differences. In every instance the kidneys are very large, nearly equal in size to the liver; they are long and narrow, and very lobulated; like some of the mammalia with conglomerate kidneys, they are destitute of a pelvis; each lobule sends a small duct to the ureter, which leaves the kidney in two branches. The ureters in general terminate in a single papilla. The papilla is situated in the cloaca between the mouths of the oviducts; it is a little elevated above the surface, and its point is directed towards a receptacle into which the urine enters. The receptacle is a continuation of the intestine, yet it may be considered distinct both from the rectum and cloaca, with both of which it communicates only by means of sphincter orifices. This conformation of parts may be seen to advantage in large species of snakes. I first observed it in the rock-snake and the rat-snake, two species of coluber, frequently found from eight to ten feet long.

The urinary ducts of serpents are frequently of an opaque white colour, from a white matter which they contain, which is visible through their transparent coats, and which may be expressed and collected from the papilla in small quantities for examination. More or less of a similar white matter is almost constantly found in the receptacle; generally it is found in soft lumps, rarely in hard masses. In the receptacle, I have always observed it pure and entirely free from fæcal matter. This solid urine, for such it is in reality, gradually accumulates in the receptacle, till it forms the masses just described. It is a long time thus collecting,

* From the Philosophical Transactions for 1818, Part II.

lecting, from three weeks to a month or six weeks. When the bulk of the masses is so considerable as to distend the part, they are expelled by an unusual exertion of the animal, most commonly in the act of devouring its food, which it takes periodically, at intervals of from three to six weeks. The urine is voided occasionally, accompanied by, but never mixed with, fæces. When expelled, it is commonly in a soft state, of a butyraceous consistence, which it loses from exposure to the air, and becomes hard and like chalk in appearance. This change is produced, I believe, merely by the evaporation of moisture. The quantity of solid urine secreted by snakes is very great, more even than might be expected from the size of their kidneys; it is not unusual to see masses weighing three or four ounces, voided by large snakes.

The chemical nature of this urine was such as I expected to find it; I say expected, because before I left England, I was told by Dr. Prout, that he had examined the excrement of a serpent in London, and had ascertained that it was nearly pure uric acid; such have I found it here in every instance, in at least eight that I have tried it; and the properties of that fresh from the ureter were precisely the same as of that contained in the receptacle, or of that voided. Before the blow-pipe, it emitted strong ammoniacal fumes, consumed without flame, and afforded only a very minute quantity of ash, consisting chiefly of phosphate of lime and a fixed alkaline phosphate, and a little carbonate of lime: in muriatic acid it was insoluble; in warm dilute nitric acid it was soluble with effervescence; and the solution evaporated, afforded the pink residue almost peculiar to uric acid; in an alkaline ley it was soluble, and the solution was precipitated by muriatic acid. These properties sufficiently prove that the nature of the urine of snakes is as above stated. Besides uric acid, I have not been able to detect any other ingredient, nor do I believe that the urine contains any other, with the exception of a little dilute mucus, with which it is mixed and lubricated.

### 2. *Of the urinary Organs and Urine of Lizards.*

I have examined the urinary organs of four different species of lizard, the *gecko iguana*, a large species resembling the *iguana*, called by the natives *kobbera-guion**, and the alligator. The shape of the kidney varies in different instances; to each ureter there is a papilla, and the papillæ are situated in the receptacle itself; and in no other respect have I been able to discover between the urinary organs of these lizards and of snakes, any material difference. Neither does the urinary secretion of these four species, and of many other species that I have examined, differ

* For an account of this animal, see Knox's History of Ceylon.

differ from that of snakes in its essential nature; in every instance I have found it nearly pure uric acid. The uric acid of the alligator contains a large proportion of carbonate and phosphate of lime. Two specimens of this urine from different alligators agreed in this circumstance; they differed, however, in one having no odour, and the other a strong one of musk; the former was from a very young, the other was from an older animal.

3. *Of the urinary Organs and Urine of the Turtle and Tortoise.*

The kidneys of the *testudo mydas* and *geometrica*, the only species I have hitherto examined, resemble those of the preceding animals in their lobulated structure. The proportional size of the kidney of snakes is greatest; that of lizards next; and that of the animals we are now considering, least.

In the bladder both of the turtle and tortoise I have found flakes of pure uric acid, but in no great abundance: it was in a transparent watery fluid, containing a little mucus and common salt, but no urea or any other substance that I could detect in the small quantity on which I operated.

It is curious to observe the links by which animals, in appearance totally dissimilar, are connected together. That there should be so close an analogy between the urinary organs and secretion of the serpent, lizard, and testudo, is not surprising, their organic structure and their habits and œconomy being so similar; but that an analogy should exist between animals so very different in general appearance as birds and amphibia, is not a little singular, yet it is true: the urinary organs of one class, as well as the lungs, primæ viæ and genital organs, resemble those of the other, and both are peculiar in secreting uric acid; those living entirely on animal food secreting it pure.

---

LVII. *On the Earthquake felt in Sicily in February* 1818. *Extracted from a historical and physical Memoir by Dr.* Agatino Longo, *Professor of Experimental Philosophy in the University of Catania.*

This memoir is divided into two parts: in the first, which is purely historical, we find the detail of the facts which preceded or immediately followed the earthquake of the 20th of February. In the second, the author attempts to explain the various phænomena observed, and proposes some reflections which this memorable event suggested to him.

He begins with some account of the earthquake which took place in Sicily the 11th of January 1693, one of the most terrible ever experienced in that country; the city of Catania was totally destroyed by it, 18,000 inhabitants perished under the ruins, and several

several towns and villages of the valley of Noto experienced the same fate. Severe shocks were felt at Palermo the 1st of September 1726; and the earthquake which took place in Calabria on the 5th of February 1783 partly destroyed Messina, and spread terror at Catania and the towns and villages situated in that direction. Since that time other shocks, more or less violent, have taken place in Sicily, but have done no great injury to the buildings, not even to those of Catania, though that town, by its proximity to Mount Etna, is most exposed to accidents of this kind. In 1810 a pretty severe shock was felt, accompanied by an undulatory motion, which lasted about half a minute; to the west of Catania was seen a flash resembling lightning: the shock was repeated the following day, but without any damage: another slight shock was felt in the night of the 18th of October 1817. But on the 20th of February 1818, at ten minutes past one o'clock, Italian time, the sky being serene, the moon shining bright, the air calm and temperate, not only the city of Catania, but the whole region which surrounds Etna experienced a most violent convulsion, which occasioned great devastation in the towns and villages of that country, and extended to almost all Sicily, to Calabria, and even to Malta, but diminishing in intensity in proportion to the distance from the principal focus.

Some signs had preceded this formidable phænomenon. On the morning of that day the sea appeared calm; but from the effect of an invisible current, it dashed violently against the shores and shoals. The fishermen felt themselves as if repelled by an unseen force when they attempted to approach the rocks partly covered by the water, which latter appeared to them to be sensibly warm. In the afternoon the waters of the Darsena were extremely low, and yet the waves approached from time to time with such violence, that passing the mole and the wall which rises above it, they broke on the opposite side as in a tempest. In lofty houses the bells rang of their own accord, and bodies freely suspended began to oscillate.

Ten days before, an abundant rain had fallen, which continued during several days, without being accompanied by thunder or lightning; and the sea, which had been previously much agitated, had become perfectly calm. Etna had been tranquil ever since the month of October 1811; in the preceding years there was an excessive drought.

Towards sunset, flames were observed in various parts, running along the ancient lavas, and some subterraneous noises were heard; in several places inflamed vapours were seen to issue from the ground, and some persons said they had beheld vivid lightning upon the mountain; while others believed that they saw the lightning, which is the precursor of the earthquake, pass rapidly over

over the heads of the inhabitants of Nicolosi. At Catania, however, and in the environs, the inhabitants were perfectly easy and secure.

The hour at which the disaster occurred rendered it less fatal than if it had happened in the middle of the night. All the population was then awake and dispersed, except in a village of Etna, were the people were at church, as usual on Fridays during Lent.

In Catania, large masses of stones fell from the tops of buildings and beat in their roofs, but without killing or even severely wounding any person. Some of the inhabitants were affected by the fright, and one lady of advanced age died the same day in an apoplectic fit caused by terror. A large mass of lava, forming a natural vault above a rock, tumbled into the sea: a fisherman had happily moved from the spot a few moments before, impelled, as reported, by a secret instinct, to doubt of the solidity of the lava.

The hour when the shock happened cannot be fixed with precision; nor is the height of the thermometer or barometer known, or the quantity of rain which had fallen in the preceding days, there being no meteorological or astronomical observatory at Catania. It may however be taken for granted that the shock took place from the east to the west, or rather from SE. to NW. Opinions are also at issue respecting the total duration of the phænomenon: some limit it to ten seconds, others make it forty seconds. The author, taking a mean between these extremes, supposes it may have been from 20 to 25 seconds.

It is thought that the motion began by shocks (*sussulto soubresaults*), which changed into undulations that succeeded each other very rapidly; this was judged to be the case, from observing that cisterns full to the brim partly emptied themselves by the effects of the oscillations. Some statues appearing after the earthquake to be turned into a rather different direction from what they were before, it was inferred that the motion was complex and vortical*. A considerable mass of Syracusan stone was turned about 25 degrees from the east towards the south. The colossal statue of an angel placed on the façade of a church, lost both arms, as if they had been lopped off with an axe, whence it was supposed that a large portion of electric fluid had been disengaged from the earth during the convulsion. This conjecture is confirmed by other circumstances, such as the bending of iron

* It is very difficult to admit this direction in the motion; for there must have resulted a nearly circular disruption in that portion of the ground, which would thus have turned on a vortical axis; and such a disruption must have left evident traces.

crosses

crosses at the tops of the churches: many persons saw also at the period of the shock a flash of lightning, and other long streaks of flame, which descended into the sea. The inhabitants of the villages about Catania thought they saw the city surrounded with flames. Two very distinct shocks were felt very near together, the first only vertical, the second vertical and vortical: the latter was the most violent; it opened the doors and windows of the houses, and the ground seemed as if it was several times moved from its level; and it is certain that several walls opened vertically, and that the light of the moon entered the room through these openings, which, however, immediately closed, so as to leave but a scarcely visible trace of the rupture.

It may be easily imagined that the populous city of Catania was in consternation. Scarcely had the shocks ceased when all the bells were set a-ringing; from the ridiculous idea, as the author confesses in a note, that this would prevent the return of the earthquake. If the city of Catania had the good fortune to escape severe injury, it was not so with other places. Mascalucia was half overthrown, and seven persons perished. Nicolosi, Trecastagne, Viagrande, suffered considerably. At Aci-Catena, the churches were cast down, and many other buildings injured; a convent of Monks was destroyed, and some of the Monks were buried in the ruins. At Zafarana, a village forty-eight miles distant, the roof of the church fell in and crushed thirty persons. At Catania itself, the following buildings received much injury; the house of the Minorites, the cupola of the church, the convents of the Crociferi, the Agostiniani, the Franciscans, and of St. Agatha, the hospitals of St. Mark and of St. Martha, the University, the Benedictine monastery, the Seminary, and many private houses.

In the night of the following day, (21st of February,) another but slighter shock occurred; and two other very violent ones, and of considerable duration, on the 28th, which did great injury in the Valle di Noto. We shall not follow the author in his minute account of all the damaged edifices, but merely observe, that in some places enormous masses of ancient lava were rent asunder, from which there issued, at the moment, a slight flame.

A rise was observed in the waters about Aci-Catena, and in the salt waters near Paterno. In some places, a salt, clayey, and sulphureous water was observed to issue from the ancient lava; and the water in some wells became turbid a few days before the earthquake, which is a prognostic mentioned by Pliny. At a place called Paraspolo, five or six minutes before the shock there suddenly issued from the ground, with great noise, fourteen large *jets* of salt water, which rose to the height of six palms, embraced a space

space of about twenty canne *, and lasted about twenty minutes. The openings by which this water issued, were still so hot, two days after, that one could not put the hand in without pain. The plants about some withered, and about others continued to vegetate; which affords reason to suppose that they did not all emit salt water. Near this place there was a loud detonation like thunder, and fragments of mortar and bricks were found detached from the walls, and scattered in various directions, which the author attributes to a sudden inflammation of gas below the building to which they belonged. It is said that the river Simeto ceased to flow at the moment of the shock, and afterwards suddenly resumed its course. The sea showed only a trifling undulation; but a bark, which was at anchor not far from the shore, grounded three times.

A short time after the shock the air became thick, and the sky was covered with clouds, which in a few hours dispersed, and the moon again shone. No electric meteors were perceived either before, during, or after the earthquake; whence the author infers that those philosophers are mistaken who ascribe earthquakes to subterraneous electrical explosions, and make them depend exclusively on a rupture of the electrical equilibrium.

It is almost superfluous to say, that the animals were the first to announce the approach of the earthquake: many persons also experienced extraordinary sensations before it commenced,—some vertigo, some a particular sensation of heat in the legs, others a kind of stupor; effects which principally depended on the greater or less degree of irritability of the nervous system of the persons who experienced them.

The author then proceeds to explain the phænomenon, which he seems to be convinced was caused by gases disengaged by the fermentation experienced in the interior of the earth by divers substances impregnated with certain fluids. None of his theories are new, and it is surprising that he has been guilty of two important omissions; the first, that he passes too lightly over the possible and probable influence of volcanoes upon earthquakes. "Nobody," he says, "can think that Etna was the cause of the late event." The other omission is that of the system which ascribes these shocks to the most incoercible force that nature affords, that of water suddenly converted by fire into steam. The well known effects applied to mechanics, tend to a more natural explanation than any of those proposed by the author.—The number of persons killed or wounded on this occasion was 169.

* One hundred canne, each containing eight palms, are 212½ English yards.

LVIII. *Ob-*

## LVIII. *Observations on the immense Loss of Lives through Shipwreck, and Opinions of various Persons concurring, respecting the Means to be used to afford Preservation: also, most satisfactory Reports on Experiments made by a Life-preserving Apparatus, recently invented by* H. Trengrouse, *of Cornwall.*

The number of lives annually lost through shipwreck cannot be ascertained; but it is well known to amount to several thousands.

Dr. Wilkinson about the year 1763 (taking the average of six years) calculated that 4200 British seamen are lost annually; and states that in twenty-seven days only, in the month of December of that year, the excessive number of 1430 were drowned. Another gentleman has stated that in the years 1781 and 1782 the numbers lost were upwards of 10,000!

Very recently an author stated the number lost during the period of his present Majesty's reign to amount to 160,000!

" Most important to Great Britain in a national view, is the preservation of shipwrecked mariners. The exigencies of our country demand a peculiar attention to the soldier and the sailor." —*Rev. Dr. Gregory.*

" When we consider that scarcely a year elapses unmarked with unhappy events of this kind, by which multitudes of mariners (and others) are precipitated into the same untimely awful grave; surely a means of diminishing those misfortunes can need no patronage in England, or any other maritime nation."—*Dr. Wilkinson.*

### *Concurring Opinions on the Means necessary to be used to afford Preservation.*

" For the accomplishment of this desirable purpose, an endeavour should immediately be made, for establishing a communication between the vessel and the shore."—*Capt. Keith.*

" The only certain means of saving the crew of a vessel stranded within 200 or 300 fathoms of the shore, is to establish a rope communication—but how is this to be done?"—*Cleghorn's Essay.*

" A communication by a rope *but once achieved,* it is easy to send on board by it to the vessel, any thing else that might facilitate the conveyance of the seamen to land."—*Capt. Manby.*

" Resolved, That in case of shipwreck, the grand object is to form a communication with the shore; and it appears to this Committee, that the most probable means of effecting this object, is to convey a rope, or line, by some projectile force, to the nearest land."—*Royal Humane Society.*

" Lieutenant Bell's idea was to project the rope *from the ship* to the shore, which is assuredly the method most to be *depended* upon, as the vessel in that case carries the means with her,

her, and need not rely on fortuitous assistance from the shore."—*Report of the Committee of the Hon. House of Commons, Jan.* 1808.

My residence being near to the shores of Mount's Bay, I have had opportunities of witnessing many melancholy shipwrecks; among others, that of H.M.S. Anson, when about 100 of her officers and men were drowned. The annihilation of this fine ship, with so many of my fellow-creatures, deeply impressed my mind; and freshened in my memory the premature destruction of about fifty fine fellows at the wreck of the Jane-and-Rebecca transport, only a few weeks preceding, and also near the same spot. These melancholy disasters led me into a train of reflection and reasoning, and I was very soon possessed by the idea of devising means for preserving lives from shipwreck. From that period have I been pursuing my object; and, happy for mankind, I have been made the honoured instrument in the hand of Providence, in devising such means as possess every probable efficacy to accomplish all that is *possible* for the purpose so anxiously wished for;—and which, from inspection and experiments made, have obtained general approbation.

*Important official Testimony.*

| | |
|---|---|
| " Lieut.-general Ramsey. | Lieut.-colonels Harris. |
| Major-general Borthwick. | Pritchard. |
| Colonels, Sir H. Framingham. | Beevor. |
| Millar. | Griffiths. |
| Sir W. Robe. | Fyers. |
| Salmon. | Majors Frazer. |
| | Payne. |

Woolwich, March 2, 1818.

Sir,—In reference to your communications dated on the 6th and 25th ultimo, I have the honour to acquaint you for the Honourable Board's information, that the Committee of Colonels and Field Officers above named, in conjunction with Rear-Admiral Sir Charles Rowley and Captains Gower and Ross of the Royal Navy, assembled on the 28th ultimo, for the purpose of inspecting an apparatus invented by Mr. Trengrouse, for preserving lives and property in cases of shipwreck, by means of a rocket; when Mr. Trengrouse exhibited his apparatus, and made the following experiment.

1st. A small rocket of eight ounces, with a line attached to its stick, was fired from a musket to the distance of 180 yards.

2d. A pound rocket was fired in the same manner, which ranged 450 yards; the line broke at 150 yards, owing to a knot in it.

3d. A pound rocket was fired from a wooden frame at an elevation of 50°, and ranged 212 yards.

The line used with the above three rounds was a mackerel line.

4th.

4th. A four-ounce rocket was then fired from the musket to the distance of 112 yards, with a line called a *mackerel snood.*

I have the honour to report that the Committee are of opinion, that Mr. Trengrouse's appears to them to be the *best* mode of gaining a communication with the shore, for the purpose of saving lives from shipwreck, that has been suggested; as well as to communicate between ships in heavy gales of wind; and that the experiment they have witnessed has fully succeeded.

I have the honour to be, &c. &c.

*P. A. Ourry, Esq.* (Signed) John Ramsey,
&c. &c. Colonel and Lieut.-general Commandant."

After having received the foregoing report, I was officially made acquainted that a further Committee of Naval and Artillery Officers was about to be convened at Woolwich, for more particularly investigating my invention, and to witness a new experiment. Sir Wm. Congreve was not present at the former; and, as he is so conversant with the nature of rockets, probably this second experiment might have been chiefly for him to have the opportunity of judging on the utility of my plan. While making my experiment, the wind was blowing a gale, and I projected two lines, by the use of only eight-ounce rockets, to the distance of 215 yards—exceeding my former experiment (with the same size rocket) by 30 or 40 yards.

A deep sea-line was also projected by one of my larger rockets, 107 yards, which was a highly satisfactory experiment to all the spectators, and far exceeded my own most sanguine expectations, as I never before attempted an experiment with a line near so large, it being sufficiently strong to haul six men through the water at a time. But to prove the power of larger and stronger rockets than those I used, Sir Wm. Congreve was pleased to make the following experiment.

| * Nature. | Weight of Grapnel. | Size of Rope. | Elevation. | Range. |
|---|---|---|---|---|
| 18-pounder reduced | 9 lbs. | $1\frac{1}{2}$ | 35 | 250 yds. |
| | 9 | $1\frac{1}{2}$ | 40 | 230 |
| | $10\frac{1}{2}$ | $1\frac{1}{2}$ | 40 | 243 |

It required eleven men to start the anchor out of the ground.

Mr. Trengrouse afterwards produced his apparatus for conveying persons on shore after gaining a communication with a rope. It consists of a hawser *roller* and *hook*, which can be

* I may here observe, that these rockets were in an iron case, and armed with an *arrow*, the stem of which being about nine inches long, penetrated the ground on falling, to some depth. Therefore, in case a vessel should be wrecked under a cliff, and no person at the time upon the shore to lend aid, by such rocket acting as a grapnel, (when falling on earth, or other penetrable substance,) the crew might materially assist themselves to climb to the top.

 fixed

fixed on after the rope is made fast, by means of a thumb-screw detaching one-half of the shank, so that the traveller may be placed on the upper part of the rope; thereby obviating the inconvenience and danger of reeving the rope through the traveller*.

An experiment being made with a three-inch rope stretched between two trees, it was found to answer the intended purpose.

| | | | |
|---|---|---|---|
| Lieut.-general | Ramsey. | Lieut.-colonels | Bingham. |
| Colonels | Sir H. Framingham. | | Phillot. |
| | Harris. | | Fyers. |
| | Fisher. | Majors | Fraser. |
| Lieut.-colonels | Pritchard. | | Payne. |
| | Beevor. | | Forster. |
| | Griffiths. | | |

In conjunction with Rear-Admiral Sir Charles Rowley, Captains Gower and Ross of the Royal Navy, and Sir William Congreve, Comptroller of the Royal Laboratory.

(Signed) John Ramsey,
Colonel and Lieut.-general Commandant.

*Certificate from Falmouth, December* 4, 1817.

"We the under-signed do certify that we have at several times witnessed experiments made by Mr. Trengrouse of Helston, with the apparatus invented by him for the preservation of shipwrecked seamen; from the results of which, we are satisfied such apparatus, if generally adopted, might be made productive of great public benefit; and might be particularly useful in the merchant service.

Pellew, Collector of Customs
C. Severland, Agent to H. M. Packets
W. Broad, Agent to Lloyd's
Richard Pellowe, Capt. R.N.
George Bell, Capt. R.N.
John Manderson, Capt. R.N.
John Bullock, Capt. H. M. packet Walsingham
Wm. Tomson, late of the India service
Robert W. Fox, jun.
James Edgcome, jun. Collector Customs, Penryn
Michael Williams
Robert Williams
Henry Williams, and sundry others."

* Besides the advantages attached to the roller as here stated, it is so constructed that its most rapid use cannot produce friction upon the rope on which it works. Two travellers are intended to be used at one time; to the hooks of which is to be suspended a *chaise roulante* for persons to sit in, which is exceedingly simple and portable, and at the same time affords accommodation and security to the most helpless or infirm man, woman, or child.

In making the experiment with the traveller, Colonel Phillot and two others were severally conveyed from one tree to the other, in the *chaise roulante.*

Sir,

"Ship Owners' Society, July 14, 1818.

Sir,—I have received your letter of the 8th of May, and the several papers since placed in my hands, on the subject of your invention for preserving lives and property in cases of shipwreck; and having laid the same before the Committee of this Society, they have considered them with great attention, as also the apparatus sent for their inspection; and I have the pleasure to make known to you, that the Committee do highly approve of your invention, as possessing all the merit which is ascribed to it by the respectable gentlemen of Falmouth, in their certificate, and alike creditable to your ingenuity and humanity; and the Committee will avail themselves of every opportunity of recommending the adoption of it on board of merchant vessels.

I am, sir, your respectful and obedient servant,

*Mr. Henry Trengrouse.* (Signed) S. Cock, Secretary."

Report of the Committee of the Elder Brethren, to whom was referred the Invention of Mr. H. Trengrouse, for saving Seamen from shipwrecked Vessels.

"The several letters, certificates, reports, and observations on Mr. Trengrouse's invention for saving seamen from shipwrecked vessels being read, the Committee took into consideration the utility of the apparatus, and believe it to afford a very probable means of saving lives from vessels driven on shore or stranded, in situations where being within reach of communication with the shore, its adoption would be practicable on board the unfortunate vessel that may be wrecked; and from the material of communication being carried within the vessel itself, they think it highly preferable to any other mode yet proposed, as it thus must be always at hand, ready to be applied the moment when wanted; and the projected instrument would be easily and certainly discoverable, even at night, by persons on shore, so as to establish the wished-for communication of an *hawser;* and the cost of the whole being but trivial, the Brethren do therefore recommend that all vessels be furnished and provided with the apparatus of the rocket and other articles exhibited.

Trinity-House, London, Sept. 3, 1818. (Signed) Js. Court."

The following is copied from a Morning Paper, and is the report of a gentleman who witnessed the experiment,—an utter stranger to me, and whom I never saw before then; consequently he could have been only influenced by the merits of the apparatus.

"There are no calamities that have befallen human beings, especially if the evils are likely to recur, that have not aroused Englishmen's minds to ponder whether remedies against them could not be provided; and hence may we trace the numberless institutions that grace this country, and make it stand pre-



eminent

eminent amongst nations for its regard to every thing that concerns humanity. As islanders, and as adventurous islanders, we are compelled to resort to the ocean as affording the means of sustaining our greatness; and that spirit of adventure has of course exposed our countrymen to divers and most afflicting dangers. Often within gunshot of our own shores, have hundreds upon hundreds of our brave countrymen perished; and not because they wanted courage to buffet the waves, but because they had not any means to make use of on which they could rely to secure their deliverance.—Various individuals have at different times suggested measures for the rescue of persons exposed to destruction in consequence of shipwreck; and amongst the rest, Captain Manby has been the most conspicuous. He devised methods for opening communications between the shore and the vessel. This, of course, might accomplish much; but it will be readily conceived to how much uncertainty it exposed the crew. The vessel might be in danger where there was no " station," as wind and tide wait for no man—so it still remained to invent means of communicating with the shore *from* the ship. To effect this is to accomplish every thing; for if a distressed vessel have an established communication with the shore, by which means the persons on board can be forwarded to land, the means of safety are at hand. This *desideratum*, an earnest and humanely disposed individual, named Henry Trengrouse, of Helston, considers himself to have supplied; and we must own that he has accomplished much more than we deemed possible to effect by such simple means.

" Yesterday his experiments were tried on the Serpentine River in Hyde Park, from the Royal Humane Society's Station, in presence of the Duke of Sussex, many members of that laudable Institution, and Mr. Pettigrew, its secretary. The experiments greatly surpassed expectation; and the select party present expressed their unqualified approbation of the leading principle of the invention. The first object of the invention is to establish a communication with the shore *from* the ship—(the opposite of what has yet been effected,) and this is done by firing off a rocket placed at the top of a gun, carrying at its tail a line from the ship. This was effected across the Serpentine, 140 or 150 yards wide, by means of a common musket. A strong line was then drawn over by persons on the opposite shore, and by it a hawser —previously to the hawser being dragged ashore, a person supplied with a convenient cork jacket (or " sailors's life-spencer") was hauled over with the greatest ease and convenience; and so useful was the jacket, that two other persons might proceed by clinging to it. The hawser having been fixed to the shore, a species of swing chair, with admirable invented pulleys and rollers

at

at the top of it, was hauled on shore with a man in it, and then back again, with wonderful facility. Three persons at a time might be forwarded to the shore in this seat with the greatest safety; and after the crew had been secured, property might be taken care of. The persons present expressed their admiration of the principle of the invention; and some able sea-faring men amongst the company were pleased with the cork jacket, and greatly delighted with the new roller, which prevents the friction or entangling of the rope.

"The experiment would have been complete, had the rope that was conveyed across the Serpentine River been made more taught, and if the rocket which carried it across, and was fired from a musket, had more force or strength. These circumstances might not occur again, and had nothing to do with the invention, which is perfectly simple, and calculated to answer every purpose intended. It has this peculiar advantage, that the line can be thrown *from the ship* on shore, and the whole apparatus being confined in a small compass, can be ready in every vessel for immediate use.—(Aug. 7th.)"

---

In this enlightened age, it cannot be too much to hope that every person who has any power will use it in promoting the adoption of this apparatus so much approved;—In the name of humanity I claim it, and am, &c.

Helston, March 18, 1819. H. TRENGROUSE.

---

## LIX. *A Letter to the Farmers and Graziers of Great Britain; to explain the Advantages of using Salt in the various Branches of Agriculture and in Feeding all Kinds of Farming Stock.* By SAMUEL PARKES, *F.L.S. M.R.I. F.S.A. E. &c.*

[The author has annexed to his Letter a copious Appendix, to which he makes very frequent reference.—Such of our readers as may be desirous of examining the valuable documents in which it abounds, we must for obvious reasons refer to the Appendix itself.]

London, Feb. 15, 1819.

Gentlemen, IN consequence of a late enactment of the legislature of Great Britain in your favour, and of the share which I took in the preliminary measures for obtaining that enactment, I think it incumbent on me to invite your attention to the subject, by addressing to you, in this public manner, the following observations.

The facts which I shall lay before you are of that importance to your own interests, and the promulgation of them is so likely to promote the welfare of the whole country, that I should consider myself culpable if I omitted to give them the greatest possi-

 ble

ble publicity, or if I neglected to use my best endeavours to place them in that clear point of view which should enable you fully to understand and appreciate them.

The expediency of manuring arable and pasture lands with salt, and of administering the same active and wholesome substance to your horses, sheep, and cattle, as a condiment for their food, and as an efficacious means of preserving them in health and vigour, will form the principal objects which I am anxious to point out for your consideration and future practice.

After a candid and unprejudiced perusal of this letter, you will, I trust, carefully examine the body of evidence which will be adduced in the Appendix, and then make such experiments upon your own estates, and with your own cattle, as are most likely to determine and convince you how far such a course of proceeding may be applicable in your own management.

The ever-memorable Sully, who was one of the greatest men France ever produced, used to say that it ought to be the first maxim of a good government to advance agriculture before manufactures, and to give to the latter only a secondary rank in the state—whereas, Colbert, who was also a great minister, assigned to manufactures the first place in the œconomical order of his administration, and gave the utmost encouragement to the arts, from a persuasion that their prosperity would furnish the only means of working up the raw materials which his country produced. It is probable, however, that this eminent statesman would not have protected the arts at the expense of agriculture, if he had considered that the principal utility of manufactures in any country arises from the price which they afford to, and the market which they procure for, the products of the soil.

The immortal Sully, in vindication of the opinion which I have just quoted, used to say that he had ever preferred the products of the soil, which could not easily be ravished from him, to those foreign conquests which occupy the attention of most governments, but which always excite resentment and jealousy. "A large, and an increasing produce of the land," said he, "ensures the liberty of the people, while it places foreigners in a sort of dependence; whereas the want of corn, the first necessary of life, gives a dependence upon foreigners, who can either furnish the commodity, or refuse it. The produce of the land," continues he, "cannot be consumed by strangers but to the profit of the inhabitants, that is, by a traffic more advantageous than the possession of the corn itself—whereas the arts and manufactures may possibly be carried off by the artifices of rivals, and pass away, together with the artists themselves, into all the countries of the world."

If these latter sentiments are founded in truth and justice, and I believe

I believe they are, then every improvement in the agriculture or rural œconomy of these kingdoms may be considered to be an important national acquisition, and I shall be excused in not offering any apology for endeavouring to call your attention to a practice which is little known in our country, but which in some foreign states has invariably been attended with decided advantages as well as profit.

The value of common salt for agricultural purposes has been long known in Germany, in Poland, in Holland, in Flanders, and in all the provinces of the United States of America; it is therefore much to be lamented that the existing duties should so long have deprived the people of this country of the various benefits which they might have derived from this valuable native production*. The mineral substance of which we are speaking is found in this island in the greatest abundance; yet, by a mistaken policy, we have hitherto given it to strangers, and have allowed many thousands of acres of our own lands, which, by the free use of salt, might have been rendered highly fertile and profitable, to remain nearly sterile, or at least in a state in which they will barely pay for the expense of their cultivation.

However, since the government has so far relaxed as to remit a great part of the duty on such rock-salt as shall forthwith be consumed in agriculture, or in feeding cattle, and as so much depends upon the manner in which this valuable boon is received by the country, it is desirable that the greatest extent of publicity should be given to the act of parliament; and that no agriculturist, not even the most humble gardener, should remain ignorant of the terms and conditions upon which he may now obtain so rich and useful a commodity as rock-salt.

Penetrated with the importance of the subject, and contemplating the variety of advantages which the landed interest must derive from the accomplishment of the measure, the act had no sooner passed than I determined to lay all the particulars before the public, in the hope that these concessions of the legislature, together with the evidence which I should be enabled to offer in proof of the advantages to be derived from the use of salt, would be amply sufficient to induce a large majority of the farmers of Great Britain to acquire such a knowledge of the new regulations as would enable them, without delay, to avail themselves of all the benefits which the government has thus offered for their acceptance.

Having no private ends to answer, and expecting to derive no personal advantage whatever from the general adoption of this

* The value of common salt as a manure was known some hundred years ago by certain individuals in this country, but the high duties and other impediments have prevented its use becoming general.

measure,

measure, I shall proceed to give you a simple outline of the general view which I have taken of the subject. It may, however, be necessary to premise, that my opinions thereon have been formed in consequence of a careful investigation of a great number of well-attested experiments, and from the perusal of that body of evidence which was delivered in the year 1817 before the Lords of His Majesty's most Honourable Privy Council, at the Board of Trade; and again in the spring of the following year, before a select committee of the House of Commons; which committee was occupied from day to day, from the sixteenth of March to the fifteenth day of May, in questioning the witnesses, and in recording their respective testimonies upon this most important proposition.

From an attentive examination of all these documents, and from a dispassionate consideration of every thing which I have been able to collect upon this great object, I am decidedly of opinion that rock-salt, at the reduced duty of five pounds per ton, is by far the cheapest, the most efficacious, and the most convenient manure for arable and pasture land, that can possibly be obtained.

More than one hundred and fifty years ago, Sir Hugh Platt, an eminent writer of that day, speaks very decidedly of the benefits which might be derived from the practice of sprinkling common salt upon land, and calls it the *sweetest*, the *cheapest*, and the most *philosophical* marle of all others. He relates the case of a man, who, in passing over a creek on the sea-shore, suffered his sack of seed-corn to fall into the water, and that it lay there until it was low tide, when, being unable to buy more seed, he sowed that which had lain in the salt-water; and when the harvest time arrived he reaped a crop far superior to any in the neighbourhood. The writer, however, adds, that it was supposed the corn would not fructify in that manner unless it actually fell into the sea by chance; and therefore, neither this man nor any of his neighbours ever ventured to make any further use of salt-water.

The same curious author tells us also of "a man who sowed a bushel of salt, *long since*, upon a small plot of barren ground on Clapham Common, and that to that day (the time when he was writing) it remained more fresh and green than any of the ground round about it."

The eminent Dr. Brownrigg, who wrote in the year 1748, in speaking of common salt, says "it is dispersed over all nature; it is treasured up in the bowels of the earth; it impregnates the ocean; it descends in rains; it fertilizes the soil; it arises in vegetables; and from them is conveyed into animals; so that it may well be esteemed the universal condiment of nature;

friendly

friendly and beneficent to all creatures endowed with life, whether it be vegetative or animal."

In some parts of Great Britain, particularly in the neighbourhood of the salt works, the value of common salt, as a manure, is well known and acknowledged; and it has lately been given in evidence before the select committee of the House of Commons, by a gentleman of the highest credit, that the farmers in Cornwall are so convinced of the value of salt as a manure*, that whenever the waste salt that has been employed in curing fish is on sale, there is a violent contention among the occupiers of the land, who shall obtain the largest share. The same gentleman informed the committee, that where wheat or barley has followed turnips, on land which had been salted, the ensuing crop has invariably escaped the mildew, although that disease had affected all the corn upon the lands immediately adjoining, on which salt had not been used.

The efficacy of salt in destroying noxious weeds, grubs, worms, flies, and insects, is well known in many districts, and those who are incredulous may very easily satisfy themselves by direct experiment. For instance, if a few common earth worms be taken out of the ground, and sprinkled with a little salt, they will be seen to writhe about for a few minutes, and then expire. Thus salt does, as it were, perform two operations at once; for, by destroying the worms and the weeds, while the land lies fallow, it prepares the ground most effectually for the reception of the corn or the plants, before it can possibly take any effect upon the crop itself. And besides this peculiar advantage, the extreme luxuriance and verdure which common salt gives to *grass* lands, when properly applied, would be so satisfactory to such farmers who would make use of it, and so convincing to all the neighbouring agriculturists of every description, that if only one or two gentlemen in each district were to employ it in a few instances, I am certain this mode of top-dressing† would very soon engage the attention of every person in the empire, who had even but a garden to manage and cultivate.

From

* There is also a practice in Cornwall of manuring the lands with sea-sand for the sake of the salt that it contains; and so very efficacious is this found to be, that a writer, ninety years ago, computed the money laid out in that and the adjoining county for sea-sand to amount to thirty-two thousand pounds per annum; and so much has this practice increased of late years, that Dr. Paris considers "the expense of land-carriage for sand used as a manure in *Cornwall alone* as now amounting at least to thirty thousand pounds annually."

† I think it necessary to remark, that where salt is used as a top-dressing for grass land, the quantity employed ought to be much less than is commonly used for ground that is to be afterwards ploughed for a crop of grain. Six bushels, or three hundred and thirty-six pounds of rock-salt, ground

*very*

From the evidence which has already been collected upon this subject, it is obvious that a great portion of the land in this kingdom might, by the proper use of salt, be made to produce nearly double the amount of the present crops of grass as well as corn. How greatly this would serve the manufacturing, and indeed all other interests of the country, I need not attempt to explain to you. Moreover, by forcing the land with a sufficient portion of salt, our crops would be brought to maturity much sooner than they now are*; a matter of considerable importance in the northern parts of this island, where much of the corn is frequently spoiled by the autumnal rains before it can be sufficiently dried by the sun and wind to stack with safety. And in the hay harvest, should the farmer be induced, from the uncertainty of the weather, to carry his hay too soon, a small quantity of salt sprinkled upon each layer of the rick will prevent the hay from becoming mow-burned, as it is called; and when hay which has been thus treated is presented to horses and cattle, it will be preferred by them to that which has been put together in a more favourable season, and not treated with salt.

The *cleanliness* of rock-salt as a manure is likewise another considerable advantage. In many cases this circumstance will be found to be very important, particularly in the grazing districts. It has repeatedly been observed, that if land be manured with dung *after* the hay has been carried off, the neat cattle will refuse to eat the eddish which grows upon such land. On the contrary, if a field be dressed with about two bushels of fine salt instead of dung, soon after the hay is cut, this inconvenience and loss will be avoided, and a large crop of aftergrass will be obtained, possessing such peculiar sweetness, that all kinds of cattle, as well as horses, will eat it with the utmost avidity.

The farmers, in some districts, are accustomed to steep their seed-corn in lime-water, and doubtless the practice is often useful; but I am decidedly of opinion that a strong brine, made by the solution of rock-salt in water, will be infinitely more efficacious. Crops of wheat are often reduced one-half in value by a disease to which this kind of grain is very liable, called the

*very fine*, and regularly sown upon the grass, would be a proper quantity for an acre of pasture-land: whereas sixteen or twenty bushels may be used upon fallows for cleaning the ground preparatory to the putting in the grain. For meadow-land, two or three bushels of crushed rock-salt may be carefully sown upon each acre, immediately after the hay is got in, with great advantage, especially in hot and dry summers.

* The late Dr. Darwin, in treating on salt as a manure, remarks, "that as it is a stimulus which excites the vegetable absorbent vessels into greater action than usual, it may, in a certain quantity, increase their growth, by enabling them to take up more nourishment in a given time, and perform their circulations and secretions with greater energy."

*smut*

*smut* or *rust* *; but when the seed has been properly prepared with salt, this misfortune can never happen. It has also been proved by some public-spirited individuals, who have made the necessary experiments, that the scab is never found upon potatoes which have grown upon land that has had a proper dressing of common salt.

In many parts of Flanders, but more particularly at Lisle, it is the practice to preserve the urine of those cattle that eat common salt with their food. This is preserved in appropriate reservoirs; and when the farmers apply it to a certain description of land, which experience has taught them to select, the effect, even without any other manure, is not only advantageous, but it is truly astonishing.

Enough, I presume, has now been offered to induce you to expect a satisfactory result from the application of salt to your fields and meadows; I shall, therefore, at present content myself with informing you, that in the Appendix you will find a list of the names of the gentlemen who have borne testimony to the efficacy of salt as a manure, and likewise the evidence of a gentleman who has used common salt upon his own farm for many years, and has witnessed the use of brine upon the lands in his neighbourhood for forty years, with the greatest advantage; and who came from a distant county on purpose to attend the select committee of the House of Commons, to report to them the substance of his experience for that very long period. You will also find there the proposals of the Board of Agriculture in London, and of the Highland Society of Scotland, both of which institutions are fully aware of the value of rock-salt in the cultivation of land; for they have offered rewards to such persons as shall give them an account of the best experiments with this valuable mineral substance, in the different branches of farming, and general agriculture.

We proceed now to the second part of our subject, which relates to the application of salt in feeding sheep and horses, and for assisting in fattening live stock. Here, however, I shall merely enumerate the several advantages which appear to have resulted from the practice, and shall then place my chief reliance on the effect which may be produced by your perusal of the several documents which are contained in the Appendix.

To ascertain the exact quantity of salt which may be necessary for the different kinds of land, and to appreciate the bene-

* I am desirous of recommending to my readers' perusal a very valuable paper, which has lately been distributed gratis by the Board of Agriculture, written by the Right Honourable Sir John Sinclair, bart. "On the means of preventing the rust in wheat by the use of salt," an object well entitled to be ascertained by decisive experiments.

fits

fits which result from its employment in all the various modes of culture that are adopted in this country, will require several long series of experiments, especially as some of the evidence given before the committee of the House of Commons was unsatisfactory and contradictory; but the advantages which have arisen from giving salt to sheep and cattle are so determinate and self-evident, that there appears to me to be nothing to prevent every farmer from immediately adopting the practice.

