THE AMERICAN JOURNAL OF SCIENCE, AND ARTS.

CONDUCTED BY

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THE

AMERICAN

JOURNAL OF SCIENCE, &c.

GEOLOGY, MINERALOGY, TOPOGRAPHY, &c.

Art. I.—*A Sketch of the Geology, Mineralogy, and Scenery of the Regions contiguous to the River Connecticut; with a Geological Map and Drawings of Organic Remains; and occasional Botanical Notices. Read before the American Geological Society at their Sitting; Sept. 11th, 1822; by the* Rev. Edward Hitchcock, A. M. of Conway, Massachusetts.*

PART III.

Scenery.

BETWEEN the geology and scenery of a country, there is an intimate and interesting connection. Let the experienced geologist be placed upon an eminence, and the contour of the surrounding region will enable him to decide with a good degree of probability, concerning the nature of its rocks. The plain will at once be pronounced alluvion. The swelling hillock or ridge with mural faces—if their aspect be dark—indicate some member of the trap family; if light coloured, they indicate granite. The conical elevation of a reddish hue will be immediately referred to old red sandstone. And those moderately steep hills, that stretch away over many a league, and form continuous and extensive

* For the map and drawings see Vol. VI. No. 1.

mountain ranges, will be known as mica slate, or gneiss, or some other rock of a schistose structure.

Such is in fact the aspect of the country along the Connecticut; and of course we here find a rich diversity of scenery, so that not only the geologist, but the poet and the painter, and every man of correct taste, will find an interest in its beauties. My object at this time is to refer to a few of the most interesting and romantic spots along this river, annexing a short description to each; in which I shall be most particular concerning those with which I am most familiar. It is not in my power to describe these scenes with the skill of the poet or the painter: But if I can succeed in inducing the traveller to visit them, it will be to him a more agreeable disappointment to have the reality exceed the description, than fall short of it.

East and West Rock.

The eminences thus named have long been celebrated, and attract the attention of the visitor who first enters the harbour or the city of New-Haven, as most singular features in the landscape;—the one lying north west and the other north east, about two miles distant. They present their naked fronts towards the city, nearly four hundred feet high, of an iron rust colour; the original dark brown aspect, being at East Rock principally destroyed by the stone quarrymen, who have, with great boldness, undermined nearly the whole of the front columns for the purposes of architecture. In ascending these cliffs, we find them to be greenstone based on sandstone.* But when the visitor reaches their top, he will find his attention diverted from the rock on which he stands, to the rich and varied prospect that stretches beneath his eye. New-Haven, with her *long line* of colleges and elegant churches on the one side, and her extensive wharf on the other, is an interesting object; and suggests to the mind a great variety of agreeable associations. Beyond the city the spectator sees the harbour, gradually widening outwards, till it is lost in Long Island Sound; and low in the horizon, he observes the sandy

* *Cactus opuntia* L. grows on these rocks as a native.

hills of Long Island.* On either side of the harbour the country gently rises into hills of moderate elevation, and is pleasantly diversified with cultivated and uncultivated patches ; and often the neat mansion is seen half covered by the trees.

East and West Rock become interesting objects to the students of Yale College, being associated with a thousand grateful recollections. To these cliffs they often resort in the hour of relaxation, to enjoy the pleasures of a rich and diversified landscape, to study the geology of the trap rocks and to breathe the serener and more bracing mountain air. Who of them, while standing there, and seeing the white crested waves breaking on the rocky shore, will not remember the ill omened cliffs of Kinsale.

Prospect Hill, East-Haven.

Professor Silliman led me to the top of this beautiful greenstone hill, which rises scarcely an hundred feet above the harbour ; but, from its top, the prospect is extremely interesting. New-Haven is presented to you in a direction nearly opposite to that in which it is seen from East or West Rock ; and the view is, in some respects, superior. East and West Rock, seen from this hill, are themselves striking objects in the rear of the city ; constituting the most prominent part of that amphitheatre of hills, which almost encloses New-Haven. Still further back, mount Carmel and the Berlin mountains may be seen as you look up the valley of Wallingford River ; and other mountains beyond these till they insensibly mingle with the heavens. Directly in front of the observer, on the west, is New-Haven harbour ; and a fine opportunity is afforded for witnessing the ar-

* A few years since, as I was crossing the salt marsh at the foot of East Rock, in company with Doct. A. Monson, I observed, on looking towards Long Island, an uncommon instance of refraction. The shore of that island appeared several degrees higher than usual and uncommonly distinct. Indeed, its altitude seemed as great, as it did a few days previous, when I happened to be sailing within two or three miles of it. It was about noon when this phenomenon was noticed in a clear very hot day of July ; the thermometer standing but little below 90°. Did the rapid evaporation produce so great a degree of cold, and consequent condensation of the air near the surface of the water, as to cause this extraordinary refraction ?

rival and departure of vessels. Indeed, the beauty of the prospect from this spot is much greater than one would suppose possible from such a mere hillock. The top of the eminence has a circular redoubt upon it, which was constructed by the inhabitants of New-Haven during the Revolutionary war, and repaired during the late war with Great-Britain. The ditch is dug in solid greenstone; but fortunately not being wanted, it is now abandoned, and has become the resort of the flocks that graze in the field; the magazine serving as a place of shelter from the storm.*

Eminence in West-Haven.—(Now Orange.)

Near the western line of this town, one or two miles south of the turnpike from New-Haven to Milford, is an elevated swell of land, which commands an extensive and delightful prospect. When I visited it, a thick fog was just breaking away and developing one object after another, till, at length, the coast of Connecticut from East-Haven to Stratford, and not less than fifty or sixty miles of the coast of Long Island became visible, as well as the villages of Milford and North-Milford; and just rising over the trees, appeared the spires of New-Haven. I know not any specific appellation for this commanding *plateau.*

Prospect from Middletown, Upper Houses.

At the north end of the village thus denominated, a few rods from the public house, is a hill, from whose summit is obtained a fine view of the basin in which Middletown is placed, with the city and the river. Here too I had the pleasure, on one occasion, of seeing the various objects of this landscape, artificial and natural, partially covered by a fog; the spires of Middletown and the more elevated trees and hills appearing above it, and reminding me of the antediluvian world half buried in the deluge.

* Attached to the red conglomerate at the foot of this hill, I found the beautiful *Borrera chrysophthalma* Ach: And this is the only place in which I have ever seen it in New-England, except upon the puddingstone of Roxbury, Mass.

Monte Video.

This is a particular part of Talcot Mountain, eight miles northwest of Hartford, at the top of the greenstone ridge extending from Berlin to Amherst. It affords one of the most interesting prospects (and with the exception, perhaps of Holyoke, the *most* interesting) to be found along the Connecticut. " The diameter of this view, in two directions, is more than ninety miles;" and the spires of more than thirty churches are visible, scattered through the broad and delightful vallies on the east and west sides of the eminence. The beauties and sublimities with which nature has invested this spot, both on a limited and an extensive scale, are greatly increased by the displays of an enlightened and correct taste in the disposition and adaptation of the various objects which this singular country residence exhibits; such as the tenant's house in Gothic style; the summer house; the boat upon the mountain lake, and rising in Gothic grandeur above the trees, the hexagonal tower, whose top is nine hundred and sixty feet above the Connecticut. But after the minute and accurate description given by Professor Silliman of these objects and this view, it is altogether unnecessary in this place to go into particulars. To the " Tour between Hartford and Quebec" the reader is with pleasure referred for a complete account of the scenery of Monte Video, which, in some respects, is altogether unique in this part of the country.

Along the same extensive ridge of greenstone, there are, no doubt, many other peaks commanding views of delightful landscapes; but not having visited them, nor seen any account of them, I am of course unable to describe them.

Mount Holyoke.

This is another of the commanding watch towers of the Connecticut. The view from its top is delightful; and the traveller, whether he be a lover of natural scenery, or a geologist, will find himself amply repaid for turning aside half a day to visit its summit.

Does he look from this elevation with an eye that is accustomed to range with pleasure over a variegated landscape? Here then will he find many forms of beauty and grandeur impressed upon the works of God and man around him. Immediately before him on the west and north, are extensive meadows, through which the Connecticut winds in silence and majesty; and as if to pay a tribute of respect to this venerable mountain, it here forms a graceful curve of three miles in extent, while its actual advance towards the ocean, scarcely exceeds fifty rods. These meadows are in a high state of cultivation, and during the summer months, the parallel strips, luxuriant with different vegetables, present a charming variety. Just beyond the Connecticut, on the western margin of the meadows, lies the beautiful village of Northampton, vieing for situation and elegance with any country town in New-England. So distinct is the view of this place from Holyoke, that with the naked eye the inhabitants may be seen as they walk the streets; while their spacious and elegant house of worship, a fine Court House,* and many seats of private gentlemen rise in a rich and diversified relief. A little to the right, in the same valley, the neat villages of Hadley and Hatfield, and still farther to the east, Amherst, with its meeting house and collegiate edifices on a commanding eminence, form resting points in this great basin, on which the eye reposes with pleasure. To the north of these villages the valley of the Connecticut is gradually narrowed by the encroachments of the highlands, until at the distance of about twenty miles, they close in upon it, and beyond this point, a sea of mountains displays ridge above ridge and peak above peak, even to the lofty range of the Hoosack and Green Mountains, at the distance of fifty or sixty miles. Southwest appears Mount Tom, a few miles distant, separated from Holyoke by the deep gulf through which the Connecticut flows; and fifty miles distant, in the northeast, rises the "cloud-capt" Monadnock.

Turning southerly, the observer will have a full view of the broad valley extending from Holyoke to Middletown; a distance of more than fifty miles. He will be able to trace the river, in all its windings, as far as Long Meadow,

* Recently destroyed by fire.

which is twenty miles distant; and by an optical deception,* it seems to ascend the whole extent, about as much as it in reality descends; appearing at the farther extremity, to be nearly on a level with the eye. Many pleasant villages are visible along the river; among which, as most striking, may be named Windsor, East-Windsor, Springfield, West-Springfield, and South-Hadley and Granby, almost beneath the eye: and these, with the many spires of other villages just visible above the trees, and the alternate patches of cultivated and uncultivated ground, checkering the plain, give a liveliness and interest to the commanding landscape.

I sat down on this eminence, on a clear summer day, with a telescope whose power was 40; and after the first thrill of admiration, produced by the general view of the scene around me had subsided, I began to examine, one by one, the objects before me through the glass. The hour divisions and indices, on the dial plate of Northampton meeting house, were as distinct as those on my watch in my hand;—and I presume an acquaintance might easily have been recognized in the streets of that place. The divisions, &c. on the dial plate of South-Hadley meeting house, five miles distant, were also very distinct. By moving the telescope slowly over the distant landscape, many spires of village churches, that were unnoticed by the naked eye, passed over its field; and, with little effort, I numbered twenty-four.

It is a general opinion that East and West Rock are visible from Holyoke. But I am satisfied that the two perpendicular bluffs appearing in that direction, are those between Berlin and Meriden; and that these conceal the New-Haven eminences. On turning the telescope, however, so as to point between the two precipices that are visible, I perceived, near the horizon, a low range of hills, about as distinct as the belts of Jupiter; which, I have little doubt, were a part of Long Island.

Suppose, next, that the man, who visits Holyoke, is a geologist. He has reached an interesting spot, if he look no farther than the naked trap on which he stands. But he will find his attention, on first visiting this pinnacle, irre-

* Explained by the common principles of perspective.

sistibly drawn to the striking and diversified geological features before him. For he has a view of nearly all the secondary region, extending from New-Haven about 110 miles northerly; and he sees a vast extent of primitive on its borders. As he casts his eye over this extensive tract, he perceives many of those grand characteristics of the different rock formations, which are not derived from their composition, but from a contour, peculiar to each, given by the Almighty Hand that originally produced them: So that if this geologist were unacquainted with the nature of the rocks before him, he would be able to say, with a good degree of confidence;—yonder hills to the south, so precipitous on the one side, and gradually sloping on the other, must belong to the trap family. But these extensive unbroken mountain ranges on my right and left, rising so gradually, must be primitive; and this intervening valley is doubtless alluvion. And on turning his eye northerly, he will pronounce the rounded Sugar Loaf and Toby to be sandstone. But it would increase his pleasure, were he to be informed that the former is the Wernerian old red sandstone, and the latter a peculiar conglomerate of the coal formation, separated from the red sandstone by a ridge of greenstone; and that its venerable head overshadows the coarsest granite, and that at its base, pressed down by its enormous weight, may be found cemeteries of fishes that swam in some antediluvian stream. He may be pointed also to the South-Hampton vein of lead ore in its whole extent; and to the localities of the beautiful beryls, sappars, tourmalines, &c. of Haddam and Chesterfield.