The most undeniable evidence has been afforded, that common salt uniformly promotes digestion in horses and cattle, and that this occasions them to make a rapid progress in fattening. It has also been found, that in feeding with chaff or cut straw, a larger quantity of this cheap and ordinary food can be given when sprinkled with salt than can be administered in any other way; and that as the filling the stomachs of cattle while fattening is a circumstance of the greatest importance, a very large portion of chaff, if seasoned with salt, may be given with the utmost advantage to the growth and health of the animals. Thus, every experimental grazier knows that an abundance of very ordinary food, if eaten with relish, will fatten cattle much sooner when given with a small allowance of substantial provender, than better food alone in a moderate quantity. There is, indeed, hardly any food that can be offered to cattle, which, if mixed with salt, will not be eaten with eagerness. Hence, nothing can be of more importance to a practical grazier than to know how to obtain this valuable saline mineral substance, at a cheap rate, and with little difficulty.

It was given in evidence last year, before the select committee of the House of Commons, that in feeding cattle, fourteen pounds of chaff, such as is produced in winnowing corn, and which of itself is of little or no value, will, when properly moistened and heated by steam, and mixed with two ounces of salt, save forty-two pounds of turnips. Surely this is a most important circumstance in the œconomy of a farm. Is it possible that this fact should pass unnoticed by any agriculturist?

A friend of mine, in the year 1812, travelled through the United States of America, from the state of Massachuset to the River Mississippi. He observed that it was usual, throughout that extensive district, to put salt within all the stacks of hay, and likewise to sprinkle it among the hay, in the proportion of about fourteen pounds of salt to one ton of hay. He says it was also a common practice in that country to give salt to sheep and cattle, and that he has frequently seen cattle follow a boy a mile or more, who held a portion of salt in his hand, tempting the animals by showing it to them. The same individual assures me also, that since his return to England he has adopted the

same

same practice, mixing salt with his own stacks of hay, and with the mashes to his horses, and constantly with the same benefit.

That horses, sheep, and cattle, would derive benefit from salt, might, indeed, be imagined from observing the great desire they discover for it, and which manifests itself in every country where this mineral substance lies within their reach. This is certainly the case, and in the Appendix many undeniable examples will be given to support the opinion. Several most curious facts, that were stated by a very respectable member of the House of Commons, to prove the salubrious effects of salt upon these animals, may also be seen in the Appendix.

It cannot then be doubted that salt, when judiciously administered to live stock, assists their digestion, preserves them from disease, and improves their condition; and from the evidence to be hereafter adduced, it will appear that the milk and butter produced from those cows which have salt given to them is more abundant, and never acquires that turnip-flavour which is generally so predominant in the milk and butter from those cows which are kept upon turnips *without* salt. It has likewise been proved, that common salt is a certain cure for the botts in horses, and is a specific against the rot in sheep; and that the wool is materially improved of such sheep as are fed with salt.

It is impossible, I conceive, to read the great body of evidence which was delivered to the Honourable the Board of Trade, and to the committee of the House of Commons, without being convinced that the benefits resulting to the grazier and agriculturist, from the employment of salt, must be great and important; especially the evidence of John Christian Curwen, esq. the representative in parliament for the city of Carlisle, who is himself a large farmer and grazier, and who stated to the committee, that upon a farm of one thousand pounds a-year, he could not estimate the annual advantages, that might fairly be expected from the free use of salt, at less than three hundred pounds.

If the benefits and profits arising from the unrestrained use of salt in agriculture be so various and considerable, how comes it to pass, it may be asked, that its employment has not been universal throughout Great Britain? Various reasons may be assigned for this; amongst others we may state the unwillingness which farmers in general evince, especially the lower class, to walk out of the old beaten path of their forefathers; the want of directions how to make use of salt for the purposes under consideration; the enormous duty upon the article itself; and, perhaps, above all others, next to the price, the many vexatious regulations to be observed before a remission of any part of the duty could be obtained.

Let us take one case as an instance of these troublesome obstructions.

structions. By an act of parliament passed in the 57th year of George the Third, it was enacted that the farmer might receive salt for the purpose of mixing with the food of sheep or cattle, at the reduced duty of five shillings per bushel, or ten shillings per cwt., such salt to be employed only and for no other purpose than feeding sheep or cattle; but before any such salt could be obtained, it was necessary to give a bond, with sufficient sureties, to the satisfaction of the Commissioners of His Majesty's Excise, in the penalty of six times the full duty upon such salt; and no further quantity of salt could be obtained, however much the cattle, after being long accustomed to it, might require its use, until the bond given on the delivery of every prior quantity should be discharged.

It was also enacted that before such bond could be discharged, a certificate must be given, declaring the whole of such rock-salt to have been used and consumed in mixing with the food of sheep or cattle, and for no other purpose whatever; and that no such certificate should discharge any such bond, unless the collector of excise should, upon inquiry, be satisfied of the truth thereof, and should underwrite the same upon the said certificate. The act declared also, that if such certificate should not be signed and delivered to such collector before the expiration of thirteen months from the time of the bond being given, or should in any respect be false, or any of the salt should be consumed in any other manner than in feeding sheep or cattle, the penalty of the bond should be forfeited.

Under such penalties and restrictions, is it at all surprising that salt has not been more generally employed for the purposes above enumerated; especially when it is recollected that, even under all these disadvantages, the farmer could not use a single bushel of salt for curing his hay, for steeping his seed-wheat, or for manuring his land, until he had paid the enormous duty of thirty pounds per ton, which of itself amounted to a prohibition?

I have, however, great pleasure in being able to congratulate you that an act passed both houses of parliament on the fifth of June last, to repeal the most vexatious of these restrictions, and to impose a low duty upon such rock-salt as should be hereafter delivered for *any* purpose of agriculture, as well as for feeding sheep or cattle.

Under this act of parliament, salt may now be had at the reduced duty of two shillings and sixpence per bushel, or five shillings per cwt.* for any of the following purposes, viz. for mixing with

* Rock-salt is not worth more than eight or ten shillings per ton at the pits of Northwich, and it may be put on board a vessel on the canal for about five shillings per ton more. Persons may be supplied with any quantity of salt on the best terms, and agreeably to the regulations of the late act of parliament,

with the food of sheep or cattle; for steeping seed-corn; for preserving hay, or for manuring land; and no bond is required to be given, nor any sureties as heretofore, for the faithful employment of the salt so obtained. And although the farmer must give a certificate that he has consumed the salt in the way the act directs, it is not necessary that time should be lost, as heretofore, while the collector makes inquiries to satisfy himself of the truth of the allegations in the certificate, but he is bound to accept the same when presented, and the farmer is entitled to receive a further supply of salt immediately.

By this important act of parliament, the farmer is also allowed to remove any part of such salt to another farm, or to sell it to a neighbouring farmer for the purposes aforesaid; and notwithstanding the penalty on a fraudulent misapplication of the salt is fixed by this act at forty shillings the bushel, or at one hundred pounds, according to the determination of the person who shall sue for the same, still the act contains a proviso, that the penalty may be mitigated by a justice of the peace to one-fourth part thereof.

Such are the alterations which have been made in the laws respecting the use of rock-salt in agriculture; and it does appear to me that every farmer who has it in his power to purchase salt should immediately procure a quantity, and make such experiments upon his land and with his live stock as shall appear to him to be most likely to increase the quantity and value of his produce. I am extremely anxious that a great number of agriculturists should immediately enter upon these experiments, because, in my estimation, this concession of the legislature is the greatest boon that the government has ever offered to the acceptance of the landed interest of this country; and that if the occupiers of the land, after the late extraordinary exertions of the select committee of the house of commons for their benefit, should discover an indifference or disinclination to accept of the proffered gift, those interested persons who are enemies to the total repeal of the laws relating to salt will avail themselves of this circumstance as an argument against the advocates for the repeal; and the whole of the late salt laws will soon be re-enacted in all their original force and severity. Whereas, if experiments were very generally instituted throughout the country, I doubt not but the farmers would soon become so fully convinced of the value of salt for the various purposes of husbandry, that a general application would ere long be made to parliament for a total repeal of

parliament, by applying to Mr. William Horne, a respectable and public-spirited merchant in Liverpool, who has lately been elected an honorary member of the Board of Agriculture in London, for his zeal in promoting agricultural experiments with rock-salt.

all the laws relating to salt; and such a petition as this would be irresistible. The agriculturist and manufacturer would then be empowered to dig rock-salt with as much freedom as they can now dig sand, or raise coal; and the various national benefits which would result therefrom would be more numerous and important than could easily be enumerated.

Having addressed you at much greater length than I at first intended, all that remains for me now is, that I should give a few necessary cautions and directions to such of my readers as may determine to adopt the practice which has been recommended in the foregoing pages.

In the first place, I am desirous of remarking that no land can be said to be fruitful which is entirely exhausted of carbonaceous matter; therefore, if it were possible for an estate to be so worn out by successive crops that little or no carbon remained in the soil, it is not likely that salt alone would restore it to its original fertility. I consider also that the land which contains most carbon will derive most benefit from the application of salt. But the safest way for a farmer to proceed is to use his salt sparingly at first, and in all cases to leave a small portion of the same land without salt, so that the real effects produced by the salt may be, by comparison, in every instance, self-evident and palpable.

A farmer who does not wish his land to lie fallow, ought, undoubtedly, to use too little rather than too much salt; because a very abundant dressing of this saline mineral substance might render the land, for one year at least, absolutely barren. We read in Scripture of the "Valley of Salt," where David smote the Syrians, which in all probability was an extent of low land that had been rendered barren by an influx of salt water. In one of the very early numbers of the Philosophical Transactions is an account of a valley of the same kind near Aleppo; and the late Dr. Browning relates that there is a vast desert on the frontiers of Russia, towards Crim Tartary, which, in consequence of a superabundance of salt, has become so absolutely sterile, that for the space of many miles neither tree nor herb grows upon it.

This reminds me of a circumstance of primary importance to all those who obtain salt under the regulations of the late act of parliament. This act enjoins that the salt shall be delivered in lumps of twenty pounds each or upwards; consequently the whole of such salt must be broken before it can be used with any advantage; for wherever salt is accumulated upon land, it must inevitably destroy all vegetation that lies beneath it. Now it has occurred to me that there is a possibility, from the carelessness of a labourer, of its being sometimes spread upon the land without being properly broken; and I am decidedly of opinion, that wherever a *lump* of rock-salt falls, whether upon arable or pasture

ture land, it must do mischief. My advice therefore is, that the proprietor of a farm, when he receives a parcel of rock-salt from Northwich, should make a point of having the whole of it ground, or reduced to a powder nearly as fine as common table salt, and passed through a sieve of the requisite fineness, before he allows any of it to be laid upon the ground. Rock-salt is not a hard substance: it may easily be crushed and divided as much as is necessary for any of these purposes.

As to the quantity of salt which it will be advisable to use for the respective crops, and upon the different kinds of land, this will be best learnt by a perusal of the several testimonials and other documents which will be found in the Appendix. But the best way of all others for ascertaining this point would be for every agriculturist to depend upon the results of his own experiments. To this end, I would advise him to institute a set of experiments upon every distinct species of grain which he is in the practice of cultivating, as well as upon his pasture land*, and to keep a register of every minute circumstance attending each of these trials.

A large kitchen-garden, wherever there is one attached to a farm-house, would in some cases be the most appropriate spot for such experiments; as this would be more under the immediate eye of the proprietor, and the experiments being upon a small scale, would be attended with little or no expense. The circumstance of an agriculturist being now empowered to divide the salt which he shall obtain by permit, among as many of the neighbouring farmers as he may think fit, is extremely favourable to such circumscribed experiments, and will be very gratifying to those who may wish to satisfy themselves of the value of common salt, and yet would not like to incur the risk of buying a large parcel solely for their own use. And as the late act allows the use of salt in agriculture, as well as for feeding all kinds of cattle, this affords a large scope for its consumption.

From the trials which have already been made in feeding the live stock upon a farm, it appears that the following quantities may at all times be administered with perfect safety.

To neat cattle four ounces of salt per day, mixed up with steamed chaff or other moistened food; one half to be given in the morning, and the other half in the latter part of the day.

To horses four ounces per day, as aforesaid.

* The right honourable Sir John Sinclair, baronet, lately published a series of sixteen distinct experiments, which he is desirous of having tried by farmers, as best calculated to ascertain the advantages of using salt in agriculture; and he distributed the paper gratis. This valuable sheet, which may be obtained at the Board of Agriculture, is well deserving the attention of all practical men.

To young heifers two ounces per day, at twice, as aforesaid.

To calves one ounce per day, divided into two portions.

To sheep two ounces per head per week. The salt to be spread very thin upon slates or tiles in the field where the sheep are fed.

Few farmers or graziers, I flatter myself, will read the foregoing pages, and the Appendix, without feeling some desire to improve their own estates, and increase the value of their live stock by the use of salt; but if there are any who are incapable of feeling a desire for improvement, I trust there are, on the other hand, many country gentlemen and enlightened agriculturists, who rejoice in every opportunity of contributing towards the national improvement of Great Britain, and who will entertain the subject from principles of pure patriotism.

It was the opinion of Aristotle, "that the cultivation of the land is favourable to liberty." And a writer of more modern times remarks, "that well ordered monarchies are most frequently found in highly cultivated and fruitful countries." There was an adage formerly in vogue, that "fields covered with ears of corn are the sources of victories." "The Sardinians," says the President Montesquieu, "were formerly very rich; and Aristeus, so famed for his love of agriculture, was their lawgiver. But the Carthaginians becoming their masters, destroyed every thing proper for the nourishment of man, and forbade the cultivation of the lands upon pain of death." The state consequently fell into decay, and for ages became the prey of a variety of conquerors. What is most remarkable, however, is, that even to this day the greatest part of the island of Sardinia remains an uncultivated barren waste. To this deplorable state of things the empire of China affords a striking contrast.

"The ancient emperors of China," says Montesquieu, "were not conquerors. The first thing they did to aggrandize themselves gave the highest proof of their wisdom. They raised from beneath the waters (or rather, they recovered from the sea) two of the finest provinces of the empire. These owe their existence to the labour of man; and it is the inexpressible fertility of these two provinces which has given Europe such ideas of the felicity of this vast country." And from the united testimony of travellers, we have reason to believe that every part of this extensive empire is constantly preserved in the highest possible state of cultivation; whereas, in England and Wales alone, there are upwards of seven millions of acres of waste land, which have been for ages, and still continue to be, of little or no benefit to the community.

The greatest obstacle to the cultivation of these lands is the want of manure, there being at present a great insufficiency for the

the lands which are already inclosed. Let the use of rock-salt, however, become general in agriculture, and this deficiency will in a great measure be supplied. Every opulent farmer will then have the means within his reach of putting the whole of his farm into the most desirable state of improvement; so much so, that it would soon be considered disgraceful for any agriculturist to allow a single rood of land belonging to his estate to remain uncultivated. This would prepare the way for the inclosure of those vast tracts of common land which we perceive in every quarter of the united kingdom; and the alteration which this would make in the face of the country, to say nothing of the increase of its inhabitants, may be more easily conceived than described.

Had our ancestors been totally inattentive to the improvement of agriculture, the greatest part of Great Britain would still have been covered with wood; and in like manner, had it not been for the progress of civilization, and the desire of improvement, the finest provinces of France and Germany would still have been overshadowed by the Hercynian forest, which in the time of Julius Cæsar extended from the borders of Alsatia and Switzerland, over the greatest part of Germany, Hungary, and Transylvania, and was said to be sixty days' journey in length and nine in breadth.

"Agriculture," said the late amiable Mr. Hollinshead, "is the most certain source of domestic riches. Where it is neglected, whatever wealth may be imported from abroad, poverty and misery will abound at home. Such is and ever will be the fluctuating state of trade and manufactures, that thousands of people may be in full employment to-day, and in beggary to-morrow. This can never happen to those who cultivate the ground. They can eat the fruits of their labour, and can always by industry obtain, at least, the necessaries of life."

However true these observations may be, thank God the times in which we live are propitious to every kind of improvement; to the progress of science, as well as to the advancement of the arts; and the spirit of inquiry which is abroad throughout the kingdom, will, I trust, induce many hundred intelligent agriculturists to attend seriously to the important points upon which I have addressed you.

Allow me to add, that I am confident those of you who feel any solicitude upon the subject, cannot more effectually consult your own best interests, or those of the community at large, than by entering immediately upon such experimental researches as are best suited to your respective situations and convenience, as your success, whatever it may be, will be equally conducive to individual and national prosperity.

I am, Gentlemen, Your most obedient servant,

 SAMUEL PARKES.

## LX. *On Sulphuretted Azote, "Thermozoophite," and Aphlogistic Phænomena.* By Mr. J. Murray.

*To Mr. Tilloch.*

London, 13th May, 1819.

Sir,—At page 165 of my Elements of Chemical Science, there is the following passage: "It is stated that sulphuretted azotic gas exists in the mineral waters at Aix-la-Chapelle; and this was first announced by Gimbernat, though all attempts by Berzelius and Hedenberg to form sulphuretted azote *artificially* have been without success. It appears probable, that as the waters in question contain both sulphuretted hydrogen and azote, the sulphuretted azote of Gimbernat may have been a mixture of these gases."—During my sojourn at Naples I had the pleasure to make some geological excursions with Signore Gimbernat. He wished me to rectify the impression to which the above refers. Sig. G. stated the fact, that he had found an *intimate combination* of sulphur and azote in these mineral waters, in a private communication to Mr. Chenevix; and it afterwards found its way into the "*Annales de Chimie et de Physique.*"—Our author never once called it sulphuretted azote, nor even gave it the name of a *chemical* compound. The reseaches of Pfaff and Voight on the same, subsequent to those of Gimbernat, confirm the existence of this *intimate combination;* but they hesitate to call it sulphuretted azote, because chemists have not been able to form it *artificially*, though the probabilities are that it is such a chemical product. Several chemists of late, however, have supposed that sulphuretted azote has actually occurred to them in their manipulations: thus Mr. Miers in his experiments on azote; and some others since. Sig. Gimbernat told me he had constantly found *nitrate of silver* to be a good test for waters containing azote or animal matter affording a *chesnut brown* colour, and also *tincture of galls*, which changes from a *straw* to a *chesnut* colour, while that *muriate of arsenic* was a very sensible reagent, in discovering the presence of *sulphur* when associated with azote, and not with hydrogen.

While on the subject of mineral waters, I may inform you that Sig. Gimbernat has discovered in the thermæ of Baden and Ischia a singular substance having much the appearance of animal matter;—indeed I could not discriminate between it and raw muscular fibre. It is formed on the surface of the rocks constantly humected by the ascending vapours of these thermal springs, and such vapours he has invariably found to contain azote. This gelatinous or albuminous matter in the process of decay gives the very fœtid odour peculiar to animal matter under decomposition. It swells like pelt, and forms *adipocire* by the action

action of nitric acid; affording also by distillation ammonia, empyreumatic oil, &c. This gentleman proposes to give it the name of "thermo-zoophite." On mentioning this circumstance and describing the phænomenon afterwards to that eminent botanist Dr. Joakim F. Sçhoüw, (the intimate friend of the late Dr. Smith of Christiana, who perished in the unfortuate expedition to the Niger,) he told me that it was his opinion it might be the *oscillatoria thermale* discovered by Adanson in some of the thermæ of France, and that he had himself noticed a substance somewhat similar above the thermal springs of *San Filippo* near to *Acquapendente*. This strange substance, he added, contains transverse striæ, which present under the lens an oscillatory movement; and hence the name.

I may add to this, that Dr. S. said he had discovered in the crater of Mount Etna in a sulphury vapour, at a temperature of 40° Reaumur (90° Fahr.), two plants, one an *alga*, the other a *hypnum*. The first seemed a plant in its simplest form, consisting of globules which appeared still transparent under the lens.

I shall in a future number of the Philosophical Magazine continue my observations on aphlogistic phænomena; meantime I only add, that I could not obtain the effect with *artificial camphor* (obtained by passing a current of muriatic gas through spirits of turpentine). A *sulphur* match does not ignite on contact with the platinum aphlogistic lamp, but instantly at that of silver; indeed in the first instance it is necessary to attach a small piece of amadou to the match. This is curious,—A body exists in such a state of combustion as not to ignite a particular substance, yet imparting to an intermediate one a degree of ignition capable of producing the effect. The matches prepared with oxymuriate of potassa kindle at either of these lamps. I succeeded most readily with the copper wire when I dissolved a little camphor in the alcohol. I have the honour to be, Sir,

Your most humble servant,

J. Murray.

P.S. By a typographical error the word *surprise* in my last memoir is made to substitute *scepticism*. J. M.

---

## LXI. *Analysis of the Chalybeate Spring at Thetford. By Mr.* Fredrick Accum.

### *Situation of the Spring.*

The water rises in a verdant meadow, situate at the east end of the town, in the Suffolk part of Thetford, near the paper-mills of Messrs. Munn.

The situation of this spring appears to be in one of those choice

 spots

spots that are said to be particularly favourable to the curative effects of medicinal waters. The land around the town as it recedes from the spring consists chiefly of fields richly variegated, here and there interspersed with gardens and houses, which in point of taste and elegance may vie with any modern buildings whatever. The uncommon fertility of the soil and romantic scenery, which are equalled by few in the kingdom, present a picture dear to the man of rural taste, as well as to the invalid. The upper strata surrounding the town of Thetford on the Norfolk side consist of chalk, and those of the Suffolk side of a dry gravelly mould. The heaviest rains that fall here cannot prevent the exercises of riding or walking for any length of time after they have ceased. The river called the Little Ouse sports itself with many turnings and windings near the spring; it abounds in fish, and permission of angling is seldom refused. The surrounding country abounds with game.

*Further Particulars concerning this Spring.*

At what period the Thetford chalybeate spring and its virtues were first discovered cannot now be ascertained.

From a memoir published in 1818, by the reverend H. C. Manning, minister of St. Peter's church at Thetford, respecting this mineral spring, it is evident that this Fountain of Health was known and analysed by Matthew Manning, physician of Thetford, in the year 1746. The analysis of Dr. Manning was added as an Appendix to his large treatise on the application of mineral waters to the cure of chronic diseases*, the first precise dissertation on that subject † which 'having been composed in the language then common to all scholars, (the Latin,) has not obtained the publicity due either to the subject, or its own intrinstic merits. —We shall therefore preface some extracts from this work by observing, that the spring having obtained a short-lived celebrity by the Doctor's recommendation of its use, was from no failure of its own, but from various causes not now worth detailing (and assuredly not from *one*—which has been invidiously assigned—*that* of medical illiberality)—again closed up; till a happier spirit of research seems once more likely to liberate it from obstruction, and to diffuse those benefits it is so well calculated to ensure.

To promote this desirable end, it has been deemed expedient to lay before the public some translated extracts from the above analysis; prefacing them with some part of the dedication of the above work to the mayor and body corporate of the borough, whom the Doctor thus addresses:

* Aquæ minerales omnibus morbis chronicis medendis, &c.

† Copied from the Reverend M. Manning's Memoirs.

"It

"It was my intention, respected sirs! in the following analysis, so to investigate the contents of your admirable spring, and to establish its virtues on the principles of sound science, that no one should, henceforth, presume to refuse them his assent. This analysis has, happily, succeeded beyond my utmost expectations; having most clearly proved these waters to *abound* in all those mineral substances required for the cure of *chronic complaints*, and consequently to be fully equal to any mineral waters either in this or any other country.

"I should not therefore think I had fully discharged my duty, without recommending them to your protecting care, &c.

"The bason itself of the spring, as well as the broken pavement, and decayed foundations of buildings around it—but covered over with soil, and not long since accidentally discovered by workmen on the premises,—indisputably prove that this spring was in frequent use in times long past. But if those who were unacquainted with the specific qualities of these waters, appear, by these works, to have paid such regard to the preservation of their sick; how much more attentive ought you to be, to whom these points have, after so long an interval, been ascertained by my labours and expense!

"A regard indeed for the general good, as well as of this place, has been my sole reason for publishing an analysis of these waters; which, if duly fostered by your protecting care, may assuredly contribute largely to the future opulence and respectability of the town of Thetford—to which I once more most heartily recommend them, and bid you farewell.

"Matthew Manning, M.D."

This analysis is closed by a detail of some cases, in which these waters were eminently successful.

Dr. M. Manning's analysis displays much chemical knowledge. He determined the most predominant constituent parts of the water with accuracy; but the science of chemistry at the time the analysis was made, was not sufficient to enable him to trace their true combinations. For it is particularly in such subjects as these, that the science of modern chemistry claims a precedence over the labours of our predecessors; in giving us a clear and accurate information as to the nature and quantities of all the foreign matters, the presence of which constitutes the difference between a common and a mineral water.

There is no department of analytical chemistry to which a greater acquisition, in point of real matter of fact, has been gained during our own times; and in proportion to this acquisition of knowledge, has the chemist been able to throw much light on the true constitution of mineral springs,—a subject which has always attracted a very large share of attention, and exercised the abilities

lities and skill of some of the most eminent men that chemistry has to boast of. Hence the records of the older experimenters must, like all those that have been superseded by a fresh acquisition of knowledge, be consigned to an honourable repose.

*Physical Properties of the Water.*

The water taken fresh from the basin of the spring is as transparent as rock crystal, and perfectly colourless. Its taste is distinctly chalybeate, and by no means unpleasant. It exhales, when minutely examined, an odour resembling the smell of iron when rubbed in contact with moisture.

The temperature of the water before it reaches the air, is invariably ten degrees below the temperature of the surrounding atmosphere. It is therefore one of those springs which lie so deep in the bowels of the earth, that it can neither be influenced by the scorching sun-beams of the summer, nor by frost in winter.

A large quantity of air-bubbles are frequently seen to ascend from the bottom of the spring, to pass through the water without being absorbed by it, and break as soon as they reach the surface; and a thin column of steam generally hovers over the surface of the spring during the cool of the morning and evening.

The water incrusts the stone reservoir at the part where the air touches the water, as well as the channel through which it flows, with a yellow brown precipitate. The quantity of water afforded by the spring amounts to nineteen gallons in an hour. The specific gravity of the water is as 279 to 277.

The water taken fresh from the spring after having been exposed to the open air for a few hours becomes turbid; a few air-bubbles are disengaged; and in twenty-four hours a precipitate becomes deposited.

If a bottle be filled with the water at the fountain head, and immediately well corked and sealed, the water may be kept unaltered for about two or three days, but in four or five days it becomes sensibly turbid.

*Examination by Reagents.*

*Exp.* 1. — To a tumbler full of distilled water was added blue tincture of cabbage, to impart to it the slightest blue tint that could be distinguished when the glass was placed between a sheet of white paper and the eye.

*Exp.* 2.—A like quantity of tincture of blue cabbage was added to a similar quantity of water taken fresh from the spring. On viewing both tumblers against a sheet of white paper, the water of the spring appeared distinctly red, the former blue.

*Exp.*

*Exp.* 3.—When the water of the spring had been boiled, it did not produce this reddening effect with blue tincture of litmus.

*Exp.* 4.—Six cubic inches of lime-water added to ten of the water of the chalybeate spring, produced a white precipitate, which disappeared by the admixture of muriatic acid.

*Exp.* 5.—Crystallized hydrate of barytes produced a copious precipitate both in the fresh water, and in such as had been concentrated by evaporation. The precipitate was not soluble in muriatic acid.

*Exp.* 6.—Oxalate of ammonia produced much cloudiness both in the fresh and in the boiled water.

*Exp.* 7.—Nitrate, sulphate and acetate of silver produced in the fresh and in the boiled water much cloudiness—which did not disappear by the addition of nitric acid.

*Exp.* 8.—Two grains of acetate of barytes rendered eight cubic inches of the chalybeate water turbid. The filtered fluid afforded with acetate of silver a copious precipitate.

*Exp.* 9.—Tincture of galls produced with the fresh water a purple hue. Water concentrated by boiling was not affected by this test.

*Examination of the gaseous Contents of the Water.*

Nine hundred and twenty-four cubic inches of the chalybeate water were introduced at the fountain head into a retort connected with a mercurial pneumatic apparatus. The water was made to boil, and the gaseous products collected in the usual manner.

After the apparatus had again acquired the common temperature, barytes water indicated 48·28 cubic inches of carbonic acid gas, of which 12·7 are contained, therefore, in one gallon of the water.

The residuary gaseous fluid, on being examined by the test of phosphorus, was found to be composed of 1·21 of oxygen and 3·04 atmospheric air.

*Analysis.*

*Exp.* 1.—Four gallons of Thetford chalybeate water being evaporated in an earthenware vessel, placed in a baker's oven, to dryness, afforded a brown mass of a slightly saline taste.

*Exp.* 2.—This product was levigated and digested in alcohol filtered, and the insoluble residue put aside for further examination. The alcoholic solution mingled with a small quantity of water, became turbid by the addition of sulphate of silver; and phosphate of soda in combination with carbonate of ammonia produced with it much cloudiness.

*Exp.* 3.—The mass which had been repeatedly acted on by alcohol was boiled first in eight parts of water, and this solution was put

put aside; and then in eighty times its weight of distilled water. The insoluble residue was soluble in muriatic acid.

*Exp.* 4.—The muriatic solution was mingled with nitric acid and evaporated to dryness, heated red hot, and again dissolved in a small portion of muriatic acid. It afforded by liquid ammonia eight grains of oxide of iron, which indicate 2·75 grains of carbonate of iron in each gallon of the water.

*Exp.* 5.—The alcoholic solution (Experiment 2) having been suffered to stand exposed to the open air for twelve days afforded a crystalline mass. The uncrystallizable portion was mixed with sulphuric acid, and heated till the colour of litmus paper employed for covering the basin in which the process was conducted, did not suffer a change of colour. The solid residue was digested in a small quantity of water, and the insoluble part separated by the filter. The soluble portion was decomposed by subcarbonate of potash;—the precipitate afforded with muriatic acid thirteen grains of muriate of magnesia; therefore 3·25 grains of this salt were contained in a gallon of the chalybeate water.

*Exp.* 6.—The insoluble residue of Experiment 5, after being boiled in a solution of subcarbonate of potash, became readily soluble in nitric acid. This solution was decomposed by subcarbonate of ammonia, and the product, after being mingled with muriatic acid, again evaporated to dryness, and strongly heated, gave 2·25 grains of muriate of lime to a gallon of water.

*Exp.* 7.—The analysis being thus far conducted, an alcoholic solution obtained as before stated, and equal to that operated on, was evaporated to dryness—covered with sulphuric acid, and again evaporated to perfect dryness. This mass digested in a small quantity of water afforded copious crystals of sulphate of magnesia. The residuary insoluble substance was soluble by boiling in water, and decomposable by nitrate of barytes,—and lastly, a similar alcoholic solution was mixed with muriatic acid, and decomposed by subcarbonate of potash, and the product heated to redness. Thus carbonate of iron and the muriates of lime and magnesia were clearly established in the water.

*Exp.* 8.—The first portion of the aqueous solution obtained in process 3, after being concentrated to a bulk of five cubic inches, was not affected by muriate of platina nor oxalate of ammonia. It was diluted with alcohol, which occasioned a crystalline precipitate to fall down. The remaining fluid was evaporated, and attempted to be crystallized. The salt produced being muriate of soda, was dissolved in water together with the saline mass obtained in process 5, and decomposed by nitrate of silver. The precipitate produced, taking 235 grains of muriate of silver to be equal to 100 of muriate of soda, indicated 2·125 muriate of soda in one gallon of the water.

*Exp.*

*Exp.* 9.—This fluid being completely freed from muriate of soda, and highly concentrated, was decomposed with subcarbonate of potash. It yielded a copious white precipitate, which, after being thoroughly ignited, gave 1·25 grain of sulphate of magnesia (taking 136·68 of magnesia to be equal to 100 of sulphate of magnesia) to be present in one gallon of the water.

*Exp.* 10.—The dilute fluid obtained in process 3, yielded a precipitate by oxalate of ammonia and nitrate of barytes; and being on a further examination found to contain nothing but sulphate of lime, it was decomposed by barytic water; and taking 100 parts of sulphate of barytes to be produced by 71 of sulphate of lime, gave three grains of sulphate of lime to one gallon of water.

The composition of the Thetford chalybeate water is therefore as follows:

*Contents in one Gallon.*

| | |
|---|---|
| Carbonate of iron .. .. .. .. | 2·75 grains. |
| Muriate of magnesia .. .. .. | 3·25 |
| Muriate of lime .. .. .. .. | 2·25 |
| Sulphate of magnesia .. .. .. | 1·25 |
| Muriate of soda .. .. .. .. | 2·125 |
| Sulphate of lime .. .. .. .. | 3 |
| | 14·625 |

| | |
|---|---|
| Carbonic acid gas .. .. | 12·07 cubic inches. |
| Oxygen gas .. .. .. | 1·21 |
| Atmospheric air .. .. | 3·04 |
| | 16·32 |

## LXII. *On the Insulated or Safety Compass lately invented by Mr.* Jennings. *By* James Horsburgh, *Esq. Hydrographer to the Honourable the East India Company.*

*To Mr. Tilloch.*

Dear sir,—As the pages of the Philosophical Magazine are always open to give publicity to the labours of those who are gifted with superior talents, I trust you will be able to afford room for a few observations on the *insulated* or *safety* compass, lately invented by Mr. Jennings, which is not yet sufficiently known, although it will probably add greatly to the security of navigation and commerce, when brought into general use.

Several men of science have been convinced, by attending to experiments made by Mr. Jennings, and his liberal explanation, that he has discovered a method of arresting the progress of the magnetic fluid, and securing the magnetic needle from being disturbed

disturbed by the contiguity of small pieces of iron, such as have been liable to disturb the mariner's compass hitherto, and have often led to the loss of much property and many valuable lives. This discovery seems capable of further extension; for the needle can be protected from the influence of *large masses* of iron, or even from the *local* attraction of all the iron in a ship:—but this cannot be effected without considerable expense, and it would not be of general utility; whereas the protection of the needle from the influence of *small* pieces of iron must be always useful, and afford great comfort to those intrusted with lives and property when navigating in narrow seas or dangerous situations.

Capt. Dunbar, an experienced seaman, who was many years a master in the royal navy, and now commander of the Brassa, lately arrived from Smyrna, had one of the insulated compasses in that vessel during the voyage, of which he writes in the highest terms in a letter to Mr. Jennings, stating that it was not attracted by iron, although part of the frame, beams, bitts, cables, and cargo of the Brassa, consisted of iron. During his stay at Malta, Admiral Penrose sent for the compass, and tried it against a large magnet which would lift forty-two pounds of iron by its attractive power, but it did not influence the compass materially. This circumstance induced the Admiral to say, he deemed it the most important invention that he had ever seen.

His Majesty's ship Isabella had one of the insulated compasses on board during the late exploration of Baffin's Bay, which obviated the effects of the local attraction of iron, although the needle of that compass was not so perfect as those at present constructed by Mr. Jennings, the result of experience and attentive observation. The ships which have lately sailed again for Baffin's Bay have been supplied by him with a great number of magnetic needles on a new and peculiar construction, from which it will probably be proved, that the needles which unite the figure of the horizontal and dipping needle, are those most proper for the purposes of navigation; and by the others, we may expect to gain more knowledge of the laws which govern the magnetic fluid, because in those regions it appears to act with increased energy, as if flowing from the immediate theatre or focus of magnetism. Several of these instruments I have seen; and the inventor, in the most candid and unreserved manner, gave me a satisfactory explanation of their principles,—which has convinced me of the wonderful fertility and originality of Mr. Jennings's mind; and to several experienced officers of the royal navy, and of the East India Company's service, as well as to myself, his inventions appear to be highly deserving of public encouragement; and it is to be hoped that the intrinsic value of the insulated

lated compass will soon bring it into general use, as an indispensable aid to the security of navigation.

Dear sir,

I am your obliged and faithful servant,

Hydrographical Office, East India House, May 15, 1819. JAMES HORSBURGH.

*** We have been informed, but we know not how correctly, that Mr. Jennings effects the insulation of the needle by inclosing it in a double case, having the space between filled with clippings of iron, previously heated, or, as it is called, *cemented* with red oxide of iron or hematite. If Mr. Jennings himself or Mr. Horsburgh will furnish us with the necessary particulars, we will cheerfully devote a portion of our pages to the making known more generally the nature and merits of so useful a discovery and application.—EDIT.

## LXIII. *Notices respecting New Books.*

*Remarks on the Account of the late Voyage of Discovery to Baffin's Bay, published by Captain J. Ross, R.N.* By Captain Edward Sabine, Royal Artillery. 40 pages, 8vo.

IN our last we noticed the work referred to in the title of this small publication, and justice demands that we should also notice the subject of the work before us. The author states the object of his pages to be, "to counteract the erroneous impression which a perusal of Captain Ross's recent publication might produce concerning the author's employments, services, and opinions during the voyage." "As Captain Ross's is not an official but a private work, I should," says Captain Sabine, "have been unconcerned had the mention of my name or occupation been even wholly unnoticed; but when I perceive that observations which I was sent to make are therein published as having been made or furnished by others, and various information copied from my papers is given as his own, whilst I am principally introduced as having held an appointment (that of Naturalist) the duties of which I am represented as not having fulfilled, but which duties formed no part of my official engagement; I am obliged in justice to myself, and in consideration of the respect due to the authority by which I had the honour of being recommended, to show the true nature of my undertaking, and that I have not failed in executing it; to claim the observations and information which are exclusively my own, and to remark on other points with which Captain Ross has connected my name."

The author shows, by a letter from Mr. Brande, writen by the direction of the President and Council of the Royal Society, addressed

addressed to John Barrow esquire, Secretary to the Admiralty, and inclosing a list of the instruments which they begged to recommend for the Northern Expeditions, that he was in the same letter recommended (not as Naturalist, but) as a proper person *to conduct the experiments* (with these instruments) on board one of the vessels.

The day after Captain Sabine's arrival in London, (Nov. 19, 1818) on the return of the Expedition, he was informed by Captain Ross that he (Captain Ross) had been ordered *to draw up an official account* of the voyage. Captain Sabine expressed his readiness to complete his papers, which were already in a state of preparation, and also to furnish information on every subject, whether connected with his duty or otherwise, which his knowledge or curiosity had enabled him exclusively to possess; adding that he would accept no share of the emoluments arising from the sale of the publication.

Learning a few days afterwards from the Secretary to the Admiralty, that the Board had decided that no account should appear under the sanction of their authority, and had resolved to return the journals and papers to the individuals who had contributed them, with liberty to make them public in any way they might prefer, Captain Sabine wrote a letter on the 7th of December informing Captain Ross of what he had learnt; and that he had thoughts, in consequence, of publishing a short narrative of the voyage.

It does not appear that any answer was received; but, a few days after, it came to the author's knowledge, that Captain Ross was at press, "and had already printed observations which he (Captain S.) knew could only have been his." "I immediately wrote to him (says Captain S.), stating what I had heard, and remarking that, if he had got any papers of mine from the Admiralty office, their contents were not complete, nor in a state to meet the public eye; but that, if the Admiralty had given him any of my papers, I had no objection to prepare them for publication and return them."

Captain Ross sent him "one paper, and only one—an abstract of the observations which Captain S. had made on the ship's daily lat. and long. by each of six chronometers and their mean." Captain Ross had obtained this document out of the Hydrographic office. "It had been printed from." The author recalculated the results, making a few alterations, and returned them; prefixing an account of the going of the six chronometers, which he had under his charge during the voyage.—The acknowledgement of these observations is contained in the following letter:

"Dear Sir,—Herewith you will receive for correction the proof sheets of the observations which you sent me for publication,

tion, and which I have to beg you will be pleased to return to Mr. Murray when corrected.—And I shall be obliged if you will send me as soon as possible, and in a state for publication, any other observations you may have made during the late voyage, relative to the various objects of the Expedition or those branches of science in which you were employed, viz. the variation and inclination of the magnetic needle, intensity of magnetic force, refraction, aurora borealis, and figure of the earth as determined by observation on the pendulum, that I may have the pleasure of giving them a place in my publication, which is now in a forward state. I am, &c.,

"London, 12th February, 1819." JOHN ROSS.

The author's answer was in substance, "that the reports on these subjects had been sent to the Royal Society at the instance of the Admiralty; and that any which were deemed worthy of being recorded would be printed, he presumed, in the Philosophical Transactions (in fact, they were at this time under examination of a Committee of the Royal Society); that if the Admiralty had given the reports to him, and had wished them to form a part of his publication, he would readily have completed them for that purpose. On receiving this reply Captain Ross returned the manuscript which had been sent him, and remarked, that as he had not the whole of Captain Sabine's observations, he could not think of publishing *any part* of them."

"On the appearance of Captain Ross's publication I perceived (says the author) that it contained observations which I had exclusively made on various subjects, printed not indeed under my name, but under that of Mr. James Clark Ross, nephew to Captain Ross, a midshipman of the Isabella. I immediately requested an interview with Mr. James Ross, and in the presence of the officers commanding the Hecla and Griper, the two ships now fitting for a new Expedition, and of Mr. Hooper, one of the officers of the Hecla, called on him for the disavowal which follows:

"March 28th 1819.—Questions put by Captain Sabine to Mr. James C. Ross in presence of Lieutenants Parry and Liddon and Mr. Hooper of the Royal Navy, with Mr. James C. Ross's answers.