This geologist cannot but perceive that the extensive valley, north and west of Holyoke, must, at some remote period, have been covered by the waters of the Connecticut, ere the passage between Holyoke and Tom was worn through—And he will also conclude, that another similar, but much larger lake, must have existed in the extensive basin south of Holyoke, before the waters of the Connecticut had forced a passage through the mountains below Middletown. Hence he will be led to speculate upon the period when these waters began to subside, and upon the time requisite to wear away such immense masses of rock: and ere he is aware, his thoughts will be led back to the period, when the cataract of Niagara began its seven mile retreat, or when the deltas of the Mississippi and Ganges, began to encroach upon the ocean, or even to that time when "all the high hills that were under the whole heaven were covered" with a deluge.

Last of all, his attention will be directed to the rock on which he stands. And he will find near him those regular columns and those sloping *debris*, that evince it to belong to the trap family, so singular in its structure and position, and whose origin is so hard to be accounted for.*

Mount Tom.

Mount Tom is higher than Holyoke and the prospect from its top is grand and extensive, but there is not that interesting grouping of objects in its immediate vicinity ; and while Holyoke attracts so many visitors, Tom is rarely ascended. Both mountains are merely distinct peaks of the same greenstone range, separated by Connecticut river.

Sugar Loaf.

It has already been stated that this is a conical elevation of old red sandstone, rising five hundred feet above the Connecticut, in Deerfield, immediately on its banks. Any one passing along the stage road from Whately to Deerfield, will be struck with the singular form and aspect of this peak, and he will not regret a visit to its top. This he will find to be an ellipse, whose diameters are about ten and thirty rods. On the east and west sides are perpendicular walls several hundred feet high. Connecticut river is a beautiful object on the east and south, and a bridge across this river, and the village of Sunderland on the opposite bank, appear to be distant scarcely a stone's throw. One fourth of the horizon is hidden on the north east by the trees. On every other side the view is distinct and commanding.

In the meadows near the south point of Sugar Loaf, a skirmish took place in August, 1675, between the Indians and the Massachusetts forces under Captains Lathrop and

* It ought perhaps to be mentioned that recently two commodious buildings have been erected upon Holyoke, where the visitor will find ample means of refreshment.

Beers; in which the former were defeated with considerable loss. And in the plain on the west side of the mountain, at a little distance, this same Capt. Lathrop, in September 1675, was drawn into an ambuscade and cut off with his company, consisting of eighty "young men, the very flower of the County of Essex." Hence the parish of Muddy Brook, which was originally called Bloody Brook, derived its ancient name.

On Sugar Loaf a two story building has recently been erected for the accommodation of visitors.*

Mount Toby.

This eminence is two or three miles northeast of Sugar Loaf, on the east side of Connecticut river in Sunderland. It is made up of the slates and pudding-stones of the coal formation, and is little less than one thousand feet higher than the river, and twice as high as Sugar Loaf. The view from its summit is, of course, more extensive: but as it embraces for the most part the same regions that are seen from Holyoke and Sugar Loaf, it is unnecessary to be more particular.

Deerfield Mountain.

At the highest point of that range of old red sandstone extending from Sugar Loaf to Gill, that is, a little south of the village of Deerfield, on the east, is a prospect, which, in one respect, is more perfect than any along the Connecticut. It is not very extensive; but the basin in which Deerfield village stands, presents a picture of rural beauty of singular delicacy and luxuriance. The village, lying at the foot of the mountain and running parallel to it, appears so much beneath the eye, that almost every building in it is dstinctly visible. Beyond this, lies one of the richest interval tracts to be found in New-England, through which the Deerfield river meanders most beautifully; and beyond these meadows, is an amphitheatre of mountains.

* Growing out of the almost naked rock on the top of the Sugar Loaf, I noticed the following rather rare and interesting plants: Asclepias verticillata. Artemisia canadensis, Arbutus uva ursi, Clinipodium vulgare, Poa quinquefida, Celtis occidentalis, &c. &c.

*West River Mountain.**

This is one of those precipitous and partially insulated peaks of mica slate that occur along the Connecticut, and which at a little distance, are often mistaken by the geologist for greenstone hillocks. It is nine hundred and forty feet above the Connecticut, and stands on its eastern bank, directly opposite to the east village of Brattleborough. That village and the intervening river are the most interesting objects in the landscape that is seen from this mountain. One fancies himself almost able, by a single leap from the summit, to throw himself into the village. Almost every other part of the landscape exhibits a tumultuous sea of moun-

* Tradition has made this mountain volcanic in former days : but observation discovers no traces of eruption. The experienced eye of Col. Gibbs (a gentleman who will always be reckoned among the fathers of American mineralogy and geology, first detected the error. (See Bruce's Min. Jour. No. 1. p. 19.) While I agree with him that the notion of flames said to have been seen issuing from this mountain arose " from a popular superstition through the country, that the presence of the precious metals is frequently indicated by a flame which arises from the ground at night," I am disposed to adopt the explanation of the accompanying " thunder," given by Dr. Allen ; (Jour. Sci. Vol. 3. p. 73) who accounts for this " by the falling of immense masses of rock." That immense masses of rock have fallen, not only from the cliff* to which Dr. A. refers, but also from the western face of the mountain, no one will deny who has visited the spot : and that the falling of these would produce a "noise like thunder," which would be heard two or three miles, no one will doubt who has chanced to be in New-Haven when the quarrymen had undermined one of the huge columns of East Rock and it was precipitated upon the base below. Although two miles distant, the report in the city is often as loud as a six pounder.

In passing over West River Mountain a few years since, near the top a rattle snake was announced ; or rather he announced himself by the thrilling shake of his rattles. Doct. ——, (who had been a companion of Wilson the ornithologist in one of his pedestrian tours through the western wilderness,) immediately despatched the snake and found him to measure above four feet in length. I mention this fact because it is uncommon in these days in this section of the country to meet with these reptiles. Indeed, I have never met with another one alive along the Connecticut, with *perhaps* one exception. I recollect however, meeting some years ago a man in Leverett, who was *barefoot* with several rattle snakes dangling over his shoulders, who told me he had been hunting them at their den.+

* On the fragments of rock at the foot of this cliff, among other interesting lichens grows the *Stereocaulon paschale*. Ach.

+ Rattlesnakes are occasionally killed on all the greenstone ranges of New England, from which they will probably never be entirely extirpated ; a dried one is now before me measuring three feet six inches in length which was killed last summer on the Woodbridge greenstone ridge near New-Haven.—*Editor*, *March* 6, 1823.

tains ; Black mountain on the one hand, and the Monadnock on the other, being prominent, and here and there, a spire, or a village, crowning a hill, or enlivening the valley.

Black Mountain.

A general description of this mountain has been given in the geological part of this sketch, and I mention it here as presenting an interesting view from its summit.

Fall Mountain.

There is a great resemblance between the situation and appearance of this and West River Mountain. Both are of mica slate—both are nearly of the same height—both are precipitous on the west side—both stand on the east bank of the Connecticut—both have a pleasant village opposite to them on the west bank, and both a bridge across the river directly in front. Bellows Falls village is nearer the base of the mountain than Brattleborough, because the river is there narrower. The observer from the top of Fall Mountain looks down almost perpendicularly upon the Connecticut, here reduced to a few rods in width, and foaming and falling among the jutting rocks, presenting an image of disorder and danger, while the neat village on the river's bank exhibits an image of peace and security.

Numerous other eminences in the primitive mountain ranges on either side of the Connecticut, command extensive and interesting prospects. But the most conspicuous have been described, it is unnecessary to go into farther particulars.

Bellows Falls.

Every thing at this romantic spot conspires to impress the beholder with the idea of wild sublimity. The perpendicular fall of the water is of no great height ; but the whole stream is here compressed into a channel of a few rods in width, worn out of solid granite, a quarter of a mile, or more, in length, down which the current dashes, as if impatient of its confinement in so narrow a bed ; and at the foot of the sluice, it spreads out again into its accustomed width and soon resumes its wonted calmness.

Near the middle of these Falls a bridge is thrown across the river, and from this, a fine view is afforded of the rapids and surrounding scenery. The first time I visited the spot, I chanced to cross this bridge from the east, as the evening twilight was dying away, and there was just indistinctness enough upon objects to leave room for the play of the imagination. In the middle of the bridge I stopped and looked into the foaming stream below, where the ragged rocks, half seen amid the partial darkness, jutting out from the banks and shooting up from the bottom, presented a real Charybdis, devouring whatever entered its jaws. Dangers enough were visible, in the dark waters below; and while nothing but the bridge seemed to separate me from destruction, on looking up, I saw the venerable Fall mountain, rising with its impending precipices, and threatening to bury the whole in ruins.

Nearly a mile below the falls, on the Vermont side, is a favourable spot for viewing them and the surrounding scenery. From this point you see the cataract nearly in front, with the bridge crossing it at right angles, with the line of vision; while the mountain, here seen in its whole length, forms a lofty mural barrier on the eastern bank. At the foot of this mountain, just beyond the bridge and almost overshadowed by the shaggy rocks, stands a large and elegant mansion house; and on the opposite side appears a neat compact village.

Turner's Falls.

These cross the Connecticut, near the point where the towns of Greenfield, Gill and Montague meet. There is no distinctive name by which they are known in the vicinity;*

* Professor Silliman denominates this cataract Miller's Falls. (See Tour. to Quebec, p. 400.) But Miller's Falls are three miles higher up the river, at the mouth of Miller's river, and not in the Connecticut.

A few years since an Indian, who lived near Turner's falls, was precipitated over them: But by his dexterity in swimming, and by placing his feet forward as he descended, he escaped alive. Some time afterward, however, as the ice in the spring time was breaking up, he was unfortunately carried over among the broken fragments and never appeared again.

and I have ventured to denominate them Turner's Falls, for a reason that will appear in the course of the description.

The river at this place runs in a northwest direction, crossing the rock strata nearly at right angles; and an artificial dam is raised upon these rocks of the coal formation, so that the whole stream, which is here more than one thousand feet wide, falls thirty feet perpendicularly. This sheet of water, however, is divided near the middle by a small island on which the dam reposes. For three miles below the principal descent, the water continues to descend so as to render a canal necessary.

The proper and almost the only spot for viewing this cataract to advantage is on the elevated ground forty or fifty rods below the falls on the northeast shore.* Standing on this spot, you have the principal fall of water nearly in front, or at right angles with the line of sight; and you can see the river above and below the dam one or two miles. The contrast, is, however, very great. Above the cataract the water is unruffled to the very verge of the precipice, down which it rolls in graceful majesty. Below, it tumbles and foams among the rocks as far as the eye can trace it. A little farther down the stream than the station of the observer, the river strikes directly against a greenstone ridge,† two hundred feet high, by which it is forced to curve to the left, more than a quadrant, and afterwards runs nearly south. The rocky island that divides the cataract, with the white foam dashing against the base of its cliffs and its top crowned with a few pines and other shrubbery, is a picturesque addition to the scenery. Several rods below this island another is planted of similar aspect, but smaller, and at a much lower level, and apparently inaccessible. The upper island may be reached by a canoe in safety; and then we can descend to the very foot of the falls and find the voice drowned by their roar; and in favourable circumstances, see the rainbow arching over the falling sheet.

* From this spot a view of these falls was taken, in 1818, by a friend, and inserted in the Port Folio for December of that year, with a short description. The dam has recently been removed several rods down the stream; so that the present view differs a little from the drawing which was then executed; and the removal of the dam, I think, has rather injured the view.

† At the foot of this ridge, in the bottom of the stream, and adhering to the rocks, grows in abundance the singular *Lemania fluviatilis* of Agardh.

The country around these falls is little cultivated and there are but few settlements on either side of the river. In almost every direction you see gently rising hills, covered with trees; of which the pine forms a large proportion. For three miles above the falls is a fine spot for a sailing excursion. You immediately enter between wooded, and moderately elevated hills, exhibiting all their original wildness; and so placid is the stream, gently curving among these hills, now and then spreading out so as to form coves along the shore, and here and there chequered by small islands, that you fancy yourself to be in the midst of a romantic mountain lake. To the coves along the shore, parties frequently resort for taking fish.

These and other circumstances render Turner's falls and the vicinity an attractive spot to any one who takes an interest in the wild and sublime scenes of nature. By a reference to the preceding part of this sketch, it will be seen that the geologist and mineralogist will find here much to awaken and gratify curiosity.*

Bellows and Turner's falls are in many respects very dissimilar. At the former, the river is narrow and the fall, viewed by itself, is not the principal object of interest; but at the latter, the Connecticut pours a broad and unbroken sheet of water over a precipice comparatively lofty, producing a roar that is frequently heard at the distance of twelve miles.

One hundred and fifty six years ago, a party of Philip's Indians, having joined those residing in Hatfield, Deerfield, &c. all being at war with the white inhabitants, resorted to Turner's falls to take fish, and encamped on the north east shore. On the 17th of May, Capt. Turner from Boston, marched from Hatfield with one hundred and fifty men, consisting of the garrison and militia from Springfield, Northampton and Hatfield, and came by surprize upon the Indian camp the next morning at day light. The Indians were totally unprepared for the attack, and fled in every direction. Some sprang into their canoes, and pushing from the shore without paddles, were hurried over the cataract

* I am at a loss to account for it, that these falls have excited so little attention and drawn so few visitors. They are but three miles from the village of Greenfield, the road is good, and the accommodations decent, at a public house on the bank.

and dashed in pieces—while some reached the opposite bank. Three hundred Indians are said to have been killed and only one Englishman. Yet the Indians who survived, being joined by another party, fell upon the English troops as they were returning and made dreadful slaughter among them. So that before they reached Hatfield, Capt. Turner was killed, and thirty seven of his men.

After reading this piece of history, no one will doubt the propriety of denominating this cataract Turner's Falls.

Shelburne Falls.

These are in Deerfield River in the west part of Shelburne: and a partial description has already been given of them in this sketch. I know of nothing concerning these rapids that requires particular description. Visiting them at low water, however, I was much struck with the number and magnitude of those spheroidal excavations in the rock called *pot holes*. They are often seen several feet in diameter and depth, and the stones, &c. by which the water wears them out, are still found at their bottom.

PART IV.

MISCELLANIES.

The greater part of the subjects to be presented under this division might, without impropriety, have been connected with the first, or geological part. But as that division had swelled more than was expected, it was thought best to throw them together at the close of the Sketch. Some of the following articles however have suggested themselves since the geological part was written.

Ancient Lakes.

Any one who examines the passage of the Connecticut and many of its tributaries, through several mountains embraced by the Map accompanying this Sketch, will be led, I think, to the conclusion that the waters of this river once flowed over the great valley along its banks, forming an extensive lake: and also, that when this began to subside, by the wearing away of the outer barriers, other barriers would appear and produce other lakes of inferior extent.

It is no argument, as some have thought, in favour of such a supposition, that so much rock occurs in this basin which is evidently a recomposition of the detritus of older formations; and that organic remains are found in these rocks. For every geologist knows that all this must be referred to a period anterior to that, in which the last grand diluvian catastrophe happened to the globe and left our continents in their present form.* Nor is the mere occurrence of masses of stone, evidently rounded by the attrition of running water, any evidence in favour of this hypothesis; for we must look for the cause of this also, as far back at least as the Noachic deluge.—No current of water with which we are acquainted is sufficient to transport such masses of rock into the situations in which we find them: "for though we can readily conceive how the agency of violent currents may have driven these blocks down an inclined plane, or, if the *vis a tergo* were sufficient, along a level surface, or even up a very slight and gradual acclivity, it is impossible to ascribe to them the Sisyphean labour of rolling rocky masses, sometimes of many tons in weight, up the face of abrupt and high escarpments."† Rounded masses of rock may however occur under such circumstances as to show them to have been removed by currents posterior to the deluge.

The principal evidence in favour of the supposition that the waters of the Connecticut once flowed over the broad valley on its banks, consists in the appearance of the channel of the river where it passes through certain mountains. Thus, every one perceives that this river must have cut its deep passage through the mountains below Middletown: in other words, this supposition will account for that gulf several hundred feet deep in which this river now flows, and we are not acquainted with any other agency that will account for it. And if it be admitted that this passage was

* See some excellent remarks on this subject in the recent work of Conybeare and Philips, entitled "Outlines of the Geology of England and Wales"—page 57 Introduction.

† Vid. same work page 29, Introduction.

once closed up nearly to the general level of the neighbouring mountains, it must have thrown back the waters of the Connecticut over the whole of the secondary tract marked on the map, with the exception of some of the highest ridges and peaks of greenstone and sandstone, which then probably formed islands in this extensive expanse of waters.

At the outlet of the Connecticut through the mountains below Middletown, a little south of the Chatham cobalt mine, and six or seven hundred feet above the present bed of the river, I saw rounded masses of old red sandstone, several inches in diameter, mixed with the fragments of the rocks in place. Such a fact I never noticed at any other place in the primitive region along the river: certainly not on the east side of it. And I was led irresistibly to the conclusion, that they were conveyed thither by the ice of the ancient lake, which would be floated to the ocean through this outlet.

In the northern part of the tract supposed to have been covered by this lake, other evidences of its existence present themselves. In the southern part of Deerfield, the sandstone cliffs of Sugar Loaf, four hundred feet above the present level of the Connecticut, bear evident marks of having been worn and undermined by water:—that is, they appear very much like similar rocks which now form the beds and banks of the Deerfield and Connecticut rivers. In the north part of Deerfield, at the west foot of the greenstone ridge, and two hundred feet at least above the Connecticut, is the channel of a stream ten or twelve rods wide, that once ran *southerly*, as appears from the little eminences of greenstone that were exposed to its action, which present a perpendicular front on the north side, while the south side is sloping and presents an accumulation of broken pieces of the rock. One mile west from this spot, and a few rods south of the village of Greenfield, appears the bed of a smaller stream which there formed a cataract,* of a few feet over a ledge of red sandstone rocks. In this rock are numerous spheroidal excavations of two or three feet in depth, leaving no doubt that a current of water once flowed there. This channel is less than one hundred feet above

* See Dickinson's View of Massachusetts, p. 33.

the Connecticut. A little to the northeast and especially one or two miles northwest of the village of Greenfield, the old red sandstone rocks are smoothed and fluted in a great many instances; indicating a former exposure to currents of water. These various circumstances render it very probable that the country was once covered by a lake.

As the passage of the Connecticut through the mountains below Middletown was gradually worn deeper and deeper, this lake would be lowered also—and in process of time, the lofty greenstone ridge, extending from near New-Haven to Amherst, would present another barrier, and at length the original lake would be divided into two; the one extending from Northfield, on the west side of this ridge, nearly to New-Haven, and the other, on the east side, from South-Hadley to Middletown. There is every appearance that the Connecticut has worn down a passage through this ridge between Holyoke and Tom.

As this process of draining continued from century to century, these lakes constantly contracted their limits, until at length the greater part of the extensive vallies they occupied were laid bare. In the western lake however, were three basins, at Farmington, Westfield and Deerfield, a few miles in extent, which would remain filled with water until the three rivers of the same name, which supplied them, had worn away passages through the greenstone ridge above mentioned. That they have done this, will be doubted by no one who will examine their course through this mountain.

Thus after the lapse of years would these lakes all be drained, leaving a rich valley for cultivation. And whoever will examine the alluvium of Farmington, Westfield and Deerfield, will be led to suppose that the period when the work was finished could not have been many centuries before the settlement of this country.

Sunderland Cave.

This is about three miles northeast of the village in the rocks of the coal formation. It forms nearly a quarter of a circle, is about ten rods through, opens on the north and west, is from two to twenty feet wide, and from ten to sixty or seventy deep. A few rods to the south is a fissure ten feet wide, nearly parallel to the cave, and sixty or seventy feet deep. Both the cave and the fissure are in an immense mass of pudding stone with scarcely any thing like stratification throughout ; and this is incumbent upon a soft, decomposable, argillaceous sandstone slate. The disintegration of this slate, either by the waters of the lake above described, or by simple exposure to the vicissitudes of the climate, has probably caused this enormous stratum of conglomerate to fall partially down and thus to form the cave and the fissure.

Favourable situation of Yale College as a School of Mineralogy and Geology.

It is a curious circumstance, that this Institution should have been fixed by its founders, who must have been altogether unacquainted with geology, at the very focus of most of the Wernerian rock formations. It stands at the southern extremity of the secondary region of the Connecticut; and had experienced geologists searched the whole of New-England, they could not have found a more eligible situation for a geological and mineralogical school. It is also a fortunate coincidence of favourable accidents, that the first mineral cabinet in the United States should have been deposited in Yale College, before there was much known concerning the interesting nature of the surrounding country

The geological professor at Yale could, even from his lecture room,* point out most of the rock formations of the globe. He could direct the attention of his pupils to the plain around them, as alluvium ; and to the hills of Woodbridge and Milford, as exhibiting interesting deposites of diluvium. On the north they would see the striking secondary greenstone eminences of East and West Rock ; and on the west, hills of primitive greenstone. In this same direction, only four or five miles distant, he might point them to the West-Haven chlorite slate, to the Woodbridge argillite, to the Milford *verd antique* and serpentine, and a little beyond, to the mica slate. A few rods to the north, or east, they might see the old red sandstone and the green-

* The cabinet which is in the third story of a high building and in which the lectures are given commands a view of the neighbouring hills.

stone dikes they contain. In East-Haven, also, six miles distant, occur the red and grey slates of the Coal Formation; in Northford, the fetid carbonate of lime; at Southington the bituminous limestone; at Westfield the bituminous shale with ichthyolites; at Durham the coarse conglomerate of the coal formation, and at Berlin the greenstone and slates of the coal formation with interesting localities of coal, galena, blende, barytes, agates and zeolites in the greenstone—all within half a day's ride. In East-Haven appears the sea beaten granite; and, a little farther to the north and east, the gneiss, hornblende slate and mica slate formations.

The mineralogy of the vicinity of Yale, is also rich and diversified. Suffice it just to mention the chalcedony, carnelian, amethyst, agates, stilbite, zeolite, laumonite, prehnite, analcime, &c. of the neighbouring greenstone: the native copper, copper and lead ores, so abundant in the same formation:—the native silver, bismuth, magnetical and common pyrites, galena, blende, the three ores of tungsten, the tellurium, fluor spar, epidote, titanium, &c. of Huntington: the asbestus, bitter spar, sahlite, serpentine, &c. of Milford: the cobalt ores at Chatham; the corundum, andalusite,* &c. of Litchfield; and the chrysoberyl, beryl, tourmalines, garnets, magnetic iron, columbium, &c. of Haddam.

Geological Position of Amherst Collegiate Institution.

This is situated on elevated ground, and commands an extensive and delightful view af the surrounding country. It stands on granite, here covered by diluvium; but the granite appears a short distance both north and south. On the west, stretches out an alluvial plain; on the south, rises the lofty Holyoke of greenstone; on the east, of gradual ascent, a mountain of gneiss; on the north, appears, a few miles distant, mount Toby, composed of rocks of the coal formation; and also the rounded Sugar Loaf of old red sandstone:—while beyond the alluvial tract, on the west, rises a high range of mountains made up of granite and sienitic granite, (containing the interesting lead mine of South-

* Recently announced by Major Delafield. Vide Amer. Journ. Sci. Vol. 6. p. 176.

Hampton,) primitive greenstone, greenstone slate, mica slate and gneiss, so that without mentioning the rare minerals found in the vicinity, it is evident that an interesting assemblage of rocks is presented in the neighbourhood for the instruction of the geological student.

Fac Simile of Goshen Graphic Granite. [See Plate 1, Fig. 1.]

A description of this granite has been already given in the First Part of this Sketch. But having since discovered some more perfect specimens, I thought it might not be unacceptable to have one of them copied. It is not common to find specimens so well marked as the one from which the plate was taken; yet, in general, they are quite handsome. The points, triangles, &c. of quartz, usually enlarge, or diminish, as they traverse the feldspar. Thus, the specimen, of which the plate is a copy, exhibited on its opposite side (about four inches distant from the surface that was copied,) the same characters but four times as large.

Pseudomorphous Granite. [See Plate 1, Fig. 2.]

It is not an easy matter to give a good graphic representation of this rock. Perhaps however, the one annexed may assist in understanding the description given on p. 17, vol. vi. The dark part represents the plates of mica;—the red part the quartz, and the uncoloured portion, the feldspar. This rock occurs abundantly in Goshen, connected with the graphic granite above described; and the transition of the one into the other is usually very sudden.

Lusus Naturae. [See Plate 1, Fig. 3.]

For a description of this, see page 15, vol. vi.