"Q. In the Appendix of Captain Ross's Account of a voyage of discovery are inserted 'Observations on the Pendulum,' with a memorandum stating '*that these observations were furnished by Mr. James Ross.*' These observations being mine, and the account of them having been copied from my papers, I call on you to disavow them, and to state how and when you became possessed of what has been printed as furnished by you?

 "A.

"A. I copied them from your papers during the voyage, by your permission.

"Q. In the Appendix is also given 'A Table showing the magnetic dip and intensity of the magnetic force, furnished by Mr. James Ross, who with Captain Sabine was employed particularly to make these observations.' I call on you, as an officer and as a gentleman, to state whether any of the observations contained in that table were made by you; whether you ever made any observations on the dip or force; and how and when you became possessed of the 'Table' printed by Captain Ross?

"A. I never did make any observations on the magnetic dip or force, and I copied that table from your papers by your permission during the voyage.

"Q. Did you not when at or near Shetland, on our return home, copy my Meteorological register for Captain Ross, at his request and by my permission; being the same register that is engraved in plates in Captain Ross's book, and which was the only one so kept in the Isabella?

"A. Yes, I did.

"(Signed) EDWARD SABINE.
JAMES CLARK ROSS.

"In presence of William Edward Parry.
Matthew Liddon, and
William Hooper."

The author pays a just tribute to Mr. James Ross for his manly and honourable disavowal of the use which had been made of his name. "I have only to add," he continues, "concerning the magnetic observations, that they are incomplete, imperfect, and printed incorrectly; that those on the pendulum are useless in their present state, as every person who understands the subject will perceive. I have however no reason to be ashamed of the manner in which even my rough memoranda on the spot were made; a state in which I little expected they would appear before the public. I have also to appropriate and to acknowledge the compliment which Captain Ross has paid to the care and attention with which the meteorological tables, which have been published by him, were kept.

"Amongst the papers which were placed in Capt. Ross's hands on our arrival in England, to be transmitted by him to the Admiralty, was one on the language of the Esquimaux who reside to the north of the latitude of 76°. When my journal was returned from the Admiralty, I noticed the absence of this paper. But as it was on a subject on which I was not officially employed, and as I had retained a copy of it, I did not give trouble by representing that it was missing; but I had it in view, when I wrote

wrote to Captain Ross, to request that he would give me an opportunity of correcting any thing he might design to publish as mine or on my authority.

"On the appearance of Captain Ross's book I perceived that he had appropriated this paper; much of the information contained therein being published, not only without acknowledgement, but in the first person. Page 121, 122, 123, 132, are copied almost verbatim from this document; wherever he has ventured upon apparently even a trivial change of expression, he has fallen into error, which betrays the want of originality. I give an instance of this:—Where he is speakiug of an animal called the *amarok*, (mis-printed *ancarok*) he remarks, 'I cannot find it to be *mentioned* by writers on Greenland.' The original sentence was, 'I have never seen a *description* of it by writers on Greenland.' The change is unfortunate; it is *mentioned* both by Crantz and Egede, writers whose works were on board; but it is not *described* by either, for they had only heard of its existence from Esquimaux."

Captain Ross had returned, as already noticed, the observations which Captain S. had sent him on the ship's daily latitude and longitude, with an account of the going of the chronometers; "not however (according to Capt. S.) until he had used the latter in making up an account which he has published as his own." Capt. S. produces evidence of this, and then proceeds—"This one fact is proof sufficient, that although Captain Ross would not publish the account I had sent him, 'because he had not all my observations,' he still would and did use it to make up one which should appear his own. But in altering it for this purpose, he has introduced mistakes and contradictions which destroy the whole."

"Capt. Ross having thus availed himself so extensively of my papers and observations in making his book, I might have expected in ordinary courtesy to have been well spoken of by him, rather than otherwise. He could not indeed conveniently have returned me acknowledgements for papers which he preferred should appear under another name; but it certainly renders it the more unreasonable, that he has gone out of his way to make me 'a Naturalist' for the purpose of showing by my note that I considered my pretensions to that honour as very slight. That Captain Ross was under no mistake as to the true nature of my official duties is shown in his letter of the 12th of February (I beg the reader to refer to it). It is Captain Ross's own testimony, that long after the voyage was over, so far from being in error as to my appointment, he enumerates, rather minutely indeed, the branches of science on which I was actually employed, and *does not even mention Natural History amongst them.* The

 letter

letter also states that Captain Ross's publication was then, (*i.e.* on the 12th of February) 'in a forward state.' Accordingly it appears on a reference, that in all the early part of his book I am mentioned as engaged in my own proper occupations, until the 117th page, when I am first introduced as 'Our Naturalist;' which situation is allotted to me during the remainder of the book; whilst others are stated to have performed the services which were exclusively my duty and my performance. I conclude, therefore, that on the 12th of February Captain Ross had not reached his 117th page; but from thenceforth, having a disposition to exhibit me to a disadvantage, and searching in vain for an opportunity in what I was sent to do, he was forced to make an occasion, in misrepresenting me as 'the Naturalist of the voyage,' which he well knew I was not."

Captain Sabine's labours even in that line which was not assigned to him are sufficiently attested by the following letters.

"From Mr. Konig.

"British Museum, April 10th, 1819.

"Dear Sir,—I have great pleasure in certifying that you was the first who sent to the British Museum a small but interesting collection of specimens, as results of the mineralogical researches made in your voyage to Baffin's Bay. It is but justice to add, that the respective localities of these specimens were carefully set down by you, and that you had no objection whatever to my showing them to any body who might wish to draw up an account of the Geology of the Arctic Regions where they were collected. I remain, dear Sir, very sincerely yours,

"Captain Sabine. Charles Konig."

"From Dr. Leach.

"British Museum, April 2d, 1819.

"I seize this opportunity to again thank you for the zeal and kindness with which you attended to my request, to collect such marine animals as might fall in your way; and when I consider how much you were occupied with the more important duties of your profession, the result has far exceeded my most sanguine expectations. You must recollect that you gave me permission in December to send a descriptive catalogue of the objects collected by you to Captain Ross, but I was at that period too much engaged to be enabled to send more than a very hasty sketch.

"In haste, your obliged and faithful,

"William Elford Leach."

And the public have a right to infer that Captain S. would have laid them under still greater obligations, but for the sapient order issued by Captain Ross (and published by himself in his 235th page) which forbade any person to collect but himself!

The following evidence of the manner in which Captain Sabine

bine is considered to have fulfilled his engagements is highly creditable.

"*Extract from the Minutes of the Royal Society, March* 18th, 1819.

"The following Report from the Committee for ascertaining the length of the Seconds Pendulum was read.

"It is the opinion of this Committee, that Captain Sabine has shown the greatest possible diligence in making the observations which were intrusted to his care, and the greatest judgement and regularity in his method of recording them; and this Committee therefore suggests the propriety of recommending Captain Sabine to the Admiralty in the strongest manner, both as deserving every professional encouragement, and as a proper person to be again appointed to take charge of the observations to be made in a new Expedition.

"At the same time the Committee cannot help expressing great regret that the opportunities afforded for Captain Sabine's Experiments on the Pendulum were so much limited by the shortness of the time allowed him at the different stations, and their wishes that this inconvenience should be remedied by the arrangement to be adopted on any future occasion.

"Resolved,—That the Council do approve and adopt the above Report.

"Ordered,—That a copy thereof be transmitted to the Admiralty."

We have felt an uncommon interest in this short but interesting statement, which has induced us to notice almost all its points; but we hesitate not to encroach still further on the reader's time, to notice one of the principal objects for which this expedition was undertaken, and the precipitation with which it was abandoned at the most promising spot that had occurred during the voyage—we mean in Lancaster's Sound. We shall give this most important part in Captain Sabine's own language:

"In Captain Ross's account of his proceedings in Lancaster's Sound my name is twice introduced, and obviously for the purpose of supporting the propriety of his conduct in not prosecuting the examination of the inlet; the inferences which are designed to be conveyed being, that he consulted with me, and that my opinion coincided with his, that it was unnecessary to go further.—An importance is here attached to my opinion, which did not show itself at the time, or during the voyage. Captain Ross was accustomed to act solely from his own judgement; he formed his plans and executed them without a reference to any person; he certainly at no time placed his confidence in me; he never showed me his instructions; consequently I need hardly add that he never consulted me as to his conduct under them.

 "But

" But I can do more than assert this—I can appeal to a letter which he wrote to the commander of the Alexander but a very few days before we arrived off Lancaster Sound, in which he expressly states that ' he always acts on his own opinions, being alone responsible—that he has never been led by any one's else—nor shall any one else share the blame, should any ever be attached to his proceedings.' When he thus professed that he would not avail himself of the judgement of his second in command, it is not probable that he should have consulted with a person whose employment was quite distinct from the nautical conduct of the expedition: and in point of fact he did not.

" But although my opinion was not asked whether I thought the inlet sufficiently explored or not, I should not have noticed the statement if it were a just one; but as it is not so, and as I did not consider the examination as satisfactory, being even greatly disappointed by our not proceeding further, I owe it to myself not to permit the following passages to pass unnoticed.

" The first occurs in page 171: ' Captain Sabine, who produced Baffin's account, was of opinion that we were off Lancaster's Sound, and that there were no hopes of a passage until we should arrive at Cumberland Strait; to use his own words, There was no indication of a passage—no appearance of a current—no drift wood—and no swell from the north-west.' I shall not detain the reader by questioning words which can only have had a foundation in some casual conversation; but content myself with referring to the time at which such conversation is stated to have taken place, ' when we were *off* Lancaster's Sound,' that is, *before we entered it*. We were in the Sound early in the morning of the 30th of August, and proceeded to sail into it until the evening of the following day, an interval in which encouragement to our progress westward opened beyond the expectations even of the most sanguine persons on board. Moreover, to what do the expressions amount?—To the absence of certain indications which every person knows are not conclusive; and to the speculations of an individual before the ships had even entered the inlet!

" The second sentence is in page 184: ' My opinions were mentioned to several of the officers after I had determined to proceed to the southward, and also to Captain Sabine, who repeated on every occasion that there was no indication of a passage.'

" The first knowledge which I had of Captain Ross's intention of quitting Lancaster's Sound was from the officer of the watch, who came down into the gun-room where I was sitting about 7 P.M. and said that the ships were making all sail out of the inlet. I asked the reason, and was answered, ' The Captain says he saw land when we were at dinner.'

" We

"We had a long run that night, with a fair wind, which took us far out of the inlet. Captain Ross states that 'his opinions were mentioned *after he had determined to proceed to the southward.*' They were so, but not until long *after he had executed his determination;* for it was not until the 1st of September, when we were out of Lancaster's Sound, and on our way down the coast, that a conversation took place between Captain Ross and myself on the subject. The purpose of this conversation was not to consult about quitting a sound which we had already left;—it was not to inquire whether I thought Captain Ross had done right or wrong in leaving it;—it was not to learn whether I agreed with Captain Ross that a passage could not exist, because he well knew that I had not seen the continuity of land, the only *decisive* proof; and that as he was the only person who had, I could form no opinion until I heard the particulars of what he had seen, and which I did not do until in that very conversation. I could know nothing but from what he should say; I had not seen any land in the direction of the inlet; I should have been very happy to have been an evidence of its existence, and to have judged for myself on so important an occasion, in preference to depending on the account of another person. But I was not on deck when the land is stated to have been visible, nor was I informed until nearly four hours afterwards that such an occurrence had taken place. It was not necessary that I should be informed of it. It is true, Captain Ross had directed that 'Captain Sabine be called whenever any remarkable object is to be seen in the *sky* or *water*,' (General orders, Nov. 8.) but I had not been called on this occasion, and therefore lost the sight of two very remarkable objects, namely, the ice in Lancaster's Sound, and the range of lofty mountains at its bottom.

"The conversation alluded to, was occasioned by my very visible mortification at having come away from a place which I considered as the most interesting in the world for magnetic observations, and where my expectations had been raised to the highest pitch, without having had an opportunity of making them. Captain Ross explained to me his reasons for not having stood on in the inlet, amongst which reasons one was his opinion that there was no passage. He said that he was directed to keep at a distance from land, and not to entangle himself in sounds where he did not find the strong current which his instructions pointed out as an indication of a passage. He said, 'You saw there was no appearance of such a current, no drift wood, which people at home talked of.' I assented to the observation inasmuch as it related to facts. He further explained, that scientific observations were considered in his instructions as very secondary; and however desirous he might be to stretch a point in my favour, he could not act in the face of his orders with such bad sailing ships and so late in the season. Of course I made no reply; these were matters for his judgement, not for mine, and I was obliged to content myself under my disappointment. I took the opportunity, however, of asking Captain Ross concerning the land which he had seen the day before, the particulars of which he recounted; but made no inquiry what I thought of them.

"It remains for me to state the opinion that I did form, and to justify it; not from any importance which I attach to it,—because however persons may differ as to whether Lancaster's Sound was or was not sufficiently explored by Capt. Ross, there can be little doubt but that it will be most satisfactorily examined by the expedition which is now preparing,—but, as a reference has been made to my opinion, it is but justice to myself to make known what it really was. Of Captain Ross's conduct I did not judge, because I did not know what his orders were: but presuming that the object of the voyage was to ascertain whether there was or was not a north-west passage, I considered direct and absolute proof of the continuity of land as the only decisive evidence of its impossibility, and as the evidence which the public would expect.

"Had we indeed found a strong current, or drift wood, I should have deemed them very hopeful indications; but their absence proved nothing; and an inlet with shores wider apart than those of Behring's Straits, with a depth of water exceeding 600 fathoms when above 30 miles from its entrance, an increased temperature of the water*, and an open sea, were encouragements to our progress westward, presenting themselves after we had entered the inlet, which rendered the absence of what are popularly called indications of a passage, of less comparative importance even than usual.

"For the particulars of this land, which stands alone to prove that the expectations so generally excited in Lancaster's Sound were fallacious, I was necessarily wholly dependent on Captain Ross. Even when he related them to me, I did not think them conclusive; and the more I considered them, the more strong my conviction grew, that Lancaster's Sound, as well as many parts of the coast which we had passed before, would be revisited."

The remaining part of this little work points out some differences between Captain Ross's printed account and his previous verbal statements respecting the land seen *by him*, and its distance; and showing from Captain Ross's log, and those of the

* The temperature of the surface of the sea had averaged 31° and 32° for a considerable time previously. When we opened Lancaster's Sound it became 36°, and continued so, generally, whilst we were in the sound.

lieutenant

lieutenant and two midshipmen, that the land, according to its bearing, could not connect the north and south shores of the inlet by more than 30 degrees of the compass.

Captain Ross, in p. 185, expresses regret that the dip of the needle was not determined at Possession Bay; and in p. 177 assigns as the cause, that " Captain Sabine thought the weather too foggy for the dipping needle."—" This statement," says Capt. Sabine, " is incorrect. So far from having said or thought so, I asked Captain Ross's permission to take the dipping needle on shore; and was refused, on the ground that the boats were only to remain for a few minutes on shore to take possession of the country, and that he did not wish them to be detained by observations." We shall make but one quotation more.

" In page 98, Captain Ross regrets that ' Captain Sabine and the party who had on the morning of the 9th landed on that which Mr. Bushnan had determined to be an island, had not proceeded further, and that they did not examine the mountains where it now appeared that this iron was found.' Captain Ross has omitted to state that Captain Sabine and the party who were with him on this island on the evening of the 8th (it was not the morning of the 9th, as we were on board and under way before midnight) returned *in consequence of a signal of recall*, and were told on their return that by being away so long they had detained the ships."

We are happy that a new expedition has been resolved on, to procure more certain information: for we have learnt nothing certain respecting Lancaster's Sound from Captain Ross's work.

---

*Journal of a Voyage of Discovery to the Arctic Regions*, performed between the 4th of April and the 18th of November 1818, in His Majesty's ship Alexander. By an Officer of the Alexander. 112 pages octavo.

This is a plain unvarnished narrative of what the author witnessed during the voyage, and should be seen by all who have read Capt. Ross's splendid volume. The following extracts may serve also as a specimen of the author's style, and are interesting as relating to the point at issue between Capt. Ross and Capt. Sabine concerning Lancaster's Sound—Was it, or was it not sufficiently explored to decide whether there is no opening through to the westward?

" At 8 o'clock, P.M. (Saturday, 29th July) extremes of the land from N. E. by E. to N. by E. ½ E., the land trending here S.E. by E. and N.W. by W. Another part of the land, high and rugged, W.N.W. by compass: the nearest part of the land distant six or seven leagues. About two hours before these bear-

ings

ings were taken, we sounded in one hundred and ninety-five fathoms, sand and small stones.

"From the latitude we are now in, we have reason to suppose that the opening, or inlet, between N. by E. ½ E., and the land to the southward, bearing W.N.W. is the entrance of Baffin's (Sir James Lancaster's) Sound; and if we may venture to question the authority of that navigator, respecting his having seen the bottom of this inlet, or, as he calls it, I suspect gratuitously, 'sound*,' it certainly has more the appearance of being the entrance of the wished-for straits than any place we have yet seen. In the first place, the sea is perfectly clear of ice; and, secondly, the water is warmer than we have found it since the 7th instant, being 36° at the surface, and 31° at the bottom. The swell of the sea, the breadth of the opening, and the depth of the water, are all flattering appearances; independently of which, we are not at a great distance from where the sea was seen by Mr. Hearne, at the mouth of the Coppermine River.

"On the morning of Sunday, the 30th, the wind being from the eastward (by compass), we stood into the inlet abovementioned, and the more we advanced, the more sanguine our hopes were that we had at last found what has been for ages sought in vain. Every thing, indeed, tended to confirm this our belief: at noon we tried for soundings with two hundred and thirty-five fathoms of line, without finding bottom; and in the evening, when the sun was getting low, the weather being remarkably clear, we could see the land on both sides of the inlet for a very great distance, but not any at the bottom of it. The bearings taken of the extremes of the land at this time are as follow:

"'At 6 P.M. fresh breezes and cloudy weather. Northern land of the inlet from N.E. ¼ N. to E. by N. ¾ N.; cape bearing N.E. ¼ N. having a deep notch near the extremity. Southern land of the inlet from S.W. by W. ½ W. Strong appearance of land S.E. by S.'"

"'At 8, moderate breezes and fine weather, with as well from N.W.: tacked. Southern land extending from S.W. by W. ¼ W. to N.W. ½ W. The nearest part of it N.W. by W. distant nine or ten miles. The whole of this land high, with many pointed hills, much covered with snow, and several large glaciers on it; this part of the coast appearing to trend about N. ½ E. and S. ½ W. the northern land, beginning with the Cape before

* Indeed, although he calls it a sound, his own words do not imply that he saw the bottom of it. They are as follow. "On the 12th day we were open of another sound, lying in the latitude of 74° 20′ N., and we called it Sir James Lancaster's Sound. Here our hopes of a passage began to be less, &c."

mentioned

mentioned as having a remarkable notch in it, N. 44° E. to E. by N. ½ N. Perceived the deviation of the compasses to be one point from one tack to the other.'—*Alexander's log.*

"The land on the south side of the inlet was high, and full of sharp-pointed hills, which were completely covered with snow, having an appearance unusually grand. In the vallies there were several large glaciers. The coast appeared to trend W. by S. (true.) The land on the north side did not appear to be either so high or so rugged as that on the opposite side, its western visible extremity being bounded by a cape, or headland, with a notch in it. This headland bore about N. 62 W. (true.) The other extreme of this land bore about N. 32 W. (true.)

"The breadth of the inlet was estimated to be from ten to twelve leagues. Our latitude, to-day at noon, was 74° 21′ 08″N. and longitude, by chronometer, 79° 01′ 46″ W. At night we saw several stars, for the first time since we crossed the Arctic circle. Although we hailed them at first as old friends, bringing into recollection the happy change of day and night in our native clime, still, on a little reflection, we could not fail to consider them as the harbingers of that dreary season which must, in a little time, suspend our researches in these regions, unless we should be so fortunate as to accomplish the object in view before that period arrives.

"The wind having been rather against us (N.N. W. by compass) during the whole of the night, we made but little progress; but on the following morning, the 31st, every thing tended, if possible, to increase our hopes. Not any ice was to be seen in any direction; and at seven o'clock, the weather being remarkably fine and clear, land was not to be discerned between N. 21° W., and N. 44° E. At this time, our distance from the northern land was estimated at seven or eight leagues, and from the southern, six or seven leagues; but, alas! the sanguine hopes and high expectations excited by this promising appearance of things, were but of a short duration; for, about three o'clock in the afternoon, the Isabella tacked, very much to our surprise indeed, as we could not see any thing like land at the bottom of the inlet, nor was the weather well calculated at the time for seeing any object at a great distance, it being somewhat hazy. When she tacked, the Isabella was about three or four miles ahead of us, so that, considering the state of the weather, and a part of this additional distance, for we did not tack immediately on her tacking, but stood on towards her, some allowance is to be made for our not seeing the land all around. Ocular demonstration would certainly have been very satisfactory to us, on a point in which we were so much interested; but we must be content,

tent, as there cannot be any doubt but that all in the Isabella were fully convinced of the continuity of land at the bottom of this inlet, or, as I may now venture to call it, agreeably to Baffin, 'sound.' In order to show the vacant space, or opening, where we did not see any land, a correct copy of the ship's log for this day is inserted in the Appendix. In this the different bearings, as well as the other nautical remarks, are noted in the order in which they were taken. Our latitude at noon, by account, was 74° 08′ 56″ N. and longitude, by chronometer, 80° 29′ 55″ W. At the time we tacked, namely, at forty minutes past three P.M., our latitude, by account, was 74° 14′ 50″, and our longitude, also by account, 81° 09′ 50″ W. This was our furthest progress west in the inlet, or sound."

We learn also from the work before us, that it was not at Lancaster Sound alone, that the fact of a north-west passage has been left in doubt. The following extract relates to what Baffin has called Sir Thomas Smith's Sound, which was visited by the ships previous to reaching Lancaster Sound:

"During the remainder of the day (Thursday the 20th of August) I passed the greater part of my time on deck, anxious to see whether the main land to the eastward, that is, the coast of Greenland, and that to the westward joined; but this I had not at any time the good fortune to see, although from ten o'clock until midnight the weather was remarkably fine and clear. It is probable that the chasm, or open space, to the northward, where not any land could be traced *by me*, might be that which Baffin calls Sir Thomas Smith's Sound; and if, agreeably to his relation, this is the 'deepest and largest sound in all this bay,' it is not likely that we should have seen the bottom of it at such a distance, as we estimate that we are twenty leagues from the northern extreme of the west land visible. By this estimation, the latitude of the northernmost land seen will be about 77° 39′ N. which is twenty-one miles on this side (to the southward) of where Baffin places the bottom of Sir Thomas Smith's Sound.

"Our latitude, to-day at noon, was 76° 40′ 52″ N., and at fifty minutes after twelve o'clock, A.M., being the time when we were furthest north, 76° 46′ 40″ N. Our longitude at that time, by account, was 73° 56′ W. The magnetic dip was taken on an iceberg in the afternoon, and found, by the mean of three observers, namely, Captain Sabine, Lieutenant Parry, and Mr. Bushnan, to be 86° 08′ 92″. They found also, at this iceberg, a tide setting E. by N. (true), at the rate of one mile per hour: it was ebbing, but fell an inch or two only at the time they were there.

"We found soundings at night in eighty-five fathoms. There was then a remarkable difference in the specific gravity of the sea-

sea-water, it being 1027·1 (temperature 42°), which is greater than we had found it since the fifth day of July.

"Between eleven and twelve o'clock, P.M. we made sail to the southward, and abandoned the search for a passage in this quarter, from a thorough conviction, I should hope, that not any such passage exists here. I am perfectly satisfied myself that this is not the place to look for it, although I must confess that I did not see the continuity of land all around the top of this bay, if it may be so termed; and, in order to show that I am not the only person who has been unfortunate in this respect, I have inserted, in the Appendix, an exact copy of the ship's log for this day, by which it does not appear that the land was seen all around at one time; neither, by a comparison of the bearings of the east land, and of the west, taken at different times, do they appear to meet."

---

*Mission from Cape Coast Castle to Ashantee, with a Statistical Account of that Kingdom, and Geographical Notices of other Parts of the Interior of Africa.* By T. Edward Bowdich, esq. Conductor. 4to, pp 512.

The Ashantees are mentioned by Bosman and Barbot as first heard of by Europeans about the year 1700; the latter calls it Ashantee or Inta, and writes that it is west of Mandingo, and joins Akim on the east: he asserts its preeminence in wealth and power. Mr. Dalzel heard of the Ashantees at Dahomey, as very powerful; but imagined them, the Intas, and the Tapahs, to be one and the same nation. Mr. Lucas, when in Mesurata, was informed that Assentai was the capital of the powerful kingdom of Tonouwah. In Mr. Murray's enlarged edition of Dr. Leyden's Discoveries in Africa, we find, "The northern border of Akim extends to Tonouwah, denominated also Inta Assiente or Assientai, from its capital city of that name, which stands about eighteen days' journey from the Gold Coast.

In 1807 an Ashantee army reached the coast for the first time, and did some injury to a Dutch settlement. The Ashantees invaded Fantee again in 1811, and a third time in 1816, and on each occasion inflicted the greatest miseries. The prolonged blockade of Cape Coast Castle, in consequence of this last invasion, led the English governor to represent to the committee of the African Association, the propriety of venturing an embassy to the kingdom of Ashantee, to conciliate the friendship of its sovereign, and establish, if possible, a commercial alliance. The suggestion was warmly taken up by the African committee; and in 1817, the store-ship which went out carried liberal and valuable presents, and every other authority and instruction necessary for the proposed mission. Mr. Bowdich was appointed conductor to the mission; and on the 22d of April it left Cape Coast Castle,

Castle, and proceeded to Annamaboe, whence it struck into the interior.

The account which Mr. Bowdich has now presented to the public of the progress and successful result of this mission is not only extremely satisfactory, but possesses a degree of interest and novelty not often equalled by books of travels. We propose in our subsequent numbers to gratify our readers with some valuable extracts from it on matters peculiarly within the sphere of this work; but at present we shall confine ourselves to a single extract from the chapter on the architecture of the Ashantees, which serves to show, as much as any other part of their domestic œconomy, the advanced state of civilization to which they have reached.

"The construction (says the author) of the ornamental architecture of Coomassie (the capital of Ashantee) reminded me forcibly of the ingenious essay of Sir James Hall (in the Edinburgh Philosophical Transactions) tracing the Gothic order to an architectural imitation of wicker-work. The character of their architectural ornaments is various and uncommon, adopted from those of interior countries, aud confessedly in no degree originating with themselves.

"In building a house a mould was made for receiving the swish or clay by two rows of stakes and wattle-work placed at a distance equal to the intended thickness of the wall, as two mud walls were raised at convenient distances to receive the plum-pudding-stone which formed the walls of the vitrified fortresses in Scotland. The interval was then filled up with a gravelly clay mixed with water, with which the outward surface of the frame or stake-work was also thickly plastered, so as to impose the appearance of an entire thick mud wall. The houses had all gable ends, and three thick poles were joined to each; one from the highest point forming the ridge of the roof, and one on each side from the base of the triangular part of the gable: these supported a frame-work of bamboo, over which an interwoven thatch of palm-leaves was laid and tied with the runners of trees, first to the large poles running from gable to gable, and afterwards (within) to the interlaying of the bamboo frame-work, which was painted black, and polished so as to look much better than any rude ceiling would, of which they have no idea. The pillars which assist to support the roof and form the proscenium or open fronts (which none but captains are allowed to have to their houses) were thick poles afterwards squared with a plastering of swish. The steps and raised floor of these rooms were clay and stone, with a thick layer of red earth which abounds in the neighbourhood; and these were washed and painted daily with an infusion of the same earth in water; it has all the appearance of red

red ochre; and from the abundance of iron ore in the neighbourhood, I do not doubt it is.

" The walls still soft, they formed moulds or frame-works of the patterns in delicate slips of cane connected by grass. The two first slips (one end of each being inserted in the soft wall) projected the relief commonly called mezzo: the interstices were then filled up with the plaster, and assumed the appearance depicted. The poles or pillars were sometimes encircled by twists of cane intersecting each other, which being filled up with thin plaster resembled the lozenge and cable ornaments of the Anglo-Norman order;—the quatre-foil was very common, and by no means rude from the symmetrical bend of the cane which formed it. I saw a few pillars (after they had been squared with the plaster) with numerous slips of cane pressed perpendicularly on to the wet surface, which being covered again with a very thin coat of plaster closely resembled fluting. When they formed a large arch, they inserted one end of a thick piece of cane in the wet clay of the floor or base, and bending the other over, inserted it in the same manner;—the entablature was filled up with wattle-work plastered over; arcades and piazzas were common. A white-wash very frequently renewed was made from a clay in the neighbourhood. Of course the plastering is very frail, and in the relief frequently discloses the edges of the cane, giving however a piquant effect auxiliary to the ornament. The doors were an entire piece of cotton wood, cut with great labour out of the stems or buttresses of that tree; battens variously cut and painted were afterwards nailed across. So disproportionate was the price of labour to that of provision, that I gave but two tokoos for a slab of cotton wood five feet by three. The locks they use are from Houssa, and quite original;—one will be sent to the British Museum. Where they raised a first floor, the under room was divided into two by an intersecting wall to support the rafters for the upper room, which were generally covered with a framework thickly plastered over with red ochre. I saw but one attempt at flooring with plank; it was cotton wood shaped entirely with an adze, and looked like a ship's deck. The windows were open wood-work carved in fanciful figures and intricate patterns, and painted red; the frames were frequently cased in gold about as thick as cartridge paper.

" What surprised me most, and is not the least of the many circumstances deciding their great superiority over the generality of Negroes, was the discovery that every house has its cloacæ, besides the common ones for the lower orders without the town. They were generally situated under a small archway in the most retired angle of the building; but not unfrequently up stairs within

within a separate room like a small closet, where the large hollow pillar also assists to support the upper story. The holes are of a small circumference, but dug to a surprising depth, and boiling water is daily poured down, which effectually prevents the least offence. The rubbish and offal of each house was burnt every morning at the back of the street; and they were as nice and cleanly in their dwellings as in their persons."

The author proceeds to give a particular description of several public and private buildings, which he has accompanied with some elegant and beautifully coloured drawings.

---

*Memoirs of the Caledonian Horticultural Society.* 2 vols. 8vo, with numerous Engravings.

The Scotish Horticultural Society was instituted in 1809. One of its chief objects was to encourage practical gardeners to communicate any new information which their experience might from time to time furnish, and to afford facilities for its publication. The Society has, therefoie, published its Memoirs periodically, in parts or numbers, four numbers forming a volume; and two volumes have already been completed. These contain more than one hundred communications, on subjects so various that almost every topic connected with horticulture is more or less treated of. It is a well known remark, that the comparative coldness and variableness of the climate has operated as a spur to the ingenuity of Scotish gardeners; and so high has their character risen, that at this day, almost all the first-rate gardens of England are intrusted to the management of gardeners from Scotland. As a proof that this high character is probably well deserved, it may be mentioned that, among the authors of the papers in these two volumes, there are no fewer than fifty-four practical gardeners, men actively engaged in the superintendance of the principal gardens in every district of the country.

---

*A Philosophic and Practical Inquiry into the Nature and Constitution of Timber;* including an Investigation into the Causes and Origin of the Dry Rot: some important Considerations introductory to the Suggestion of a better Method for seasoning Timber; a Proposal for effectually preserving Timber against ever contracting the Dry Rot or Internal Decay; and the Particulars and Result of a Set of successful Experiments made and tending to establish the Authenticity of the above Proposal. By John Lingard. 8vo. pp. 56.

The general object of the remedy proposed by the author consists (p. 33) " in the application of a liquid composition which renders timber afterwards impervious to moisture of any kind; and

and so effectually is this object" said to be "attained, that the liquid introduced by which the destructive matter is expelled can never itself be dislodged; but it lies in the pores in a concrete state, and presents an invincible opposition to all other fluids." By this introduction, the author afterwards adds, "the timber, as has been actually ascertained by experiment, is capable of being so increased in strength, that a section of *rotten* oak branch, not prepared, was broken by the weight of 34 pounds; the other section of the same branch, prepared with the composition, could not be broken by the weight of 112 pounds."

---

*Just published*, "Letters from the North of Italy, addressed to Henry Hallam, Esq." in two volumes octavo.

---

*In the Press*, "An Inquiry into Dr. Gall's System concerning Innate Dispositions, the Physiology of the Brain, Materialism, Fatalism, and Moral Liberty, &c." By J. P. Tupper, M.D. Fellow of the Royal College of Surgeons, and of the Linnean Society; Member of the Cercle Medical of Paris, and of the Society of Arts and Sciences of Bourdeaux, and Surgeon Extraordinary to His Royal Highness the Prince Regent.

---

Mr. Byewater has in the press (and it will be published in a few days) "Physiological Fragments, or Sketches of various Subjects intimately connected with the Study of Physiology."

---

## LXIII. *Proceedings of Learned Societies.*

### ROYAL INSTITUTION.

It gives us great pleasure to announce the very flourishing state of this Institution, which was founded in 1800, and has ever since contributed largely to the advancement of the various branches of science. Its real value does not however appear to have been appreciated until lately; for its income (derived from the subscriptions of those who attend the Lectures and Library) has seldom or ever been equal to its necessary expenditure, and consequently it became involved in debt. At the Annual Meeting in May 1818, it appeared from the Report of the Visitors to the members, that the income of the preceding year had for the first time exceeded the expenditure by 147*l.* 18*s.* 8*d.*, and that the debts were reduced below 2200*l.* That same Report also mentions a circumstance which ought to be universally known and recorded; viz. that John Fuller, esq. of Rose Hill, Sussex, had, in proof of his zeal for the stability and success of this Institution, presented it with a donation of one thousand pounds, which is not taken into account in the above statement of accounts.

The Lectures have never been better attended than in the present season; and by the Report that was made to the General Meeting on the first of the present month, it appears the last year's income exceeded the expenditure by no less than 688*l.* 11*s.* 11*d.* and the debt had been reduced below 1500*l.* And as this was still without taking the munificent present of Mr. Fuller into account, there could be no doubt but the whole debt would be paid off before the close of the year, and some means adopted for establishing a permanent fund.

Several valuable presents have also been received by the Institution, particularly a large collection of books, the property of the late Mrs. S. S. Banks, sister of Sir Joseph Banks, which were presented by his lady; a magnificent brass hydraulic press on a large scale, presented by Messrs. Bramah, and many other articles, chiefly books, instruments, and minerals. A subscription has likewise been set on foot for establishing a repository of models of manufacturing implements, improvements of various kinds, and useful works of art.

We must say that no pains have been spared by the Managers or Professors of this Institution to render it worthy of the encouragement it now seems to be meeting from the public. We heartily congratulate them on the success of their endeavours, and hope they will continue to persevere with that same zeal and energy that has brought them into favourable notice.

---

## LXVI. *Intelligence and Miscellaneous Articles.*

### ARCTIC EXPEDITION.

*To Mr. Tilloch.*

Sir, —We were too sanguine in our expectations of the results of the late expedition to the Arctic circle, and were disappointed. Nay, the officers engaged in that perilous enterprise have been by some unjustly criticized, because more had not been done—because, in fact, they could not overcome *impossibilities*. The results of that great attempt were not brilliant—the fault was not theirs—materials could not be collected where such did not exist. They could not create; but I have no doubt that they accomplished all that skill, perseverance and courage could command. I remember that in discussing the prospects which we might reasonably indulge, with that eminent astronomer, geographer and hydrographer the Baron de Zach, at Genoa,—he told me that he considered the expedition as one more hazardous than any which characterized the enterprises of Columbus, but

but that we could not with propriety ground any high expectation upon it.—How correct the opinion was, which the Baron formed in the first instance, may be collected from the following extract from his *Correspondance Astronomique, Géographique, &c. à Gênes,* page 401—"It only remains for us to fix our hopes upon the scientific discoveries; on the magnetism, the electricity, the *aurora borealis,* &c., in fine, upon all those phænomena which particularly belong to these regions; and even then we must not expect great discoveries. We ought not even to be astonished (and those who know the difficulties and the chances of these navigations will not), if we shall one day hear that these vessels have not gone so far, and have not approached the pole so near, as some whale ships have done before them. The time of which Seneca speaks in his *Medea* (act ii.) that might one day arrive, *quibus Oceanus vincula rerum laxet,* has not yet occurred, and may perhaps never arrive for the polar region." I have the honour to be, sir,

Your very humble servant,

London, May 18, 1819. J. MURRAY.

---

### VARIATION OF THE MAGNETIC NEEDLE.

The mistake seems to have prevailed, pretty generally, that the western variation of the direction of the magnetic needle from the meridian or true north, had some time ago reached its *maximum,* and was now decreasing, and the needle at a very slow rate approaching again towards the true north. The reverse of this seems however to be the case, from the recent and delicate observations of Colonel Mark Beaufoy, made at his seat near Stanmore in Middlesex; whence it appears that the variation uniformly *increased* from the month of April 1817 until January 1819, and has fluctuated since. The total of increase in two years to the 31st of March, as deduced from the monthly means of all the observations, is $2' 25''$;—the mean of all the observations made in the first quarter of the present year, shows the variation to have been then $24° 37' 0''$.

---

### ASTRONOMY.

*To Mr. Tilloch.*

SIR,—The astronomical observations and remarks which you have lately inserted in your valuable Philosophical Magazine, are of such importance as to merit the particular thanks of your readers, and indeed the gratitude of the world at large.—To me, although but an amateur in astronomy, they have been particularly gratifying; and as you possess such able correspondents in this science, I beg through your medium to ask their assistance in a matter of no difficulty to those who are in the constant habit of observing,

observing, and which will afford great pleasure to several of my friends, as well as to many of your readers, since what I ask is not to be found in any of the works on astronomy which I have consulted, nor I believe any where in a concentrated form.—This is merely a table of the most curious and interesting objects of the heavens, with the telescopic powers best suited for their examination, and the months of the year when such as are amongst the fixt stars may be inspected to the greatest advantage. Many who possess telescopes, and a taste for astronomy, suppose that after looking at the sun, moon and planets, they have seen all that their instruments can show them; while the nebulæ, double stars, and other objects of extreme curiosity are neglected, from a want of the knowledge of them, and the situations where they are to be found.—I am persuaded such a table would promote an interest for astronomical observation among young people, be considered a valuable communication by your readers; and, if it could be got on to a single side to paste upon a mill-board, would sell separately. I am, sir, your most obebient servant,

London, April 18, 1819. A CONSTANT READER.

The form in which I should put such a table would be as follows:

*The sun* at all times of the year. A dark glass must be used with the telescope. Is most conveniently seen either before or after passing the meridian, on account of his lesser elevation: a power of from 18 to 90 may be used to examine the spots.

*The planets*—For their places, and the times when visible, see Ephemeris. Mercury and Venus must be viewed with a low power, and the object-end of the telescope shaded by about six inches of additional tube, which may be made of paste-board. Then give similar directions for the moon and other planets. Then take the months regularly, and under each place the sideral objects which are about the meridian in that month.

---

### ANCIENT CITY DISCOVERED.

In the year 1772 excavations were by order of the French Government made in the small hill of Chatelet in Champagne, on the site of a Roman town destroyed in the wars of Attila, but preserved in part by being covered with earth. Many of the curious articles there found are preserved in Paris in the house of Abbé Tersan, a veteran of fourscore, who is occupied in getting engravings from them for general circulation. An official report by M. Grignian presents some interesting details respecting this excavation. The remains of about 90 houses, eight small crypts or subterraneous chapels, with a number of cellars, cisterns and wells, were discovered. The streets, which were regularly paved, and quite straight, were only from 15 to 20 feet in width: the pavement,

pavement, where the stones were uneven, was cemented with river pebbles, or gravel. The houses were oblong, and were founded on a bed of stones bound together with lime. Only the better houses had crypts, which were all nearly of one form—some only 7 feet by 8; others 9 by 15: the descent to them was by stone stairs, and the light was admitted by two openings. The cisterns were in diameter from 6 to 8 feet; in depth 15 to 18. Some circular openings resembling wells, but probably drains (as there are no springs in the hill), were found, in none of which was water found, except one; the deepest was 55 feet. Many fragments of beautiful pottery were found in them, thrown in, as is supposed, by the slaves, to conceal their awkwardness from their masters. Water-pipes made of wood, some of them bound with iron, were found; also medals, fragments of statues, goblets, spoons of various shapes—some oval, others circular; lamps, rings, pins, amulets, weighing-scales, surgical instruments, locks and keys—The keys were some of copper, some iron, the smaller on rings, and many of them like those now in use. Wheels, nails, dishes, knives, and scissars, were likewise found; also many pieces of iron which had escaped decay by being covered with hard lime; likewise pieces of bone, and *styli* for writing on wax tables, of from 3 to 4 inches in length. Many fragments of glass were collected, and of a quality which showed that the manufacture was by no means in a state of infancy.

---

## ERUPTION OF A VOLCANO.

Batavia, Nov. 7, 1818.

M. Rienwardt, Director of the Affairs relative to Agriculture, Arts and Sciences, was last month in the government of Preang during a violent eruption of the volcano of Goenoing, and has communicated many important particulars respecting it. The first effects were perceived on the 21st of October between ten and eleven P.M. when the mountain amidst violent shocks, which were felt at Trogong, began to throw up from the summit red hot stones in immense quantities and a great mass of lava. Happily the wind blowing from the south-west, carried all these inflamed bodies towards the uninhabited mountains, and the inhabited districts were spared. The eruption lasted till noon of the 24th. Besides the principal crater at the summit of the mountain, its sides at different heights also emitted fire and smoke for several days after the eruption.

On the 28th of October, M. Rienwardt attempted to ascend the mountain, which was very troublesome and dangerous, on account of its height and steepness, and the heaps of loose and sharp stones, as well as the heat of the ground, and the rolling down of stones from the summit. It became more difficult as they ascended higher. M. Rienwardt had left Trogong at daybreak, and nearly reached the summit at 2 o'clock in the afternoon. The barometer stood then at 25·35 English inches, and the thermometer at 75° of Fahrenheit. He now hoped, with another effort, to reach the spot where the eruption took place; but was obliged to desist, and to leave this dangerous place, by the coming loose of a large mass of the upper heap of stones. The Goenoing-Goenloer is part of a chain of mountains, almost all situated in a direction north-east to south-west. The mountain of Agon to the N.E. is nearly of the same height as the volcano, which is near 3,100 English feet above Trogong, and 5,200 English feet above the level of the sea.

---

### MEDICAL PROPERTIES OF HYDROSULPHURATE OF IRON.

Professor Van Mons has discovered that the hydrosulphurate of iron, produced by iron, sulphur, and water, possesses when taken internally the property of making salivation instantly cease as if by enchantment; and when administered externally, of curing the worst of scabs and sores.—*Journal de la Médecine de la Belgique.*

---

### RECEIPT FOR MAKING THE PURPLE ENAMEL USED IN THE MOSAIC PICTURES OF ST. PETER'S, ROME.

One lb. sulphur, 1 do. saltpetre, 1 do. vitriol, 1 do. antimony, 1 do. oxide of tin, 20 lbs. minium, oxide of lead 40 lbs.; all mixed together in a crucible and melted in a furnace: it is next to be taken out and washed to carry off the salts: afterwards melt it in the crucible, add 19 ozs. rose copper, ½ oz. prepared zaffre, 1½ oz. crocus martis made with sulphur, 3 oz. refined borax, and 1 lb. of a composition of gold, silver and mercury: when all are well combined, the mass is to be stirred with a copper rod, and the fire gradually diminished to prevent the metals from burning. The composition thus prepared is finally to be put into crucibles and placed in a reverberatory furnace, where they are to remain twenty-four hours. The same composition will answer for other colours, by merely changing the colouring matter. This composition has almost all the characters of real stone, and when broken exhibits a vitreous fracture.

The above receipt was received from an Italian clergyman who has considerable chemical knowledge, and he had it from one of the persons employed in St. Peter's during his residence there at college.

---

### OIL FROM PUMPKINS.

The seeds of pumpkins are commonly thrown away; but abundance of an excellent oil may be extracted from them. When peeled, they yield much more oil than an equal quantity of flax. This oil burns well; gives a lively light; lasts longer than other oils,

oils, and emits very little smoke. The cake remaining after the extraction of the oil may be given to cattle, who eat it with avidity. The oil when cold is greasy, soft and pure; it does well for frying, especially fish.—*Bibliothèque Physico-Economique.*

## PAPER FROM BEET-ROOT.

A M. Sinisen has published at Copenhagen, an account of a series of experiments which he has made for ascertaining the practicability of manufacturing paper from the pulp of beet-root. As a proof of the success of his experiments, he has printed his work on paper manufactured from this material.

## EXPERIMENTAL DESIDERATA.

*To Mr. Tilloch.*

Sir,—It has often struck me that many valuable facts might be added to science, if occasional series of queries or experiments were published, by way of turning the attention of those who have leisure and opportunity, to particular points in the œconomy of nature, or the wide field of philosophical research. Many persons have a peculiar turn for certain pursuits, and would feel a satisfaction in communicating their results, if invited to do it by the method I take the liberty to recommend. By this means, those who were more deeply versed in science might avail themselves of the labours of others, who only required a few hints in order to regulate their observations and direct their inquiry. It might lead persons of congenial habits to a closer connexion, and many a hint might be thrown out calculated to excite a spirit of investigation tending to important results. As an illustration of the object I propose, I would submit the following queries and experiments to be tried in the course of the summer.

Q. 1.—Let seeds of different sorts be placed at different and given depths (say a foot asunder) in the earth, in soil of similar quality in flower-pots. Required the appearance of each set at the expiration of three months. What degree of vegetation was observable, and what increase of weight. This experiment may throw considerable light on many singular facts respecting the sudden appearance of plants and flowers where none had been known to exist for years before; and also upon some other points in the œconomy of nature which require further attention.

Q. 2.—Place certain seeds in similar soils, let them be supplied with equal portions of water impregnated with various ingredients—for instance, the different salts or gases, or filtrations from dung or other substances in a state of decay. Required their increase of weight, and appearance as to health and luxuriance, at the end of a given time.

Q. 3.—A similar experiment might be tried, and similar re-

 sults

sults required, if the seeds were made to vegetate under particular gases, water of the same quality being used in each case.

Hitherto much difficulty and uncertainty has been experienced in constructing hygrometers.—Query, Have any experiments been tried to ascertain how far absorbing substances might be used in forming them? Might not one be constructed, by exposing a given portion of perfectly dried mouldering whin-stone to the air for a certain time, and observing the increase of weight? Common brick-dust or sulphuric acid are also well known to be equally absorbent, and might be used with success. E. S.

*** Experiments similar to some of those recommended by our correspondent have been made at different times; but they may certainly be varied and extended. Absorbent substances have been tried as hygrometers; none however will answer the purpose that do not possess also the property of giving off moisture, in dry weather, within the usual range of atmospheric temperature. Sulphuric acid therefore, and all substances that have a strong tendency to absorb water, but not to part with it, must necessarily be excluded from hygrometric substances, in the common acceptation of this term. T.

---

CYCAS CIRCINALIS.

In the month of June last year there was exposed for sale in the flower-market of Paris, a plant rarely met with in northern countries, and which attracted a great deal of notice. It was the Cycas of the East Indies (*Cycas circinalis*), a species of palm and an evergreen, the stalk of which rises in its native habitat to the height of from three to five metres, and then divides into a number of very short branches. It is crowned by a cluster of leaves of a beautiful glossy green, which are curled inwards previously to their perfect development, but afterwards turned outwards. The collets of the male flowers take sometimes an appearance very similar to a large pine-apple. The female flowers yield an oval nut of the size of a small orange. The Indians eat the almonds of these fruits, and make a sort of sago of them which they prize greatly. The nuts of the Cycas of Japan (*Cycas revoluta*) are particularly valued on this account. The specimen then exhibited in the Parisian market had five stalks very straight, and armed with prickles in a manner nearly similar to the Eglantine. The Emperor of Austria gave for the fellow of it in 1814 no less than 5000 francs (208*l.* 6*s.* English).

---

CACTUS TRIANGULARIS.

Mr. Shræder, of Baltimore, possesses a *Cactus triangularis* of extraordinary beauty, and perhaps the only one in full vegetation in the United States of America. On the night of the 27th of August

August 1818, it presented the phænomenon so rare to this plant, of being in flower. It began to expand between seven and eight o'clock at night; it was entirely open at eleven, but at four o'clock next morning it again collapsed, and was quite closed up at five o'clock.

In the *Mémoires du Museum d'Histoire Naturelle*, (vol. iii. p. 190) M. Desfontaines has given an interesting account of a species of this plant indigenous to Mexico, which flourished in the course of July 1817 in the *Jardin des Plantes* at Paris. The short-lived flowers of this plant are inodorous, of a blood-red colour, and of the most sparkling brilliancy.

---

### SPHYNX ATROPOS.

The great dryness of the summer of 1818 has been the cause of an unusual multiplication of insects, and of attracting towards the north some species which seemed confined by nature to southern latitudes. Among this number the Journals of France take particular notice of a species of *Lepidoptera*, which has made its appearance in that country, known by the name of the Sphynx Death's Head (*Sphynx Atropos* L.), so called on account of three black spots in the centre of a yellow spot of its corslet, which form a pretty exact resemblance of a Death's head. It has proved extremely destructive to that valuable branch of rural industry—the Apiary. In the months of August and September last, numerous hives, especially in the department of Lower Charente, were wholly destroyed by its ravages. The animal has been accused by the people of not only attacking the bees and devouring them, but of sucking the honey with the utmost avidity. The fact is, however, that the *Sphynx Atropos* has no organ fit for devouring bees. Its mouth consists of a beak not very long, with which it sucks or may suck the honey from the combs; but if it does kill the bees, it can only be by the action of its wings. It appears pretty clear, however, that the bees when supposed to be devoured have only fled out of the way of their enemy. It has been observed, that as soon as the low funereal sound, which the *Sphynx Atropos* produces by sticking its antennæ against its beak, is heard in the neighbourhood of a hive, the bees instantly take the alarm; in a few moments all is disorder and confusion; and in many instances, which have no doubt given rise to the vulgar idea of their being devoured, the colony have been seen immediately to abandon their habitation in a body, never to return. The honey, not the bees, is the object of prey; and it is, in all probability, only when the bees attempt an unavailing defence of their treasures, or are too tardy in their flight, that any of them are even killed. The *Sphynx Atropos* is large and voracious; but it lives chiefly at the expense of the potatoe, the garden

garden bean, and the jessamine. In one day it will entirely devour the leaves of any single plant.

An effectual means of protecting bee-hives from the attacks of this animal, would probably be to shut up all avenues to the hives but those which are strictly necessary for the entrance and exit of the bees. It might also be advisable to avoid planting potatoes, garden beans, or jessamine, in their vicinity. But undoubtedly the best thing for an apiary threatened by such an enemy to do, is to employ persons to beat up his usual haunts and destroy him. The insect may be easily recognised by its large size and yellow coat, with spots of a light or dark green.

---

## EXTRAORDINARY LIZARD.

A lizard four feet long, of the species described in Count de la Cepède's History of Oviparous Quadrupeds by the name of *Tupinambus* in America, and *Galtabe* in Africa, was found on the beach by Hordle Cliff, near Milford, Hants, the morning after the ship British Tar, from Sierra Leone, was wrecked. It appears this animal is the largest of the kind ever brought to Europe—the one in the Royal Cabinet of Paris measuring three feet eight inches, and one in the Cabinet at Lisbon, three feet four inches. These are the only two that are to be found in any public exhibition in Europe. The body of this lizard is the same length as the tail, covered with hard scales of an oval and circular form; the colour of the body is of a greenish cast; the spots from the back to the sides are regular, and in four distinct rows, about four inches apart; these spots had all the appearance and beauty of a large pearl set with small ones, and the black spots are equal in beauty to the white. The legs are furnished with strong hooked claws, as beautifully spotted, and resemble a handsome piece of lace. The head is like a frog's, the teeth long and sharp. It could not have been long dead when found, as it was scarcely cold.

---

## BEES.

It appears from a communication which Captain Call, a celebrated apiarian residing at Taplow-hill near Maidenhead, has lately made to the Secretary of the British Apiarian Society, meeting at No. 205, Piccadilly, that every reasonable degree of success and profit attends the mode of extracting a part of the comb and honey from the hives at successive periods. The weight of honey and comb in 22 of Captain C.'s hives, after deducting the weight of these hives, was ascertained on the 17th of September last to be 641 lbs.; and from which subsequently, in September and October, 207½ lbs. of honey were extracted, at two operations; which is at the rate of 324 lbs. of honey and comb gained from 1000 lbs. of the contents of the hives, or near

9 lbs.

9 lbs. 7 oz. from each hive, on the average of the whole, or 26 lbs. for each of the eight hives which were actually deprived of honey. Fifteen of the above 22 hives were weighed at five different periods, the collective weight of whose honey and comb was found to be 438 lbs.; which last weight increased to 1000: and the other four weights being increased in the exact same proportion, they stand as follows; viz. In September 1000 lbs., in October 998 lbs. on December 15th, 751 lbs., on January 25th, 669 lbs., and on March 11th, 521 lbs. of honey and comb: these weighings being intended for showing the rate of the bees' winter consumption of honey.

---

### POISONED EGGS.

A small farmer in the village of Heath, near Wakefield in Yorkshire, lately had several of his hens die, owing, as has since appeared, to a neighbour into whose garden they had been in the habit of straying, having strewed barley impregnated or mixed with arsenic, in order to destroy them. One of these poisoned hens laid an egg about an hour before she died, which the farmer unknowingly ate, fried with a collop, (being then in perfect health,) but he was soon after seized with violent pains and sickness.—An experienced medical man who was called-in two hours afterwards, instantly pronounced, from the symptoms, that poison had been taken, and immediately administered an emetic and castor oil, by which the patient's life was saved: but he continued ill for several days, and without doubt, it is said, he would have died if medical aid had not been called in.—This ought to operate as a caution against this not uncommon, yet dangerous mode of ridding oneself of trespass from our neighbours' poultry. It has excited the surprise of many that the egg could become so strongly infected with the arsenic, before the hen was killed by it. On the discovery of the cause of the farmer's hens dying, his wife cut open the crops of two of those which lately had sickened, and after carefully emptying the crops of all the barley and other matters and washing them out, sewed them up again; and strange to say, they survive, and seem likely to recover.

---

### EUHARMONIC ORGAN.

Mr. John Alsager the organist, who in May 1817 went out with one of Mr. Liston's patent organs to Calcutta, (as is mentioned in vol. xlix. p. 266) safely arrived there in the beginning of September following; and the church of St. Andrew, then building for the Presbyterian or Scotch congregation, being nearly finished, the organ was erected under Mr. Alsager's direction, and tuned by him, and at the opening of the church, on Sunday the 8th of March 1818, gave universal satisfaction. We learn that Mr. A. has been commissioned to order a chamber organ to be be sent out, having 43 notes in each octave; and which organ is now building by Messrs. Flight and Robson in St. Martin's Lane: and which when finished, will, it is hoped, be exhibited to professors and amateurs, as on the former occasions. The four notes intended to be introduced in this organ, besides those of the St. Andrew's church organ mentioned in our xlixth volume, p. 268, are A‵♭ = 404Σ, A‵*, = 487Σ, D′♭ = 68Σ, and D‵* = 129Σ (which latter, is not one of the 59 notes of Mr. Liston's "Essay:" and besides which, it is intended to omit B‵♭, and substitute F♭ = 218Σ. It is intended to use, occasionally, 9 pedals, in changing the notes when required, for adapting the scale to the twelve finger-keys in use.

---

## LIST OF PATENTS FOR NEW INVENTIONS.

To Joseph Whetherly Phipson, of Birmingham, for his improvement in manufacturing pipes, tubes or conductors for gas and other purposes.—24th April, 1819.

To Thomas Willcox, of Bristol, for a pneumatic stove for heating atmospheric air, and diffusing the same through houses, hot-houses, green-houses and other buildings, upon the principle of introducing a column of atmospheric air into a chamber containing a stove of a new and peculiar construction, thereby creating a reservoir of hot air capable of being diffused by means of flues throughout buildings of any dimensions.—28th April.

To John Pinchback, of Atherston in the county of Warwick, for his new method or methods of making a machine or machines for catching flies and wasps, which he conceives will be of public utility.—1st May.

To Robert Copland, of Liverpool, for his new or improved method or methods of gaining power by new or improved combinations of apparatus applicable to various purposes.—1st May.

To Uriah Haddock, of Mile-End in the county of Middlesex, for his improved method of producing inflammable gas from pit-coal, superior in purity to any other inflammable gas produced from the same said substance by the method or methods hitherto in practice.—4th May.

To William Sawbridge, of White Friars-lane, Coventry, for certain improvements on engine looms for weaving figured ribbons.—6th May.

To Henry Booth, of Liverpool, for his improved method or means of propelling boats and other vessels.—6th May.

To John Lowder, of the parish of Walcot in the county of Somerset, for his certain improvements or machines for the preparation of hemp or flax, and other fibrous vegetable substances. —8th May.

To James Mason, of Birmingham, for a method of working the

the oars or paddles of boats, barges, ships, and other kinds of navigating vessels, communicated by a foreigner residing abroad. —8th May.

To Sarah Thomson, of Rotherhithe, in the county of Surrey, cork manufacturer, in consequence of a communication made to her by her late husband Archibald Thomson, deceased; and also by her late son Alexander Thomson, deceased, for an invention of a machine for cutting corks.—15th May.

To James Hollingrake, of Manchester, for making and working a manufacture for applying a method of casting and forming metallic substances in various forms and shapes with improved closeness and soundness and texture.—15th May.

To William Rutt, of Shacklewell, Middlesex, printer and stereotype-founder, for certain improvements in printing-machines, which improvements do not extend to the inking apparatus.—24th May.

To Tew Cooper, of Weston by Weeden, Northamptonshire, for certain improvements on and additions to machines or ploughs for the purpose of underdraining land.—18th May.

---

## *Meteorological Observations kept at Walthamstow, Essex, from April* 15 *to May* 15, 1819.

(Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *April* | | | |
| 15 | 44 60 | 29·35 | WS.—Rain early, at 7 clear and *cirrostratus*; very fine day; dark night. |
| 16 | 51 57 | 29·10 | SE.—Fine morn and day; clear and *cumuli*; some rain after 5 P.M.; night cloudy. |
| 17 | 45 55 | 29·30 | S.—Showers and sun early; day fine, and night star-light. Moon last quarter. |
| 18 | 47 58 | 29·60 | SE.—Sun and *cumuli* early, and fine in the morn; after 2 P.M. showers and wind till about 11 P.M., and then star-light. |
| 19 | 42 59 | 29·76 | SW.—Hazy morn, showery day, and the night very dark. |
| 20 | 54 57 | 29·64 | SW.— Rain in the night; the morn cloudy; the day showery and windy; and night dark. |
| 21 | 50 59 | 29·60 | SW—S.—Hazy morn; then *cumuli* and windy, and star-light at night. |
| 22 | 43 52 | 29·72 | NW.—*Cirrostratus* and wind; afterwards showery; fine afternoon; dark night. |
| 23 | 44 52 | 29·78 | N—NW.—*Cirrostratus* and wind early; a fine day, with some showers; night dark. |
| 24 | 48 49 | 29·50 | NE.—Very rainy morning; some gleams of sun, but *frequent* rain all day, and rainy night. New moon. |
| 25 | 47 43 | 29·69 | NE—E.—Showers and great wind till about 3 P.M.; fine afterwards, and star-light night. |

*April*

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *April* | | | |
| 26 | 44<br>51 | 30·09 | NE.—Windy, clear and *cirrostratus,* and clear fine day; star-light night. |
| 27 | 43<br>50 | 30·15 | E.—Clear and *cirrostratus;* a perfect clear sky after 3 P.M. and clear night. |
| 28 | 42<br>58 | 30·23 | E—SE.—Very fine sunny morn, and continued the same all day, with some wind; fine moon-light night. |
| 29 | 47<br>55 | 30·15 | SE.—Very fine morn and day; moon-light night, and slight *aurora borealis.* |
| 30 | 42<br>58 | 29·95 | E.—Fine morn and day; night bright moon-light. |
| *May.* | | | |
| 1 | 46<br>63 | 29·84 | SE.—Very fine morn, day and evening; clear moon and star-light. |
| 2 | 51<br>68 | 29·71 | SE.—Sun, wind and *cirrostratus,* morn; very fine day; evening rainy and windy. Moon first quarter. |
| 3 | 57<br>70 | 29·60 | SE.— *Cirrostratus*; very fine morn; afterwards cloudy and dark; at night *cirrocumuli,* moon and stars, and moon in a *corona.* |
| 4 | 56<br>67 | 29·41 | SE.—Clear and *cumuli*; windy fine day; very rainy evening. |
| 5 | 51<br>66 | 29·55 | SE—S.—Fine windy morn and day; clear and *cirrocumuli* and wind at night. |
| 6 | 49<br>67 | 29·91 | SE.—At 7 A.M. fine and clear; at 8 a thick *stratus* and deep gloom; afterwards very fine day; and very clear night. |
| 7 | 56<br>68 | 30·10 | SE.—In the morning clear and *cirrostratus*; day very fine; at night beautiful *cirrocumuli.* |
| 8 | 52<br>69 | 30·00 | E.—Fine morn and day; fine *cirrocumuli* at night, and moon-light. |
| 9 | 60<br>71 | 30·05 | E—W.—Fine morn and day; rainy evening. Full moon. |
| 10 | 51<br>70 | 30·20 | NW.—Fine hot morn and day; at night windy and cloudy. |
| 11 | 54<br>67 | 30·18 | W—SW—NW.—Gray morn and day; and cloudy night. |
| 12 | 59<br>68 | 30·04 | W—NW.—Gray morn; fine day; light early, but no stars visible, but afterwards clear and bright. |
| 13 | 52<br>63 | 30·01 | NW.—Clear sky at 7 A.M.; afterwards fine day; clear and *cumuli.* |
| 14 | 51<br>63 | 30·20 | NW.—Clear sky; sunny and windy all day and very clear; night cool. |
| 15 | 47<br>58 | 30·51 | NW—SE.—Very fine clear morn; afterwards sun and *cumuli,* and warmer than yesterday; fine evening. |

In Flower.

May 15. Geranium *sylvaticum, Pyrenaicum, Robertianum, lucidum,* and *sanguineum.*— Veronica *montana* and *serpyllifolia.* — Papaver *Cambricum.* — Symphytum *officinale.* — Ranunculus *acris, bulbosus* and *auricomis.*— Erysimum *Alliaria.*—Lychnis *dioica.* —Ajuga *reptans.*—Trollius *Europæus.* —Geum *rivale.*— ♄ Staphylea *pinnata.*—Raphanus *Raphanistrum.*—Convallaria *Majalis.*—Thlaspi *Bursa pastoris.*—Garden peas in pod 9th May.

Erratum.—Feb. 26, for fine *rain* read fine *morn.*

METEORO-

METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1819. | Age of the Moon | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| April 15 | 21 | 59·5 | 29·53 | Fine |
| 16 | 22 | 54·5 | 29·26 | Cloudy—heavy rain A.M. |
| 17 | 23 | 54·5 | 29·50 | Fine |
| 18 | 24 | 52·5 | 29·70 | Showery |
| 19 | 25 | 54· | 29·85 | Fair |
| 20 | 26 | 59· | 29·74 | Showery |
| 21 | 27 | 56· | 29·70 | Fine |
| 22 | 28 | 50·5 | 30· | Cloudy |
| 23 | 29 | 49· | 29·91 | Ditto |
| 24 | new | 51· | 29·80 | Ditto—rain at night. |
| 25 | 1 | 50·5 | 30· | Stormy |
| 26 | 2 | 53· | 30·30 | Fine |
| 27 | 3 | 54·5 | 30·33 | Cloudy |
| 28 | 4 | 58·5 | 30·33 | Ditto |
| 29 | 5 | 57·5 | 30·16 | Fine |
| 30 | 6 | 59· | 29·98 | Ditto |
| May 1 | 7 | 64· | 29·90 | Ditto |
| 2 | 8 | 66· | 29·82 | Ditto |
| 3 | 9 | 67· | 29·77 | Ditto |
| 4 | 10 | 64· | 29·70 | Cloudy—showery P.M. |
| 5 | 11 | 58· | 29·73 | Ditto—rain A.M. |
| 6 | 12 | 63· | 30·06 | Ditto |
| 7 | 13 | 67· | 30·18 | Ditto |
| 8 | 14 | 67· | 30·20 | Fine |
| 9 | full | 73· | 30·28 | Ditto—rain in the evening. |
| 10 | 16 | 65· | 30·30 | Ditto |
| 11 | 17 | 63·5 | 30·20 | Cloudy |
| 12 | 18 | 69·5 | 30·16 | Ditto |
| 13 | 19 | 68·5 | 30·12 | Stormy |
| 14 | 20 | 62· | 30·23 | Fine |

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

*For May* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| April 27 | 45 | 50 | 40 | 30·23 | 40 | Fair |
| 28 | 46 | 55 | 46 | ·23 | 51 | Fair |
| 29 | 48 | 55 | 44 | ·05 | 52 | Fair |
| 30 | 47 | 60 | 45 | 29·95 | 63 | Fair |
| May 1 | 51 | 62 | 50 | ·89 | 64 | Fair |
| 2 | 55 | 67 | 55 | ·76 | 84 | Fair |
| 3 | 62 | 69 | 56 | ·66 | 82 | Fair |
| 4 | 56 | 64 | 55 | ·59 | 56 | Showery |
| 5 | 55 | 66 | 56 | ·70 | 76 | Fair |
| 6 | 58 | 68 | 51 | 30·05 | 84 | Fair |
| 7 | 55 | 64 | 55 | ·13 | 69 | Fair |
| 8 | 59 | 72 | 56 | ·10 | 74 | Fair |
| 9 | 60 | 74 | 55 | ·17 | 88 | Fair |
| 10 | 57 | 68 | 54 | ·24 | 60 | Fair |
| 11 | 56 | 64 | 58 | ·21 | 56 | Cloudy |
| 12 | 60 | 67 | 55 | ·10 | 66 | Fair |
| 13 | 57 | 66 | 54 | ·10 | 65 | Fair |
| 14 | 56 | 64 | 50 | ·17 | 66 | Fair |
| 15 | 55 | 61 | 50 | ·12 | 60 | Fair |
| 16 | 50 | 66 | 55 | ·12 | 64 | Fair |
| 17 | 58 | 69 | 56 | 29·95 | 76 | Fair |
| 18 | 60 | 69 | 57 | ·90 | 78 | Fair |
| 19 | 57 | 62 | 56 | ·64 | 0 | Rain |
| 20 | 56 | 60 | 55 | ·67 | 0 | Rain |
| 21 | 55 | 59 | 54 | ·52 | 57 | Stormy |
| 22 | 56 | 64 | 55 | ·80 | 47 | Fair |
| 23 | 58 | 63 | 52 | ·97 | 50 | Fair |
| 24 | 55 | 57 | 50 | ·98 | 0 | Rain |
| 25 | 50 | 63 | 47 | ·94 | 39 | Fair |
| 26 | 50 | 58 | 44 | ·97 | 36 | Cloudy |

N.B. The Barometer's height is taken at one o'clock.

## LXVI. *On Dr.* Murray's *Statement respecting the Origin of the Doctrine of Definite Proportions, and the Arrangement of the Elementary Principles of Chemical Compounds.* By William Higgins, *Esq.*

*To Mr. Tilloch.*

Sir, — You will much oblige me by inserting in your Magazine, the following observations on an extract taken from the first volume of Dr. Murray's System of Chemistry (page 127, 4th edition, 1819).

"In a work (says the Doctor) published by Mr. Higgins a number of years ago (A Comparative View of the Phlogistic and Anti-phlogistic Theories, with Inductions, 1789) some cases of chemical compounds are stated, in which the chemical combinations are held to consist of one particle of the one body, with one particle, two particles, three, four, or five of another. In sulphurous acid a single particle of sulphur is supposed to be united with a single particle of oxygen, and in sulphuric acid with two particles of oxygen (page 36). Water is held to be composed of one particle of oxygen with one of hydrogen, and to be incapable of uniting to a third particle of either (page 37). In sulphuretted hydrogen the particles of sulphur are supposed to be to those of hydrogen as nine to five* (page 81): and in the nitrous compounds he supposed one particle of nitrogen to be combined with two particles of oxygen, forming nitric oxide; one with three, constituting red nitrous acid; one with four, constituting the pale yellow acid; and one with five, forming colourless nitric acid (page 133-5†). But in these statements there is no trace of any induction that this might be a general law of chemical combination; the opinion was not extended beyond those few cases, nor was it brought forward with any prominent distinction: it accordingly attracted no attention; and Mr. Higgins himself never prosecuted it, nor announced it further, until he advanced his pretensions subsequent to the publication of Mr. Dalton's System. He certainly therefore has little or no claim to the doctrine."

The Doctor might add more important cases to the foregoing outlines; yet the few he brings forward are sufficient to prove, although he did not intend it, that the doctrine of definite proportions and the arrangement of the elementary principles of chemical compounds were clearly developed at that distant period. Why did not the Doctor give us the outlines of Mr. Dalton's

* *Supposition* is out of the question, all these statements are supported by accurate experiments.

† The Doctor omitted the gaseous oxide, which consists of one and one.

ton's System, by way of contrast?—were he to attempt it, he could not produce a single new fact in his favour, except that of making the particle of hydrogen as the standard weight of those of other bodies.

Few as the foregoing cases which the Doctor adduces may appear, Lavoisier's anti-phlogistic theory, or the doctrine of Sir Isaac Newton respecting the laws of gravitation, might be confined to still fewer.

We will now attend to the Doctor's remarks on those cases, as he calls them. "But in these statements, &c." Nothing can be more glaringly unjust than this assertion, as the following extract taken from my Comparative View will prove. After having shown by means of diagrams and numbers, that the one particle of oxygen is united to the one particle of sulphur in the atom of sulphurous acid, with greater force than the two particles of oxygen in the atom of sulphuric acid, in consequence of the force of attraction of the particle of sulphur being equally divided between the two of oxygen, I proceeded thus: "This seems to be a *general law*: all bodies unite with greater force to half the quantity of those substances to which they have an affinity, than to the entire;—instance, carbonate of potash will part with a certain portion of its carbonic acid in a moderate degree of heat, yet it requires a very strong heat to expel the whole. In like manner crystallized sulphate of potash will part with most of its water in a heat below ignition, but it requires a strong red heat to drive away the entire of its water. Thus we find, in proportion as the potash is deprived of one part of its carbonic acid, its power of retaining the remainder is increased: and the same law holds good as to the expulsion of water from the salts. I shall forbear mentioning several other circumstances of the like nature*." Dr. Wollaston had written a paper on this subject a few years ago, without any reference to what I advanced thirty years back: of this I have taken notice in this Magazine, vol. 51, page 169. Here follows another extract on the same laws extended to metallic oxides: "I have already shown upon what principle the bases of the acids retain their oxygen with less force when fully saturated with it than when united to a small portion. The same law holds good in all other combinations, and is explicable on the same principles. Almost all bodies will unite to the different substances to which they have an affinity, in various proportions until they arrive at the point of saturation, which limits their power of chemical attraction. There are exceptions to those laws;—instance, the elementary principles of water will only unite in one proportion, so that we can never obtain it in an

* Comparative View, pages 40, 41; or Atomic Theory.

intermediate

intermediate state. The cause of this I have already attempted to demonstrate. Metals will unite to oxygen in various proportions until they are saturated. If 100 grains of a metal are only capable of uniting to fifteen grains of oxygen, they will attract and retain five grains with greater force than ten, and ten grains with greater force than fifteen*."

In the foregoing example I made use of the numbers 5, 10, 15, the two latter of which being multiples of the former, in order to the establishment of the principles of definite proportions, and it accords with many similar examples in my *Comparative View*.

Dr. Murray, in treating on those principles, which originated with me, does not take the smallest notice of the source whence he derived his information, although in his explanation he makes use of nearly the same words, as the following short extract taken from his chapter on chemical attraction will show. "If 100 parts of a metal combine in one combination with ten of oxygen, and in another combination with twenty of oxygen, ten parts of oxygen in the latter compound will be easily abstracted, while the other ten parts, or that proportion which constitutes the first compound, will be retained with a much more powerful force. Sulphur combines with two proportions of oxygen; the larger proportion which exists in one of these is easily abstracted, while the entire quantity is abstracted with more difficulty. Charcoal and oxygen afford a similar example †." So he goes on. Were I to comment on the foregoing circumstances as they deserve, it would be too severe; therefore I leave my readers to judge for themselves, and I have not the smallest doubt but they will feel as I do at this present moment.

Having demonstrated by means of diagrams and numbers the laws by which certain metals precipitate others in their *metallic state* from solution in acids‡, I next proceeded to the cause of some metals precipitating others in the state of oxides. "Let us suppose 100 grains of *tin* when in perfect solution in acids, to be united to 15 grains of oxygen with the force of 5·5. Let *iron* attract oxygen with the force of seven, and let us suppose this force of the *iron* to be reduced to six by the accession of 7·5 grains of oxygen § taken from the *tin*, and the attraction of the *tin* to the remaining oxygen to be increased by the abstraction of this quantity of oxygen: in this case *iron* cannot precipitate *tin* in its metallic state, although it may have greater attraction to oxygen than the *tin* has. Hence it is evident that a

* Comp. View, pages 274, 275. † Page 77. ‡ Ib. from page 262 to page 273.

§ Here again the numbers chosen are 7, 5 and 15, the latter being a multiple of the former; this cannot be supposed to be mere chance.

metal in order to precipitate another metal in its metallic state, must not only unite to oxygen in greater quantities, and attract it more forcibly, but that this superiority of force must be very considerable*.

The reader is to understand that this species of philosophy was not known before I published my Comparative View. Let us now attend to the Doctor's next observation: "The opinion was not extended, &c." It was not a fanciful business, or matter of mere *opinion*; what I advanced was prominently distinguished, being supported by experiments and demonstrations; it stood the test of subsequent investigations, and is now adopted by all the philosophers of Europe; and the *opinion* was extended beyond the few facts which the Doctor was pleased to bring forward, as the foregoing extracts will sufficiently prove. "It accordingly attracted no attention." The work, it is true, did not attract that attention which the doctrine it established and elucidated merited; but this is not to be wondered at, when we consider that at the time it was written, chemistry had not obtained the rank of a science, and had not a fixed doctrine to guide it. "And Mr. Higgins himself never prosecuted it, nor announced it further, until, &c."

So far as relates to the development of fundamental principles it could not be advanced a single step, even at this day, beyond the limits at which I left off in my *Comparative View*. I have indeed applied it a little more extensively in my *Atomic Theory*, and also in a paper on the *connexion* of *light* and *caloric*, published in this Magazine, vol. 51, page 81. There is as much originality in this paper, and perhaps it is as interesting as any of the principles developed in my *Comparative View*; and yet it has not been noticed, nor should I myself mention it, had not the subject in question led me to it. Probably in about twenty years hence some writer will announce it as his own, together with my hypothesis on electrical phænomena. And to give it greater publicity was impossible, unless I were to puff it off in the daily prints or monthly magazines, which would be a species of quackery beneath any man of science: besides, I had not the smallest doubt but it would sooner or latter make its own way, as I predicted in the preface.

The work was presented to the public in as simple and conspicuous a style as the nature of the subject would admit of; and if the period at which it appeared was not sufficiently matured to appreciate its merit, it could not be the fault of the author. As to advancing my *pretensions subsequent* to Mr. Dalton's *publication*, I am surprised the Doctor should make use of such expressions, having the date and facts of my Comparative View

* Comp. View, pages 275, 276.

before

before him. A man must be very stupid, or timid, who, on finding his property invaded, would not step forward to defend it; and this I did when attacked by Mr. Dalton and his accomplices. I was perfectly aware of the importance of the system which I promulgated with so much labour, study and care; as the diagrams, and the various demonstrations that appear throughout the work will fully prove.

Twenty-three years have elapsed since I was appointed Professor of Chemistry to the *honourable* the Dublin Society by the act of parliament which established the professorship; and ever since, what is called the *Atomic Theory* formed a part of my annual course of lectures. My learned friend Dr. Haworth, one of the physicians of Bartholomew's hospital, and formerly one of the Radcliff travelling fellows from Oxford, with whom I had the pleasure of being intimately acquainted at the university, before I published, zealously espoused my system soon after it appeared. We both, I remember, were not a little amused at the reviewers of the day, who scarcely knew what to make of it; but most of them, particularly those of the English and Analytical Reviews, allowed that it upset the *phlogistic theory*.

Notwithstanding the confidence I felt as to the importance of my system, yet I would have remained silent, and left it to posterity to judge of it when I was no more, had it not been for the attempt made to wrest it from me while living and able to defend it.

"He certainly therefore has little or no claim." To have no claim because I was silent until Mr. Dalton published, that is, until Mr. Dalton laid hold of the fruits of my labour—is a very strange mode of reasoning.

I have made so many replies to attacks similar to that of Dr. Murray that I consider it needless to say any thing more; I therefore refer my reader to vol. 48 of this Magazine, pages 363 and 408; to vol. 50, page 407; and to vol. 51, pages 81 and 161; and also to my *Atomic Theory*, which may be had of Longman, Hurst, and Co. I must however make the following remarks:

When I wrote the *Comparative View* in the year 1788, (for it was published in March 1789,) the attention of the philosophical world was entirely engaged by the arguments brought forward *pro* and *con* the antagonist doctrines, so that nothing else was minded: at that time I was the only person in Great Britain that adopted the theory of Lavoisier; in France very few of his countrymen supported him, and scarcely any on the rest of the continent countenanced his theory.

I readily perceived from the arguments advanced by the different writers on both sides of the question, that nothing deci-

 sive

sive could be accomplished, and that in order to completely detect the errors of the one doctrine, or to confirm the truth of the other, some new mode of investigation must be adopted. During this arduous and minute investigation, *that system* which is now called the Atomic Theory gradually started up before me at every step I advanced. And by these means my object was so far crowned with success, that the delusion of the *phlogistic doctrine* was no longer doubted. Mr. Kirwan, Dr. Black, Mr. Cavendish, Dr. Higgins, &c. recanted; and there was nothing heard of this memorable contest, except a few feeble efforts made by Dr. Priestley to revive it at its last gasp. During this clashing of opinions it could not be supposed that the refined mode of investigation which I invented, should be understood or attended to, only so far as related to the grand question of the day; and so soon as the controversy ceased, my book, which put an end to it, ceased to be interesting, and of course to be read; because the public looked for nothing else in the work, from the very *title* of it, "*Comparative View* of the *Phlogistic* and *Anti-phlogistic Theories.*"

Notwithstanding the active part I had taken with so much success in this memorable controversy, Dr. Murray never mentioned my name in his historical sketch on the subject, although he enumerates the few French chemists who joined Lavoisier in defence of his theory. Every liberal-minded man must condemn such conduct; for it shows either determined prejudice or a culpable neglect as an historian*.

While composing my book I considered myself as writing for the next century; for I was perfectly aware that the new views which I intended to bring forward could not be well understood, from the state chemistry was in at the time; as the following extract, taken from the *Journal de Physique* for May 1817, page 392, describes: "Here, even Mr. Higgins has proved himself to have conceived and developed the base of that theory (*the Atomic*) at a time when chemistry was scarcely emerged from a chaotic state, and at the moment when the results of Lavoisier had been still contested by many distinguished philosophers, particularly by Mr. Kirwan in England."—The following is another extract taken from the same paper:

"The character of so distinguished a philosopher as Mr. Dalton will not allow us to suppose that he acted the part of a plagiarist towards Mr. Higgins. Still, however, we must in truth say that the work cited of the latter, contains in nearly the same expressions the bases and the principal facts which Dalton brings forward as the foundation of his *theory*." It is remarkable that

* See his Introduction, page 26, 4th edition.

a foreigner

a foreigner should do me that justice which my fellow-subjects of Scotland so shamefully withhold.

Much of what Dr. Murray advances in his chapter on Chemical Affinities, but particularly what relates to the various modifications occasioned by the beautiful laws of definite proportions, is to be found for the first time in my Comparative View, with the proportions also in which the gases unite in volumes.

The modifications of attraction occasioned by the solvent power of water on saline substances, gums, sugars, &c. together with the power by which water dissolves gases, and the gases water, were introduced for the first time in the same work, and represented as a species of influence intermediate between chemical attraction and that of aggregation or gravitation, but nearer the former than the two latter*.

I also introduced another modification of attraction with which chemists were not acquainted at the time; viz. that dry oxygen will not unite to dry inflammable bodies in the common temperature of the atmosphere, not even with iron, without the mediation of water, or a sufficiency of moisture; and that under these circumstances it is the oxygen of the water that unites to the inflammable bodies, while the oxygen of the gas unites to the hydrogen of the water in its nascent state, so as to reproduce water;—this fact was proved by experiments†.

Chemistry derived considerable advantage by calculating the relative forces of bodies to oxygen one and one and one and two, &c.: instance, we should not be able to account for the different phænomena produced by the action of concentrated sulphuric acid, dilute sulphuric acid, and sulphurous acid on iron and zinc and other metals, without this knowledge. It enables us to account upon incontrovertible principles, that during the solution of iron in dilute sulphuric acid, the atom of acid is completely decomposed, that is, deprived of the whole of its oxygen, by the superior attraction of the metal for that principle; the attraction of the particles of *iron* being 7, that of the particle of sulphur to its two particles of oxygen being $5\frac{1}{10}$: therefore the *force*, and consequently the *velocity* with which the oxygen moves towards the iron, leave the sulphur far behind in the state of ultimate division; and being within the influence of atoms of water, it instantly deprives the hydrogen of its oxygen; and the sulphurous acid formed in this way as instantaneously unites to the metallic oxide so as to constitute sulphate of iron.

When sulphurous acid is poured on iron no decomposition of water can take place, because the particle of sulphur being only

* Comparative View, pages 73, 74.

† Ib. page 13, or *Atomic Theory*, pages 52, 53.

united to one particle of oxygen with the force of $6\frac{7}{8}$, they must move together with equal pace to meet the metal, and consequently no hydrogen is liberated. The demonstrations which I produced to support those principles will bear the strictest scrutiny*.

I would advise Dr. Murray to read over more carefully this part of my system, and to correct his explanation on the same subject in his chapter on *chemical attraction*. He also gives a wrong explanation on the cause of the inflammation or combination of inflammable gases and oxygen gas by the electric or common spark. I refer him on that subject to my *Atomic Theory*, pages 28, 29. I could point out many more false explanations; but as I do not intend to act the part of a reviewer, I will pass them over, self-defence being my present object. All the laws resulting from definite proportions derive their origin from my *Comparative View*, as I have repeatedly proved.