Desiderata in the Geology and Mineralogy of the Connecticut.

It may be remarked in general, that but a small part of the geology and mineralogy of this region has been brought to that degree of perfection to which these sciences have been carried in some countries in Europe; and, therefore, there are desiderata in the whole. But some parts are more deficient than others ; and I shall take the liberty of noting some of those points which seem more particularly to demand the further attention of the geologist. Among these the following may be named.

1. A more exact determination, in many instances, of the boundaries of the several formations.

2. Further examination of the exact relative position of the old red sandstone and the coal formation.

3. Further search for greenstone dikes, not only in the old red sandstone, but also in the coal formation, and even in primitive rocks.

4. Whether the beds of secondary greenstone detach veins from one to the other, as in the isle of Sky.

5. A further examination of the granitic beds, to determine whether like connecting dikes or veins may not be found uniting them also.

6. A more thorough search to ascertain whether all our granite does not exist in the form of beds and veins.

7. To find more instances in which the coal formation and greenstone form alternating beds.

8. An examination of the beds of clay and gravel, found along the Connecticut, for shells and other organic remains.

9. Further search in the coal formation for organic remains.*

10. Examination of the bituminous limestone of Southington, especially with the query of Prof. Silliman in mind, (Journal p. 63, vol. 6.) whether this rock may not itself be, or be connected with, bituminous marl slate ?

11. The extensive range of greenstone, running from Berlin to Amherst has as yet been but little examined for minerals, as well as many other greenstone ridges. Indeed, the mineralogy of this whole region requires farther exploration, and promises the diligent student much fruit.

Meteorological Fact.

The following circumstance, although connected with geology, does not strictly come within the limits of this

* Dr. Cooley informs me that he has recently discovered another locality of ichthyolites in Deerfield, about three miles from the locality in Sunderland.

Sketch : Yet it seems worth noticing, but hardly of sufficient importance to form a separate paper.

In going westward from Connecticut river, we first pass over an alluvial tract and then continue gradually to ascend, for twenty miles, to the top of Green and Hoosak mountains. As might be expected, the winters on this elevated land continue two or three weeks later than in the valley ; that is, the farmer can sow his seeds two or three weeks earlier in the valley than on the hills. But in autumn, the destructive frosts are usually as much later on the hills than along the river :—so that one frequently passes from the river in October, where almost every vegetable is destroyed, and finds the crops uninjured on these hills ; and the crops there are about a fortnight later than those in the vallies, so as to require this lengthening out of their time of ripening. I have been disposed to attribute this fact to the greater moisture of the atmosphere of the vallies, arising from the more copious exhalations from the river, whereby the effects of frost are greatly increased, even at the same temperature.

*Tabular Arrangement of the Rock Formations along the Connecticut.**

* I here follow with pleasure the very simple yet ingenious arrangement of rocks, which is adopted by Conybeare and Phillips, as the basis of their recent work on the Geology of England and Wales. It has the rare merit of being entirely free from hypothesis. It would be well if a similar purification from the alloy of uncertain systems, could be extended through every part of geology. The work, however, is rapidly advancing and in the hands of such men as the authors of this work, and of Mc Culloch, Greenough, Buckland, Webster, Borrè, Cuvier, Brongniart, &c. we confidently expect that it will be speedily accomplished.

In the above table, I may have put down some rocks in the Inferior Order, which the authors of this arrangement will place in the Submedial Order. For their acoount of these orders is not yet published ; and in the general sketch, they have given, only a part of the rocks belonging to each order are enumerated.

I. Inferior Order.

Mutually Interstratified and without any regular order of succession. [Printed sideways beside rocks 1–5.]

		Rocks observed in contact with those in the leading column.	
1. Granite.	Common	Sienitic Granite	N. Hampton, Belchert'n, &c.
	Porphyritic	Gneiss	Leverett granitic range,
	Graphic	Hornblende Slate	Do. Granville, &c.
	Pseudo-morphous	Mica Slate	Conway, Williamsburgh, &c.
		Serpentine	Westfield, Mass.
		Limestone, (No. 7.)	Conway
		Diluvium	Passim
		Alluvium	Northampton
2. Sienite, or Sienitic Granite.*		Granite	Northampton, &c.
		Hornblende Slate	Chatham.
		Primitive Greenstone	Whately.
		Diluvium	Do.
		Alluvium	Northampton.
3. Gneiss.	Common	Granite	Leverett, &c.
	Glandulous	Hornblende Slate	Passim.
		White Gran. Limestone	Litchfield County.
		Mica Slate	Leverett, Granville,
		Steatite	New-Salem. [&c.
		Diluvium	Passim.
4. Hornblende Slate		Granite	Granville, &c.
		Sienitic Granite	Chatham.
		Gneiss	Passim
		Mica Slate	Shelburne, Colerain, &c.
		Diluvium	Passim.
5. Mica Slate		Granite	Conway, &c.
		Gneiss	Monson, Wilbraham, &c.
		Hornblende Slate	Shelburne, Heath, &c.
		Limestone, (No. 7)	Deerfield, Conway, &c.
		Argillite	Leyden, Woodbridge, &c.
		Chlorite Slate	Whitingham, Milford
		Greenstone Slate	Whately, Do.
		Serpentine	Middlefield.
		Steatite	New-Fane, &c.
		Old Red Sandstone	Passim.
		Coal Formation	S. Hampton Lead Mine.
		Diluvium	Passim.
		Alluvium	Wilbraham.
6. Talcous Slate		Mica Slate	Plainfield, Hawley, &c,
		Chlorite Slate	Whitingham.
7. Limestone, or a Granitic Aggregate of Silex, Carb. Lime and Mica		Granite (in veins)	Conway.
		Mica Slate	Deerfield, &c.
		Argillite	Putney.

* This is undoubtedly the rock denominated sienitic granite, by Dr. Mc Culloch, in his Geology of Glen Tilt. (Geol. Trans. Vol 3. p. 299 and 300.) That is, he regards it as a mere variety of granite, distinguished from other varieties by the presence of hornblende in any proportion. Had I read his memoir on the Tilt before the geological part of this sketch was written, I should not have separated sienite from granite, but have treated the two rocks as mere varieties.

		Rocks observed in contact with those in the leading column.	
8. Chlorite Slate		Talcous Slate	Whiting ham.
		Mica Slate	Do.
		Argillite	Guilford, Vt. and Woodbridge.
		Verd Antique	Milford.
		Prim. Greenstone	Do.
		Diluvium	Do.
		Alluvium	Orange, (Ct.)
9. Steatite		Gneiss	New-Salem.
		Mica Slate	Middlefield.
		Serpentine	Do.
10. Serpentine		Granite	Westfield, Mass. (Eaton.)
		Mica Slate	Middlefield, (Dewey.)
		Granular Limestone	Milford.
		Steatite	Middlefield, (Do.)
11. Verd Antique		Primitive Greenstone	Milford.
		Chlorite Slate	Do.
12. Primitive Greenstone	Unstratified; Greenstone Slate	Mica Slate	Wolcott?
		Chlorite Slate	Milford.
		Sienite	Whately.
		Verd Antique	Milford.
		Old Red Sandstone	Whately, Gill.
		Coal Formation	Gill, Northfield.

The order of succession of the seven preceding rocks is very variable and uncertain.

II. Submedial Order.

13. Argillite	Mica Slate	Putney, Woodbridge.
	Limestone, (No. 7.)	Do.
	Prim. Greenstone	Woodbridge.
	Chlorite Slate	Do.
	Old Red Sandstone	Do.
	Diluvium	Do.
	Alluvium	Brattleborough.

III. Medial Order.

14. Old Red Sandstone	Common; Conglomerated	Granite	Northampton.
		Mica Slate	Deerfield.
		Argillite	
		Prim. Greenstone	
		Second. Greenstone	
		Coal Formation	
		Diluvium	
		Alluvium	

			Rocks observed in contact with those in the leading column.	
Interstratified.	15. Coal Formation.†	Wacke* Trap Tuff Dark bastard Limestone Bituminous Do. Fetid Do. Seams of Coal Fine red arg. Sandstone Coarse gray Siliceous Do. Very Micaceous Do. Black tortuous Do. Bituminous Shale Finer Puddingstone Coarse Do.	Granite Gneiss Mica Slate Old RedSandstone Prim. Greenstone Sec. Greenstone Diluvium Alluvium	Southampton? Montague. S. H. lead m. Passim. Gill. Passim. Do. Enfield, (Ct.)
	16. Secondary Greenstone	Compact Columnar Amygdaloidal Porphyritic.	Granite Old Red Sandstone Coal Formation	East-Haven? East and West Rock. Gill, Berlin, &c.

IV. Superior Order.

17. Diluvium	- -	Above most or all of the preceding formations.
18. Alluvium.	Oceanic deposites Beds of Gravel Do. Clay Do. Sand Loam Decomposed Rocks and Vegetables	Above most of the preceding formations.

* Prof. Silliman has decided, in the affirmative, the question whether this rock exists along the Connecticut. Vide Journal of Science, Vol. 6. p. 51 note.

† In Conybeare and Phillips' late interesting work on the Geology of England and Wales, (p. 311,) the Bituminous Marle Slate, with the accompanying limestones, sandstones and conglomerates, is placed in the supermedial order ; that is, immediately above the rocks of the coal Formation; and if the Rocks above denominated the Coal Formation should prove to belong to the Bituminous Marlite Formation, according to Mr. Brongniart's opinions, they must be placed in the Supermedial order also. But what becomes of the old red sandstone (rothe todte liegende) which lies immediately below the Bituminous Marl Formation in Germany, and below the coal formation in England? These writers (or rather Rev. W. D. Conybeare, who wrote the article here referred to) regard the rothe todte liegende of the Germans, as distinct from the old red sandstone of England. *Query*—if the rocks along the Connecticut are really the coal formation of Europe, may not the red sandstone east of the river in Chatham, East-Hartford, Windsor, &c. be the rothe todte leigende ; and that west of the river the old red sandstone of England?

This same writer, speaking of the real coal formation, says that "at least ten characters will be found in common between the carboniferous

P. S. *Coal Formation.*

Since the publication of the description of this series of rocks along the Connecticut, I have had an opportunity to examine more extensively than I had done before, the coal formation of Rhode-Island; and thus to institute a comparison between the two. And I feel satisfied that they are very distinct from each other; and that the Rhode-Island formation is the oldest. There is a sort of general difference between them, which is readily recognized by the eye, but which it is not easy to describe. In the Rhode-Island rocks, however, there is a greater resemblance, in the general aspect and in the fracture, to primitive rocks than in those of the Connecticut; and the former are, in general, harder and more compact than the latter; and their cement is more argillaceous. The coarse puddingstone, so abundant in Roxbury, Dorchester, &c. and which is seen at intervals most of the distance to the anthracite beds in Portsmouth, approaches, in certain varieties, very near a similar rock in Montague, Sunderland. Durham, &c. In the first named rock, however, the cement is rather more abundant, and the rock, as Maclure very happily expresses it, "has the appearance as if the cement at the time of formation had a consistence sufficient to prevent the particles from touching each other." Certain fine red and coarse gray slates occur in the two formations which can hardly be distinguished, except that those in Rhode-Island (as well as most of the other transition rocks there,) are traversed by veins of quartz, but those on the Connecticut never are.

I would not be understood as endeavouring to prove that the Rhode-Island formation belongs to the Wernerian transition class and that of the Connecticut to the secondary. Both probably are transition; yet the one may lay claim to a greater age than the other.

and transition class (of Werner) for one which could lead to an opposite arrangement"—that is with the flœtz class, and also "that the sandstones of the lower part of this series approach closely in character to the more obviously mechanical varieties of greywacke, and indeed so completely pass into that rock, that in many instances the limits between this series and that of transition rocks, can only be arbitrarily assigned."—(pp. 323 and 324.)

Gneiss.

The more I examine the rocks in New-England, the better convinced I am that the extent of this rock in this region, has been overrated by geologists. The truth is, that almost in every place which I have examined, mica slate alternates with gneiss, or overlies it, so as to occupy nearly, sometimes more than half the surface. Hornblende slate and granite, also occur in the same series. In passing from Northampton to Boston, I have never found any gneiss east of Worcester; although in going from Providence to Hartford, this stratum occurs only twelve miles from the former place and continues with alternations of mica slate, &c. to within a few miles of the latter place.

I cannot avoid remarking here, that wherever I have seen beds and veins of granite in gneiss and mica slate, I have usually found the strata much distorted and deranged in the vicinity; and *vice versa*, where derangement of the slate appeared, I have generally been able to discover veins or beds of granite. And wherever granite veins exist, granite beds are not usually far off. I might say more on this subject: But it has only recently attracted my particular attention, therefore I desist. I am satisfied, however, that many of the phenomena of Glen Tilt are repeated in New-England.

Greenstone—primitive—transition and secondary.

The second supposed distinction between the primitive and secondary greenstone of the Connecticut is very imperfectly stated page 32 vol. 6. The mere fact that the primitive greenstone forms beds in other rocks does not distinguish it from secondary greenstone; since this occurs in the same situation. But the former, at the sides of the bed, passes by imperceptible gradations into other rocks, such as greenstone slate, chlorite slate, &c. thus excluding the idea that it could have been forced in between the strata of other rocks after their consolidation: whereas the latter rock is distinctly characterized to the very line of junction with the sandstones and puddingstones, unless there be a slight chemical change a few inches on either side of this line, as if by heat.

It may not be amiss to state here that the greenstone of the Connecticut has a very different aspect internally and externally from the epidotic and sienitic greenstones in the vicinity of Boston. The latter are evidently transition, being associated with the sienite, porphyry, gray wacke, argillite, &c. But I am not prepared to state precisely in what respects they differ from the greenstone of the Connecticut.

And although it does not strictly belong to this place, it may not be amiss to refer to the interesting dykes of basaltiform greenstone occurring in sienitic granite in the vicinity of Boston, of which I do not recollect to have seen an account. I have noticed them in Sudbury and Weymouth in real granite—that is, the rock was destitute, at the place of hornblende. One in Weymouth, or perhaps in Braintree, I traced several rods, and it retained its width with mathematical exactness, and the sides were perfectly smooth. These dykes deserve more examination and better description. Perhaps some of them contain real basalt.

White Augite.

Since writing the account of this mineral found in Goshen, which occurs on page 225 vol. 6. I have visited the locality again, and find it in immense abundance. About two miles north of Goshen meeting house, a few rods beyond a tavern on the west side of the road, is a pasture almost covered by bowlders of granite. These bowlders are full of augite, some of the crystals of which are from twelve to eighteen inches long and three or four wide, although they are very imperfect. Every cabinet in the world might be supplied from them. I noticed also in the same rock some crystals of beryl more than an inch in diameter.

Precious Garnet.

This occurs abundantly in gneiss in west and south Brookfield. Some are an inch diameter; their colour is light poppy red, and it is rare to find any exhibiting the form of the crystal distinctly, so that perhaps they ought to be referred to pyrope.

Prismatic Mica

Found in the northern part of Williamsburg in granite. Good specimens may thence be obtained.

Art. II.—*Geological Essay on the Tertiary Formations in America, by* John Finch, *Fellow of the Philosophical Society of Birmingham, Professor of Geology and Mineralogy.*

[Read before the Academy of Natural Sciences, at Philadelphia. July 15, 1823.]

Introduction.

TO trace the connexion between the rocks of different continents, to observe the order of their superposition, and to examine the exterior formations of the earth, are the business and study of the Geologist.

The mountain masses, which occur in various parts of the globe, obey one general law; and the crystallized rocks which contain no fossils, and are equally called primitive, whether they occur in Europe, Asia, or America, are constantly found in the same position. When we ascend in the scale of formations, and arrive at those rocks which contain fossils, we find each stratum decidedly marked by the remains of zoophytes, or shells, peculiar to it. These fossils constitute the medals of the ancient world, by which to ascertain the various periods, during which the exterior coat of the earth was consolidated.

It has been observed, that these organized remains occur in so regular an order, that it is like examining a cabinet of shells, where you are sure to find, in every drawer, those peculiar ones which have been deposited within it.

The order of position among secondary rocks is also seldom inverted. If in one quarter of the world you find a sandstone, containing salt and gypsum, situated above another, containing the impressions of peculiar madrepores, in all other countries where these rocks are found, they preserve the same relative position.

This law is the foundation of Geology, on which alone it rests; and every portion of either the old or new continents that is examined, seems to produce fresh evidence of its truth.

Among the discoveries made, in consequence of the generous rivalry which takes place between nations in scientific pursuits, none have given a greater impulse to the science of Geology than the researches of Messrs. Cuvier and Brongniart, who first traced and described the tertiary formations in the vicinity of Paris, and thus placed before us the secret of the last revolutions, which our planet has undergone.

The next memoir which elucidated these strata, and gave rise to the opinion that they might be found in other countries besides France, was published by Mr. Webster, in the Transactions of the Geological Society in England; he proved the existence of two basins, in the Isle of Wight, and near London, possessing fossil remains similar to those found near Paris.

By succeeding Naturalists these formations have been found in several parts of Europe, in Asia, and Africa, let us endeavour to trace their existence upon this continent.

The primitive, transition, and secondary rocks obey the same laws in America, as in other parts of the world, and why should she be supposed to be destitute of the tertiary formation, the discovery of which has conferred such splendour on the geological schools of London and Paris.

In America, an immense tract of country, extending from Long-Island to the sea of Mexico, and from thirty to two hundred miles in width, is called an alluvial formation. by most of the geologists who have written upon the subject and by some it appears to be considered as an exception to the general arrangement and position of strata, which are found to occur in other countries.

From an examination of fossils brought from that quarter of the United States, from a personal inspection of some of its strata, and the perusal of most of the publications which bear a reference to it, I wish to suggest that what is termed the alluvial formation, in the geological maps of Messrs. Maclure and Cleaveland, is identical and contemporaneous with the newer secondary, and tertiary formations of France, England, Spain, Germany, Italy, Hungary, Poland, Iceland, Egypt and Hindoostan.

Although to place the subject beyond dispute, it would be necessary personally to examine all the various fossils from each separate stratum, and the formations on the spot where they occur, yet still sufficient evidence may be collected to place that extent of country in a different point of view, from that in which it seems to have been hitherto regarded.

In the first place, the opinion that it is alluvial or deposited by the ocean or by rivers, at a comparatively recent period, seems quite inadmissible. The eastern shores of continents are more liable to lose than gain from the ocean, and there are no rivers on that coast which could have deposited such an accumulation of sand and marle, and the hills of limestone which that country contains.

In strict geological language the term alluvial can only be applied to the depositions which take place on the banks, or at the debouchure of rivers, such as are formed by the Ganges, the Nile, the Danube and the Mississippi, the extent of which is easily ascertained by a correct map. Smaller rivers, such as occur more frequently on the Atlantic border of the United States, do not in centuries deposit sufficient sand to alter the geographical features of a country.

The following descriptions of strata found near the Atlantic are taken partly from my own notes on the few which I have seen; from the publications of Mr. Maclure, Dr. Mitchell, and Mr. Hayden, and from the personal information of several friends to geological science, amongst whom I wish more particularly to mention the names of J. G. Bogert, Esq. and Major Delafield of New-York, and Major Ware of Philadelphia, all of whom are well known in the scientific world, and upon whose correctness, every reliance can be most firmly reposed. I have added the name of the strata in England and France, to which they may probably be referred, at the same time I do it merely as a slight sketch of what may be attempted by future observers, and submit it to the public with every possible deference to their opinion. It is merely an outline which must be left to future geologists to fill up, and to ascertain, in a more rigid manner. It is sufficient to the present memoir if it merely suggests the coincidence between the higher formations in Europe and those of America, leaving it to abler pens to correct the mistakes, and supply the deficiencies of the present essay.

1. *Ferruginous Sand.*

This formation, which occupies a situation between the oolites and chalk in England, is to be traced in the following description, which is derived from Mr. Maclure.

Considerable deposits of bog iron ore occupy the lower situations in New-Jersey, and many of the more elevated and dividing ridges are crowned with a sandstone, and puddingstone. Quantities of ochres, varying in color from bright yellow to dark brown, are found in abundance in this stratum, in flat horizontal beds.

2. *Plastic Clay and Sand Formation*

consists of an indefinite number of beds of sand, clay, gravel and lignite, which appear to alternate without any very exact order. The following is a description of it as it occurs in England.

SANDS of various colors, in beds varying from an inch to fifty feet in thickness; the pure white silicious sands used for making Glass are generally obtained from these strata.

CLAYS in beds of various thickness, and of the brightest and most variegated hues, so that they have sometimes been compared to the colors on the leaves of a tulip: white, red, blue, grey, yellow, black, indeed almost every variety of color may in different situations be traced in these clays. Their utility is great, as in fact they are necessary for the porcelain manufacturer, potter, for bricks, and every purpose where a pure clay is required; some of the varieties stand the heat of the strongest fires, and are used in Glass houses; sometimes it assumes the appearance, or is replaced by marle containing peculiar fossils.

GRAVEL or small, rounded pebbles form whole strata in this formation and exhibit as strongly as the largest bowlders, the great attrition which they must have undergone, to reduce them to their present size.

LIGNITE, or Wood Coal, always accompanies the Plastic Clay and sand, and is generally stratified, although it sometimes occurs in solitary masses. It usually contains amber, and sulphuret of iron.

The Plastic clay and sand formation may be readily identified wherever it presents itself, the character of the clays and their bright color, and the alternation of beds of clay, sand, pebbles and lignite render it easy to distinguish it. At the same time it may be considered as the most important of the tertiary formations, on account of its use in the arts.

It was first discovered in France, but is peculiarly prominent, and finely illustrated in England, at Alum bay in the Isle of Wight, where from some unknown cause, the strata have assumed a vertical position, and the sea washing the face of the cliffs has presented a fine section to the Geologist.

In England the plastic clay is, I believe, found only in this formation, but in France, a bed of white clay and sand accompanies some of the higher formations. It must remain for future observations to ascertain whether some of the white plastic clays of America belong to the higher or lower formations. I am inclined to think that most of the American clays are contemporaneous with the English plastic clay and lower French strata, but it is a point which must be decided at a future time, when the exact order and position of these formations is known in America.

This formation is the most extensive of the tertiary strata in the United States, and presents an important feature in its Geology; it may be traced at different points nearly to the distance of a thousand miles. The following are some of the localities where it occurs.

The situation where it may be studied with the greatest advantage and where it is exhibited in greater perfection than in any other part of the United States, is at Gay Head, on the island sometimes called Martha's Vineyard in Mass. The cliffs are two hundred feet in height, and consist of a succession of beds of clay, sand, ochres and lignite of the brightest hues, and the waves of the ocean which flow at the foot of the hill are tinged by the coloring matter of the sands and clays. I am informed by a gentleman of Philadelphia, who has visited this place, that amber has been found floating in the ocean, near, undoubtedly derived from the lignite of this formation, and I have a specimen of it in my collection.

At Sand's Point upon Long-Island, it is very conspicuous, consisting of beds of very white clay and fossil wood. The range of hills which extend through the centre of this island, are composed of diluvial sand, gravel, &c. accompanied by enormous masses of rolled pebbles and bowlders.

The plain to the south of this is well known to consist principally of sand, distinguished by the evenness of its surface, and nearly the whole of Long Island, at the depth of thirty to fifty feet, consists of a stratum of sand and gravel, in which are various shells, venus, ostrea, murex. In the same stratum are found boughs and trunks of trees, bark and damaged wood. Nearly the whole of this island may therefore be considered as forming a part of the plastic clay and sand formation, unless indeed the sand hills near Brooklyn may be considered as part of another formation. Upon Staten Island the plastic clay is conspicuous in several situations.

In New-Jersey this formation occupies a very extensive tract of country; the clays from Amboy, the port where they are shipped, have been long celebrated in commerce. In ascending the stream of the Raritan, I had great pleasure in tracing this formation on the south-east shore, to within three miles of Brunswick; it probably extends across the whole of New Jersey. At Bordentown, on the Delaware, it is very conspicuous: the banks of the river, for two miles south of that town, afford as good an opportunity of viewing it as can be wished by the geologist. The sands are of the most brilliant hues, and you may count a hundred alternations of color in the distance of a few feet. Beds of lignite and blue clay, interspersed with iron pyrites, with which in one or two situations the shore is covered; large masses and beds of ochre of the most brilliant appearance; the waters of the Delaware colored by the wreck of these strata; altogether present a fine view to the admirer of tertiary formations. In some instances the banks are undermined by the river, or by land springs; large masses of the cliffs give way, and what are called land slips occur, in which sands, clays, lignites and pyrites are mingled with the wrecks of the kalmia, liriodendron, carex, and magnolia.

I have been informed by Professor Vanuxem of South Carolina College, that amber has been found in the lignite of this formation; some of the white clays of commerce are obtained at a distance two miles up the creek at Bordentown.