The relative quantity of matter, or relative size of the ultimate particles of gases, was also deduced, in the same work, from their specific gravities, making an allowance for the size of their respective atmospheres of caloric: thus, although a cubic inch of oxygen gas is fourteen times heavier (some make it more) than a cubic inch of hydrogen gas; yet, as there are but half the number of particles in the latter that the former contains, the particles of oxygen can be no more then seven times heavier†. The ultimate atoms of the gaseous oxide of azote are nearly one-fourth lighter than those of nitrous gases; yet the latter gas is lighter in volume than the gaseous oxide, in consequence of the expansion occasioned by its calorific atmospheres (*not temperature*‡).

The ultimate particles of azotic gas are almost twice as heavy as those of oxygen gas, yet the latter gas is heavier in volume. This is ascertained by the fact, that one cubic inch of azote contains only the same number of particles that half a cubic inch of oxygen contains; for this is the proportion of the constituents of the gaseous oxide, being a compound of one and one. It bears the same proportion with those of the constituent principles of water, and the same inference as to the relative weight of their respective particles may be fairly deduced§. Oxygen gas diminishes very little by uniting to sulphur in the proportion of one and one; and as the resulting compound (sulphurous acid gas) is only about twice the weight of oxygen gas, the ultimate particles of both elements must contain nearly the same quantity of matter, and the size of the calorific atmospheres of the acid atoms must also be the same with those of the particles of oxygen gas alone.

* Comparative View, pages 42, 43, 44; or Atomic Theory.

† Ib. page 37. ‡ Ib. page 15. § Atomic Theory, page 146.

alone*. The same law holds good as to oxygen and carbon, the gas will not increase or diminish on uniting to two portions of the latter.

By the foregoing means have I been enabled to ascertain the relative weights of the ultimate particles of matter, and there is no other way whatever left to arrive at so desirable and so important an object. I should presume that the specific gravity of the ultimate particles of all bodies is the same, their size constituting the difference of their weights.

I shall terminate this part of the subject by the following extract, taken from my *Comparative View* (pages 255, 256): "Metals in their simple state are insoluble in water; but combined with acids they are soluble. Iron and sulphur chemically united form an insoluble mass; iron and oxygen form also an insoluble compound; but *iron, oxygen* and *sulphur* will form a very soluble compound. *Azote* in its simple state has no sensible affinity to metals; yet when combined with a sufficiency of oxygen it will unite to them and render them soluble. It is clear from these facts, although oxygen alone will not render metals soluble in water, that it is through its mediation a third body will unite and form a soluble compound. But which of the three substances has the *solvent* power most inherent in it, is what we cannot pretend to explain."

I only produce the foregoing passage in consequence of seeing something on the same principle adduced by Dr. Murray in his chapter on Attraction (page 64), in which he quotes Berthollet on the same subject, as explaining the cause of the solubility of saline substances, &c.; yet he takes no notice of the above remarks made at so early a period of the progress of chemical science.

The Doctor, in order to deal fairly, should add some of the above cases, as he calls them, to the *few* he has quoted in his note: but no doubt he was aware, had he done so, that little or none would have been left for Dalton, Gay-Lussac, Berthollet, and Dr. Wollaston, who have written long after me on those interesting subjects, and of course have no claim to originality.

It is extraordinary with what avidity the *various* principles which I advanced in my *Comparative View* have been picked up, without the smallest reference to that work. In short, there never was a publication so completely plagiarized; I could enumerate six authors who had taken facts and ideas from it, which they brought forward as discoveries of their own. Most of those I have noticed on former occasions, which was a disagreeable task to my feelings.

And as to Dr. Murray, although, as I said before, my system

* Comparative View, page 80.

runs

runs through almost the whole of his chapter on Attraction, he never mentions my name; and the extract which is the object of this paper was in a note at the foot of the page, in order to have it detached from the body of his compilation.

In my early days I happened to embark in controversy on a philosophical question of the first importance to chemistry. I had at that time to contend with philosophers and gentlemen, who had no other object in view but the advancement of science. Far from being envious, they felt a pride to appreciate the labours and talents of others. Of late I have had no philosophers to contend with, nor scientific questions to discuss. The question on which I have been occasionally engaged the last four years, is simply this, whether the *Atomic System* be Mr. Dalton's or mine. From the number of evidences on record, nothing could be more readily decided than this point, were it not for prejudice and want of respect for truth and justice; and I believe ignorance also stands somewhat in the way, for the most important part of my system has been overlooked.

What can be more glaringly unjust than to bring forward my own facts and examples, nearly in the same words, to support Mr. Dalton's *pretensions*, and those of others? This unparalleled ill treatment may be traced through the whole of the publications of Drs. Murray and Thomson, particularly so far as relates to the Atomic Theory; and I experienced the same shameful treatment from those who wrote on the same subject for the *Cyclopædias*. When those gentlemen despise truth and justice they certainly can have no love or respect for science. To men who are determined to act contrarily to their judgement and integrity facts are useless, and arguments can no longer avail *.

As I have brought forward repeatedly and on various occasions (more for the sake of science than for any selfish views of my own) a number of undenied facts to support my claim, I shall now take leave of the subject for ever. I have done my duty, and leave the public to judge for themselves; being convinced that though many have been imposed on, the deception cannot be of long duration. I am, sir,

Your very humble servant,

WILLIAM HIGGINS.

* I cannot pass over the *liberality* of Mr. Parkes, who hands over my system to Mr. Dalton. He tells us in his Chemical Catechism (8th edition! page 483, 1818) that he felt "desirous, in justice to Mr. Dalton, to say that we are indebted to him for our first ideas respecting this important doctrine, on which he has built his *Atomic Theory*." Mr. Parkes should first read my *Comparative View*, and study the theory in its *original state*, before he ventured to give an opinion on a subject with which he appears to be so slightly acquainted. No men speak more loudly of *justice* and *honour* than those who are in the act of committing an outrage against both.

LXVII. *De-*

## LXVII. *Description of a new Species of North American Marten* (Mustela vulpina). *By* C. S. Rafinesque*.

The regions watered by the Missouri are inhabited by many animals as yet unknown to the zoologist, although many have been noticed by travellers. A species of marten has lately been presented to the Lyceum of Natural History in New York, which was brought from that country, and appears to belong to a peculiar species, very different from the common martens of Europe, Asia and America, although it has in common with it the character of the yellow throat; but the head, feet and tail afford so many peculiar characters, that no doubt can be entertained of its diversity. I have therefore given to it the name of *Mustela vulpina* or Fox Marten, owing to its head and tail being somewhat similar to that of a fox.

### Mustela vulpina.

*Definition.*—Brown; three large yellowish spots underneath on the throat, breast, and belly: cheeks, inside of the ears, and a spot on the nape, white: tail tipped with white, one-third of its total length: feet blackish: toes white.

*Description.*—This animal is of a fine shape; its size is rather above mediocrity, being about half a foot high, and the total length being about twenty-seven inches, whereof nine form the tail. The general colour of the fur is a drab brown, and it is neither coarse nor very fine. The head is elongated oblong, about four inches, long-shaped like that of a fox: the snout is narrow: the nose is black, notched and granulated, furnished on each side with black whiskers two inches long: there are three long black hairs or *vibrissæ* above each eye, and a few shorter ones scattered behind them on the cheeks, chin and tip of the lower jaw, which is white: the cheeks are whitish, and there is a white spot on the nape of the neck: the ears are large, broad, and white inside. There are three large oblong spots on the throat, breast and belly; this last is the largest: that on the breast, the smallest. The fore legs are shorter then the hind ones, and have behind three very long hairs or *vibrissæ:* the feet and toes of all the legs are covered with long fur: the former have a dark brown or blackish ring, and the latter are of a dirty white: there are five long toes to all the feet, of which the inner one is the shortest: the nails are white, retractile, and shorter than the fur. The teeth are as in the genus *Mustela*, and white; those of the lower jaw are larger and stronger: the grinders are four on each side: they are broad, trifid, with the middle lobe sharp and very long: the tusks or dog-teeth are very strong, curved, and approxi-

* From the American Journal of Science, No. I.

mated, leaving a very small place for the incisores, which are very small, very short and flat, the two lateral ones on each side are situated diagonally; the second behind, and the two middle ones are only half the size of the others. The tail is bushy, particularly at the top, where there is a white pencil of long hairs; the brown of the remainder is darker than on the body.

From the above accurate description it will appear evident that this animal is very different from the common marten of North America. It must be a very ferocious little animal, which is indicated by the strength of the teeth.

---

## LXVIII. *On a new Method of treating Factorials and Figurate Numbers.* *By Mr.* Peter Nicholson.

*To Mr. Tilloch.*

Sir, — As the following method of treating factorials and figurate numbers is new, I hope you will have the goodness to insert it in your valuable publication The Philosophical Magazine, as it will be found to apply to many of the most useful parts of algebra: as in the binomial theorem, in equations of all dimensions, in combinations, &c.

London-street, May 17, 1819. Peter Nicholson.

### FACTORIALS.

*Definition.*—An algebraic product of which the difference between every two adjacent factors is equal to the same given number, is called a factorial.

*Notation.*—In a factorial are to be considered the number of factors, otherwise called the exponent, the first factor, and the common difference, whether + or —.

Let $m$ be the first factor, $n$ the number of factors, and $c$ the common difference; then every factorial may be thus indicated $m^{n|c}$: let $n=4$ and $c=1$, then will $m^{n|c}=m^{4|1}=m(m+1)(m+2)(m+3)$. Again, if $n=5$ and $c=-1$, then will $m^{n|c}=m^{5|\bar{1}}=m(m-1)(m-2)(m-3)(m-4)$. Again, let $m=-p$, and $c=-e$; then will $m^{n|c}=(-p)^{n|\bar{e}}$, which will be affirmative or negative, according as $n$ is even or odd. Thus let $p=3$, $n=4$, and $e=2$; then $(-3)^{4|\bar{2}}=(-3)(-5)(-7)(-9)=945$. Again let $n=5$; then $(-3)^{5|\bar{2}}=(-3)(-5)(-7)(-9)(-11)=-10395$.

*Proposition.*—Any two factorials in which the base of the one is equal to the sum formed by adding the product of the exponent

nent and common difference of the other to its exponent, may be reduced to one.

For let $m^{n|c}$ and $[m+nc]^{h|c}$ be the two factorials, the base of the latter being formed as announced in the proposition: then because $c$ is the common difference, and $m$ is the first factor of the factorial $m^{n|c}$, the second factor will be $m+c$, the third $m+2c$, the fourth $m+3c$, and so on. Therefore in $n+1$ factors, the $(n+1)$th factor from the first will be the first factor, together with $n$ times the common difference $c$; therefore if the factorial $(m+nc)^{h|c}$ be annexed to the factorial $m^{n|c}$ as two factors, the product will be the factorial $m^{n+h|c}$.

PROBLEM.

To resolve a given factorial into two factorial factors, in which the factors of each shall have the same common difference as the factors of the given factorial, and the one a given exponent less than that of the given factorial.

*Rule.*—1. Take the less from the greater of the two given exponents, and the remainder will be the exponent of the factorial factor which is not given.

2. To the base of the given factorial apply either of the exponents of the two factorial factors, and the common difference, and the quantity thus formed will be one of the factorial factors.

3. To the same base add the product of the exponent and common difference of the factorial factor thus completed, and to the sum as a base apply the remaining exponent of the two factorial factors, and the common difference, then the quantity thus formed will be the other factorial factor.

*Examples.*—1. Resolve $m^{n|c}$ into two factorial factors, so that one of them may have the given exponent $r$.

By rule, $n-r$ will be the exponent of the other. Now if $m^{r|c}$ be the one factorial, $(m+rc)^{n-r|c}$ will be the other.

Or, if $m^{n-r|c}$ be the one factorial $[m+(n-r)c]^{r|c}$ will be the other.

2. Resolve $m^{n|c}$ into two factorial factors, so that one of them may have the given exponent 1.

By rule, $n-1$ will be the exponent of the other. Now therefore, if $m^{1|c}=m$ be the one factorial factor, then $(m+c)^{n-1|1}$ will be the other: or if $m^{n-1|c}$ be the one factorial, then will $[m+(n-1)c]^{1|c}=m+(n-1)c$ be the other.

3. Resolve $m^{n|1}$ into two factorial factors, so that one of them may have the given exponent 1.

By rule, $n-1$ will be the exponent of the other. If therefore

$m$

$m^{1|1} = m$ be the one factorial factor, then will $(m+1)^{n-1|1}$ be the other. Or if the one factorial factor be $m^{n-1|1}$, then will the other factorial factor be $(m+n-1)^{1|1} = m+n-1$.

4. Resolve $m^{n|c}$ into two factorial factors, so that one of them may have the given exponent $r$.

By rule, $n-r$ will be the exponent of the other. Therefore if $m^{r|\bar{c}}$ be the one factorial factor, then will $(m-rc)^{n-r|\bar{c}}$ be the other.

Or if $m^{n-r|\bar{c}}$ be the one factorial factor, then will $[m-(n-r)c]^{r|\bar{c}}$ be the other.

5. Resolve $m^{n|\bar{1}}$ into two factorial factors, so that one of them may have the given exponent 1.

By rule, $n-1$ is the exponent of the other. Therefore if $m^{1|\bar{1}} = m$ be the one factorial factor, the other will be $(m-1)^{n-1|\bar{1}}$.

Or, if the one factorial factor be $m^{n-1|\bar{1}}$, the other will be $(m-n+1)^{1|\bar{1}} = m-n+1$, which is the last term of the factorial $m^{n|\bar{1}}$.

THEORY OF FIGURATE NUMBERS.

*Def.* 1. In any number of series $\left\{\begin{array}{lllll} a_1, & b_1, & c_1, & d_1, & \&c. \\ a_2, & b_2, & c_2, & d_2, & \&c. \\ a_3, & b_3, & c_3, & d_3, & \&c. \\ & \&c. & \&c. & \&c. & \end{array}\right.$

placed in due order, if $n$ be the number of any series beginning with that which is placed first, and $m$ the number of the term in the $n$th series, and if the $m$th term of the $n$th series be expressed by $\frac{m^{n|1}}{1^{n|1}}$, each series is called an order of figurate numbers *.

*Corollary* 1.—Hence by this definition the first order of figurate numbers will be the series of natural numbers 1, 2, 3, &c.: for if in $\frac{m^{n|1}}{1^{n|1}}$ we make $m$ successively equal to 1, 2, 3, &c. and $n$ equal to 1, we shall have $\frac{1^{1|1}}{1^{1|1}}$, $\frac{2^{1|1}}{1^{1|1}}$, $\frac{3^{1|1}}{1^{1|1}}$ &c., which are the same as the numbers 1, 2, 3, &c.

* The author has here adopted Legendre's definition of figurate numbers.

*Def.*

*Def.* 2.—The $m$th term of the first, second, third, &c. order is called the $m$th vertical column.

Thus $\frac{m^{1|1}}{1^{1|1}}$, $\frac{m^{2|1}}{1^{2|1}}$, $\frac{m^{3|1}}{1^{3|1}}$, &c. is the $m$th vertical column.

*Corollary.*—Hence the $n$th term of the $m$th vertical column is the same as the $m$th term of the $n$th order of figurate numbers; for by definition 1, $\frac{m^{n|1}}{1^{n|1}}$ is the $m$th term of the $n$th order, and by the last definition the very same is the $n$th term of the $m$th vertical column.

*Def.* 3.—The first term of the $n$th order, the second term of the $(n-1)$th order, the third term of the $(n-2)$th order, &c. is called the $n$th diagonal series.

Thus $\frac{1^{n|1}}{1^{n|1}}$, $\frac{2^{n-1|1}}{1^{n-1|1}}$, $\frac{3^{n-2|1}}{1^{n-2|1}}$, &c. is the $n$th diagonal series.

*Corollary* 1.—Hence if $x$ be the number of the term of a diagonal series, then any term will be $\frac{x^{n-x+1|1}}{1^{n-x+1|1}}$, where $x$ must never exceed $n+1$.

*Corollary* 2.—Hence if $n$ be made equal to 1, and $x$ successively equal to 1 and 2, the first diagonal series will be $\frac{1^{1-1+1|1}}{1^{1-1+1|1}}$, $\frac{2^{1-2+1|1}}{1^{1-2+1|1}}$; that is, $\frac{1^{1|1}}{1^{1|1}}$, $\frac{2^{0|1}}{1^{0|1}}$, which in effect is the same as 1, 1.

*Corollary* 3.—Hence the $m$th terms of any two consecutive orders of figurate numbers will also be the $m$th terms of two consecutive diagonal series.

*Proposition* 1.—The $(m+1)$th term of the $(n+1)$th order is equal to the $m$th term of the $(n+1)$th order and the $(m+1)$th term of the $n$th order.

For $\frac{(m+1)^{n+1|1}}{1^{n+1|1}}$ is the $(m+1)$th term of the $(n+1)$th order.

Now each of the terms of the fraction $\frac{(m+1)^{n+1|1}}{1^{n+1|1}}$ may be resolved into two factorial factors, so that one of them may have the given exponent 1: therefore the factorial $(m+1)^{n+1|1}$ is equal to $(m+1)^{n|1} \times [m+(n+1)] = m^{n+1|1} + (n+1)\ (m+1)^{n|1}$, and the factorial $1^{n+1|1} = 1^{n|1} \times (n+1)$: whence

$(m+1)$

$$\frac{(m+1)^{n+1|1}}{1^{n+1|1}} = \frac{m^{n+1|1} + (n+1)\,(m+1)^{n|1}}{1^{n|1} \times (n+1)} = \frac{m^{n+1|1}}{1^{n+1|1}} + \frac{(m+1)^{n|1}}{1^{n|1}}.$$

*Proposition* 2.—In any two consecutive orders of figurate numbers, the sum of $m$ terms of the antecedent order is equal to the $m$th term of the consequent order.

Let $1,\ b,\ c,\ d,$ &c.
$1,\ \beta,\ \gamma,\ \delta,$ &c.

be any two consecutive orders of figurate numbers; than by the last proposition

$$1 + b = \beta$$
$$\beta + c = \gamma$$
$$\gamma + d = \delta$$
&c. &c.

The sum of these equations is

$$1+\beta+\gamma+b+c+d=\beta+\gamma+\delta;$$

take away the common quantities $\beta$, $\gamma$, and there will remain

$$1+b+c+d=\delta;$$ Q. E. D.

*Corollary* 1.—Hence the sum of $m$ terms of any order is equal to the $m$th term of that order, when the exponent of each of its terms is increased by unity.

*Corollary* 2.—Hence the first order of figurate numbers being given, the consecutive orders may be derived to any order required; thus,

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st order | 1 | 2 | 3 | 4 | 5 | 6 |
| 2d order | 1 | 3 | 6 | 10 | 15 | 21 |
| 3d order | 1 | 4 | 10 | 20 | 35 | 56 |
| 4th order | 1 | 5 | 15 | 35 | 70 | 126 |
| &c. | | | &c. | | | |

*Proposition* 3.—The $m$th term of the $n$th order is equal to the $(n+1)$th term of the $(n-1)$th order.

For $\frac{m^{n|1}}{1^{n|1}}$ is the $m$th term of the $n$th order of figurate numbers. Now the factorial $m^{n|1}$ may be resolved into two factorial factors, so that one of them may have the given exponent $m-1$ (see factorials): therefore $m^{n|1} = m^{n-m+1|1} \times (n+1)^{m-1|1}$; also the factorial $1^{n|1}$ may be resolved into two factors, so that one of them may have the given exponent $n-m+1$, therefore

$1^{n|1} = 1^{m-1|1} \times m^{n-m+1|1}$;

whence $$\frac{m^{n|1}}{1^{n|1}} = \frac{m^{n-m+1|1} \times (n+1)^{m-1|1}}{1^{m-1|1} \times m^{n-m+1|1}} = \frac{(n+1)^{m-1|1}}{1^{m-1|1}}.$$

*Corol-*

Fig. 1.

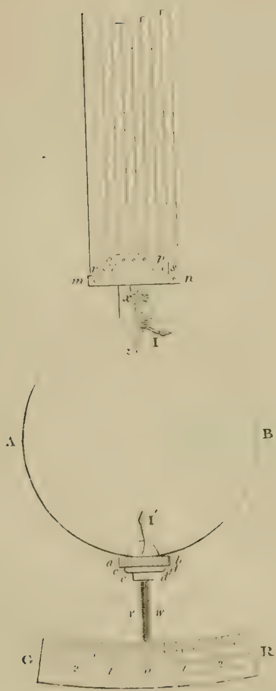
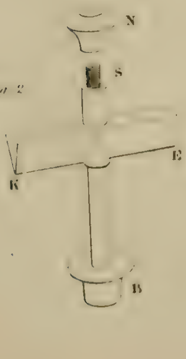



Fig. 2



*Corollary* 1.—Hence one expression of figurate numbers can easily be converted into another equivalent expression by the following.

*Rule*.—Add unity to the exponent of the numerator of the given expression, and it will give the first factor of the numerator of the new expression; and take unity from the first factor of the numerator, and the remainder will be the exponent of both the numerator and denominator of the new expression; the first factor of the denominator being the same as that of the given expression.

*Proposition* 4.—The first, second, third, &c. terms of the $m$th vertical column are equivalent to the second, third, fourth, &c. terms of the $(m-1)$th order of figurate numbers.

For by definition the first, second, third, fourth, &c. terms of the $(m-1)$th order of figurate numbers are respectively $\frac{1^{m-1|1}}{1^{m-1|1}}$, $\frac{2^{m-1|1}}{1^{m-1|1}}$, $\frac{3^{m-1|1}}{1^{m-1|1}}$, $\frac{4^{m-1|1}}{1^{m-1|1}}$, &c.: then by the rule to corollary 1, proposition 3, if the exponents of each factorial in the numerator be increased by 1, and the first factor of each of the factorials be diminished by 1 for the first factor and exponent of the respective terms of a new series of figurate numbers, we shall have the equivalent series $\frac{m^{0|1}}{1^{0|1}}$, $\frac{m^{1|1}}{1^{1|1}}$, $\frac{m^{2|1}}{1^{2|1}}$, $\frac{m^{3|1}}{1^{3|1}}$, &c.; but by definition 2, the second, third, fourth, &c. terms $\frac{m^{1|1}}{1^{1|1}}$, $\frac{m^{2|1}}{1^{2|1}}$, $\frac{m^{3|1}}{1^{3|1}}$, &c. are called the first, second, third, &c. terms of the $m$th vertical column. Q. E. D.

*Corollary*.—Hence because by proposition 2, the sum of $m$ terms of the preceding order of any two consecutive orders of figurate numbers is equal to the $m$th term of the consequent order; the sum of $m$ terms of the $(m-1)$th vertical column must be less by unity than the sum of $m$ terms of the $(m-1)$th order of figurate numbers.

*Proposition* 5.—The $n$th diagonal series of figurate numbers is $1, n, \frac{n^{2|1}}{1^{2|1}}, \frac{n^{3|1}}{1^{3|1}}$, &c.

For by corollary to definition third, any term of the $n$th diagonal series is $\frac{x^{n-x+1|1}}{1^{n-x+1|1}}$.

 But

But by the principles of factorials $\frac{x^{n-x+1|1}}{1^{n-x+1|1}} = \frac{n^{n-x+1|\bar{1}}}{1^{n-x+1|1}}$, where the first factor in the numerator of the second side of the equation is the last factor of the numerator in the first side; and because the common difference of the factors of the first side is $+1$, the common difference of the factors in the second side must be $-1$; also because the reverting of the fraction does not change the number of factors, therefore the exponent of the numerator must be the same on both sides, as is exhibited.

$$\text{Now, } \frac{n^{n-x+1|\bar{1}}}{1^{n-x+1|1}} = \frac{n^{x-1|\bar{1}} \times x^{n-2x+2|1}}{1^{x-1|1} \times x^{n-2x+2|1}} = \frac{n^{x-1|\bar{1}}}{1^{x-1|1}}.$$

Let $x$ be expounded by 1, 2, 3, &c. in the last side of this equation, and we shall have $1, n, \frac{n^{2|\bar{1}}}{1^{2|1}}, \frac{n^{3|\bar{1}}}{1^{3|1}}$, &c. Q. E. D.

*Proposition* 6.—The sum of any two consecutive terms $x$ and $x+1$ of the $n$th diagonal series of figurate numbers is equal to the $(x+1)$th term of $(n+1)$th diagonal series. For, by Proposition 1, the sum of the $m$th term of the $(n+1)$th order, and the $(m+1)$th term of the $n$th order is equal to the $(m+1)$th term of the $(n+1)$th order. Now the $m$th term of the $(n+1)$th order and the $(m+1)$th term of the $n$th order are any two consecutive terms $x$ and $x+1$ of any diagonal series $n$; also the $(m+1)$th term of the $(n+1)$th order is the $(x+1)$th term in the next diagonal series following. Q. E. D.

*Corollary* 1.—Hence if any diagonal series be given, the next following will be found: Thus, let 1, B, C, D, &c. be given, then the next will be 1, (1+B), (B+C), (C+D), &c.

*Corollary* 2.—Hence if the first diagonal series be given, we may derive as many consecutive diagonal series as we please, as in the following table:

| | | | | | | |
|---|---|---|---|---|---|---|
| First diagonal series | 1, | 1 | | | | |
| Second diagonal series | 1, | 2, | 1 | | | |
| Third diagonal series | 1, | 3, | 3, | 1 | | |
| Fourth diagonal series | 1, | 4, | 6, | 4, | 1 | |
| Fifth diagonal series | 1, | 5, | 10, | 10, | 5, | 1 |
| &c. | &c. | | &c. | | | |

LXIX. *Re-*

## LXIX. *Observations on Larch: together with two Experiments of the Strength and Resilience of the Timber, and Size of largest Tree cut in* 1817, *or growing in* 1819. *By* John, Duke of Atholl.

The following remarks on larch were transmitted by the Duke of Atholl to the Commissioners of Naval Revision, May 1807; and will evince, not only the great importance which in his opinion attached to the subject, but also his wish to make the result of his practical knowledge known, for the advantage of his country.

Since the period of 1807, the wishes of the Duke of Atholl, that the larch might be tried for naval purposes, has been carried into effect; and a frigate of 28 guns is now building at the Royal dock-yard of Woolwich, to be constructed entirely of that species of timber.

---

The introduction of this most valuable tree into Scotland, at least into the county of Perth, took place in the year 1738; when a Highland gentleman, Mr. Menzies, of Glenlyon (Perthshire), brought a few small plants from London; his servant carrying them on horseback on the top of his portmanteau. Some of these plants he left at Monzie, near Crieff, some at Dunkeld, and the remainder he carried home, where some have been cut, within these few years, of a great size. The four left at Monzie are in full vigour (1807); the largest nearly twelve feet in circumference, at three feet and a half above the ground. Those left at Dunkeld are also in full vigour (1807); some were placed in a green-house, but not thriving, were turned out. The largest is about twelve feet in girth, at three feet and a half above the ground, and is computed to contain four load of solid timber, or two hundred feet. Some years elapsed before any more larch were planted at Dunkeld. A few, however, were planted at Blair in that interval. But the larch planted between the years 1740 and 1750 were inconsiderable in point of number. For the planting of the rocky mountains round Dunkeld, with a view to their growing wood, which has since been done, would at that time have been treated as a chimerical idea. The plantations on the lower grounds were necessarily small in extent.

### *Trials of Larch.*

1777.—It is now thirty years since I have cut and used larch for different purposes; and as yet I have met with no instance to induce me to depart from my opinion, that larch is the most valuable acquisition, in point of useful timber, that has ever been introduced into Scoland: and I speak from having used and cut larch of from fifty to sixty years' growth.

 The

The small larch I have used were thinned out of plantations for upright paling, rails and hurdles. Those fit for sawing, were sawn through the middle; the smaller used round, with the bark on. I have found young larch, so used, more durable than oak copse wood of twenty-four years' growth.

1795.—The larger and older larch which I have cut, have been used for a variety of purposes. Boats built of it have been found sound, when the ribs, made of oak forty years old, were decayed. I have for years built all my ferry and fishing-boats of larch.

In mill-work, and especially in mill-axles (where oak only used formerly to be employed), larch has been substituted with the best effect.

1806.—Last winter, in cutting up an old decayed mill-wheel, those parts of the water-cogs, &c. which had been repaired with larch about twenty years before, though black on the surface, on the hatchet being applied, were found as sound and fresh as when put up.

There is not a sufficient quantity of larch of fit growth, to bring that wood into general use for country purposes; but such as has been cut and sold, has brought two shillings per foot, in some instances more. About the year 1800 I received twelve guineas for a single larch-tree of fifty years' growth. I was at the same time offered twenty pounds for another larch, which I declined cutting. The tree sold had eighty-nine solid square feet of wood; and the purchaser cut two if not three axles for mills out of it.

1806.—Last year I cut out twenty larch-trees from a clump where they stood too thick. I left the finest trees standing, and received one hundred guineas for the twenty trees taken out, being at the rate of two shillings per foot. The largest of the twenty trees measured one hundred and five feet in length, five feet eleven inches in girth at four feet from the ground, and contained ninety-four square feet of timber. One tree measured one hundred and six feet; two, one hundred and seven; and one, one hundred and nine feet in length; but, being drawn up by standing too close, did not contain so much solid wood as the first.

It is not in the quality only of the wood that I consider the larch a great acquisition; but in the nature of the ground, where it will not only grow luxuriantly, but I am persuaded will arrive at a size fit for any purpose to which wood can be applied.

The lower range of the Grampian Hills, which extend to Dunkeld, are in altitude from one thousand to seventeen hundred feet above the level of the sea; a range of mountains to the height of twelve hundred is now in the course of being planted. They are in general barren and rocky, composed of mountain schist slate and iron stone. Up to the height of twelve hundred feet, larch are planted, and grow luxuriantly, where the Scotch fir,

fir, formerly considered the hardiest tree of the north, cannot rear its head. In considerable tracts, where fragments of shivered rocks are strewed so thick, that vegetation scarcely meets the eye, the larch puts out as strong and vigorous shoots as are to be found in the valleys below, or in the most sheltered situations.

I have been employed for the last five years in forming a very extensive plantation of larch, on mountains similar to what I have described. The plantation embraces a tract of nearly eighteen hundred Scotch acres, nearly one thousand of which I have already planted (1807), mostly with larch, placing Scotch fir only in the wet grounds where larch will not grow, and mixing spruce on the highest points, finding from experience that that tree is next in value to the larch, and thrives in alpine situations almost equally well.

In all the larch which I have cut, I have never met with one instance of decay. But I have seen larch cut in wet situations and tilly soil on low moors some miles below Dunkeld, which at forty years of age were decaying at the heart. The larch is certainly an alpine tree, and does not thrive in wet situations.

In 1795 a species of blight appeared on the larch, which in low situations destroyed numbers. The season in which this was observed to any extent, the frosts were very severe late in the spring, and the clouds of frost fog, which rested on the larch, in calm mornings, when just coming into leaf, produced the blight. I did not find trees above twenty-five or thirty feet in height affected by it, neither did it appear at all on the higher grounds, where a slight breeze of air could shake the trees. For eight or ten years past severe frosts at the end of spring and beginning of summer, have partially brought a somewhat similar blight, which, though not essentially injuring the growth of the wood, except in a few instances, nearly destroyed the flower of the larch, which has prevented my having been able to obtain larch seed in the quantity I wished, in order to carry my intention into effect;—to cover all the mountainous tract near Dunkeld belonging in property to me, with larch, which I am persuaded, at the distance of sixty or seventy years from planting, will be fit for most naval purposes.

The comparative value of larch and Scotch fir will not bear calculation. In the year 1800 I sold a larch of fifty years old for twelve guineas; while a fir, of the same age, and in the same soil, brought fifteen shillings. A fall of snow will destroy in one night, and break and tear down sometimes more than one-third of a fir plantation. This I have often experienced at all ages. High winds also destroy firs in numbers.

The larch are never broken by snow, and very seldom torn up



by

by winds, and then only in single trees. Scotch firs are bad and shabby growers (with me at least), at about eight hundred feet of altitude. Larch grow luxuriantly some hundred feet higher.

The late Duke of Atholl, my father, was the first who formed plantations around Dunkeld or Blair, to any extent (in 1765). The quantity of old larch I could at present spare, therefore, cannot be considerable ; but should the Board, from any thing I have said of its durability in boats, &c. &c. be inclined to make trials for naval purposes, I could perhaps furnish for *that purpose* forty or fifty load: or, I should be extremely ready and happy to carry into effect experiments, if the Board should think fit to direct the making of any, to prove the strength, weight, durability, &c. &c. of larch wood.

I would not, Gentlemen, have troubled you with the foregoing detail, but from a thorough conviction that larch timber may be used, in many instances, as a substitute for oak.

That this substitute may be had of a prime quality in sixty or seventy years from the period of planting.

And, lastly, that this substitute may be the produce of otherwise barren and unprofitable mountains. Whereas oak timber will always be found to thrive best in lands either taken from, or well adapted to, agricultural purposes, and more particularly to the growth of *wheat.*

---

The further and various trials made by the Duke of Atholl of the quality and endurance of larch; the extent of plantations of that species of tree formed and forming on dry, and of the *Pinus alba*, or Norway spruce, on wet lands ; and the surprising fertilizing quality of the leaves or spines of the larch, which in the course of between twenty and thirty years convert the most barren and rugged mountains, formerly not worth nine-pence per acre, into an herbage worth from ten to fifteen shillings per acre; —it is the intention of the Duke to put together, and make known, for the general good.

In the mean time, he confines himself to the observations formerly transmitted in 1807, to the commissioners for naval revision, along with two trials of the strength of larch, made in 1812 and 1818*, and the age and dimensions of the largest larch-tree that has been cut, or is now growing on his estates.

* The description of the trials in 1818, here referred to, is a quotation from the Philosophical Magazine for March 1818 (see our fifty-first volume, page 214), and needs not therefore to be repeated in the present article.

Results

*Results of the Experiments made on the Strength of Larch Timber received at Woolwich Yard in the Year* 1808, *and proceeding from the Estate of His Grace the Duke of* Atholl, *in Scotland, compared with Riga Fir Timber, and American White Pine.*

| Date of the Experiments. | Description of the Timber. Quality. | Description of the Timber. How long kept in Store. | Dimensions of the Battens. Length. | Dimensions of the Battens. Size | Weight of the Battens at the time of Experiment. | Distance of the Fulcrum from the end of the Battens to which the weights were affixed. | Curvature received by the Battens under the pressure of Half hundred weight. | Curvature received by the Battens under the pressure of One hundred weight. | Curvature remaining after the removal of the weight. | Weight under which The fibres upset or crippled. | Weight under which The Battens broke. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Year.* | *ft. in.* | *inches.* | *lbs. oz.* | *ft. in.* | *inches.* | *inches.* | *inches.* | *cwt. qrs. lbs. oz.* | *cwt. qrs. lbs. oz.* |
| 1812. 16th June. | Larch. Outside | 4 | 6 0 | 2 by 2 | 5 8 | 5 0 | $7\frac{3}{8}$ | $16\frac{1}{8}$ | .... | ............ | 1 2 2 0 |
| | Larch. Heart | 4 | 6 0 | 2 × 2 | 5 10 | 5 0 | $3\frac{1}{2}$ | $7\frac{1}{2}$ | $\frac{7}{8}$ | 1 0 14 0 | 1 0 14 0 |
| | Larch. Outside | 4 | 6 0 | 2 × 2 | 5 5 | 5 0 | $5\frac{1}{2}$ | $10\frac{1}{2}$ | $\frac{1}{2}$ | ............ | 1 0 25 0 |
| | Larch. Heart | 4 | 6 0 | 2 × 2 | 5 8 | 5 0 | $3\frac{1}{8}$ | $6\frac{1}{8}$ | $\frac{3}{4}$ | 1 1 20 0 | 1 1 22 0 |
| | Riga, dry | 6 | 6 0 | 2 × 2 | 7 6 | 5 0 | $3\frac{7}{8}$ | $10\frac{1}{8}$ | .... | 1 0 7 0 | 1 0 7 0 |
| | American White Pine, wet | 8 | 6 0 | 2 × 2 | 6 7 | 5 0 | $3\frac{5}{8}$ | $10\frac{5}{8}$ | $1\frac{5}{8}$ | 1 0 7 0 | 1 0 10 0 |

The average and relative strength of the three species will therefore stand as under; viz.

| | *Average Strength.* *cwt. qr. lbs.* | *Relative Strength.* | |
|---|---|---|---|
| Larch .................. | 1 1 8 | ........ 1,000 | |
| Riga, dry .............. | 1 0 7 | ........ ,804 | Or about 1-5th less strength than the larch. |
| American White Pine, wet | 1 0 10 | ........ ,824 | |

The above experiments were tried in the presence of Captain Baynton, R.N, and the first was also witnessed by His Grace the Duke of Atholl, Commissioners Peake and Thomson, George Yeats, Esq. &c. &c.

J. LE BARRALLIER.
JOHN PEAKE.

Dimensions of Larch Tree, cut at Blair Atholl, 1817.

| *Feet. In.* | *Girth.* | *Root Cut.* | *Contents.* | |
|---|---|---|---|---|
| | Ft. In. | Length. Ft. In. | Cubic Feet. | |
| | | 1st.—31 6 | 172 | Woolwich Yard. |
| At 1 | 12 0 | 2d.—25 4 | 60 | |
| 19 | 8 3½ | 3d.—14 3 | 16 | |
| 57 | 4 10 | | 248 | |
| 82 | 2 0 | 4th.—10 11 | 4·8 | Home use. |
| To Top, 20 | | | | Home use.—Under six square inches. |
| 102 | | 82 | 252·8 | Age—79 Years. |
| | | Top, 20 | | |
| | | 102 | | |

DUNKELD.

A Larch Tree planted 1738, measured February 15, 1819.

| *Above Ground.* | | *Contents.* | *Age.* | |
|---|---|---|---|---|
| *Feet.* | *Girth.* Ft. In. | *Feet.* | | |
| At 1 | 17 8 | | 80 | This Tree is in full vigour. |
| 2 | 14 6 | | | |
| 3 | 12 7 | | | |
| 4 | 11 9 | | | |
| 5 | 11 5 | | | |
| 6 | 11 1 | | | |
| 10 | 10 4 | 300, | | |
| 20 | 9 7 | | | |
| 30 | 8 11 | | | |
| 40 | 7 11 | or | | |
| 50 | 6 3 | | | |
| 60 | 4 8 | | | |
| 70 | 3 2 | 6 Load. | | |
| | 1 10 | | | |
| 75 | | | | |
| To Top, 14 | | | | |
| 90 | Total Height. | | | |

LXX. *On*

## LXX. *On a new Method of applying the Power of Man to the moving of Machinery, with at least six times the Effect that can be produced by mere muscular Exertion. By the Rev. Dr.* Edmund Cartwright.

*To Mr. Tilloch.*

Dear Sir, Having lately discovered a method by which a man's power in giving motion to machinery of any kind, may be employed with at least six times the effect that may be obtained by mere muscular force, I am desirous of giving a discovery, embracing such a variety of purposes, the most extensive publicity :— and this I cannot do more effectually than through the medium of your Philosophical Magazine. The power with which a man can work through the day, and every day, is commonly calculated at 28 or 30 lbs. If, therefore, a way can be pointed out by which the whole of his absolute gravity can be brought into constant action, he will increase his power (calculating upon the average) as six to one. Now this is to be done by means so simple and obvious, that it seems nothing less than a miracle that the idea did not occur, even to the common knife-grinder, centuries ago. It is nothing more than having two cranks upon the axis to be moved, standing perpendicularly to each other, and the operator shifting his weight alternately from the treddle of one crank to the other. If the diameter of the crank's revolution does not exceed seven or eight inches, the muscular exertion will be trifling. To bring the whole or such part of the operator's muscular force into action as may occasionally be wanted, he might have straps upon his shoulders, such as are used by chair-men, which, being fixed to any convenient part of the machine, would enable him to add to his weight double the power of his absolute gravity; and this additional weight, when not wanted, he could be relieved from by a very slight inclination of the shoulders. These ideas I have actually reduced to practice, and have had a four-wheeled carriage made, which has fully ascertained the principles that are here laid down. To this carriage I attached a plough. We had not, however, proceeded above twenty yards, when being impatient to try the full power of the machine, I ordered the men to add their muscular force to that of their gravity; when the machinery which I had substituted in the place of treddles gave way, and terminated the business for that day. On my return home I shall expect to find the damage repaired. My substitutes for cranks are ratchet-wheels acted upon by treddles which have pauls upon them, which, when the treddles are lifted up, fall into a ratchet. The treddles are lifted up by means of a strap on the treddle under which the operator passes his foot.

As

As there is not a shadow of doubt but that an able-bodied man can in this way exert the power of a horse, I should not despair of seeing, were I to live but a few years longer, carriages of every description travelling the public road without the aid of horses. For mill-work of every kind this mode of working will have a decided advantage over animal power. In the first place, it will not require a twentieth part of the space; in the second place, not a tenth part of the expense of machinery; and lastly, it will save all the original cost of the horses and their daily decrease in value:—the space required for four men to work in, need not be more than four feet square, and the expense of the machinery will not exceed five pounds. But the most extensive application of this principle I look for in navigating vessels. When we take into consideration the immense expense of a large steam-engine, the space it occupies, together with the fuel to work it, and the combined danger of fire and its blowing up, no prudent man would hesitate which he would adopt. In the fisheries it would be particularly useful. The fishing-vessels could go out and return at pleasure, so as always to bring their fish fresh to market, to say nothing of the facilities it would afford of dragging their nets.