It is probably a continuation of the same plastic clay and sand which appears in New Jersey, on the river Delaware, three miles above Philadelphia. It is there distinguished by beds of white sand, pebbles and porcelain clay. I am rather inclined to arrange the sand of New-Jersey in the same class; but future observations must determine this point.

Philadelphia is built upon a plastic clay and sand formation; the sand is of variegated hues; the clay, which is very pure, is found at thirty feet below the surface of the ground.

At Cape Sable, in Maryland, vast beds of lignite are found, containing amber, which has been described by Dr. Troost in the American Journal of Science. It is well known that the amber of Prussia is found in a similar situation, and thus in distant parts of the world similar strata contain the same mineral substances; and the amber of the Baltic has an ally and a brother in the formations of plastic clay, sand, and lignite, at Gay Head, Bordentown and Cape Sable.

The clays of this formation abound in Florida; specimens are deposited in the cabinet of the Academy of Natural Sciences in Philadelphia, from Escambia bay, seven miles above Pensacola, and from Mobile bay in Alabama.

I am informed by Major Ware, who has travelled over great part of the southern frontier of the United States, that the plastic clay extends over several hundred square miles, in a direction south and south-east of the Chicasaw Indians. In the tract of country which this embraces, in every excavation which the inhabitants make to obtain water, they dig up a fine dark red clay, which in some instances they use to paint their houses; the surface is composed sometimes of the clays and sometimes of the sands of this formation.

Another situation where it appears in a very conspicuous station, and with prominent characters, is at Chicasaw Bluffs and at Natchez, which have been described by Mr. Nuttall under the term alluvial, in his tour to the Arkansas. It also abounds in many other situations, and on a reference to Cleveland every locality which is noticed as affording porcelain and potter's clay, may be considered as belonging to this formation. Its exact geographical boundaries can only be determined in the course of time, when the tertiary formations of America have attracted that attention which it is the object of this essay to awaken. The extent of it may be considered a subject of congratulation to the

American public, because it shows that for many thousands of years there is an ample supply of the materials for the manufacture of earthenware, porcelain and glass, whenever the country shall consider it desirable to support or encourage those manufactures more extensively than at present.

It is a subject of some interest to ascertain whether the fossil shells ef this formation in America are similar to those of Europe. At Powleshook, opposite New-York, and at the celebrated village of Communipa, on a small elevation one quarter of a mile north of it, and to some distance inland, are extensive strata of fossil oyster shells, forming beds, from six inches to two feet in thickness. Mr. Pierce, in his description of New-Jersey, also mentions many banks of them, and I have heard of one which extends several miles ; they may probably be classed as belonging to this formation. In the opinion of many persons, both learned and otherwise, these are shells left by the Indians ; but an examination of the places where they occur, especially at the hill near Communipa, wlll, I imagine, satisfy every geologist as to their origin.

3. *Calcaire Silicieuse, of the Paris basin.*

The siliceous limestone or Buhr stone of Georgia, is a formation decidedly contemporaneous with the above mentioned stratum; although the principal part of the celebrated French mill-stones are from a rock higher in the series, the Meuliere sans coquilles, yet some are obtained from the Calcaire Grossier ; and to this stratum and the C. Silicieuse, I consider the Georgia Buhr stone allied, both by the similarity of mineralogical character, and the nature of fossil remains. The American Buhr stone contains splendid impressions of two or three varieties of mactra. Tellina, melania and turritella, and many others will no doubt be found in it on future investigation.

The cavities in the limestone, which are numerous, are lined with siliceous incrustations, and if great care was exercised in the Georgia quarries to procure only the hardest stratum, it would no doubt supersede the introduction of French Buhr stone, but at present they appear to make no selection ; consequently many of the softer varieties come to market, which are of no use, and prevent their general adoption. The Buhr stones, which are used extensively in the western States, and are obtained on Racoon creek, at Huntsville, and many other situations, belong to a very different formation; they are composed of chert, containing an enormous quantity of organic remains of encrini, and consequently are more ancient than the Georgia stone.

4. *London Clay.*

In the banks of James river, Va. there is a large quantity of organic remains imbedded in a bank of clay. At Richmond are found fossil triangular teeth, apparently belonging to sharks, and other pieces of bone, at a distance of sixty feet from the surface.

All these fossil remains are similar to those found in the London clay, and from the same spot I have seen fossil shells, similar to those which are deposited in the collection of the Geological Society in London, and which were obtained in the deep excavations at Highgate hill.

At Washington, under the mass of diluvian gravel, of which the higher part of the capitol hill is composed, there is a stratum of clay, which contains many organic remains. Trunks and branches of trees are found at a distance of fifty-four feet from the surface; and farther down the river, in digging wells, shark's teeth are often met with. In the cabinet of Major Delafield of New-York, are many fossils characteristic of this formation. Near Williamsburg, fifty miles from the Atlantic ocean, the skeleton of a large fish was discovered; amongst other parts, fragments of the ribs, and all the vertebræ were found regularly arranged.

In Italy and other countries, the same phenomenon has been observed, and a careful examination would establish the similarity of the strata in which they were found.

5. *Calcaire Ostrèe.*

Under this name, until its prototype is discovered in the old continent, or until its order in the succession of rocks is known, I propose to mention the most remarkable formation in the world, when we consider the almost *incredible* quantity *of fossil shells* which it contains.

In works upon Geology, when noticing the extent of banks of fossil shells which are known to be abundant in various parts of the world, that near Tours in France, has generally been considered as most extensive. It is a bank of shells nearly unchanged, nine leagues long and twenty feet thick, but in the Southern States of America the stratum of shells, which is now to be described, extends six hundred miles in length, from ten to one hundred miles in width, and if the known measurement in one part of the line may be supposed a fair criterion, three hundred feet in thickness. The principal part of the formation is composed of shells, and therefore may be hereafter classed as the largest collection of fossils in the world.

All my information respecting it is derived from Nath'l. A. Ware, Esq. member of the Academy of Natural Sciences, Philadelphia, who travelled over many parts of this formation, and paid great attention to its character. In Bartram's travels to the Southern States, the commencement of this stratum is mentioned, and the termination of it in the Chickasaw country is noticed by a writer in Silliman's Journal; but this is the first memoir which traces it through its whole extent, and the public are solely indebted to Major Ware for the account.

Character. It is a stratum of shells, in some situations united by a scanty calcareous cement, but from which the shells may be readily detached; in this state it is called by the inhabitants a soft limestone, which in the quarry is easily cut by any edge tools, but becomes harder on exposure to the air. In other parts it presents immense banks of loose shells, ten or fifteen miles in length, without the mixture of any foreign substance.

Fossils. This extensive formation is chiefly composed of a large species of ostrea, which I believe has not yet been described. A specimen of it may be seen in the Philadelphia museum; it is twelve inches long and two and three-quarters wide, and each valve from half to two and a quarter inches thick—Major Ware says they occur larger; on account of their great size I propose to call them Ostrea Gigantissima. The shells appear but slightly changed by their residence in the earth, and are in many parts used for burning into lime.

Mineral Contents. In some situations it contains large quantities of iron pyrites.

Springs. The water yielded by this formation is very unhealthy, and in many situations the scarcity of it presents a serious impediment to cultivation; in Alabama they have sunk in this stratum three hundred feet to find good water, but have not succeeded in penetrating through the limestone.

Geographical Extent. It commences at the Eutaw springs near Santee river in South Carolina, passes to Orangeburgh, and crosses the Savannah river fifteen miles below Augusta, occasionally disappearing under the sand.

It may then be traced to Burke County in Georgia, crosses the Ogeechee near Louisville; then near Sandersville, passing through Wilkinson County; it is then found at St. Mark's in Florida, where the tower and fort are built of this limestone. The basis of the land forming the north-east boundary of the Sea of Mexico, is composed of it; from thence to Alachua plains, crossing the Apalachacola, and proceeding in a north-west direction across the head of the Choctaw creek, it meets the Alabama river near Cahawba, where this formation expands, and forms a basin one hundred miles square, comprising the counties of Montgomery, Dallas, Wilcocks, Greene, Marengo, and part of Washington, in the State of Alabama. On many parts of the surface in these counties, there is a rich loam; but the limestone is so near the surface, and water so scarce and bad as to present many difficulties to the cultivator.

It then passes north-west, by Demopolis, a French settlement, to the Chickasaw country, where it terminates near the bluffs; in this situation, for many hundred square miles, the ground is white with the detached oyster shells, which have been bleached by exposure to the weather.

6. *Upper Marine Formation.*

In Europe one part of this is usually distinguished by large tracts of sands, which not only afford no return to the farmer, but rebel against his dominion, and destroy his improvements.

The sands of Norfolk, Pomerania, Ostend, Bayonne and Bordeaux belong to this formation. On the south-west coast of France, hills of sand advancing like an enemy upon the peaceful villagers, overwhelm houses, trees and forests in their irresistible progress, and many villages marked in the records of the middle ages, have been destroyed by it.

The same soil produces the same effect, though upon distant continents; and the upper marine sands of Virginia imitate upon a small scale the devastations committed by their brothers in Guienne.

At Cape Henry, the sands yearly advance, surround the cottages and light-house, overwhelm gradually a noble forest, and carry devastation in their train. The description applied by Latrobe to the advance of one of these sands, will apply most faithfully to the progress of the others; and the method adopted to subdue and fix the sands near Bayonne, and to save the houses and forests from the deluge of sand, might, we should suppose, be advantageously adopted in Virginia.

And that system of agriculture which has converted the barren sands of Norfolk into fertile and beautiful farms, might be introduced upon the same formations in America, making some allowance for difference of climate.

At Staten Island, the sand upon one part of the coast begins to overwhelm a grove of white cedar; and upon some of the hills of Brooklyn opposite New-York, I have observed the sand gradually carried forward by the wind, and the whole surface of the hill apparently changing its position.

7. *Diluvial.*

After the production of these regular strata of sand, clay, limestone, &c. came a terrible irruption of water from the north, or north-west, which in many places covered the preceding formations with diluvial gravel, and carried along with it those immense masses of granite, and the older rocks, which attest to the present day the destruction and ruin of a former world.

Many more instances might be adduced to establish the identity of what has been called the alluvial district in America, with the tertiary formations of England and the continent of Europe; but the object of the present memoir is merely to draw the attention of Geologists to the subject.

It is probable that upon an accurate investigation the country between the Alleghanies and the Atlantic will be found to consist of eight or ten distinct formations, agreeing precisely in their general character with the newer strata in England and France. The fossil shells from the various beds would not, perhaps, all be exactly like those of Europe, but a sufficient number would be found so, to establish their relation and order of succession. The fossil shells from many of these various strata, preserve their angles and sharp tender edges unbroken; the skeletons of fishes and animals which are found, are many of them entire: they must have heen deposited at the bottom of a tranquil ocean.

It may be said that a knowledge of these strata is of no use, but not only is it desirable to pursue science to its farthest bounds, but it will be found that a knowledge of these formations will be useful to the manufacturers of America, for in these strata are found materials necessary for the potter, glass-maker, builder, &c. They are the repositories for clay, sand, pyrites, ochre, fuller's earth, &c.; and when the boundaries of the various formations are accurately determined, it will be known where we can expect to find these different substances.

Geology will achieve a triumph in America, when the term alluvial shall be banished from her Geological Essays, or confined to its legitimate domain, and then her tertiary formations will be seen to coincide with those of Europe, and the formations of London, Paris and the Isle of Wight, will find kindred associations in Virginia, the Carolinas, Georgia, the Floridas, and Louisiana.

Art. III.—*Notice of a recently discovered copper mine on Lake Superior, with several other localities of minerals; by* H. R. Schoolcraft.

Sault Ste. Marie, July 29th, 1823.

Dear Sir.—I transmit to you, through the Secretary of War whose permission I solicit to have it published in the American Journal of Science, a copy of a letter which I have addressed to him, announcing the discovery of a vein of copper ore, upon the shore of lake Superior. I have taken some pains and been at some expence to investigate this subject, and to procure specimens of the ore. From all I can learn, the vein is a very large and rich one, running horizontally into the shore, and the ore is very easily detached. And I am disposed to think, from the specimens received, it will yield as great a per centum of metal, as similar ores (it is a Malachite) produce at the best European mines.

I am making up a small box of specimens for you, taken from this vicinity. In it you will receive pieces of the ore referred to. Unfortunately (for cabinets) it is a very crumbling vein, and the person I employed to visit it, not having any taste for such pursuits, handled the specimens without proper care, so that the richest pieces are reduced to fragments.