I am, dear sir, very faithfully yours,

65, Halford Place, May 29, 1819. EDMUND CARTWRIGHT.

---

LXXI. *On the different "Rates" of* PENNINGTON'S *Astronomical Clock, at the Island of Balta, in Zetland, and at Woolwich Common, Kent; with comparative Tables, and Remarks upon the Results of various other Pendulum Experiments. By* OLINTHUS GREGORY, *LL.D. of the Royal Military Academy; Honorary Member of the Literary and Philosophical, and the Antiquarian, Societies of New-York; of the Literary and Philosophical, and the Antiquarian, Societies of Newcastle-upon-Tyne; Corresponding Associate of the Academy of Arts, Sciences, and Belles Lettres, at Dijon, &c.*

It was my original intention to postpone the publication of any account of the experiment with Pennington's astronomical clock in the Zetland Isles, till after I had ascertained its "rate" at Dunnose, and some other stations to which it was proposed to take it; but, as circumstances which I need not now explain, prevented me from taking the clock to Dunnose last summer, and continue still to operate in the same way, I do not conceive it would be right to wait till the series of proposed operations with the clock is completed, before I put the public in a capacity to judge

judge what reliance may be placed upon the principal results already obtained.

It will, first, be proper to present a concise description of the clock itself. The "movement," as it is technically called, is such as is usually put to astronomical clocks of the best construction, and has "Graham's dead-beat escapement," with the pallets jewelled—this being all the jewelling which the clock has. The pendulum is a gridiron compensation, and is suspended by a spring, through an orifice in which a steel axis passes, upon the middle of which it is firmly clamped between two pieces of brass. The ends of this axis rest in Vs upon the top of two short pieces of brass, which are firmly screwed to the "rising-board" (that is, the board upon which the clock is fixed) at about five inches asunder, but are so much inclined as to approach within an inch and a half of each other at top; where they are connected by a piece of brass which is screwed to the back of each, and made additionally steady by two other pieces of brass, of which one is screwed to each of them and to the back-plate of the clock. The suspending spring is about one inch and a half long; half its length playing freely below the small horizontal axis, while the other half is fixed by pins in a slit at the top of the middle steel-bar that projects from "the gridiron." The ball or bob of the pendulum is seven inches across and two inches thick at the middle; it weighs about fourteen pounds avoirdupois, and rests by its centre upon the "regulating nut," which is a cylindrical brass one made sufficiently long to reach the centre of the ball: it is united to a brass prismatic stem which issues above the upper part of the ball, and proceeds to the gridiron part of the pendulum. The "regulating nut" changes the length of the pendulum in the usual manner, by being "tapped" upon a screw, whose threads are about forty to an inch, and upon which one revolution, by elevating or depressing the bob, makes a difference in the "rate" of about thirty sidereal seconds in a day. The curve surface of this nut is graduated into thirty equal divisions, and an index screwed upon the bob points downward so as to show the *division* or portion of a thread at which the nut stands. Another index fixed near the top of the bob points horizontally to equal divisions on the prismatic stem, and shows the actual thread of the screw upon which the nut rests when it supports the bob at any assumed position.

It having been found inconvenient, in moving astronomical clocks from one place to another, to have the ball of the pendulum and the rod inseparably attached to each other; these have been so constructed as to admit of occasional separation. To effect this, "milled heads" have been made to the two lower cylindric pins, which connect the outer bars of the pendulum with the

the inferior cross piece of brass to which the stem, screw, and bob are appended. By these means the said cylindric pins are easily taken out, and the bob with its adjusting screws, &c. separated from the compensating part of the pendulum, and attached to it at pleasure: proper marks upon the pins, screws, &c. preventing any junction except of corresponding parts, after a temporary separation has taken place.

This description will, perhaps, be rendered more perspicuous by a reference to Plate IV. fig. 1: *op*, *rs* and *mn*, are the horizontal pieces, to which the nine vertical bars of the pendulum are attached. The two exterior bars are attached to the cross piece *mn*, by the milled-head cylindric pins, which enter where two dots are marked in the figure between *m* and *n*: when those pins are taken out, the cross-piece *m n* with all that is below it is susceptible of complete separation from the upper part of the pendulum; and each part then packs in a stuffed box, of which the relative fitting is so nice as to allow of neither shake nor strain. A B is the bob or ball of the pendulum, as before remarked, seven inches across. It is so perforated as to admit the prismatic stem $x\ z$ to enter at $z$, while the screw passes out below I′. The regulating nut $a\ b$ is 1·4 inch across, and carries on its rim thirty equal divisions. Another smaller nut $c\ d\ c'\ d$, of which $c\ d$ is 1·1 inch, and $c'\ d'$ 0·5 inch, is placed below the former; and was intended to keep it steady in travelling. Its thickness is three-tenths of an inch, and its weight is less than three-quarters of an ounce. Its weight and dimensions are given thus particularly, for a reason which will appear in the sequel. The indexes I and I′ point to divisions on the upper stem and lower nut respectively; and when the parts are separated at *m n*, the previous divisions at which I and I′ stood are carefully registered, that the pendulum may be accurately restored to its former state with regard to length, before it is again permitted to vibrate permanently, with reference to an experiment.

To the vertical back of the mahogany clock-case is screwed a graduated metallic arch G R, near which the pointed inferior extremity of the screw $v\ w$, swings during the oscillations of the pendulum; the arch G R serving by this mean to measure the extent of those oscillations. To the bottom of the clock-case are screwed three strong feet of cast-iron, which project horizontally; near their exterior extremities they are met by three strong brass bars, which proceed downwards in slanting directions from the sides and back of the clock-case: the several extremities of these bars and of the horizontal feet, being screwed firmly to each other, and to the clock-case, give to the whole such a degree of stability as admits of no perceptible effect from the vibrations of the pendulum. By means of nuts and screws

to

to this tripod, the clock-case is adjusted to horizontality and verticality, after the manner of portable transit instruments; two spirit-levels which are fixed within the clock-case at right angles in the same horizontal plane, enabling us to ascertain when the adjustment is complete.

In Balta the three feet on which the clock and its case thus rested, were placed upon three separate portions of rock which were chamfered down till they were nearly in one horizontal plane; the position of the clock was then easily rectified by means of the adjusting screws. At Woolwich Common those feet are placed upon the heads of three separate piles which stand detached from the floor of the Observatory. In Balta a suitable piece of rock was selected as the pedestal of the *transit instrument* (which is a portable one by Troughton): the top of the rock was properly levelled; holes were drilled to receive fused lead, on which, after it had cooled, the feet of the transit instrument were placed. A wooden frame was placed round the piece of rock, to keep the observer from accidentally pressing against it during the observation. At Woolwich Common the transit instrument is placed upon a piece of stone thirteen inches square and six deep, which is half embedded in a strong prismatic box of sand, that rests upon piles. This, which I recommended as an appropriate pedestal for a transit instrument, has been found to answer remarkably well; the instrument, when properly adjusted, having preserved its level accurately for months in succession *.

These particulars are premised from a conviction that the public cannot be expected to place any confidence in the results of an experiment, unless the means taken to guard against the probable errors are fairly explained. Under this persuasion I shall, as I proceed, enter into minutiæ, where their omission might occasion doubts; and may here mention, while speaking of the clock, that the actuating weight was never permitted to descend lower than within two inches of the top of the pendulum ball; lest a nearer approximation of two such masses of brass, might produce irregularity (however slight) by their mutual attraction.

The small island of Balta, upon which M. Biot, Captain Colby, and myself fixed, after mature deliberation, as by far the most convenient on the whole, for landing our apparatus and carrying

* Such a box may be readily made to take to pieces, and join together again by screws; and will then serve to accompany a portable transit instrument from place to place, as it may be needed. But for a permanent observatory, it might be well to have the sand contained in a case of bricks. The instrument would then, I am persuaded, be less affected by any external impressions, than if it stood on a solid block of stone.

on

on our several operations in concert, serves as a natural breakwater to the fine harbour of Balta Sound, and is separated from Unst (to which M. Biot's apparatus was removed after he quitted us) by two narrow straits. After tents were set up for M. Biot, for ourselves and the soldiers who accompanied us, a temporary house, with walls of stone and a strong tarpaulin cover, was erected for the reception of the astronomical clock and transit instrument; and suitable spots within a few yards of this were chosen for the establishment of the great theodolite tent, and that for the zenith sector. Mr. Edmondston's house at Buness, in Unst, where M. Biot ultimately fixed his station, was within sight of ours: the distance being about two miles and a half, and bearing nearly west by north *.

The house in which the clock was placed, stood at an elevation of 121 feet above the level of low water in Balta Sound, and in north latitude 60° 45′ 3″. The transit instrument being adjusted to the plane of the meridian, by one of the methods described in Ludlam's Astronomical Observations, published in 1769, and confirmed by means of the elongations of the pole-star observed with the great theodolite by Captain Colby, a suitable meridian mark was fixed, at the distance of more than two miles on the island of Unst. The pendulum of the clock was set in motion on the morning of July 30, 1817. On the next day, when it seemed to have attained its full rate, its semi-arc of vibration was 2° 20′; and thus it continued until August 17th, when the clock was taken down, and its parts returned to their respective boxes.

Were I here to copy the entire record of my observations with the transit instrument much room would be uselessly occupied; because the mean or reduced time upon the five wires in no instance deviated more than three-tenths of a second from the time on the meridian wire, and usually agreed to about one-tenth of a second. I shall, therefore, reserve the entire publication of these to a more suitable time and place, and here simply present results. They are sufficiently numerous for the purpose; but not so numerous as would have been obtained in the same interval, in a climate better suited than Zetland for astronomical observation †.

* Buness is, in fact, as little above the level of the sea, as any point which could have been selected in the north of Zetland. It is almost entirely surrounded by hills, at no great distance; and was, therefore, in my opinion as well as Captain Colby's, altogether unfit for an astronomical station, from which triangulation was to proceed; however much the hospitality of Mr. E. might render it an agreeable residence.

† From July 22d, to August 17th, we had but one day that was entirely free from rain: though during the whole interval we were but once visited with a *fog*, and that did not last more than an hour.

Taking

Taking the "rate" of the clock as determined day after day, by the sun or different stars, as I could observe them in succession, it may be exhibited as follows:

| | | | |
|---|---|---|---|
| 1817. August 1st, 2d, rate from | $o$ Herculis | $+21''{\cdot}9$ | |
| August 2d, 3d, .... | $\gamma$ Aquila | 21·9 | |
| August 3d, to the 9th, | $\alpha$ Lyræ | 21·9 each. | |
| August 1st, 2d, .... | Sun | 21·95 | |
| Do. 4th, 5th, .... | Do. | 21·9 | |
| Do. 5th to the 10th, .. | Do. | 22·0 each. | |
| Do. 11th, 12th, .... | Do. | 22·2 | |
| Do. 12th, 13th, .... | Do. | 21·95 | |
| Do. 13th, 14th, .... | Do. | 22·15 | |
| Do. 14th, 15th, .... | Do. | 22.1 | |
| Do. 15th, 16th, .... | $\alpha$ Lyræ | 22·0 | |

From these and some other observations from day to day, I inferred that no change either of temperature or of barometric pressure experienced here, occasioned a change of *half a second* in the "rate." I therefore proceeded to deduce the average "rate" at Balta, from those observations on which I could most rely, on account of being enabled to see the star pass *all* the wires of the transit instrument. The result is here presented.

| | | | | |
|---|---|---|---|---|
| $\alpha$ Ophiuchi, | 13 | observations, whole gain | $287''{\cdot}1$ | mean $22''{\cdot}08$ |
| $\xi$ Herculis, | 2 | ...... ...... | 43·2 | .. 21·6 |
| $o$ Herculis, | 2 | ...... ...... | 43·7 | .. 21·85 |
| $\eta$ Serpentis, | 2 | ...... ...... | 43·2 | .. 21·6 |
| $\alpha$ Lyræ, | 16 | ...... ...... | 351·62 | .. 21·95 |
| $\gamma$ Aquilæ, | 16 | ...... ...... | 350·30 | .. 21·89 |
| $\alpha$ Aquilæ, | 16 | ...... ...... | 351·66 | .. 21·978 |
| $\beta$ Aquilæ, | 14 | ...... ...... | 309·1 | .. 22·07 |
| $\epsilon$ Cygni, | 13 | ...... ...... | 287·3 | .. 22·1 |
| | 94 | | 2067·18 | |

Hence $2067{\cdot}18 \div 94 = 21''{\cdot}991$, may be assumed for the mean rate (+) at Balta.

This does not differ so much as four-tenths of a second, from any single rate furnished by the whole series of observations; and is within an eighth of a second, of more than four-fifths of the daily rates, as ascertained by different stars.

*Both* the nuts *a b* and *c d c′ d′*, were below the bob, and close to each other during the Balta observations; the respective indexes I and I′, pointing to divisions agreed upon before the clock left Woolwich; viz. 1 to 13 and 1′ to 30.

Notwithstanding the close agreement of the rates of the clock as determined by observations from day to day, it was exposed to considerable and rapid changes, especially of temperature, as will be seen from the table subjoined.

Day

| Day 1817. | Barometer. | | Fah. Thermometer. | | |
|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | Diff. |
| July 31 | 29·411 | 29·223 | 68° | 54° | 14° |
| August 1 | 29·333 | 29·315 | 61 | 50 | 11 |
| 2 | 29·434 | 29·413 | 57 | 49 | 8 |
| 3 | 29·530 | 29·422 | 68 | 53 | 15 |
| 4 | 29·488 | 29·426 | 56 | 51 | 5 |
| 5 | 29·737 | 29·663 | 51 | 48 | 3 |
| 6 | 29·707 | 29·687 | 50½ | 50 | ½ |
| 7 | 29·646 | 29·632 | 53½ | 52 | 1½ |
| 8 | 29·641 | 29·638 | 55½ | 52½ | 3 |
| 9 | 29·752 | 29·730 | 57 | 52 | 5 |
| 10 | 29·834 | 29·826 | 61 | 54 | 7 |
| 11 | .. .. | .. .. | 64 | 53 | 11 |
| 12 | .. .. | .. .. | 63½ | 55 | 8½ |
| 13 | 29·892 | 29·864 | 62 | 53 | 9 |
| 14 | 29·963 | 29·942 | 66½ | 53 | 13½ |
| 15 | 29·941 | 29·920 | 59 | 54 | 5 |
| 16 | .. .. | .. .. | 56 | 52 | 4 |

The thermometer by which the temperature was measured, hung upon the side of the clock-case; the barometer which served to measure the atmospheric pressure, hung within two feet of the clock. The great differences between the maximum and minimum temperatures on July 31st, and August 1st, 3d, 11th, and 14th, were occasioned by the sun's rays striking upon the slightly elevated tarpaulin roof of the transit-house, thus greatly raising the afternoon temperature, and by the wide opening from the top to the bottom of the roof during observation, which gave a corresponding depression to the temperature at night.

The rapid depression of from 13° to 15° of temperature, took place on three afternoons between four o'clock and ten: yet this produced no appreciable change in the rate: from which we may infer, that the compensation in the pendulum is exceedingly perfect, and that the instrument does not yield to the changes of temperature "by starts," as has been often objected to the gridiron compensation.

Again; the "rate" of the clock, not varying from its mean rate more than one-fifth of a second on any day during the observations, although the barometric column varied from 29·22 to 29·96; we may, I think, fairly infer, that if the barometric changes do not exceed an inch, in the course of a series of comparative experiments with this clock, the introduction of any allowance for the air's buoyancy or its resistance, would be a useless refinement in the computation.

We

We may now proceed to detail more briefly the observations to determine the rate of the clock at Woolwich Common; omitting as unnecessary the register of the barometer and thermometer: of which the former oscillated between 30·402 and 29·464, the latter between 54° and 42°.

The hall of my dwelling-house having a window that opened to the north, from which I could conveniently observe several circumpolar stars, the clock was set up there November 15, 1817; the proposed observatory at the Royal Military Academy not being then ready to receive the apparatus. The nuts *a b* and *c d c′ d* were placed *precisely* as they had been in Balta; and of course the pendulum was effectively of the same length. After the clock had been going two days, the semiarc of vibration was observed to be 2° 30′; and so it continued till the clock was stopped.

The transit instrument was placed on a slab of stone half imbedded in sand, as before mentioned. The latitude of the place of observation is 51° 28′ 41″ north; its altitude 201 feet above the level of the sea.

The "rate" of the clock, as given by observations upon different stars from day to day, varied between −19 6″ and −20″.

The mean rate as determined from those stars which presented a series of observations upon all the five wires of the transit telescope, is as below:

| | | | | |
|---|---|---|---|---|
| β Ursæ majoris, | 15 observations, | whole loss | 296″·1, | mean 19″·74 |
| γ Ursæ majoris, | 14 .... | .... | 276·22 | .. 19·73 |
| ε Ursæ majoris, | 14 .... | .... | 275·8 | .. 19·7 |
| ζ Ursæ majoris, | 14 .... | .... | 276·2 | .. 19·73 |
| η Ursæ majoris, | 12 .... | .... | 236·4 | .. 19·7 |
| χ Ursæ majoris, | 2 .... | .... | 39·38 | .. 19·69 |
| | 71 | | 1400·10 | |

Hence we have 1400·1÷71 = 19·72, for the mean daily rate (−) at Woolwich Common.

But, as the constant semiarc of vibration was less at Balta than at Woolwich Common, a correction must be made upon one of the rates on that account. Thus, if $D = 2°\frac{1}{2}$ and $\delta = 2°\frac{1}{3}$, we have (Hutton's Course, vol. iii. p. 358, or Gregory's Mechanics, book ii. chap. 2), $\frac{4}{3}(D^2 - \delta^2) = \frac{5}{3}(\frac{25}{4} - \frac{49}{9}) = 1''\cdot342$, correction to be taken either from the + rate at Balta, or from the − rate at Woolwich Common: consequently there results, for

| | | | |
|---|---|---|---|
| Balta, | N. lat. 60° 45′ 3″, | alt. of station 121 feet, | rate +20″·649 |
| Woolwich Com. | 51 28 41, | .. .. 201 .. | .. −19·72 |

The number of vibrations in a sidereal day being at Balta 86420·649, at Woolwich 86380·28; we have from well-known principles 86380·28² : 86420·649² : : 1 : 1·0009304.

 Such

Such would be the ratio of the lengths of a pendulum to vibrate seconds at the two assumed stations: and from this it follows, that if at the temperature 50°, 39·136 inches be the length of a second pendulum at Woolwich Common, its length at the spot assumed for the experiment in the isle of Balta would be 39·1724 inches; and this result, I have no doubt, is exceedingly near the truth.

But before a result of this kind can be classed with others, in order for application to the question of the earth's figure, the deductions from the respective series of observation must be reduced to the same level. Such reduction I shall make conformably with the principles usually adopted, although I am persuaded (and could easily show, would it not extend this paper to too great a length) that it often introduces a greater error than that which it is intended to correct. In the case before us, where the difference between the levels of the two stations is eighty feet and 2101,0000 feet the earth's radius, we have $\left(1+\frac{160}{21010000}\right)$, or 1·000007615, for the factor by which the last term of the above ratio must be multiplied. The multiplication being effected, we have when reduced to the level of the sea,

Length pend. at *Woolwich*: length at *Balta* : : 1 : 1·0009379.

This ratio is the only independent result as to the lengths of pendulums at the two places furnished by the apparatus committed to my charge.

To judge to what extent confidence may be placed in this ultimate deduction, let us consider what will follow, supposing the difference in the rates at the two stations to be appreciated within only *half a second* of the truth. Then, since $(n+d)^2-n^2=2nd+d^2$, $n$ being $=86400$, and $d$ less than $\frac{1}{2}$, $2nd$ is less than $\frac{1}{88869}$ of $n^2$, that is, the difference between the lengths of two pendulums that shall vibrate seconds at the respective stations, is, by such an experiment, ascertained to within the 2220th part of an inch.

I have no conception that any result which depends upon actual measurement, and still more upon measurement and computation conjointly, can go *beyond* this degree of accuracy; if, indeed, it can attain it.

If it were true that the terrestrial meridians were similar ellipses, and if it were at all philosophical to attempt to infer the "compression" of the earth, as it is technically termed, from *two* observations upon the pendulum; it would follow from those which have been here described, adopting the well known method by means of two similar equations:

$$m = \lambda + d \sin.^2 L$$
$$n = \lambda + d \sin.^2 L':$$

and,

and, taking the compression $= \frac{5}{2} \cdot \frac{1}{289} - \frac{d}{\lambda}$ *, that the said compression is expressed by the fraction $\frac{1}{427 \cdot 6}$; agreeing nearly with the result of a comparison between the measurements of degrees at the equator and in America. But the only use to which two or three results thus obtained by one observer can be legitimately applied, is to make them parts of a series obtained by different persons in different places, and reduce the whole to computation by the " method of least squares." The general result would in such case *probably* agree nearly with $\frac{1}{305}$, the deduction from the lunar theory.

So long, however, as the investigations are conducted upon the hypothesis that the meridians are similar ellipses, or even ellipses at all, they proceed upon a *petitio principii*, and must involve error, while they are employed to elicit truth. For, as Horsley remarked when speaking of this very hypothesis†, " Plausible as it may seem, I must say that there is much reason from experiment to call it in question. If it were true, the increment of the force which actuates the pendulum as we approach the poles, should be as the square of the sine of the latitude; or, which is the same thing, the decrement, as we approach the equator, should be as the square of the cosine of the latitude. But whoever takes the pains to compare together such of the observations of the pendulum in different latitudes, as seem to have been made with the greatest care, will find that the increments and decrements do by no means follow these proportions; and in those which I have examined, I find a regularity in the deviation which little resembles the mere error of observation. The unavoidable conclusion is, that the true figure of the meridians is not elliptical. If the meridians are not ellipses, the difference of the diameters may, indeed, or it may not, be proportional to the difference between the polar and the equatorial force; but it is *quite an uncertainty what relation subsists between the one quantity and the other:* our whole theory, except so far as it relates to the homogeneous spheroid, is built upon false assumptions, and there is no saying what figure of the earth any observations of the pendulum give."

In reference to the irregular figure of the earth, Laplace, when speaking of the irregularities of its meridians, as proved by ac-

* It should not, moreover, be forgotten in this inquiry, that new and correct experiments on pendulums at the equator, and a more correct appreciation of the equatorial radius of the earth, may change the fraction $\frac{1}{289}$, and all which depends upon it.— See Clairaut's elegant disquisitions *Su la Théorie de la Figure de la Terre*, part II. § 20.

† Letter to Captain Phipps.

tual measurement*, says: "—— et s'il compare le degré du Cap de Bonne Espérance aux degrés mesurés dans l'hémisphère boréal de la terre, il y a lieu de croire que les deux hémisphères boréal et austral sont différens entre eux. La figure de la terre est donc *très composée*, comme il est naturel de la penser, lorsque l'on fait attention aux grandes inégalités de sa surface, à la différente densité des parties qui la recouvrent, et aux irrégularités du contour et de la profondeur des mers."

If these reflections be correct, how absurd and unphilosophical must be the procedure of those persons, who make the coincidence or the want of coincidence of a result (deduced from one or two experiments) with an assumed value of the compression, the test of the accuracy or the inaccuracy of the experiments themselves!

As the attention of men of science is now drawn, and is likely to be drawn still more, to the subject of experiments with the pendulum, it may be useful to collect together the principal results which have been furnished during the last and present century with regard to this point. These I shall present in the following tables; in which the several measures of the pendulum and corresponding forces of gravity are, for the more convenient comparison, referred to the length and force at the equator as the standard unit.

I. *Places having North Latitude.*

| Place. | Latitude. | Comparat. Length of Pendulum. | Observers. | Length, if Compression $=\frac{1}{336}$. |
|---|---|---|---|---|
| Equator ....... | 0° 0′ 0″ | 1·00000 | Bouguer | At 10° 1·000172 |
| Portobello ..... | 9 34 0 | 1·00020 | Bouguer | |
| Pondicherry .. | 11 56 0 | 1·00041 | Gentil | |
| Madras ....... | 13 4 0 | 1·00079 | Sir J. Warren | At 15° 1·000381 |
| Umatag ....... | 13 17 52 | 1·00032 | Ciscar, &c. | |
| Manilla ....... | 14 35 49 | 1·00087 | Ciscar, &c. | |
| Manilla ....... | 14 35 49 | 1·00082 | Gentil | |
| Acapulca ..... | 16 50 49 | 1·00075 | Ciscar, &c. | |
| Jamaica ....... | 18 0 0 | 1·00114 | Campbell | |
| St. Domingo.... | 18 27 0 | 1·00097 | Bouguer | At 20° 1·000666 |
| Macao ........ | 22 12 0 | 1·00061 | Ciscar, &c. | |
| Malta......... | 35 54 0 | 1·00262 | d'Angos | At 30° 1·001423 |
| Cadiz ......... | 36 31 46 | 1·00209 | Ciscar, &c. | |
| Monmerey ... | 36 35 45 | 1·00181 | Ciscar, &c. | |
| Formentera.... | 38 39 56 | 1·002693 | Biot, Arago, Chaix | At 35° 1·001872 |
| Toulouse ..... | 43 36 0 | 1·00303 | d'Arquier | |
| Figeac ........ | 44 36 45 | 1·003199 | Biot, Mathieu | At 40° 1·002352 |
| Bordeaux ..... | 44 50 25 | 1·003181 | Biot, Mathieu | |
| Clermont...... | 45 46 48 | 1·003322 | Biot, Mathieu | |
| Geneva ....... | 46 12 0 | 1·00263 | Mallet | At 45° 1·002845 |
| Vienna ....... | 48 12 47 | 1·00319 | Liesganig | |
| Paris ......... | 48 50 14 | 1·00332 | Bouguer | |
| Paris ......... | 48 50 14 | 1·003607 | Biot, Bouvard, Mathieu | |

TABLE

* *Mec. Céleste,* tome ii. p. 144.

TABLE continued.

| Place. | Latitude. | | | Comparat. Length of Pendulum. | Observers. | Length, if Compression $= \frac{1}{336}$. |
|---|---|---|---|---|---|---|
| Paris ... ... | 48 | 51 | 38 | 1·00370 | Borda | At 50° 1·003340 |
| Nootka....... | 49 | 35 | 15 | 1·00319 | Ciscar, &c. | |
| Gotha........ | 50 | 56 | 8 | 1·00338 | Zach | |
| Dunkirk...... | 51 | 2 | 8 | 1·003824 | Biot, Mathieu | |
| Woolwich..... | 51 | 28 | 41 | 1·003756 | Gregory | |
| London....... | 51 | 30 | 49 | 1·003551 | Desaguliers | At 55° 1·003818 |
| London....... | 51 | 30 | 52 | 1·003835 | Whitehurst, reduced by Troughton | |
| London ...... | 51 | 31 | 8 | 1·003825 | KATER. Ther. 62° | |
| Leyden ...... | 52 | 9 | 0 | 1·00374 | Lulofs | At 60° 1·004268 |
| Arengsberg ... | 58 | 15 | 9 | 1·00406 | Grischow | |
| Mulgrave .... | 59 | 34 | 20 | 1·00466 | Ciscar, &c. | |
| Petersburg .. | 59 | 56 | 35 | 1·00434 | Mallet | |
| Balta (Zetland) | 60 | 45 | 3 | 1·004697 | Gregory | At 70° 1·005025 |
| Unst (Zetland). | 60 | 45 | 35 | 1·004685 | Biot | |
| Archangel .... | 64 | 33 | 0 | 1·00474 | ——— | |
| Pello ........ | 66 | 48 | 0 | 1·00470 | Maupertuis | At 80° 1·005519 |
| Ponoi........ | 67 | 4 | 0 | 1·00481 | Mallet | |
| Kola ........ | 68 | 54 | 0 | 1·00510 | Mallet | |
| Spitzbergen .. | 79 | 50 | 0 | 1·00530 | Phipps, Lyons | |

## II. *Places having South Latitude.*

| Place. | Latitude. | Comparative Length of Pendulum. | Observers. |
|---|---|---|---|
| Equator ............ | 0° 0′ 0″ | 1·00000 | Bouguer |
| Zamboanga......... | 6 54 27 | 1·00042 | Ciscar, &c. |
| Lima .............. | 12 4 38 | 1·00050 | Ciscar, &c. |
| Madagascar ........ | 17 40 0 | 1·00073 | Gentil |
| Isle Babao ......... | 18 35 45 | 1·00091 | Ciscar, &c. |
| Isle of France........ | 20 10 0 | 1·00135 | ——— |
| Port Jackson ........ | 33 51 20 | 1·00207 | Ciscar, &c. |
| Cape of Good Hope .. | 33 55 0 | 1·00208 | Lacaille |
| Monte Video ........ | 34 54 38 | 1·00217 | Ciscar, &c. |
| Conception ......... | 36 42 32 | 1·00212 | Ciscar, &c. |
| Port St. Helena ...... | 44 29 34 | 1·00328 | Ciscar, &c. |
| Port Egmont........ | 51 21 3 | 1·00348 | Ciscar, &c. |

These tables (in the computation of which I have taken considerable pains to reduce the various measures accurately to one standard) exhibit some singular anomalies*. The different temperatures at which the lengths were ascertained, doubtless furnish one cause of discrepance, which, in most cases, from the want of proper data, it is quite impossible to remove. But, after all fair

* Compare, for example, Arengsberg with Mulgrave and Petersburg, Figeac with Bordeaux, Malta with Geneva, Paris with Gotha, Madras with Umatag, and generally the northern with the southern hemisphere, or the numbers in either hemisphere with the numbers in the last column, which are computed from Laplace's formula (*Mec. Céleste*, tome ii. p. 150), for $\frac{1}{336}$, which he exhibits as the medium compression from fifteen pendulum experiments at different places.

 allowance

allowance is made for this circumstance, as well as for the probable errors of observation, there will still remain such diversity in the results from any law which has yet been assigned, as will induce the investigator to seek for some general cause distinct from imperfections in the apparatus, and from inevitable aberrations in their use.

Laplace, when reasoning on this subject from the examination of results obtained at only fifteen different places, says, "Nous remarquerons ici que les mêmes anomalies que présentent les divers degrés mesurés depuis Dunkerque jusqu'à Barcelonne, et dont la cause est *sans doute l'irrégularité des parties de la terre*, se retrouvent dans les longueurs observées du pendule; car Grischow a observé à Pétersbourg et à Arengsberg, sous des latitudes tres-peu différentes entre elles, des variations dans ces longueurs, sensiblement plus grandes que celles qui résultent de la loi précédente de la variation du pendule de l'équateur aux pôles."—*Mec. Céleste*, tome ii. p. 151.

Another philosopher, who (though he thinks fit to give his opinion on this subject anonymously) is so clearly seen through the veil that he may be appealed to as an authority, observes—" It must not be supposed that, with the pendulum carried to its present state of sensibility and precision, the results will be free from inconsistency, or beyond the influence of the local irregularities that may exist immediately under the surface of the earth. Were the pendulum the same inaccurate instrument that it was a few years ago, it might not feel the influence of such causes as only increase or diminish the intensity of gravity by a very small part of the whole. But when the length of the pendulum can be determined to the ten-thousandth of an inch, or to $\frac{1}{134959}$ of its whole length, the force of gravity is measured with the same precision, and one part out of 134959 is rendered sensible. Now, it seems to us probable, that the variation in the density of the strata immediately under the surface, may produce a change in the intensity of gravitation, much more considerable than one part in 134959; the pendulum will not fail to be affected by this irregularity, and to give information of it. The force with which Schehalien disturbed the plumb-line was about $\frac{1}{34376}$ of gravity, or nearly four parts in 134959. We think that, without any exaggerated suppositions, by the presence of an extensive stratum of gneiss, or of hornblende schistus, or of any great body of granite, immediately under the surface at one place, and of chalk, common sandstone, or limestone at another, a difference in the intensity of gravity, even greater than the preceding, may be readily produced."—*Edin. Rev.* vol. xxx. p. 421.

On the whole, if I thought the opinion of so humble an individual as myself would have any weight in this interesting inquiry,

quiry, I would most earnestly recommend that proper persons be appointed to make experiments with pendulums, not only in different places on the same meridian, or in widely differing latitudes; but in various places upon or near the same parallels of latitude. Experiments of this kind can be made with more frequency and conducted with less expense, than any other class of operations for determining the figure of the earth; and they would not only be subservient to the determination of that figure, generally, but would furnish by their local anomalies ready indications of geological peculiarities, which might not previously have been detected by geologists themselves. That every possible satisfaction might result from these experiments, it would be adviseable that at each station they should be conducted *simultaneously*, by *three*, or at least *two* distinct classes of apparatus, and by separate observers. It was on a high estimate of the advantages of simultaneous operation at the same place by means of different instruments and observers, that I anxiously engaged in the experiment in the Zetland Isles. While I regret that M. Biot, by quitting the Balta station, and by declining to make a regular exchange of records of the respective experiments, precluded us from realizing this species of benefit; I have the satisfaction of feeling that the occasion of the separation cannot correctly be imputed, either to myself or to Captain Colby, my indefatigable and liberal-minded associate in that expedition.

This paper might now terminate, were it not that an accidental circumstance, the tendency of which to introduce error has been most industriously and ungenerously misrepresented, and made the basis of an illiberal comparison between the accuracy of my experiment and that of M. Biot, by persons who have not taken the trouble to ascertain *facts*—renders it expedient that I should present them here.

There being no observatory at the Royal Military Academy in 1817, the "rate" of the clock was ascertained by the Rev. Lewis Evans, at his private observatory on Woolwich Common, in the spring of that year. The rate was found to keep generally between ·3 and ·9 of a second, the mean being, nearly, + ·44; and on April 14, 1817, the clock, pendulum, and bob, were carefully packed up in their respective cases. I was not present at the packing, because at that time it was not determined that I should for a season quite my official duties at Woolwich, for the purpose of assisting in the proposed operations in the north. Col. Mudge and M. Biot started for Edinburgh early in May; and on June 28th I joined them at Leith. On my arrival there I found Col. Mudge too ill to render it possible for him to accompany us further northward, or indeed to give any specific directions as to the way in which he should wish the business to be conducted, or any detailed account of the state of the apparatus. He quitted Leith on his way home, the next morning; and on June 30th, I travelled from Leith to the Seadley Hills near Dundee, in order to acquaint Captain Colby with the state of affairs, and request him to suspend the operations in which he was there engaged, and accompany us to Zetland. To this he assented with that eagerness to promote the cause of science which has uniformly marked his character*.

On our arrival at the north of Zetland, as soon as the removal of M. Biot to Unst rendered it necessary for Captain Colby and myself to carry on our operations apart from that philosopher, we agreed that the captain with his assistant should undertake the observations with the zenith sector and the great theodolite, while I carried on those with the transit instrument and determined the rate of the clock; each, however, assisting the other in setting up the apparatus. Neither of us was at all aware that when the "rate" of the clock was determined at Woolwich, the nut $a\ b$ alone was screwed beneath the ball of the pendulum, and that the smaller nut $c\ d\ c'\ d'$, was simply applied during the voyage, under the idea that it would serve to give steadiness to the former. This smaller nut has a neat milled-head which gives it every appearance of an ornamental finish to a *constant* part of the apparatus; and as such I continued to use it during the going of the clock at Balta, simply taking care that it was brought up close to the nut $a\ b$, while *it* stood in its proper position, as ascertained by the indices I and I′. I made no computations of what might be the expected acceleration in latitude 60° 45′, lest their result should unconsciously bias my judgement in reference to the experiment; but I knew very well, from my general recollections of the theory, that a clock which went truly at Woolwich, ought to gain from 35″ to 40″ *per diem* at Balta. An acceleration, therefore, which fell short of my expectations, not merely by two or three seconds, but by from fifteen to twenty, could not but excite my astonishment. The observations of each succeeding day and night, convinced me that the rate was at least *nearly* correct; so that, as I could neither detect nor conjecture any cause of variation in the clock, I began to suspect that there might be some latent cause in the geological structure of the

* It is with reluctance I advert to such a trifle; but as it may serve to show the injustice of animadversions which have been freely indulged respecting the *dispositions* with which we met M. Biot, I shall be excused for stating that while we were at Aberdeen in our way to Zetland, Captain Colby and myself procured for M. Biot's use from our friends among the Professors at Marischal College, such magnetical and eudiometrical apparatus, as he thought himself likely to want when he arrived at the place of our ultimate destination.

island.

island. My reflections in reference to this point bear date "August 8th, 1817," in my journal, and were read to Dr. Wollaston and Captain Kater on the 4th of December, when they came to Woolwich to examine the clock.

On the return of the clock to Woolwich its rate was again tried by Mr. Evans at his observatory, and found to be nearly the same as it had been in the preceding March and April. After this I set it up for experiment, at my own residence, as before described; and had scarcely got it in motion when Colonel Mudge explained to me the intention of the smaller nut, which his severe indisposition had prevented him from doing when at Leith. This explanation, while it accounted satisfactorily for the apparently small acceleration at Balta, tended in no degree to diminish the rational confidence which might be placed in the invariability of the clock's motion while it was there; but simply made me the more solicitous to obtain the correct result at Woolwich, that the aggregate acceleration due to the change of latitude might become known: after which I was, of course, desirous to appreciate the real effect of the supplementary nut upon the pendulum. The aggregate acceleration, therefore, having been determined, as already described in this paper, I stopped the clock and *inverted* the nut, so as to make $c' d'$ upwards and $c d$ below it, leaving the nut $a b$ as before, and bringing up the smaller nut so as to be in contact with it. This I did because it was evident that such a process would produce a greater effect in the rate than would have been occasioned by depressing the smaller nut four or five threads of the screw. The inversion, however, considering that this smaller nut weighed less than three quarters of an ounce, could not be expected to produce more than a slightly perceptible effect: and thus it was found in fact; for before the supplementary nut was inverted the rate at Woolwich common was —19·72 (as before stated), while after inversion the rate appeared to be about —19·8.

I next took off the smaller nut entirely, and found the rate of the clock, on a mean of seven days, to be +·82, differing very little from what it had been found by Mr. Evans.

Early in 1818 the clock was removed from my house to the new Observatory at the Royal Military Academy, in north latitude 51° 28′ 29″·5. During the months of January, February, and March that year, by observations on stars south of the zenith, I ascertained the rate of the clock with the smaller nut on and off alternately, twice in succession; allowing several days to each trial. The first comparison gave 20″·4, the second gave 20″·2, for the variation of the rate occasioned by this change in the circumstances of the pendulum.

Bearing in mind that in the intervals between the experiments here

here spoken of the clock had been put up and taken down several times, and its different parts packed up in separate cases; that they had been exposed to the tossings of three rough and tedious voyages; and that the apparatus had been subjected to experiment in summer's heat and winter's cold; the agreement of results at Woolwich before and after the expedition, and with the smaller nut on and off, is so great, as, in my mind, to preclude all doubt as to the accuracy of the compensation, or the general correctness of the ratio of lengths furnished by the pendulum. I have only to add further, with regard to it, that during four months of the year 1818, and more than two months of the present year, in which I have taken account of the rate of this clock, I have never found it to vary so much as *half a second*.

If compensation pendulums could be always so constructed that the variations in their rate should be confined within as narrow limits as those which are recorded in this memoir; they would, I conceive, demand the preference in all cases where commodious and accurate comparison of the force of gravity in different regions was the experimenter's object.

Having thus presented every fact that can possibly serve to assist the public in estimating how much or how little credit is due to the results furnished by Pennington's clock in this inquiry, I most positively disclaim all uncandid sentiments while I point out concisely some defects, which in my judgement attend the corresponding experiments with the French apparatus, with which they have been so invidiously contrasted.

The apparatus employed by M. Biot is a slight modification of that which was contrived originally (I believe) by Borda, and consists (besides the clock which serves to determine the oscillations of the pendulum used in the experiment, by the method of *coincidences*) of four distinct parts. 1. A "knife-edge" suspension which is supported by a horizontal plane having a longitudinal aperture. The knife is crossed in its middle, perpendicular to its edge, by a small stem, at the top of which is a nut or button, capable of being fixed higher or lower by the threads of the screw to which it is fitted; and thus of adjusting this part of the pendulum, when detached from the rest, to the same interval of oscillation as the entire apparatus. This is shown at fig. 2. where KE is the "knife edge," SB the stem projecting both above and below it, S the screw, and N the nut which by working upon it serves to regulate the time of oscillation. 2. A very fine metallic thread, of equal diameter in the whole of its length, which is attached by its upper extremity to the extremity B of the stem, by a small screw. 3. A small hollow segment or cup, to the interior of which a ball of platina or other metal adheres by means of a thin coating of a greasy substance; the cup being attached

attached to the lower extremity of the metallic thread. These together constitute the vibrating part of the apparatus. 4. A metallic circular plate, capable of accurate adjustment to horizontality, and of very gentle elevation or depression by means of a fine screw, so as to be brought into contact with the bottom of the ball, when the pendulum is at rest; and thus to furnish the actual distance between the fixed plane which supported the "knife edge" and the bottom of the ball.

Now, without adverting to other matters which call for the utmost nicety in this experiment, it is obviously requisite that the knife-edge with its stem and nut be made to vibrate, not *apparently*, but to a considerable degree of precision, in the same time as the wire and attached cup and ball: for a very slight difference in their respective times of vibration may evidently impair the accuracy which is assumed in the result. But how can the interval of vibration in the upper part of the apparatus be made *equal* to that of the other portion, when this latter is not known, being a main object of the experiment itself? How, again, is the latter ever known *separately*, when the experiments determine solely the motion of the *complex* pendulum? But admitting, in order to lessen the difficulty, that it *is* known, how are the knife-edge, stem, and nut, made to vibrate accurately or *nearly* accurately in the same time? To ascertain whether they do so or not, appears a problem of equal difficulty, and requiring equal care with the other. Supposing, however, all this effected, and the *precise* period of oscillation of the knife-edge, stem, and nut, ascertained and adjusted for one latitude, and for one temperature,—how is it determined through what space the nut, N, must move, to ensure the same or any proposed time of oscillation in another latitude or at another temperature? And it is evident that in so short a part of the apparatus as this which we are now considering, where a minute change in the position of the nut may change that of the centre of oscillation (that is, of N K E B) even *inches*, the variations of gravity in different latitudes, or of temperature whether in different latitudes or the same, may so affect the place of that centre, as to disturb the vibration of the complex pendulum, and totally to cancel all pretensions to extreme accuracy in the general result drawn from the experiment. All this, then, requires a frank explication before the result can be safely adopted, even though it may agree with an hypothesis to which our prepossessions tend; unless it be decisively confirmed by another experiment of unquestionable correctness.

But there is another circumstance which may, still more than the preceding, affect the precision of M. Biot's operations in the north. To obtain the length of a second or other pendulum, from

from such operations, appropriate corrections for the changes in temperature and in atmospheric pressure, are applied to two measurements; viz. that of the diameter of the ball of the pendulum, and that of the vertical distance between the plane of suspension and the horizontal metallic plate which is screwed up to become a tangential plane to the ball of the pendulum when hanging at rest. Of these measurements, I venture, with all proper deference to the ingenuity of M. Biot, to question the accuracy of the second; and it is due to the cause of scientific truth to state why I entertain doubts. The adjusting screw, &c. by which the metallic plate was elevated to come into contact with the bottom of the ball, were fixed upon a prismatic block of stone which, both at Leith and in Unst, was embedded in the earth. The consequence was, that when M. Biot, or any other individual whom he permitted to approach, stood within a foot or two of the apparatus, as he set down or took up one of his feet, the stone with the adjusting screw, metallic plate, &c. *perceptibly* became elevated or depressed, so that in one case the ball would *touch* the plate, in the other *vibrate freely*. Several persons besides myself witnessed this effect, both at Leith Fort, and in Mr. Edmondston's cow-house where the apparatus was placed in Unst: M. Biot, indeed, was in the habit of advancing and receding within suitable limits, to show to strangers this motion in the stone and what it carried. Now, as it was not possible to bring up the metallic plate to touch the ball, and to measure the distance between that plate and the plane of suspension, without the observer's moving to and fro, and at the same time moving the stone, the question naturally arises, *How was error precluded?* If it be replied, that the conductor of the experiment always knelt down gently on a certain point when he screwed up the plate, and stood on that point, or some other constant point, every time he approached (for he must approach *several* times, see Biot's Physical Astronomy, vol. iii. p. 159. Additions) for the purpose of applying his metallic ruler to measure the abovementioned distance; the obvious remark is, that notwithstanding those precautions there would probably be a *constant* deviation of the horizontal metallic plate from its true position; and that since the change of position in the plate was *perceptible* during different positions of the observer, it is further probable that the said constant deviation, should it be such, far exceeds the allowable limits of error in an experiment which pretends to an accuracy expressed by a recorded result carried to the ninth place of decimals*. Is this deviation appreciable? If it be—upon what principles, and by what process?

* M. Biot gives ·994948151 of a metre as the length of the second pendulum at Unst. He does not specify to what temperature this determination ris eferred.

Nothing

Nothing was easier than to have removed this cause of doubt altogether. If it were not convenient to have the plate with its adjusting screw, &c. rise from a stone, *detached* from the floor, but projecting from the pier to which the upper part of the apparatus was attached, as exhibited in the neat representation of the whole given in the 3d volume of Delambre's Astronomy; a platform might have been placed on a detached frame, on which the observer might kneel or stand, as required, while he performed the several operations. M. Biot had such a platform in the temporary observatory erected for his Repeating Circle; why he omitted it with regard to the pendulum apparatus I know not.

I can now cheerfully leave this general question in the hands of the public; regretting, however, very sincerely that the ungenerous detraction which renders necessary the latter part of this memoir, should have also compelled me to give it something of a personal complexion, by requiring not merely a defence of my own operations, but at least my *opinion* of those of our foreign companion in the voyage. In all this, I can conscientiously affirm that I am not actuated by a love of fame, but by a desire to obtain justice. Personal sacrifices I *did* make, with regard to the Zetland expedition, solely in order to promote the cause of science, and obtain new facts in an interesting department of inquiry. But it would be puerile indeed to expect any *reputation* to accrue from the circumstance of having made accurate observations with a transit instrument—that is, from having succeeded in the *simplest* class of operations in practical astronomy.

Royal Military Academy,
June 15th, 1819.

OLINTHUS GREGORY.

---

## LXXII. *On the Aggry Beads of Africa.* *By* T. EDWARD BOWDICH, *Esq.**

THE natives invariably declare that the aggry beads are found in the Daukara, Akim, Warsaw, Ashanta, and Fantee countries, the greater number in the former (first) being the richer in gold: they say they are directed to dig for them by a spiral vapour issuing from the ground, and that they rarely lie near the surface;—the finder is said to be sure of a series of good fortune. The plain aggry beads are blue, yellow, green, or a dull red; the variegated consist of every colour and shade. The Fantees prefer the plain yellow bead, the Amanaheans the blue and yellow, for which they will give double the weight in gold; those of inferior beauty frequently fetch a large price from having been worn by some royal or eminent character. Dr. Leyden, who writes "the

* From Mr. Bowdich's Account of his Mission to Ashantee.

aigris

aigris is a stone of a greenish blue colour supposed to be a species of jasper, small perforated pieces of which, valued at their weight in gold, are used for money," (which I never heard of,) rather describes the pope bead; though that is semi-transparent (of a bright blue) resembling carnelian (which is frequently found in these countries), and said to be obtained in the same manner as the aggry bead. Issert * writes, "they are a sort of coral with inlaid work: the art of making beads is entirely lost, or was never known in these parts: it is not improbable that in the golden age of Egypt she had communication with the Gold Coast; indeed, it has been thought, and perhaps not without some reason, that the Gold Coast is the Ophir of Solomon."

The variegated strata of the aggry beads are so firmly united, and so imperceptibly blended, that the perfection seems superior to art: some resemble mosaic work; the surfaces of others are covered with flowers and regular patterns, so very minute, and the shades so delicately softened one into the other and into the ground of the lead, that nothing but the finest touch of the pencil could equal them. The agatized parts disclose flowers and patterns deep in the body of the bead, and thin shafts of opaque colours running from the centre to the surface. The natives pretend that imitations are made in the country, which they call boiled beads, alleging that they are broken aggry beads ground into powder and boiled together, and that they know them because they are heavier; but this I find to be mere conjecture among themselves, unsupported by any thing like observation or discovery. The natives believe that by burying the aggry beads in sand they not only grow but breed.

The colouring matter of the blue beads has been proved by experiment to be iron; that of the yellow without doubt is lead and antimony with a trifling quantity of copper, though not essential to the production of the colour. The generality of these beads appear to be produced from clays coloured in thin layers, afterwards twisted together into a spiral form, and then cut across; also from different coloured clays raked together without blending. How the flowers and delicate patterns in the body and on the surface of the rarer beads have been produced, cannot be

* Dr. Issert, a Danish gentleman, who had the good fortune to cure the former king of Ashantee's sister of a lingering disorder, after she had exhausted all the skill of the fetish woman, and came to Christianburg-castle in despair. He afterwards expressed his wish to visit the Ashantee kingdom; and being encouraged, he set out in June 1786; and staying some days in Aguassim, was just about to enter Akim when he was recalled by the governor. A dangerous illness, heightened by his disappointment, soon afterwards disgusted him with the country, and he left it for the West Indies. His letters descriptive of his tour, so far as it extended, have been hitherto only known in the German and Dutch languages.

so

so well explained. Besides the suite deposited in the British Museum, I had the pleasure of presenting one of the most interesting kind to Baron Humboldt; and I have also sent one to Sir Richard Hoare; as it seemed to correspond so closely with the bead which he found in one of the barrows, and describes as follows in his History of Wiltshire:—"The notion of the rare virtues of the Glain Neidyr, as well as of the continued good fortune of the finder, accords exactly with the African superstitions." A large glass bead of the same imperfect petrifaction as the pulley beads, and resembling also in matter the little figures that are found with the mummies in Egypt, is to be seen at the British Museum. This very curious bead has two circular lines of opaque sky blue and white, which seem to represent a serpent entwined round a centre which is perforated. This was certainly one of the glain neidyr of the Britons, derived from *glain* which is pure and holy, and *neidyr* a snake. Under the word *glain* Mr. Owen in his Welsh Dictionary has given the following article:—"The glain neidyr, transparent stones, or adder stones, were worn by the different orders of the bards, each having its appropriate colour. There is no certainty that they were worn from superstition originally; perhaps that was the circumstance which gave rise to it. Whatever might have been the cause, *the notion of their rare virtues was universal* in all places where the Bardic religion was taught. It may still be questioned whether they are the production of nature or of art." The beads which are the present object of my attention are thus noticed by Bishop Gibson in his improved edition of Camden's Britannia. "In most parts of Wales, and throughout all Scotland, and in Cornwall, we find it a common opinion of the vulgar, that about Midsummer-eve (although in the time they do not all agree) it is usual for snakes to meet in companies; and that by joining heads together and hissing, a kind of bubble is formed like a ring, about the head of one of them, which the rest by continual hissing blow on till it comes off at the tail; and then it immediately hardens and resembles a glass ring, *which whoever finds* (*as some old women and children are persuaded*) *shall prosper in all their undertakings*. The rings which they suppose to be thus generated are called Gleinú Nadroedh, *i. e. gemmæ anguium*, whereof I have seen at several places about twenty or thirty. They are small glass amulets, commonly about half as wide as our finger rings, but much thicker; of a green colour usually, though some of them are blue, and others curiously waved with blue, red, and white. I have also seen two or three earthen rings of this kind, but glazed with blue and adorned with transverse streaks in furrows on the outside. There seems to be some connexion between the glein neidyr of the Britons and the *ovum anguinum* mentioned

tioned by Pliny * as being held in veneration by the Druids of Gaul, and to the formation of which he gives nearly the same origin. They were probably worn as an ensign or mark of distinction, and suspended around the neck, as the perforation is not sufficiently large to admit the finger."

The bead engraved in Tumulus No. 9 resembles closely a coarse sort of bead, still manufactured in Syria, brought over by Dr. Meryon. The glass globes dug up in Lincolnshire, and presented by Sir Joseph Banks to the British Museum, are very like a distinct sort of aggry beads dug by the natives even more rarely than the others, but not larger than a moderate-sized apple: they are more opaque than the other beads; and the ground or body is generally black, speckled confusedly with red, white, and yellow.

*Aggry* is the generic not the abstract name: '*awynnee*' is bead, but *aggry* is an exotic word no native can explain. When first I heard of similar beads having been lately dug in India, I associated for an instant the expectation that it might have been in the neighbourhood of Agra, and thus have thrown some light on the name; but it appears they were found in Malabar. I am indebted for the following account of this interesting discovery to a gentleman lately returned from India: "The bead you sent me is more like those I saw in India than any I have seen before, but it is thicker and shorter; neither does the material of which it is formed exactly agree with those in India, which appear to be of a red glass very like red carnelian (such however are frequent among the aggry beads) with white lines of enamel inlaid as it were in the body of the bead. I gave these to a friend in India, who promised to send them to the Asiatic Society in Calcutta. The circles of stone in which these beads have been found abound most in Malabar, in the neighbourhood of Calicut; but I have seen them in other parts of India, and I am of opinion that they might be traced throughout the whole of the southern peninsula. They are formed of large masses of rough stones placed round in irregular circles, some of very large extent, some of smaller; they appear so much like natural rocks that most persons would pass them unobserved. Several of these circles about three years since were excavated in the vicinity of Calicut, and in the centre of each of them we found, at the depth of about five feet, a large earthen jar, of the same shape as those found in Wiltshire, as near as we could judge, for it was broken to pieces: it was about four or five feet deep, its mouth in general closed with a square piece of granite: the beads were found at the botom of these jars with some pieces of iron, apparently parts of swords and spears. There was an iron javelin found in one of these places tolerably perfect;

* Plinii *Hist. Natural.* l. 29. c. 3.

it

it was about five feet long, with a large iron knob at one end of it. In the centre of one of the circles we came to a flight of seven steps, which led to a cave excavated in the rock; it measured eleven feet in diameter and seven feet in its highest part; the entrance to it was a square opening of about eighteen inches, which was closed up by an immense block of granite. We found in this place a great number of earthen pots of very curious shape; in one of these were the remains of bones which appeared to have been but imperfectly calcined; in several of the larger jars there were the husks of rice, which dropped into dust immediately they were opened. We found here also an iron tripod, and a very curious stone somewhat similar to what the Indians now use for grinding their curry-powder on. The large stones forming the circles were set upright and capped with still larger ones. They are not of granite, but of the stone of the country in which they are situated; they are of different sizes; I have seen some of them ten or twelve feet high, and the large stone on the top from ten to twelve feet in diameter, or perhaps more. Coimbatore is a district situated between the Coromandel and Malabar coasts; it is bounded on the east by the river Cavery, on the banks of which the tumuli are in general situated. In some a few silver coins have been found of a square figure with characters on them, which none of the most learned Bramins have been as yet able to make out; it is in these also, that remains of very large swords, &c. have been found. The Roman coins to the number of 90 were all of gold, and Nero's; each of them had a cut or slit in it; they were not found in one of these barrows, but were discovered in a garden by one of the natives when digging; they were in a small copper pot. Pandu kuri literally means Pandu's caves or holes. Pandu is a very celebrated personage in the Hindu mythology, and a great warior; it is common in India to ascribe to him all great works of antiquity: this term, therefore, only shows that these places are very ancient, and that the present inhabitants are quite ignorant of their origin.

---

## LXXIII. *Notices respecting New Books.*

*Journal of a Route across India through Egypt, to England in the latter End of the Year* 1817 *and the Beginning of* 1818. By Lieut. Col. FitzClarence. 4to. with Plates, pp. 526.

This well written, interesting work is not a mere journal of stages and distances. It embraces many details respecting late military transactions in India, in some of which the author was personally concerned in the course of his route; enlightened views respecting the line of policy pursued in the maintenance of our eastern possessions; allusions to the history and policy of former conquerors and sovereigns in that quarter; geographical divi-

divisions, customs, antiquities, and monuments of art—particularly the excavated temples; the author's journey across the Desert to Egypt; and some interesting particulars respecting the labours of Belzoni, Caviglia, and Salt, in exploring the pyramids, the sphynx, the tombs, and the temples, in Egypt and Nubia.

As military operations come not within the plan of our publication, we will select some particulars respecting the antiquities of Egypt, which, with previous articles in our present volume, will give our readers some idea of the labour it has cost the meritorious individuals above named to lay open these ancient edifices, to procure the knowledge that has been obtained respecting them, and to gain possesion of those singular monuments which already grace the British Museum, with others now on the way, or in readiness to be embarked, to be deposited in the same singularly splendid and unrivalled collection of Egyptian antiquities.

On the author's arrival at Cairo, he introduces us at once to some of the curiosities collected by Mr. Salt. "At last (says he) we reached the door of the house I was in search of, and learned, with pleasure, that its owner was at home. I jumped off my donkey, and passing through a narrow passage, entered a court-yard of small dimensions; and from the extraordinary figures against the walls around me, should have fancied I was in the catacombs, had I not recollected that I was in the sanctum sanctorum of an inveterate and most successful antiquarian. The lantern illuminated the massy figures around; and having the prospect of viewing them the next morning, I went on with the hope of entering when supper was on the table; but before I could attain the desired object, I had to pass two large wooden figures, like porters, at the door, from the tombs of the kings of Thebes . . . . . . . . While at supper, Mr. Belzoni, of whom I had heard so much, made his appearance, and I was greatly struck with his person, being in the Turkish costume. He was the handsomest man I ever saw, was above six feet six inches high, and his commanding figure set off by a long beard. He spoke English perfectly, and the subject which had engrossed our thoughts so long, that of opening the second pyramid, was brought on the tapis*."—It was agreed that they should set off next day to see the adjacent wonders.

"I had much conversation with Mr. Salt and Signor Belzoni respecting the late discoveries in and near the ruins of Thebes, which seem to surpass every thing in the world except Ellora †. The tomb lately opened by Mr. Salt was discovered by Mr. Belzoni,

* For an account of this labour of Belzoni see p. 210 of this volume.

† The author alludes here to the grand temple, Keylas (or Paradise) and other excavations, extending for nearly two miles, near the village of Ellora, all cut out of solid red granite—a much more difficult labour than that of excavating

zoni, by what he calls a certain *index*, which has guided him in opening the second pyramid: what this index is I know not; but certainly he has been most successful, and cherishes the intention, if supported by our government, of doing much more. In my opinion, he is too valuable a man for us to permit to labour for any other nation. Fame appears to be the object for which he is most anxious, though he has nothing to live on but the produce of a few statues sold to the Comte de Forbin (who has been in this country travelling for the French Government), to replace those various niches in the Louvre now vacant by our having forced them to deliver back divers works of art to their original possessors.

"Mr. Salt showed me some beautiful specimens of papyrus which he had himself taken out of the mummy wrappers. They all appeared to have at the top of the roll a representation of religious worship, and the figures were painted in more than one colour. He pointed out some small wax figures; one with the head of a woman, one with an eagle's head, one with a monkey's, and another with that of a ram: these were uniformly found in the better kind of mummies. To prove that sculpture had been carried to very great perfection among the ancient Egyptians, he showed me a small leg and thigh made of wood, about 10 inches long, most correctly carved, and equal to, if not surpassing, any thing I had previously seen. He showed me also a piece of linen covered with hieroglyphics, which appeared exactly as if it had been printed. Several mummies which he had opened had down the front of their person broad pieces of leather, gilt, as fresh as the day they were made; and I have understood that gilding has, in several instances, been proved to be well known to the Egyptians. . . . . . .

"Both Mr. Salt and Mr. Belzoni were enraptured with the sarcophagus they had discovered; and when I fully comprehended its beauty and value, my feelings were congenial with theirs without having seen it. A piece of alabaster 9 feet 3 inches long

vating in calcareous materials as in Egypt. Of this grand temple he has given in the volume before us such an account as the short time he was there would permit. He speaks of the sculptured decorations and the taste of the ornaments in this temple being such as "would do credit to the best period of the Grecian school;" and gives the following measurements of this extraordinary place "from the Asiatic Researches."—Gateway, height 14 feet: passage of the gateway, having on each side rooms fifteen feet by nine, 42 f.; inner area or court, length from the gateway to the opposite scarp 247 f.; breadth of this court 150 f.; greatest height of the rock out of which the court is excavated 100 f. Dimensions of grand temple: door of the portico 12 f. by 6 f. broad; length from this door entering the temple to the back wall of the temple, 103 f. 6 in.; length from the same place to the end of the raised platform behind the temple, 142 f. 6 in.; greatest breadth of the inner part of the temple, 61 f.; height of ceiling 17 f. 10 in.; two porches on each side without, 34 f. 10 in. by 15 f. 4. in.—Editor.

 would

would in itself be a curiosity; but when it is considered that so much pains have been used in the elaborate carving of so fragile a material, it almost surpasses belief. It is made something in the form of a human body, but the sides of it are not above $2\frac{1}{2}$ inches thick, all deeply carved in miniature figures representing triumphs, processions, sacrifices, &c. All these figures are stained in the deepest blue; and when a light is placed in the inside, the alabaster being transparent, they appear upon a pellucid ground. It was found in what Mr. Belzoni supposes to be a tomb of the god Apis, and was most unaccountably placed across the top of a hollow passage (which leads 300 feet beyond, into the solid rock, and has not yet been explored to the utmost) with not above one inch resting on one of the sides, so that, had it slipped, it would have fallen and been shattered to pieces.

"We visited the court-yard which I had passed through last night, and surveyed four statues of black granite as large as life, with women's bodies and heads of lions. They are in a sitting posture, with the emblematical key of the Nile in one of their hands. Belzoni discovered these, with about thirty others, deep under the sand. They had been deposited there without regularity, as if to be concealed. Two of these he had sold to the Comte de Forbin for the French Museum. Mr. Salt next drew my attention to two wooden figures as large as life, found at Thebes in a standing position. They were covered with a sort of varnish, and had their eyes and part of their bodies inlaid with some metal."

On the 10th of March 1818, the author set off with Messrs. Salt and Belzoni to view the Pyramids. He pays a just tribute to Captain Caviglia, who so successfully explored the well as it used to be called in the great pyramid; to him and Mr. Salt, in laying open the front of the sphynx; and to Belzoni, of whose labours in opening the second pyramid he gives some particulars. "At a distance were Arabs employed on the third pyramid, by Belzoni; and certainly, if we may judge from his former success at Thebes, and the second pyramid, it is to be hoped he will not labour in vain."

"We proceeded (says the author) to the buildings of masonry situated to the west of the great pyramid. The paintings in the interior of one of these are particularly curious, representing, among other things, the mode by which large stones were transported both by land and water. In the former of these the stone is placed on a sledge drawn by bullocks with collars, which at the present period are not used in the country. Figures of persons ploughing, driving herds of cattle, fishing, in several instances cooking immense quantities of provisions, and in one design, an uncommonly spirited fight in boats, in which the weapon

pon made use of is a spear, and the figures are particularly slender and black. They appeared to me to represent persons similar to the Arabs I saw at Mocha, or the slight forms of the inhabitants of the southern parts of India. They did not strike me as having the features of the negro."

Speaking of the colossal head, now in Mr. Salt's possession, which was brought from the neighbourhood of Thebes, and is called the head of Orus, the author says: "It is ten feet from the top of the mitre to the chin, having a band round the bottom part of it not unlike a turban. It is of red granite, and in very fine preservation. There is an arm eighteen feet long of the same statue, with the fist clenched, of excellent proportions. Belzoni thinks he could convey the whole of the figure to England piecemeal, and that it might be placed in any public situation, as one of the greatest and most complete remains of antiquity ever carried out of Egypt. The celebrated French stone has also been removed to this place [Cairo]. It consists of a block of granite about four feet square, and has evidently been an altar. On the sides are figures with draperies supporting the summit. I hope eventually to see the whole of these in the British Museum;"—and so must every one who can duly appreciate such valuable antiquities.

We have not only been amused but instructed by the work before us, which cannot fail to be highly acceptable to the historian, the military man, and the antiquarian.

---

*Description of the Process of manufacturing Coal-Gas for the Lighting of Streets, Houses, and public Buildings; with Elevations, Sections and Plans of the most improved Sorts of Apparatus now employed at the Gas-Works in London, and the provincial Towns of Great Britain;* accompanied with comparative Estimates exhibiting the most œconomical Mode of procuring this Species of Light. With seven Plates. By Fredrick Accum, Operative Chemist, Lecturer on Practical Chemistry, &c. pp. 330.

It will be remembered that when the art of lighting by gas was yet in its infancy, Mr. Accum published a Treatise, containing a description of the various processes of the art as far as then understood and practised in the metropolis. Such was the general avidity for information on the subject, that in the course of a few years four large impressions of the work were disposed of, and it was successively transferred into the French, German and Italian languages. Since Mr. Accum wrote that Treatise, however, the art of manufacturing and applying coal gas has undergone many material improvements, all combining to bring it to a degree of simplicity, precision, and œconomy, far surpassing every thing

 which

which the original mode of practice exhibited. Mr. A., sensible of this, felt, as he informs us, that he should have been "guilty of an injustice to the constant demand which still exists for his former Treatise," had he not made it his duty to suit it to the changes which have taken place; and in execution of this design, he has now presented the public with what is in fact quite a new work, superseding altogether the former publication, but superseding it, we must readily allow, from circumstances of necessity, and with an undoubted view to the public good.

The object which Mr. Accum seems already to have pursued in the present work has been, to make it a compendium of all the best information which the practice of the art down to the present moment has been able to afford; and we must do him the justice to state it as our opinion that he has fulfilled his object with equal amplitude and exactness. It includes not only the result of his own experience in this department, which appears to have been extensive, but a great number of valuable data with which he has been favoured by other gentlemen practically versant in the art; and we are well satisfied the ingenious author will not be disappointed in the hope he expresses of its proving a work of truly practical utility.

The following are the contents of the work: Part I. General nature and advantages of the art of procuring light by means of carburetted hydrogen or coal-gas.—II. Outline of the new art of procuring light by means of coal-gas, and theory of the production of gas-lights.—III. Classification of pit-coal and maximum quantity of gas obtainable from different kinds of coal.—IV. Form and dimensions of the retorts originally employed for manufacturing coal-gas; application of heat; the plan originally adopted; report on a course of operations made with sets of 66, of 30, of 116, and of 64 retorts worked on the flue plan; oven plan lately adopted; description of the retort oven.—V. and VI. Account of experiments pursued on a large scale in order to ascertain the most profitable mode of employing the retorts; differences of opinion which have existed among practical men with respect to the degree of temperature fittest to be applied, and the number of hours at a time during which the retorts may most advantageously be kept in action, with the particular results which the experiments instituted into these points have afforded; and various other data calculated to enable the reader to adopt that mode of operation which under every circumstance of locality will be found most advantageous.—VII. Detailed description of the horizontal rotary retorts, the application of which has led to a more œconomical, expeditious, and easy method of manufacturing coal-gas than heretofore practised; advantages which these retorts present; particular results they afford, and method of applying

plying them.—VIII. Purification of coal-gas; comparison between the apparatus for this purpose as originally constructed, and the improved machinery lately adopted; test apparatus for certifying the purity of coal-gas and the proper manner of working the lime-machine; best method of preparing the quick-lime. —IX. Account of the various improved gas-holders which have been invented and are now in action; gas-holder with governor or regulating gauge; revolving gas-holder; collapsing gas-holder; reciprocating safety-valve, &c.—X. Description of the gas-meter (an entirely new machine) lately adopted at the Birmingham, Chester and other gas-works, which measures and registers the quantity of gas manufactured in any given time from any given quantity of coal, or consumed during any period by any number of burners or lamps; great services of this machine both to the manufacturer and consumer of gas; to the manufacturer, by serving as a complete check on his workmen as to the quantity of work that ought to be performed,—and to the consumer, as an exact measure of the quantity of gas he receives and ought to pay for.—XI. Governor or gauge for regulating the pressure of the gas before it enters into the mains; directions to workmen for fixing it; application of this apparatus for regulating the magnitude of the flames of gas-burners and lamps.—XII. Gas-mains and branch-pipes; rules to be observed for applying and distributing gas-pipes to the greatest advantage.—XIII. Most efficient mode of introducing gas to the interior of houses; instructions to workmen for adapting the gas-pipes and insuring success at the least cost under every variety of circumstances.—XIV. Illuminating power of coal-gas; quantity of gas consumed in a given time by different kinds of gas-burners and lamps; comparative cost of gas, tallow, and oil lights of different intensities; and most improved method for ventilating apartments lighted by gas.—XV. Account of the manufacture of gas from coal tar, vegetable tar, and oil.—And, XVI. Other products obtainable from coal; viz. coal tar, coal oil, pitch, ammoniacal liquor; manufacture of carbonate of ammonia and muriate of ammonia from the ammoniacal liquor; London price list of the most essential articles in the manufacture and application of coal-gas.

The plates, seven in number, are very elegantly coloured, and present sections, plans and elevations of all the most improved sorts of apparatus now employed at the Gas-works in London, and the principal provincial towns in Great Britain.

---

*The Theory and Practice of Gas-lighting, in which is exhibited a Historical Sketch of the Rise and Progress of the Science, and the Theories of Light, Combustion, and Formation of Coal; with*

*with Descriptions of the most approved Apparatus for generating, collecting and distributing Coal-gas for Illuminating Purposes.* With fourteen appropriate Plates. By T. S. PECKSTON, of the Chartered Gas-Light and Coke Company's Establishment, Peter-street, Westminster. 8vo, pp. 458.

We have here another work professing to embrace the same objects as the one by Mr. Accum, which we have just noticed. Mr. Peckston in going over the same ground as Mr. A. seems not to have found it necessary to deviate greatly from the line of description followed by the latter in the earlier editions of his work: in some instances, indeed, he has adhered perhaps too literally to Mr. A.'s statements and illustrations. See particularly p. 73, the rules in which Mr. Accum acknowledges he borrowed from the Plain Dealer, but which Mr. Peckston borrows at second-hand without making any acknowledgement either to the Plain Dealer or Mr. Accum. Compare also from p. 85 to 90 inclusive, on the theory of the combustion of coal, with what is said on the same subject in the former editions of Mr. A.'s work. Mr. Peckston, however, is less to be quarrelled with for enriching his work with valuable matter from preceding writers, than for omitting much new matter, which, though within his reach, seems altogether to have escaped his observation. A sufficient cause for this deficiency may perhaps be found in the following resolution, of which in his preface he apprizes the reader: "He (Mr. P.) has only further to observe, that in no one instance does he intend to lay before the public experiments which have not been made under his own observation; unless of such a nature as are likely to be beneficial, and then by stating his authority." Mr. P. has, we think, adhered sufficiently to the first part of this intention; but failed in the second. He has confined himself too much to his own experience, and made too little inquiry after the experience of other labourers not less assiduous in the same department. As far as he goes he is generally an intelligent, correct and well-informed guide, but he has neither gone far enough nor looked sufficiently round about him. We shall subjoin, as we have done with Mr. Accum's work, a table of the contents of Mr. Peckston's, in order that our readers may judge for themselves between them; but that the judgement we have ventured to pronounce may not go forth without some facts in support of it, we shall briefly point out a few of those instances in which we think the sin of omission is honestly chargeable against Mr. Peckston.

In p. 212, in speaking of the purification of gas, he informs us that "means have been tried for purifying the gas by lime in a semi-fluid state, thus decreasing the quantity of this objectionable matter; but the vessel which *my* observations were made upon was found

found inadequate for accomplishing the purpose of purification." In the hands of *other* people, however, this vessel appears to have performed its office very satisfactorily; for we learn from Mr. Accum's work that it has been adopted at the Gas-Works at the Royal Mint, Chester, Birmingham, Bristol, and "many other provincial gas establishments."

In treating again from p. 220 to 272 of the gas-holder, and giving "descriptions of such *as would best answer the purpose of the manufacturer*," he states pretty positively that a certain cylindrical gas-holder, which he describes minutely, with the appendages of balance weights, pulleys, and frame-work, "is the *most simple* construction of gas-holders for working on the ordinary principles that has hitherto been adopted." With balance weights, pulleys and frames—"the most simple construction!"

Would not Mr. P. think a machine without any of these appendages a vast deal more simple? The reader who may think with us that there can be no doubt on the subject, will please to be informed that all these appendages have actually been got rid of, and that gas-holders are now every where to be found in full action, without any such specific gravity apparatus attached to them. All that Mr. P. informs us is, that some experiments have been made by a Mr. Malam to attain a "method of working the gas-holder without using chains or balance weights, and in such a way as to have the pressure uniform at all its heights;" and it does seem a little strange that a set of experiments done in a corner, and never adopted in large practice, should have so particularly attracted Mr. P.'s notice, while he has overlooked entirely how perfectly all the objects of these experiments have been already publicly effected by the gas-holders without specific gravity apparatus adopted at the Gas-Works of Bristol, Birmingham, Chester, and most of the recent establishments for lighting by coal-gas. The gas-holder of this description at Bristol is, we believe, the largest which has been yet erected in this country. For its dimensions see Mr. Accum's work, p. 177. So much has the removal of the old appendages, as exemplified in Mr. Peckston's "*most simple* construction of gas-holders," contributed to lessen the expense of this part of the apparatus, that, as we learn from Mr. Accum's book, "a reservoir for storing up any quantity of gas may now be furnished for nearly one-half the sum which such a vessel cost as originally constructed."

The manner in which this important improvement has been effected is by attaching to the gas-holder what is called a regulator or governor, through which the gas is made to pass before it enters into the mains. Mr. P. has not been unaware of the existence of this instrument, for he has devoted a chapter exclusively to it; but singularly enough he omits including among the

various

various uses to which it is applied, that to which it is chiefly applied—the regulation of the specific gravity of the gas-holder.

In the chapter on the regulator or governor to which we have just alluded, Mr. Peckston observes, p. 357, that "the smaller ones," for the purpose of regulating the size of flames in the burners, "such as have fallen beneath *his* notice no reasonable person would expect much service from." We have here another instance of the disadvantage of judging from a limited sphere of observation; for it is a matter of notoriety that many hundred governors of the description alluded to by Mr. P. have been for some time in constant action at Bristol, Birmingham, Chester, Manchester, &c. and have been found to answer extremely well.

The chapter on gas-meters is almost wholly occupied in an attempt to settle the comparative merits of the gas-meter originally invented by Mr. Clegg, and the instrument of the same kind supposed to be an improvement invented by Mr. Malam. We are not at all disposed to take any part in the controversy, resting satisfied that both instruments may be employed with advantage; but we hold it a duty to see that the facts as between the parties are fairly stated. Mr. P. asserts, p. 334, "that in the large establishments, where of course the gas-meter (*i. e.* Mr. Clegg's gas-meter) would in proportion be more useful, it has not been introduced." We suspect that Mr. P.'s information on this point is somewhat inaccurate. On consulting Mr. Accum's work, we find that gas-holders of this description have been adopted at the Gas-works at Manchester, Bristol, and Chester; and "larger" or better conducted establishments than these we need not look for, with a view to any sanction which their system of practice affords. It is also but just to observe on the other hand, that although it is now about two years since Mr. Malam's supposed improvement was made public; yet the only gas-meters erected on his plan, of which we can find notice taken in Mr. P.'s book, are two—one at Brick-Lane, and another small one in Mr. P.'s own office.

In the chapter on retorts, Mr. P. mentions that the first three of the rotary retorts which were ever put up, were worked under his (Mr. P.'s) observation; and that had not the expense of erecting retorts of this description been very considerable, and the wear and tear enormous, they would doubtless have been adopted in the establishment to which he belongs; but that "both were so much against them that every idea of using them *there* was entirely relinquished." This it will be observed was a first trial, and like most first trials appears to have been a very unsuccessful one; but Mr. P. seems not aware of what the reader will find fully shown in Mr. Accum's work, that since then the rotary

retorts

retorts have undergone such improvements in point both of the facility and the œconomy of working them, that though not used at Mr. P.'s establishment, they are now used almost everywhere else—at the Royal Mint, Bristol, Birmingham, Chester, &c.

While we have thus pointed out some of the deficiencies which have arisen from the circumstance of Mr. P. confining himself too much to his own experience, we must not forget a tribute of well-deserved praise, which remains to be paid to the various Tables which he has given of the results of that experience. They are all very accurate, and calculated to be of great value to practical men.

The following is Mr. P's table of contents :—

ers in general use.—Chap. XVII. On the gas meter.—Chap. XVIII. On the regulator.—Chap. XIX. On tests.—Chap. XX. On the chemical constitution of coal-gas.—Remarks on the methods of obtaining it, and cursory observations on its usefulness when employed for generating artificial light, and for other purposes.—Chap. XXI. On the coke, tar, ammoniacal liquor, &c., produced from coal during the process of distillation.—Chap. XXII. On the tendency of the gas-light scheme towards promoting the coasting trade.—Where gas-light is most economically used.—Its safety.—Remarks on arranging a station.—Recapitulation of the process for generating gas.—Mr. Onthett's apparatus.—Mr. Malam's retorts.—Conclusion.

---

*Familiar Lessons on Mineralogy and Geology*, explaining the easiest Methods of discriminating Minerals and the earthy Substances commonly called Rocks, which compose the Primitive, Secondary, Flœtz or Flat and Alluvial Formations. To which is added a Description of the Lapidaries' Apparatus, &c. With Engravings and coloured Plate, &c. By J. Mawe, Author of the New Descriptive Catalogue of Minerals.

The author describes "the object of these familiar lessons to be, to unlock as it were a casket of useful knowledge, and to present to the *learner*, a compendious view of the beauty and value of its contents." It is written with simplicity, and, as a guide to more comprehensive publications, cannot fail, we think, to be instrumental in promoting the interests of science.

---

Mr. Curtis has just published a second and enlarged edition of his work on the Anatomy, Physiology and Diseases of the Ear. In this edition the physiology is much extended, and the uses of the different parts of the human ear are more fully explained by a minute comparison of its structure with that of the different classes of animals, particularly quadrupeds, fowls, insects, the amphibious tribe, and also fishes. The treatment employed in the various diseases of the ear is also considerably enlarged.

---

Mr. Murray has in preparation for the press "Observations on some Parts of Italy during the Autumn of 1818, with occasional Notices Agricultural and Mineralogical."

---

## LXXIV. *Proceedings of Learned Societies.*

### CORK INSTITUTION.

Mr. Davy, Professor of Chemistry in the Cork Institution, has just closed his Elementary Course of Lectures and Demonstrations,

tions in Chemistry, delivered at the Laboratory of the Cork Institution to a Class of Medical and other Students. This was the first Course of the kind ever delivered in the city of Cork, and has been greatly extolled by the highly respectable class which attended it. It is with much satisfaction we have heard that it is Mr. Davy's intention to deliver a course of a similar nature next year.

One of his pupils has favoured us with some of his concluding observations. In addressing Medical Students he said, "As Chemistry forms an indispensable part of your profession, it is not a mater of *choice*, but of *necessity*, that you acquire a competent knowledge of this science. The sooner you are initiated into the principles and doctrines of chemistry, the better. The acquisition will not only be important in itself, but it will derive additional value from the early habits of application with which it will furnish you;—habits which will be always useful, and which you may immediately transfer to every other pursuit. Whilst you are attending lectures on chemistry, and studying the best elementary works on the science, you ought to be furnished at least with a small apparatus (which may be done at a trifling expense), and make experiments yourselves.—The information you will thus gain, will make a deep and lasting impression, and will in fact be more valuable than that which you can acquire by any other means.

You have chosen a useful, an honourable, but an arduous profession; you all, I trust, anticipate the day, when you shall attain eminence and distinction in it; when the talents, which now in the season of youth you are cultivating with assiduity, shall grow up and be matured in flourishing manhood, and not only reflect lustre on your own name, but confer honour upon your country. And why not? In every liberal art, in every useful science, eminence is the reward of labour. It is a proud distinction which no power on earth is competent to confer; a tribute due only to industry; nor is it ever paid but as the price of individual and active exertions.

The highest motives are not wanting to awaken in you a laudable and generous ambition;—reputation, influence, rank, and property, are distinctions equally open to the talents of every individual, and they particularly invite you to honourable exertion. Animated by a noble emulation, inspired by an ardent enthusiasm, you can scarcely fail of ultimately attaining the proud and enviable summit of excellence.

So interesting is the study of chemistry (independently of its professional applications) that the pursuit of it in early life will not dispose you to cast it off with the playthings of childhood, or the amusements of youth. A taste for this science, when once imbibed,

imbibed, is scarcely ever eradicated. It grows with the progress of refinement, and is often conspicuous in those who are most distinguished in active and social life. It affords security against ignorance, superstition, and vice. It helps to open and enlarge the mind, cures it of little partialities and narrow prejudices, and gives it a generous, liberal, and manly way of thinking.

Chemistry is not an abstract study, terminating in barren and empty speculations; but a practical science, designed to increase the sum of human happiness, and intended solely for the occasions and uses of life. As chemistry is eminently conversant with Nature, in her slow and silent as well as in her magnificent and terrible operations, we cannot turn our attention to it without feeling an expanse of thought, and a conscious elevation of mind. We cannot behold this wonderful system of things, with its mutual adaptations and subserviencies, without admiring the wisdom and power and goodness of our beneficent Creator, so eminently displayed in the perfection and majesty of his works.

## LXXV. *Intelligence and Miscellaneous Articles.*

### NEW LIQUID.

A NEW compound consisting of two atoms of oxygen, and one of hydrogen, was discovered by M. Thenard when prosecuting his experiments on the oxygenized acids, detailed in the preceding pages of this volume. This liquid is less volatile than water, in which it is soluble in any proportion. It may be obtained almost free from water by placing the solution under the receiver of an air-pump with sulphuric acid. When thus concentrated as much as possible, its specific gravity is 1·417. It has the property of destroying or of whitening all organic substances. A drop let fall on oxide of silver decomposes the latter, with explosion, attended frequently with an emission of light.

### WAVELLITE—A SUBPHOSPHATE OF ALUMINA.

Berzelius has discovered, by a careful analysis, that wavellite contains phosphoric acid. This mineral yields by analysis: alumina 35·35; phosphoric acid 33·40; fluoric acid 2·06; lime 0·50; oxides of iron and manganese 1·25; water 26·90.

### SULPHURIN ACID.

This new acid, discovered by M. Gay-Lussac and M. Welther, is, as its name expresses, a combination of sulphur and oxygen, intermediate between sulphurous and sulphuric acid as regarding the dose of oxygen taken into combination. It is obtained by passing a stream of sulphurous acid gas over black oxide of manganese.

manganese. A sulphurinate of manganese is thus formed in the oxide, from which it is separated by throwing the whole into water, which dissolves the sulphurinate. Caustic barytes precipitates the manganese, and forms with the sulphurin a salt very soluble, which crystallizes like nitrate on muriate of barytes. The sulphurinate of barytes thus obtained is decomposable by sulphuric acid, added gradually to its solution, which precipitates the barytes, leaving the sulphurin acid in the water. It may be much concentrated without any loss.