I annex a few localities of minerals, in the region of the lakes, more particularly of Michigan Territory, which have not, I believe, been heretofore noticed.

HENRY R. SCHOOLCRAFT.

Professor Silliman, New-Haven.

[Copy.]

(Communicated for this Journal by permission of the Hon. J. C. Calhoun, Secretary of War.)

Sault Ste. Marie, July 28th 1823.

Sir.—Having on a former occasion been requested to communicate such information as I possessed respecting the existence of copper upon the shores of lake Superior, I now take the liberty of transmitting to you, through the intervention of Governor Cass, specimens of an ore of that metal, which were taken from a vein recently discovered in the region referred to.

The precise locality of this ore, is, the extremity of the great peninsula of Keewiiweenon, which stretches from the southern shore of the lake towards *La Baie Noire*, and is distant about two hundred and twenty-five miles from this post. A deep bay washes the eastern side of this peninsula, which receives a river that has its source near the banks of the lake, and running at right angles with the point, nearly insulates it from the main land, forming a route of communication which is generally passed in light canoes. There is a portage of only two hundred and seventy-five rods from the source of this river, to the shore of the lake *west* of the point, and the distance saved by the route is commonly estimated to be ninety miles.

This is the channel pursued by the expedition through the upper lakes in 1820, and consequently we were precluded from making any personal observations upon the extremity of that point of land. Heavy barges, such as are usually employed by the fur traders, cannot, however, cross this portage, but are compelled to keep out in the open lake. In traversing around this peninsula, they must pass a small bay and point of rock known among the Canadian boatmen by the name of *La Roche Verte*, which is, in fact, the vein of copper ore, of which specimens are sent, where it juts out abruptly upon the lake.

The person whom I employed to procure these specimens left this place early in the month of May last, but having other pursuits likewise in view, did not return until within a short time. He reports, that the vein of ore is about one fathom in width, rising with a broken, hackly surface out of the water, and that it extends in a direct line from the lake into the interiour—its course being marked upon the bed of the lake by a broad green stripe reflected through the water, and upon the shore by parallel walls of the enclosing rock, which constitutes the matrix of the ore. He further represents that this peninsula rises into conical mountains of considerable elevation, and that the strata frequently show themselves in precipitous cliffs upon the water's edge. From the specimens of this formation which lie before me, and the best information I have been able to procure, I am led to conclude that the entire peninsula consists of a spine of granite, with sandstones, amygdaloid, and secondary trap deposited around its base. The soft, reddish brown, ferruginous rock, which exists in connexion with the ore, is probably allied to the former strata. No experiment has been made to determine the quality of the ore. It appears from external characters, to be the compact *Malachite* of authors which is stated generally to yield, at the mines of Cornwall and Saxony, from fifty-six to seventy per cent. of oxid of copper, the remainder being chiefly carbonic acid and water. It is consequently among the number of the ores of this metal that are most profitably wrought in the large way. Should you entertain a wish to place a portion of the ore transmitted in the hands of a chemist for the purpose of analysis, I take the liberty to suggest that the envelope containing the *small granulated masses*, would probably afford the fairest test.

It may be pertinent to add to the foregoing remarks, that I have succeeded in the course of the present season, in procuring from lake Superior, a mass of native copper weighing forty-two pounds, which is very pure and malleable, and contains small points of native silver! This mass is from the waters of the Ontonnägon, but it is no part of the great mass formerly described.

HENRY R. SCHOOLCRAFT.

U. S. Indian Agent, resident at St. Mary's.

Hon. John C. Calhoun Secretary of War.

Localities of Minerals.

Sulphate of Strontian.—Presque Isle, on the Maumee river, Wood County, Ohio. This locality is the site of Wayne's celebrated victory over the confederated Indians in 1794. The Maumee river here washes a rocky shore, surmounted by a grove of oaks, with an extensive prairie back of it. The crystals of Strontian are plentifully imbedded in the rocky bank of the river, which is a compact limestone, similar, in its characters, to that which pervades the shores of lake Erie. It is about 40 miles south of the noted locality of this mineral upon "Strontian Island," and indicates how extensively this substance is distributed through that section of country. There is nothing peculiar in the forms of the crystals found at this place, or other characters, unless it is a tendency in the colour of all the specimens observed, to assume a full sky blue. Some of these crystals contain *other* crystals of calcareous spar imbedded. I first visited this locality in July, 1821. I have also in my posession a nodular mass of limestone from the north shore of lake Huron, having impressions of the madrepore upon its surface, which, on being broken upon one end, disclosed *radiated* crystals of Sulphate of strontian, in connexion with, and shooting into, limpid masses of foliated gypsum. This mass is about 9 inches in diameter, and the limestone merely forms a crust around the aggregated mass of crystals.

Calcareous Spar.—*Roche de Bout*, on the Maumee river, Wood County, Ohio. Imbedded in limestone, and exhibiting its most common forms of crystalization. Frequently in perfect dodecaedrons of a light yellow hue. Also, massive and translucent, of a honey yellow colour, forming the *cement* of a beautiful variety of puddingstone, on the right bank of the Wabash, 5 leagues above the junction of the Tippecanoe river, Indiana.

Calcareous Tufa.—On the *left* bank of the Wabash, directly opposite the preceding. On reaching this part of the river, the traveller who descends by water, after passing a sudden bend of the river, observes, on his right, a level prairie with a small Indian village upon its margin, and upon his *left*, a long line of dark grey cliffs, with a precipitous front upon the river, and covered with forest trees of a small and recent growth. These cliffs are a calcareous tufa, more or less spongy or vesicular in their structure, and imbed, plentifully, fragments of shells, stems of vegetables, leaves, and other remains. The external surface is somewhat blackened, by the weather, but the fresh fracture discloses a light grey, yellowish grey, or greyish white colour. This is probably the newest rock formation between the Ohio and the Mississippi rivers! How extensive it is, cannot be stated. It disappears, or is hid below alluvial soil, as we approach the mouth of the Tippecanoe.

Fibrous Gypsum.—Neekimenis,* or Goose Island, lake Huron, Michigan Territory. This small island is situated nine miles distant from Michilimackinac, on the route to the *Sault* of St. Mary. The gypsum is imbedded in a kind of loamy clay, which forms a pretty extensive flat, upon the south-eastern end of the island, which has so little elevation above the water, that it is partially inundated during the prevalence of certain winds. The masses are detached. Sometimes the fibres are 4 or 5 inches long, and possess a pearly white colour. Where exposed to the air, they are somewhat decayed, and broken down. This gypsum is associated with a gray granular variety, imbedding small

*The name which the Aborigines apply to it.

crystals of brown, or yellowish-brown foliated gypsum, variously grouped.

Compact Gypsum.—At Sandusky Bay, Ohio. This gypsum forms a continuous stratum extending horizontally, from the flat shore of the lake, near the Light House, into the bed of lake Erie. It is situated so low as to be entirely covered by the water during the prevalence of easterly winds. It is of a uniform white colour, with a fine close grain, and its surface presents very minute glimmering folia. It yields easily to the knife, or can be turned in a lathe, and is sometimes so compact and hard as to take a polish. These varieties may be considered *a gypseous alabaster.* Some attempts have been made to convert this material into inkstands, and other utensils. It has also been ground for agricultural purposes, and if found to answer expectation, may become an article in the commerce of the Lake.

Smoky Quartz.—At point Keewiiweenon,* Lake Superior, M. T. In a crystaline mass, associated with amethyst. This mass separates with a blow of the hammer, falling into innumerable translucent, dull crystals deeply striated across the lateral planes, and sometimes terminated by smooth six sided pyramids. The colour is not equally intense, but often appears in clouds, and is sometimes intermingled with the violet hue of the amethyst.

Amethyst.—With the preceding. Its colour passes from violet to purple, and is seldom uniformly diffused. It is intimately connected with the preceding variety, and the colours so mingled, in some pieces, as to make it difficult to determine to which subspecies they ought to be referred. I say *subspecies*, because, it would seem, from this connexion, that the former is entitled to that destinction as well as the latter !

Greasy Quartz.—At the *Sault de Ste. Marie*, County of Michilimackinac, Mich. Ter. In detached fragments, white, opaque, laminated, and possessing the peculiar *fatty* lustre.

Milky Quartz.—With the preceding. Neither of these varieties has been traced in situ. I suppose them to belong to the primitive ranges along the north shores of lake Superior.

*Called *Keweena* in my Nar. Jour. and upon the maps of Sir Alex. Makenzie. The above pronunciation is taken from the Chippewa Indians who inhabit the country. The double vowels are calculated to convey their *long* sounds.

Chalcedony.—At Point Keewiiweenon, Lake Superior. Imbedded in Amygdaloid, in globular masses from the size of an ounce ball to that of a hen's egg. Also, very plentifully, along the shore, more or less abraded.

Agate.—With the preceding. Imbedded, or detached. All the specimens which I have obtained from this place are onyx agates, consisting of parallel stripes of variously coloured chalcedony, jasper, hornstone or quartz. They vary in size from small nodules, to that of a 32 pound shot. When broken from the rock they present a uniform dull brick red surface, which is worn off from the masses that lie along the shore. I possess the fragments of a single specimen, that was probably 5 inches in diameter, in which the outer layer, which is $\frac{4}{10}$ths of an inch broad, is a light violet coloured *amethyst.*

Mica.—This substance is so generally wanting in the granitic rocks of this region, that I had doubted whether we possessed any true granite in this part of the continent. It exists, however, in the granite of the Porcupine mountains of lake Superior, in large folia, of a silvery and somewhat pearly hue. The specimens brought to me from those mountains, in the course of this season, are connected with a high flesh coloured feldspar, and small masses of common quartz ; and are quite conclusive as to the *primitive* composition of those mountains.

Clay stone.—On the banks of the river St. Mary's, near the *Sault,* or Falls of St. Mary, Mich. Ter. It occurs in detached rounded or elongated masses in a kind of clay which is employed for bricks, or it is sometimes found in loose masses along the banks of the river. It assumes various imitative forms. H. R. S.

July, 1823.

ART. IV.—*Localities of minerals, communicated by Dr.* WILLIAM MEADE.

Philadelphia, April 9, 1823.

SIR,

Having made an extensive tour last Summer to the Eastward, particularly in the States of Connecticut and Massachusetts, I had an opportunity of examining the Mineralogy of some districts which have hitherto escaped notice. If the observations which I have drawn up on this subject are sufficiently interesting to deserve a place in your Journal, they are much at your service.

Yours very respectfully,
WM. MEADE.

Prof. Silliman.

On visiting Worcester, Massachusetts, I met with a Specimen in the Cabinet of William Lincoln, jun. Esq. which attracted my notice. This promising Mineralogist was polite enough to accompany me to the place where it was obtained, and where I procured sufficient to ascertain that it was Vesuvian or Idocrase of Haüy. The Character of it is as follows.

It occurs in Groupes and in Cavities, seldom imbedded, massive or crystalized; form, a short rectangular four sided Prism, more or less truncated on the lateral edges so that some of the crystals are distinctly eight sided. The terminations are planes; the sides of the crystals are generally deeply striated so as to resemble the Egerine of Werner. Colour brown, lustre brilliant, translucid, some of the crystals are imperfectly transparent, about the hardness of quartz, easily fusible with intumescence into a transparent glass. It is accompanied by small pale green crystals of pyroxene, and beautiful small garnets of a wine yellow colour, crystalized in rhomboidal dodecahedrons. The matrix of all these appears to be a compound rock containing a mixture of massive Garnet, Pyroxene, and Idocrase. The Cavities are lined with Calcareous Spar in which the crystals of Idocrase of about one fourth of an inch in length appear to be set; by submitting the Carbonate of Lime to the action of dilute Nitric acid, beautiful and distinct Crystals of Idocrase and of Garnet can be obtained.

From the above description I think there can be no hesitation in calling this mineral Idocrase. It is found in abundance in the neighbourhood of Worcester in a primitive rock, but the best specimens are obtained from the stone walls where the crystals are very distinct, in consequence of the weakened state of the stone, which exposes the cavities and leaves the crystals unaltered; this is very much the case with respect to other minerals particularly the Macle or Chiastolite of Stirling and the staurotide at Northampton and Winthrop, where fine Crystals can only be procured by long exposure of the Matrix to the action of the Atmosphere.