### VESTIUM, A NEW METAL.

This metal has its name from the discoverer, Professor Von Vest of the Johanneum in Gratz. It is found in the nickel ore of Schladming (an ore mixed with cobalt pyrites) ; and also in cobalt ore. In its reguline state it has the appearance of iron, is brittle, and has a fine granular texture. The existence of this metal is, however, questioned by Mr. Faraday and Dr. Wollaston.

### CRYSTALLIZED DIAMOND IN IRELAND.

An exceedingly fine specimen of crystallized diamond has been found in the sand of a small stream in the north of Ireland. It is of the species called by lapidaries *the yellow* diamond, of extreme beauty and remarkable size.—*Public Journals.*

### THE NECRONITE (A SUPPOSED NEW MINERAL).

[Extract of a Letter from Dr. H. H. Hayden of Baltimore, to Professor Silliman of Yale College, United States.]

" It (the necronite) occurs in a primitive marble or limestone which is obtained twenty-one miles from Baltimore. It occurs for the most part in isolated masses in the blocks or slabs both in an amorphous and crystallized state. It is most commonly associated with a beautiful brown mica of the colour of titanium, small but regular crystals of sulphuret of iron, tremolite, and small prismatic circles of titanium which are rare. The form of the crystals is a rhomboid approximating very much to that of the felspar, and which has inclined some to consider it as such. Also the hexaedral prism resembling that of the beryl. This form is rare, and has not as yet, I believe, been found complete. Its colour is a bluish white and clear white. Its structure much resembles felspar ; being lamellar, sometimes opaque, semitransparent and transparent, at least in moderately thin pieces. It scratches glass, carbonate of lime, and even felspar in a *slight* degree. In all our efforts it has been found infusible *per se*, or with borate of soda, and even from all the force of heat that could be excited in a smith's furnace it came out unchanged in every respect. The acids seem to have no sensible effect upon it, either cold

cold or hot. This is all that I can say of it at present, except that it possesses a most horrid smell. " It is from this last characteristic that Dr. Hayden proposes to call it *necronite*, from the Greek νεκρος.

Dr. Hayden subsequently found in a marble of the same kind, but from a different quarry and a few miles distant from the first, a quartz almost as fetid as the necronite, and likewise associated with *small* prisms of titanium. " These substances," he adds, " carry with them a degree of interest in another point of view. They seem to invalidate the opinion that the fetid smell of secondary limestone shale, &c. is derived from the decomposition of animal matter; as their *gangue* is decidedly a rock of primitive formation.

### TUNGSTEIN AND TELLURIUM FOUND IN AMERICA.

It is well known to mineralogists that tungstein is very rare, and that tellurium is found only in Transylvania. Both metals have been discovered in a bismuth mine in the town of Huntington, Connecticut. The tungstein was in the state of yellow oxide, and the tellurium in the metallic state. The tungstein is stated to be abundant in the mine; it is the ferruginous species known to mineralogists by the name of wolfram. Both the tungstein and the tellurium are found blended in the same pieces, but whether in mere mixture or in chemical combination is not yet quite determined. Many specimens of the tungstein exist without the tellurium, but every piece which has afforded tellurium has also afforded tungstein, and in greater abundance. Even in well-defined crystals both metals have been found in the same crystal, and where the external appearance was homogeneous. In other specimens a difference seems to be apparent, and a proper ore of tellurium appears to be blended with a proper ore of tungstein. This latter ore is the wolfram composed of oxide of tungstein, or, as some choose to say, tungstic oxid combined with iron and manganese. The crystals, however, are octahedral; a fact which we believe is not mentioned of this species by authors, although this form is found in the calcareous tungstein.—*American Journal of Science*, No. III.

### ACOUSTIC INSTRUMENT FOR ASCERTAINING THE STATE OF THE LUNGS.

Dr. Laennec lately presented to the French Academy of Sciences an acoustic instrument, which, according to the Doctor, affords a certain means of discovering diseases of the thoracic viscera, and particularly phthisis pulmonalis. M. Percy was appointed by the Academy to make a special inquiry into the utility of the instrument; and the report he has made is extremely favourable. The little advantage, says the reporter, which has in many cases been

been derived from the percussion of the breast, according to the method of Auenbrugger, and a consideration of the facility with which sound is transmitted through solid bodies, suggested to the inventor the idea of studying, by the aid of similar intermediums, the different sounds which the movements of the respiratory and circulating organs produce in the interior of the chest, and of ascertaining whether the sounds which they emit might not give some more certain signs than those already known, as to the maladies with which they may be affected. The instrument which M. Laennec made use of for this purpose was a cylinder of wood, one foot in length, sixteen lines in diameter, and perforated in the centre (like a pipe) by a bore of three lines in diameter. This instrument, when applied to the chest of a healthy individual when speaking or singing, only produces a sort of humming sound, more marked at certain points of the chest than others. But when there exists an ulcer on the lungs, the hummings sound changes into a phænomenon altogether singular, which the inventor calls *pectoriloquy*, and which the reporter M. Perey regards as sufficient for furnishing a certain and easy sign of any alterations in the state of the lungs. M. Laennec distinguishes three sorts of *pectoriloquy*, which, according to his anatomical researches, correspond with the size of the ulcers, with their state of vacuity or fullness, and with the consistency of the matter which they inclose.

### ANTIQUITIES IN ARABIA PETRÆA.

Mr.Banks, who has not yet returned to this country, has made drawings of the excavations at Uadi Moosa, walls which are supposed to have formed part of the public buildings of the ancient city of Petra. He has also visited and made drawings of Jerrasch, a city which by the ruins appears to have excelled in beauty and magnificence Palmyra and Balbec.

### LUNAR ATMOSPHERE.

By an eclipse of a small star by the moon on the 5th of December 1818, observed by Mr. J. B. Emmett, and published in The Annals of Philosophy, No. 77, it appears that the star was visible when really behind the moon's disc; an effect that could be produced only by the refraction of the atmosphere of the moon. The existence of a lunar atmosphere has been very generally doubted, but certainly contrary to every philosophical principle.

### MOVING MOUNTAIN.

In the vicinity of Namur there is a mountain of considerable elevation, from the foot of which there formerly issued a spring of water, remarkable for its copiousness and for never being exhausted.

hausted. Within these few years, the fortifications of the city and citadel of Namur have been receiving great enlargements; and the spring happening to be in the way of them got encumbered, and finally disappeared. Not long afterwards the whole mass of the mountain was observed to be in motion, inclining in a direction towards the river Meuse; owing, as is reasonably conjectured, to the pent up water having increased to such a quantity as to heave the mountain from its foundations. It has continued ever since imperceptibly moving forwards in the same direction, without any part of it tumbling away, or any crevice breaking out in its sides. Already it has advanced as far as the old road to Dinant, which it now covers so completely, that a new line of communication has been obliged to be opened by a bridge over the Meuse. The country people have given it the name of The moving mountain, and look to see it, ere long, depositing itself in the bed of the Meuse.—*Journal de Gand.*

---

## MUNGO PARK.

The *Liverpool Mercury* contains an extract from a letter which has been received by a gentleman of that town from his brother at Juddah, a sea port on the Red Sea. This extract purports to give some information respecting the above enterprising traveller. It is as follows:

"Dec. 13, 1818.

"On my landing at Juddah, a place where I did not expect to hear an English word, I was accosted by a man in the complete costume of the country, with 'Are you an Englishman, sir?' My answer being of course in the affirmative, appeared to give him pleasure beyond expression. 'Thanks and praise to God!' he exclaimed, 'I once more hear an English tongue, which I have not done for fourteen years before.' I have been much amused by him since; his account of the Abyssinians, the inhabitants of a country that has absorbed fourteen years of his existence, is indeed truly interesting.—You must, no doubt, have heard or read of him; he is that Nathaniel Pearce spoken of by Mr. Salt in his Account of his Travels in Abyssinia. He was left there by Lord Valentia, and has been the greater part of the time in the service of one or other of the chiefs in various parts of the country. At the time I met with him, he was endeavouring to make his way to Tombuctoo, where he says Mungo Park is still in existence, detained by the chief. He says the whole country almost idolize him for his skill in surgery, astronomy, &c. &c. They say he is an angel come from heaven to administer comforts to them; and he explains to them the motions and uses of the heavenly bodies. He is, Pearce says, very desirous to make his escape, but finds it impossible.—'What!' say they, 'do 'do you suppose us so foolish as to part with so invaluable a treasure? If you go away, where are we to find another possessing so much knowledge, or who will do us so much good?'—Pearce appeared to have been resolutely bent on endeavouring to reach Tombuctoo, but had for some time been labouring under severe illness."

Happy should we be if Pearce's statement should be found correct, and the illustrious Park still in existence. That Pearce gave the above relation to the writer of the letter, we do not doubt; but we question the truth of that relation. There is a greater weight of evidence to prove the melancholy fate of Park, than there is to prove his being still in existence. No intelligence has been received from him since he left Sansanding in the year 1805; and this fact itself is a strong presumption that he is not now in existence, and a corroboration of the several accounts which have been published respecting the manner of his death, the most recent of which we lately noticed. Pearce, we suppose, obtained his intelligence respecting Park in Abyssinia; but the distance of Tombuctoo from the eastern coast is so great, and the intermediate regions so completely a *terra incognita*, that this consideration alone is sufficient to overthrow the whole story. But there is one fact which to us is decisive against the truth of Pearce's relation. Many of our readers may have read the narrative of Robert Adams, a sailor, who was wrecked in the year 1810 on the western coast of Africa, detained by the Arabs of the Great Desert, and carried by them to Tombuctoo. He remained there several months, resided the whole period of his stay in the palace of Woollo the king, and frequently walked about the town. Adams, from the uncommon degree of curiosity which he excited, believed that the people of Tombuctoo had never seen a white man before. Now, supposing Park to have been then detained in that city (and he must have been there at that time, if Pearce's story be true), engaged in explaining to the rude and ignorant natives the sublime science of astronomy, is it at all probable, either that Adams would not have seen or heard of so wonderful a man, or that Park would not have found some means of communication with Adams? The writer of the letter states, that when he met him at Juddah, Pearce was endeavouring to make his way to Tombuctoo. This, in our opinion, is as improbable as the story about Park. For where is this Juddah? It is, no doubt, the well known sea-port of Arabia Felix on the Red Sea. If it be so, and if Pearce were endeavouring to penetrate to the far famed Tombuctoo, is it not a little singular that he should endeavour to do so from Juddah, which is on the Asiatic side of the Red Sea, which, before he could commence his journey, he must cross to the African side?



STORM

## STORM COMPASS.

*To Mr. Tilloch.*

SIR,— The subject of the compass having been inserted in your last Number, I take the liberty to advert to a new *storm compass* which was introduced into the port of Genoa by a Danish vessel. The Baron de Zach first called my attention to it, and I took a sketch of it at the time; but as it appears to me sufficiently explained at page 200 of The "*Correspondance Astronomique*," &c. I shall simply submit a translation.

It seems an interesting improvement, and may be useful; and it might have escaped my recollection, but for the incident in question.

"All the secret of the *storm compass* consists in this, that the cap fixed at the bottom of the box is mounted according to the *suspension of Cadran*. The whole compass is suspended *à la Cadran*, and the cap in like manner: thus the motion of the vessel is doubly counterbalanced. The cap reversed, is mounted in a kind of fork which attaches to the bottom of the box; it balances in this fork, and carries below a little tail of copper, which serves as a counterpoise for it in the different balancings on every side. We can now easily comprehend that the needle of such a compass ought necessarily to experience fewer shocks in the violent movements of a ship upon a stormy sea, than in ordinary compasses in which the box is well counterbalanced, but not the card. It is on this account that it receives the name of *storm compass*.

I have the honour to be, sir,

Your most obedient humble servant,

London, June 1, 1819. J. MURRAY.

## LIST OF PATENTS FOR NEW INVENTIONS.

To Edward Wall, of Minchinhampton, Gloucestershire, for certain improvements on stage-coaches, and other descriptions of carriages.—18th May, 1819.

To George Atkins, of Hornsey-road in the parish of Islington, Middlesex, for his instrument for ascertaining the variation of the compass, which he intends to denominate The Meridian Declination Dial.—18th May.

To John Thomas Barry, of Plough-court, Lombard-street, London, for his improved appurtenances for distillation, evaporation, exsiccation, and for the preparation of colours.—24th May.

To William Geldart and John Servant, both of Leeds, and Jonathan Howgate of Leeds, for certain improvements in the manner of heating dryhouses, maltkilns, and other buildings requiring heat.—1st June.

To Charles Attwood, of Bridge-street, Blackfriars, for a mode of manufacturing mineral alkali and vegetable alkali, and the application

plication thereof, so far as relates to mineral alkali, by way of improvement on, or addition to, other modes heretofore known or in use, but more particularly in the manufacture of kelp.—22d June.

To John Lewis, William Lewis, and William Davis, all of Brimscomb in the county of Gloucester, for certain improvements in the application of pointed wires, or other pointed substances of a suitable nature, for the purpose of raising the pile or face of woollen or other cloths of fabric requiring such process. —19th June.

To John Lewis, William Lewis, and William Davis, all of Brimscomb in the county of Gloucester, for certain improvements in the application of mechanical powers for the purpose of laying, smoothing, and polishing the pile or face of woollen or other cloth or fabric; and also for the purpose of cleansing at the same time the said cloth or fabric requiring such operations. —19th June.

To John Nedson of Linlithgow, for discovery of certain vegetable substances not hitherto used by tanners and leather-dressers, which may be employed in tanning and colouring leather, and for the discovery of certain vegetable substances not hitherto used by dyers, which may be employed in the art of dyeing.—19th June.

---

*Meteorological Observations kept at Walthamstow, Essex, from May* 15 *to June* 15, 1819.

(Usually between the Hours of Seven and Nine A.M. and the Thermometer (a second time) between Twelve and Two P.M.]

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *May* | | | |
| 15 | 47<br>58 | 30·11 | NW—SW.—Very fine clear morn; afterwards sun and *cumuli*; and warmer than yesterday; fine evening. |
| 16 | 48<br>68 | 30·00 | SE.—Fine sunny windy morn and day; and star-light night. Moon last quarter. |
| 17 | 51<br>70 | 29·99 | E—S.—Clear morn, and fine day, and clear night; at 8 P.M. beautiful *cirrocumuli.* |
| 18 | 56<br>67 | 29·72 | SW.—Very fine morn and day; slight rain about 11 A.M.; stars at night and cloudy. |
| 19 | 51<br>66 | 29·60 | NE—SE.—Rainy till about 9 A.M.; day cloudy and showery, and cloudy at night. |
| 20 | 57<br>62 | 29·50 | SW.—Rain and *cumuli*; very showery day, and rainy evening. |
| 21 | 56<br>61 | 29·50 | E.—Gray morn, and showery day; fine afternoon; star-light night. |
| 22 | 55<br>57 | 29·60 | SE.—Showers and sun till after 11 A.M.; fine day; night star-light. |
| 23 | 57<br>73 | 29·90 | E.—Clear morn, and very fine day; windy and cloudy at night. |
| 24 | 60<br>60 | 29·95 | E.—Clear and *cirrostratus*, and wind; showery day, and the same at night. New moon. |
| 25 | 51<br>58 | 29·90 | E—N.—Showery morn; day cloudy and windy; night star-light. |

| Date. | Therm. | Barom. | Wind. |
|---|---|---|---|
| *May* | | | |
| 26 | 54<br>61 | 29·86 | NE.—Wind, and *cirrostratus*; fine day, but little sunshine; cloudy night. |
| 27 | 51<br>60 | 29·82 | NE.—Gray morn; fine sunny day; night cloudy. |
| 28 | 47<br>60 | 29·90 | NE—E.—Clear and fine *cumuli;* fine day; moon-light. |
| 29 | 44<br>57 | 29·90 | N.—Clear morn; fine day; clear night. |
| 30 | 52<br>67 | 30·05 | W—SW.—Slight showers in the morning; day cloudy; a shower at 7 P.M.; early moonlight and thin *stratus*; and no stars appeared till late in the evening. |
| *June* | | | |
| 1 | 56<br>68 | 300·5 | SW.— Cloudy morn; fine day, sun and wind; cloudy night. Moon first quarter. |
| 2 | 59<br>68 | 30·05 | S by E.—Hazy and windy in the morning; a fine day; and moon-light night. |
| 3 | 59<br>72 | 30·00 | SW—SE.—A fine morn and day; but a cloudy night, and at 8 P.M. some drops of rain. |
| 4 | 59<br>71 | 29·90 | SE—S.—A gray morn; a fine day, but some showers; at night clear and *cirrostratus.* |
| 5 | 51<br>74 | 30·00 | W—S—NW.—Very fine morn and day; moon-light night. |
| 6 | 54<br>70 | 30·05 | NW—SE.—Clear and *cirrostratus*; fine hot day; windy at night, clear, and *cirrostratus.* |
| 7 | 58<br>69 | 29·59 | SE.—Showers and sun; a fine day, and clear night. |
| 8 | 58<br>69 | 29 59 | SE.—Clear and *cirrostratus*; sun and shower; at night clear, and fine mottled *cirrostratus.* Full moon. |
| 9 | 53<br>69 | 29·65 | W—S.—Clear and windy; sun and *cumuli*; showers after 1 P.M.; a thunder, lightning and hail-storm about 3 P.M. |
| 10 | 53<br>69 | 29·65 | W—S.—Morn clear and windy; showers after 1 P.M. and a great storm of hail and thunder and lightning about 3 P.M., and grand *cumulostratus*, clear night. |
| 11 | 51<br>69 | 30·00 | SW.—Clear and *cirrostratus*; fine day; a hail storm about 3 P.M.; night clear and *cumuli.* |
| 12 | 52<br>61 | 30·00 | SW.—Clear, and very showery day; fine afternoon; and clear night. |
| 13 | 56<br>72 | 30·05 | SW.—Fine clear morn; fine day; clear and *cumuli*; fine clear night. |
| 14 | 53<br>69 | 30·00 | W.—Clear and windy morn; and fine day; rain after 5 P.M. till after 7; cloudy night. Moon last quarter. |
| 15 | 55<br>60 | 29·75 | SW.—Showers and sun at 7 A.M.; great rain after 8½ A.M. till after 1 P.M.; sunshine at 2 P.M. |

---

*At Walthamstow, in Flower, June* 15, 1819.

Hesperis matronalis.— Geranium rotundifolium, molle, et pusillum.— Ranunculus parviflorus.— Lychnis Viscaria et Flos Cuculi.— Polemonium cœruleum. — Chelidonium majus.—Myosotis scorpioides.—Digitalis purpurea.— Erysimum officinale.—Aquilegia vulgaris.— Sinapis barbarea.— Brassica Napus.—Dianthus Armeria et Cæsius.—Polygonum Bistorta.—Galium Aparine.—Lysimachia nemorosa.—Coronopus didyma.— ♄ Sambucus nigra.—Anagallis arvensis.—Rumex Acetosa.—Cynoglossum officinale.— Sedum acre.—Sedum Forsterianum.—Cardamine pratensis.—Malva sylvestris.— Lavatera arborea.—Spartium scoparium.— Lapsana communis. Ægopodium Podagraria.—Stachys sylvática.—Epilobium montanum.

METEORO-

# CONTENTS

## OF THE FIFTY-THIRD VOLUME.

CONTENTS.

## CONTENTS.

CONTENTS.



THE

METEOROLOGICAL JOURNAL KEPT AT BOSTON, LINCOLNSHIRE.

[The time of observation, unless otherwise stated, is at 1 P.M.]

| 1819. | Age of the Moon | Thermometer. | Barometer. | State of the Weather and Modification of the Clouds. |
|---|---|---|---|---|
| | DAYS. | | | |
| May 15 | 21 | 60· | 30·17 | Fine |
| 16 | 22 | 68·5 | 30·16 | Ditto |
| 17 | 23 | 69·5 | 30·05 | Ditto |
| 18 | 24 | 68·5 | 29·90 | Ditto |
| 19 | 25 | 53· | 29·75 | Rain |
| 20 | 26 | 55· | 29·73 | Ditto |
| 21 | 27 | 60· | 29·70 | Ditto |
| 22 | 28 | 66·5 | 29·86 | Fair |
| 23 | 29 | 69· | 30·10 | Very fine |
| 24 | new | 57·5 | 30·12 | Cloudy |
| 25 | 1 | 59·5 | 30·10 | Very fine |
| 26 | 2 | 57·5 | 30·10 | Cloudy |
| 27 | 3 | 61· | 29·96 | Fine |
| 28 | 4 | 54· | 30· | Ditto |
| 29 | 5 | 51·5 | 30·06 | Cloudy |
| 30 | 6 | 51·5 | 30·07 | Ditto—rain P.M. |
| 31 | 7 | 60·5 | 30·23 | Fine |
| June 1 | 8 | 68·5 | 30·10 | Fine |
| 2 | 9 | 68·5 | 30·15 | Ditto |
| 3 | 10 | 69· | 30·08 | Ditto |
| 4 | 11 | 70·5 | 30·02 | Ditto—heavy rain in the evening. |
| 5 | 12 | 71· | 30·09 | Ditto |
| 6 | 13 | 67·5 | 30·10 | Ditto |
| 7 | 14 | 68·5 | 29·70 | Cloudy |
| 8 | full | 69·5 | 29·72 | Showery—in the afternoon a tremendous storm of rain in torrents, with thunder and lightning. |
| 9 | 16 | 72· | 29·72 | Fine |
| 10 | 17 | 68·5 | 29·81 | Ditto |
| 11 | 18 | 68·5 | 30·10 | Ditto—heavy rain P.M. |
| 12 | 19 | 62· | 30·10 | Showery |
| 13 | 20 | 68·5 | 30·16 | Fine |
| 14 | 21 | 63· | 30· | Showery |

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

*For June* 1819.

| Days of Month. | Thermometer. 8 o'Clock, Morning. | Noon. | 11 o'Clock Night. | Height of the Barom. Inches. | Degrees of Dryness by Leslie's Hygrometer. | Weather. |
|---|---|---|---|---|---|---|
| May 27 | 48 | 58 | 46 | 29·87 | 36 | Fair |
| 28 | 47 | 56 | 45 | ·95 | 60 | Fair |
| 29 | 46 | 54 | 44 | ·99 | 63 | Fair |
| 30 | 47 | 58 | 49 | 30·05 | 58 | Fair |
| 31 | 49 | 59 | 54 | ·17 | 52 | Cloudy |
| June 1 | 56 | 62 | 56 | ·15 | 50 | Showery |
| 2 | 57 | 68 | 57 | ·10 | 66 | Fair |
| 3 | 58 | 69 | 58 | ·02 | 64 | Fair |
| 4 | 59 | 67 | 56 | 29·94 | 48 | Small Rain |
| 5 | 60 | 69 | 56 | 30·14 | 66 | Fair |
| 6 | 60 | 70 | 57 | ·10 | 68 | Fair |
| 7 | 56 | 68 | 57 | 29·70 | 60 | Fair |
| 8 | 59 | 69 | 56 | ·70 | 65 | Fair |
| 9 | 60 | 69 | 57 | ·75 | 60 | Fair |
| 10 | 58 | 66 | 55 | ·86 | 49 | Showery |
| 11 | 56 | 68 | 50 | 30·05 | 42 | Fair |
| 12 | 55 | 64 | 55 | ·08 | 40 | Showery |
| 13 | 56 | 68 | 56 | ·04 | 58 | Fair |
| 14 | 56 | 69 | 53 | ·02 | 50 | Showery |
| 15 | 54 | 61 | 52 | 29·84 | 0 | Rain |
| 16 | 54 | 57 | 51 | 30·04 | 47 | Fair |
| 17 | 53 | 67 | 53 | ·15 | 46 | Fair |
| 18 | 54 | 60 | 50 | ·08 | 0 | Rain |
| 19 | 60 | 70 | 56 | ·22 | 48 | Fair |
| 20 | 58 | 68 | 57 | ·28 | 63 | Fair |
| 21 | 58 | 73 | 60 | ·16 | 76 | Fair |
| 22 | 61 | 68 | 59 | ·14 | 60 | Cloudy |
| 23 | 60 | 69 | 58 | ·10 | 66 | Fair |
| 24 | 60 | 60 | 60 | 29·85 | 0 | Small Rain |
| 25 | 61 | 65 | 60 | ·83 | 0 | Small Rain |
| 26 | 60 | 66 | 56 | ·68 | 55 | Fair |

N.B. The Barometer's height is taken at one o'clock.

# INDEX TO VOL. LIII.

END OF THE FIFTY-THIRD VOLUME.

*Printed by R. and A. Taylor, Shoe-Lane, London.*

illustrative of Dr. BREWSTER's Paper on Light.—A 4to Plate to illustrate Sir H. DAVY's Paper on the Fire-damp of Coal-Mines, and on Methods of lighting the Mines so as to prevent its Explosion; and the Account of Mr. STEPHENSON's Safe-Lamp for Coal-Mines.

Vol. XLVII. Illustrated with a Quarto Plate describing the PLANISPHERE of DENDERA.—A Quarto Plate to illustrate Mr. BROWN's Paper on Architecture.—A Plate to illustrate Sir GEORGE CAYLEY's Paper on Aërial Navigation; and Mr. LONDON's Hydrometer.—A Quarto Plate of the Temple of Kournou at Thebes.—A Plate of the new Baths at Ramsgate.

Vol. XLVIII. A Quarto Plate of the Strand or Waterloo Bridge erected over the Thames at the Savoy, London.—A Quarto Plate to illustrate Mrs. IBBETSON's Anatomy of Vegetables.—A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Physiology of Vegetables.—A large Quarto Plate to illustrate Mrs. IBBETSON's Paper on a new View of Vegetable Life.—A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Physiology of Vegetables; and Mr. MORNAY's Mass of Native Iron found in Brasil.

Vol. XLIX. A Plate to illustrate Dr. EVANS's Communication on Terrestrial Magnetism; a new Electro-atmospherical Instrument; and Mr. ANDREW HORN's Paper on Vision.—A Quarto Plate to illustrate Mrs. IBBETSON's Physiology of Vegetables.—A Plate to illustrate the Solar Spots which appeared during the Year 1816;—and Mr. BEVAN's Improvement on the Sliding-Rule.—A Plate descriptive of Mr. EMMETT's Instrument for the Measurement of the Moon's Distance from the Sun, &c.; also a New Reflecting Goniometer.—A Plate to illustrate Chevalier BAADER's Method of communicating Rotatory Motion; Lieut. SHULDHAM's improved Method of working a Capstan; and STEELE's new Modification of NOOTH's Apparatus, &c.

Vol. L. A Plate to illustrate Sir HUMPHRY DAVY's new Researches on Flame, and Sir GEORGE CAYLEY's Paper on Aërial Navigation.—A Plate representing a Section of the Pneumatic Cistern, with the Compound Blow-pipe of Mr. HARE; and a Sketch of a Steam-Vessel intended to run between London and Exeter.—Representation of Apparatus for Sublimation of Iodine—Model of a Safety Furnace by Mr. BAKEWELL—Apparatus for consuming Fire-damp in the Mine—and Apparatus for re-lighting the Miners' Davy.—A Plate illustrative of the New Patent Horizontal Water-Wheel of Mr. ADAMSON.—A Plate illustrative of Mrs. IBBETSON's Theory of the Physiology of Vegetables.—A Plate to illustrate Mr. DICKINSON's new System of Beaconing.

Vol. LI. A Plate illustrative of Mr. CAPEL LOFFT's Paper on the Probability of Meteorolites being projected from the Moon.—Two Plates: one, of Mr. H. TRITTON's Improved Apparatus for Distillation; and another, of the Figures in BRADLEY's Gardening illustrative of the Article on the KALEIDOSCOPE.—A Plate illustrative of Mrs. IBBETSON's Paper on the Anatomy of Vegetables; and Mr. TREDGOLD's on Revetements.

Vol. LII. A Plate illustrative of Mr. UPINGTON's Electrical Increaser for the unerring Manifestation of small Portions of the Electric Fluid.—A Plate illustrative of Mrs. IBBETSON's Paper on the Fructification of Plants.—A Plate illustrative of the Rev. JOHN MICHELL's Theory of the Formation of the Earth.—A Plate illustrative of Capt. KATER's Article on the Pendulum; and New Apparatus for impregnating Liquids with Gases.—A Plate illustrative of Sir H. DAVY's Apparatus for Volatilization of Phosphorus, and Mr. SMITH's Essay on the Structure of the poisonous Fangs of Serpents.

Vol. 53. Philosophical Magazine. Jan. 1819

## Contents of Number 249.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

Richard and Arthur Taylor, Printers, Shoe Lane, London.

---

## ENGRAVINGS.

Vol. LI. A Plate illustrative of Mr. CAPEL LOFFT's Paper on the bability of Meteorolites being projected from the Moon.—Two tes: one, of Mr. H. TRITTON's Improved Apparatus for Distillation; another, of the Figures in BRADLEY's Gardening illustrative of the Ar-e on the KALEIDOSCOPE.—A Plate illustrative of Mrs. IBBETSON's Pa- on the Anatomy of Vegetables; and Mr. TREDGOLD's on Revete-nts.

Vol. LII. A Plate illustrative of Mr. UPINGTON's Electrical In-ser for the unerring Manifestation of small Portions of the Electric id.—A Plate illustrative of Mrs. IBBETSON's Paper on the Fructifica- of Plants.—A Plate illustrative of the Rev. JOHN MICHELL's Theory he Formation of the Earth.—A Plate illustrative of Capt. KATER's ticle on the Pendulum; and New Apparatus for impregnating Liquids h Gases.—A Plate illustrative of Sir H. DAVY's Apparatus for Vola-ation of Phosphorus, and Mr. SMITH's Essay on the Structure of the sonous Fangs of Serpents.

## Contents of Number 250.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

Richard and Arthur Taylor, Printers, Shoe Lane, London.

Vol. XLVIII. A Quarto Plate of the Strand or Waterloo Bridge erected over the Thames at the Savoy, London.—A Quarto Plate to illustrate Mrs. IBBETSON's Anatomy of Vegetables.—A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Physiology of Vegetables.—A large Quarto Plate to illustrate Mrs. IBBETSON's Paper on a new View of Vegetable Life. —A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Physiology of Vegetables; and Mr. MORNAY's Mass of Native Iron found in Brasil.

Vol. XLIX. A Plate to illustrate Dr. EVANS's Communication on Terrestrial Magnetism; a new Electro-atmospherical Instrument; and Mr. ANDREW HORN's Paper on Vision.—A Quarto Plate to illustrate Mrs. IBBETSON's Physiology of Vegetables.—A Plate to illustrate the Solar Spots which appeared during the Year 1816;—and Mr. BEVAN's Improvement on the Sliding-Rule.—A Plate descriptive of Mr. EMMETT's Instrument for the Measurement of the Moon's Distance from the Sun, &c.; also a New Reflecting Goniometer.—A Plate to illustrate Chevalier BAADER's Method of communicating Rotatory Motion; Lieut. SHULDHAM's improved Method of working a Capstan; and STEELE's new Modification of NOOTH's Apparatus, &c.

Vol. L. A Plate to illustrate Sir HUMPHRY DAVY's new Researches on Flame, and Sir GEORGE CAYLEY's Paper on Aërial Navigation.—A Plate representing a Section of the Pneumatic Cistern, with the compound Blow-pipe of Mr. HARE; and a Sketch of a Steam-Vessel intended to run between London and Exeter.—Representation of Apparatus for Sublimation of Iodine—Model of a Safety Furnace by Mr. BAKEWELL—Apparatus for consuming Fire-damp in the Mine—and Apparatus for re-lighting the Miners' Davy.—A Plate illustrative of the New Patent Horizontal Water-Wheel of Mr. ADAMSON.—A Plate illustrative of Mrs. IBBETSON's Theory of the Physiology of Vegetables.—A Plate to illustrate Mr. DICKINSON's new System of Beaconing.

Vol. LI. A Plate illustrative of Mr. CAPEL LOFFT's Paper on the Probability of Meteorolites being projected from the Moon.—Two Plates: one, of Mr. H. TRITTON's Improved Apparatus for Distillation; and another, of the Figures in BRADLEY's Gardening illustrative of the Article on the KALEIDOSCOPE.—A Plate illustrative of Mrs. IBBETSON's Paper on the Anatomy of Vegetables; and Mr. TREDGOLD's on Revetements.

Vol. LII. A Plate illustrative of Mr. UPINGTON's Electrical Increaser for the unerring Manifestation of small Portions of the Electric Fluid.—A Plate illustrative of Mrs. IBBETSON's Paper on the Fructification of Plants.—A Plate illustrative of the Rev. JOHN MICHELL's Theory of the Formation of the Earth.—A Plate illustrative of Capt. KATER's Article on the Pendulum; and New Apparatus for impregnating Liquids with Gases.—A Plate illustrative of Sir H. DAVY's Apparatus for Volatilization of Phosphorus, and Mr. SMITH's Essay on the Structure of the Poisonous Fangs of Serpents.

Vol. LIII. A Plate illustrative of Dr. URE's Experiments on Caloric, Mr. LUCKCOCK's Paper on the Atomic Philosophy, and Mr. BOLTON's on the Purification of Coal Gas.

Vol. 53. Philosophical Magazine. March 1819

## Contents of Number 251.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

RICHARD AND ARTHUR TAYLOR, PRINTERS, SHOE LANE, LONDON.

## ENGRAVINGS.

Vol. XLVIII. A Quarto Plate of the Strand or Waterloo Bridge erected ver the Thames at the Savoy, London.—A Quarto Plate to illustrate Irs. IBBETSON's Anatomy of Vegetables.—A Quarto Plate to illustrate Irs. IBBETSON's Paper on the Physiology of Vegetables.—A large Quarto late to illustrate Mrs. IBBETSON's Paper on a new View of Vegetable Life. —A Quarto Plate to illustrate Mrs. IBBETSON's Paper on the Physiology f Vegetables; and Mr. MORNAY's Mass of Native Iron found in Brasil.

Vol. XLIX. A Plate to illustrate DR. EVANS's Communication on Terrestrial Magnetism; a new Electro-atmospherical Instrument; and Mr. ANDREW HORN's Paper on Vision.—A Quarto Plate to illustrate Mrs. IBBETSON's Physiology of Vegetables.—A Plate to illustrate the Solar Spots which appeared during the Year 1816;—and Mr. BEVAN's mprovement on the Sliding-Rule.—A Plate descriptive of Mr. EMMETT's nstrument for the Measurement of the Moon's Distance from the Sun, &c.; also a New Reflecting Goniometer.—A Plate to illustrate Chevalier BAADER's Method of communicating Rotatory Motion; Lieut. SHULDHAM's improved Method of working a Capstan; and STEELE's new Modification of NOOTH's Apparatus, &c.

Vol. L. A Plate to illustrate Sir HUMPHRY DAVY's new Researches on Flame, and Sir GEORGE CAYLEY's Paper on Aërial Navigation.—A Plate representing a Section of the Pneumatic Cistern, with the compound Blow-pipe of Mr. HARE; and a Sketch of a Steam-Vessel intended to run between London and Exeter.—Representation of Apparatus for Sublimation of Iodine—Model of a Safety Furnace by Mr. BAKEWELL —Apparatus for consuming Fire-damp in the Mine—and Apparatus for re-lighting the Miners' Davy.—A Plate illustrative of the New Patent Horizontal Water-Wheel of Mr. ADAMSON.—A Plate illustrative of Mrs. IBBETSON's Theory of the Physiology of Vegetables.—A Plate to illustrate Mr. DICKINSON's new System of Beaconing.

Vol. LI. A Plate illustrative of Mr. CAPEL LOFFT's Paper on the Probability of Meteorolites being projected from the Moon.—Two Plates: one, of Mr. H. TRITTON's Improved Apparatus for Distillation; and another, of the Figures in BRADLEY's Gardening illustrative of the Article on the KALEIDOSCOPE.—A Plate illustrative of Mrs. IBBETSON's Paper on the Anatomy of Vegetables; and Mr. TREDGOLD's on Revetements.

Vol. LII. A Plate illustrative of Mr. UPINGTON's Electrical Increaser for the unerring Manifestation of small Portions of the Electric Fluid.—A Plate illustrative of Mrs. IBBETSON's Paper on the Fructification of Plants.—A Plate illustrative of the Rev. JOHN MICHELL's Theory of the Formation of the Earth.—A Plate illustrative of Capt. KATER's Article on the Pendulum; and New Apparatus for impregnating Liquids with Gases.—A Plate illustrative of Sir H. DAVY's Apparatus for Volatilization of Phosphorus, and Mr. SMITH's Essay on the Structure of the poisonous Fangs of Serpents.

Vol. LIII. A Plate illustrative of Dr. URE's Experiments on Caloric, Mr. LUCKCOCK's Paper on the Atomic Philosophy, and Mr. BOLTON's on the Purification of Coal Gas.—A Plate representing Mr. RENNIE's Apparatus employed in his Experiments on the Strength of Materials; and the Marquis RIDOLPHI's Improvement on the Gas Blow-pipe.

Vol. 53. Philosophical Magazine. March 181

## Contents of Number 252.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

RICHARD AND ARTHUR TAYLOR, PRINTERS, SHOE LANE, LONDON.

THEATRE OF ANATOMY, MEDICINE, &c.
Blenheim-Street, Great Marlborough-Street.

THE SUMMER COURSE of LECTURES, at this School, will begin on Monday, June 7.

Anatomy, Physiology, and Surgery, by Mr. BROOKES, daily, at Seven in the Morning.—Dissections as usual.

Chemistry, Materia Medica, &c. daily, at Eight in the Morning; Theory and Practice of Physic at Nine; with Examinations, by Dr. Ager.

Three Courses are given every year, each occupying nearly four months.

Further particulars may be known of Mr. Brookes, at the Theatre; or of Dr. Ager, 69, Margaret-Street, Cavendish-Square.

ENGRAVINGS.

Vol. XLIX. A Plate to illustrate Dr. EVANS's Communication on Terrestrial Magnetism; a new Electro-atmospherical Instrument; and Mr. ANDREW HORN's Paper on Vision.—A Quarto Plate to illustrate Mrs. IBBETSON's Physiology of Vegetables.—A Plate to illustrate the Solar Spots which appeared during the Year 1816;—and Mr. BEVAN's Improvement on the Sliding-Rule.—A Plate descriptive of Mr. EMMETT's Instrument for the Measurement of the Moon's Distance from the Sun, &c.; also a New Reflecting Goniometer.—A Plate to illustrate Chevalier BAADER's Method of communicating Rotatory Motion; Lieut. SHULDHAM's improved Method of working a Capstan; and STEELE's new Modification of NOOTH's Apparatus, &c.

Vol. L. A Plate to illustrate Sir HUMPHRY DAVY's new Researches on Flame, and Sir GEORGE CAYLEY's Paper on Aërial Navigation.—A Plate representing a Section of the Pneumatic Cistern, with the compound Blow-pipe of Mr. HARE; and a Sketch of a Steam-Vessel intended to run between London and Exeter.—Representation of Apparatus for Sublimation of Iodine—Model of a Safety Furnace by Mr. BAKEWELL—Apparatus for consuming Fire-damp in the Mine—and Apparatus for re-lighting the Miners' Davy.—A Plate illustrative of the New Patent Horizontal Water-Wheel of Mr. ADAMSON.—A Plate illustrative of Mrs. IBBETSON's Theory of the Physiology of Vegetables.—A Plate to illustrate Mr. DICKINSON's new System of Beaconing.

Vol. LI. A Plate illustrative of Mr. CAPEL LOFFT's Paper on the Probability of Meteorolites being projected from the Moon.—Two Plates: one, of Mr. H. TRITTON's Improved Apparatus for Distillation; and another, of the Figures in BRADLEY's Gardening illustrative of the Article on the KALEIDOSCOPE.—A Plate illustrative of Mrs. IBBETSON's Paper on the Anatomy of Vegetables; and Mr. TREDGOLD's on Revetements.

Vol. LII. A Plate illustrative of Mr. UPINGTON's Electrical Increaser for the unerring Manifestation of small Portions of the Electric Fluid.—A Plate illustrative of Mrs. IBBETSON's Paper on the Fructification of Plants.—A Plate illustrative of the Rev. JOHN MICHELL's Theory of the Formation of the Earth.—A Plate illustrative of Capt. KATER's Article on the Pendulum; and New Apparatus for impregnating Liquids with Gases.—A Plate illustrative of Sir H. DAVY's Apparatus for Volatilization of Phosphorus, and Mr. SMITH's Essay on the Structure of the poisonous Fangs of Serpents.

Vol. LIII. A Plate illustrative of Dr. URE's Experiments on Caloric, Mr. LUCKCOCK's Paper on the Atomic Philosophy, and Mr. BOLTON's on the Purification of Coal Gas.—A Plate representing Mr. RENNIE's Apparatus employed in his Experiments on the Strength of Materials; and the Marquis RIDOLPHI's Improvement on the Gas Blow-pipe.—A Plate illustrative of Mr. MEIKLE's Paper on Calorific Radiation; Mr. LOWE's on the Purification of Coal Gas; and Mr. HUGHES's on ascertaining Distances.

## Contents of Number 253.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

RICHARD AND ARTHUR TAYLOR, PRINTERS, SHOE LANE, LONDON.

Vol. 53. Philosophical Magazine. June 18

## Contents of Number 254.



---

*** Communications for this Work, addressed to the Editor, Pickett-Place, Temple Bar, will meet with every attention.

Richard and Arthur Taylor, Printers, Shoe Lane, London.