Though Vesuvian or Idocrase is generally found in Volcanic Rocks and has been at one time supposed to be peculiar to them, yet it is now well ascertained that it occurs in primitive Rocks also in Norway, Piedmont, and other places. There can be no question with respect to the primitive formation in which these specimens are found near Worcester, but as I believe it is the first instance where it has been observed in this Country it is worth notice. A mineral of a green colour has been observed at Franklin near Sparta, which some Mineralogists here have called Idocrase; it will however, I suspect, be found to be epidote: neither its crystalization or chymical character identify it with idocrase; it is nearly infusible by the blowpipe, and can only be reduced by an intense heat to a black scoria: this is an essential distinction, as nothing can be more characteristic of idocrase than its easy fusibility with intumescence into a clear glass; indeed Mr. Nuttall in his admirable memoir on the mineralogy of Sparta, the first which has appeared on the subject, takes notice of this but calls it epidote though resembling Idocrase.

Proceeding from Worcester towards Boston I was induced to deviate from the direct road in order to visit Stirling where the chiastolite or macle is found in such abundance. This is perhaps one of the most interesting localities for this curious mineral that has been as yet known, few places afford it in such abundance or in such various forms of crystalization. That which is the most common is described in Cleaveland and the figure 31 plate 4 is a good specimen of it, but the varieties which it assumes would require a much more particular description, as they do not appear to be sufficiently noticed.

The crystals which are some inches in length, are imbedded in a dark bluish argillite, and would escape notice, except where the terminations of them appear on the surface where the schist has been weathered. It is only by dividing the slate across its natural fracture or cleavage that the real structure of the Prism can be demonstrated. When a transverse section of the schist is thus made and the surface polished many varieties of crystalization may be exposed to view.

Within about eight miles of Stirling on the Boston road in the town of Bolton a very remarkable limestone quarry has been worked for some years, chiefly for the purpose of making lime for which it is well qualified; it is little noticed as it lies off the road and is very limited in its extent shewing itself only on the surface of a ledge occupying a few acres of land; it is a large grained white marble similar to that of Kingsbridge and New Milford, imbedded in gneiss and appears to be connected with that extensive deposit of granular limestone which accompanies the primitive formation from the Hudson through the Western parts of the New-England States to Canada. Wherever this deposit of primitive limestone has been examined it assumes nearly the same character and is accompanied by the same class of minerals more or less interesting from their variety.

At Bolton the first mineral which attracted my attention was augite, pyroxene of Haüy, it occurs sometimes in single crystals half an inch long imbedded in the granular limestone which so loosely invests them that the crystals fall out when the stone is broken: frequently however these crystals are observed in considerable groups firmly set on one end in particular, the other end of which is always terminated and can be easily examined. These crystals which are from a very minute size to that of half an inch long, are in the form of four sided prisms truncated on their lateral edges, and terminated by four sided summits whose faces correspond with the alternate lateral edges. Colour dark green on the surface though sometimes nearly white in the centre; when the crystals are small they are of a lighter green and translucid: it is fused with difficulty by the blowpipe into a brown scoria. Some of the crystals have a very interesting appearance, they are dark brown of an oily lustre, and have a bronze surface somewhat *chatoyant* so as to resemble extremely the description given of the elaolite or fettstein, which as far as I know has not as yet been observed crystalized : however as Haüy considers both scapolite and elaolite as only varieties of pyroxene, I see no reason why this mineral should not be so distinguished, though I will not take it upon me to assert it without farther observation.—Associated with these minerals I have also noticed the titane siliceo-calcaire or sphene; it occurs disseminated in the granular limestone in irregular grains as well as beautifully crystalized; the form of the crystals are rhomboidal prisms with diedral summits similar to those which are found accompanying the pyroxene both at Ticonderoga and at Sparta, but the colour is darker being a clove brown with a fine metallic lustre.— Fine specimens of tremolite are also found here intimately mixed with the carbonat of lime; it is in large and distinct crystals, structure foliated, of a pearl white colour and silky lustre, highly phosphorescent either by heat or friction.

Intersecting the limestone at Bolton lie beds of white quartz as at Kingsbridge: imbedded in this quartz rock fine specimens of scapolite are to be found; it occurs massive constituting a considerable part of the rock, in distinct concretions, and crystalized ; colour pearl white, the crystals are generally opaque but sometimes translucent, their form a four sided prism, the two lateral edges of which are inclined at angles of 93, and the other two at angles of 87, the lateral edges are generally truncated by planes which form with the corresponding sides of the prism angles of 133, fracture foliated, cross fracture fine grained, and uneven, sufficiently hard to scratch glass, easily frangible, phosphoresces slightly on hot coals, fuses before the blowpipe with intumescence into a white enamel, some of the crystals are from one to two inches in length, and half an inch in diameter, they are slightly streaked longitudinally, and have been at first sight mistaken for white beryl, but their crystaline form has on examination no resemblance, indeed the character of scapolite is strongly marked in the appearance of many of the specimens which consist of groupes of acicular crystals aggregated into thick fasciculi composed of parallel or diverging fibres. The crystals are imbedded in a friable vitreous quartz, and can be easily dissected from their matrix in which they are rather loosely invested ; by this means groupes of large and distinct crystals can be obtained. It does not appear that there is much difference between scapolite and augite either in their chymical characters or crystaline form; indeed Haüy considers scapolite and elaolite as only varieties of pyroxene: the most distinguishing character that I perceive is, that scapolite is ealy fusible into a white enamel, while the augite is very infusible before the blowpipe; this shows a striking difference between what is called the white pyroxene of Kingsbridge and the common augite, as the Kingsbridge augite is as fusible as the scapolite of Bolton, which would rather induce us to place this variety of pyroxene with the scapolites which in many other respects it resembles.

Before I conclude it may not be quite uninteresting to inform you that while on a visit to Chesterfield, Massachusetts, I had an opportunity of seeing a fine specimen of the siliceous oxyd of manganese, which was obtained in that neighbourhood, but the precise locality I was unable to ascertain, owing to an inadvertence of my companion in having prematurely given an opinion of its value. I however obtained a few specimens from the mass which was shown me, which I shall describe as follows ; it is of a bright rose red colour, and translucid, particularly at the edges, with some lustre, structure rather granular, found in compact masses accompanied with the gray oxyd, hard, scratches glass, takes a fine polish and in this state constitutes a beautiful mineral which is rather rare, found only in Sweden and in England, it is so exactly similar to specimens which I have from Devonshire that it is impossible to distinguish the difference. W. M.

Art. V.—*Miscellaneous Localities of Minerals.*

Notice of Fluor Spar by Thomas H. Webb.

" Since writing you, I have had the pleasure of being able to trace out the new locality of *Fluor*.* It is situated in Cumberland, about one mile beyond Diamond Hill, on the direct road to Wrentham. It is found at a number of different places. At one it is imbedded in a vein of quartz traversing a granitic or sienitic rock, and at another it is found with quartz loose in the ground. The colours of the specimens which I obtained are purple, blue of various shades, from pale to indigo, blue with a tinge of green, and white. They all, (with the exception of the white,) appear of a beautiful purple when viewed by candle light."

* For another locality of *Fluor*, in Sekonk, Mass. communicated by Mr. Webb, See Jour. Sci. v. iv, p. 53.

New Localities of Tourmalines and Talc.—Extract from a letter to the Editor.

The tourmalines are from Paxton, Mass. where they occur in a granitic rock, particularly amongst the quartz, and are so thickly imbedded in it, as to alter considerably the appearance of the rock. They are regularly formed double acuminated crystals, of a jet black colour. The largest perfect ones that were brought, are about three fourths of an inch in length ; from this they are of all sizes downwards to that of nearly the smallest grain, but still are regularwell defined crystals, as may be easily ascertained by the aid of a magnifying glass.

The talc differs from any that I have ever heard mentioned or seen described. This singular variety is from near Worcester, Mass. The mass has a brownish cast and is composed of two parts. The one is compact, of a dirty white and yellowish colour, constituting the base ; the other is in thin plates of a yellowish and blackish cast, and resembles mica very much in appearance. It exhales an argillaceous odour upon being moistened. When pulverized it seems to consist of a yellowish powder interspersed with small shining laminæ. If subjected to the flame of a blowpipe, or that of a common lamp, it expands and shoots out into a variety of fanciful forms, resembling most generally small *worms* having the *vermicular motion exact.* It sometimes expands with such force as to be thrown some distance. These vermiform remnants are composed of small irregular scales, loosely adhering to each other, having a silvery white appearance and metallic lustre.

If this proves to be a new variety, would it not be better in giving it a distinctive appellation to select one that will indicate the peculiar property it possesses, than to make use of an arbitrary name. I term it Vermiculite (worm breeder) from Vermiculor, to breed or produce worms.

THOMAS H. WEBB."

Coal, Gypsum and Barytes, by Horatio N. Fenn, M. D. Geneseo, N. Y.

Small specimens of *Coal,* collected about eight miles from Geneseo. The vein from which they were taken is about six inches in width and half an inch thick. It is situated in the face of a cliff fifty feet in height—composed of a dark coloured, calcareous slate, which by friction emits a fœtid odour. This cliff forms the boundary of a narrow valley or Glen, through which flows a brook, bearing the Indian name of Quisequagh. A considerable residuum is left behind, after burning; "but I think it the best *bituminous coal* I have seen in this part of the State."

Foliated gypsum of a rose colour. Several specimens were found below the falls at Rochester, one of which is very beautiful. It is composed of a bivalve shell, resembling that of the common *round clam,* the inside of which is completely filled with sulphate of Lime of a beautiful rose red.

Nodular Sulphate of Barytes, from the bed of the Genesee river, a few miles below Rochester. The Nodules are embedded in red sandstone, and externally have the general appearance of agates.

Sulphur in Granite.

Extract of a letter from Mr. Robert Mair, *dated*

Stamford, (Con.) Aug. 25, 1823.

"A few days since, a stone of a curious nature, nearly the size of a bushel, was broken to pieces. I procured a few specimens, which I send you. The minuter fragments were taken from the center of the stone; the larger shew the outward appearance.

The people in the vicinity imagine it fell from a thunder cloud. The hill on which it was found they have already named *Brimstone Hill.*"

Note. The specimens above alluded to are granite, inclosing sulphur. As far as can be judged from them, the stone was originally a small *bowlder* of granite, inclosing a collection *(geode)* of crystals of *iron pyrites.* The granite is fine grained, with but little mica, except in some veins, which seem almost completely formed of it—feldspar white, quartz limpid, with a bluish tint. Part of the granite retains its original colours, but the greater part is deeply stained brown and yellow, with oxide of iron. Some points of it are of a beautiful pink colour, as if stained with manganese. The minuter fragments consist of the quartz and felspar, covered with delicate incrustations of minute crystals of sulphur, having the appearance of *sublimated sulphur.* The sulphur is sometimes pale yellow, but has mostly a greenish tinge—much of the sulphur came to hand in the state of powder full of crystals of *iron pyrites*, from the size of a pea down to the minutest grains. The explanation of this appearance seems easy—the centre of the granite probably formed a geode, lined or filled with *pyrites.* By a spontaneous decomposition, attended with the extrication of heat, the sulphur was sublimated, and the iron converted into oxide has stained the stone.

This apparently unimportant fact may have no little weight in settling the question of the origin of volcanoes. It may have been only on a very small scale, what Ætna is in the large way. J. G. P.

Localities of Minerals near West-Point, from Dr. Cutbush.

Sulphuret of Molybdenum, in granite and gneiss, West-Point, and Constitution Island, opposite the Point.

Kaolin, from decomposed feldspar, accompanying quartz. West-Point.

Tremolite, glassy and fibrous, or asbestiform, in sienite. West-Point.

Schorl in granite. West-Point.

Adularia in granite rock. West-Point.

Coccolite, Fort Putnam, West-Point, in blocks. This mineral I observed nearly two years since.

Garnets, common in gneiss, and imbedded in mica slate. West-Point.

Precious Serpentine, Putnam County. This is remarkably elegant. The locality was first observed by Captain Douglass.

Glassy Actynolite. Vicinity of West-Point.

Magnetic iron ore. Constitution Island.

Epidote. West-Point.

Siliceous schistus and *Lydian stone.* West-Point.

Diallage, more or less metalloidal. West-Point.

Ferruginous sand, and some specimens resembling decomposed *greywacke*, containing organic remains, such as the chamite, cochlite, gryphite, musculite, ostracite, pectinite, terebratulite; and about four miles from here, towards Newburg, where the secondary formation commences, we find orthoceratites imbedded in *greywacke.* The former, containing organic remains, has been found a few feet below the surface of the level of West-Point.

Localities of Minerals, by Dr. Jacob Porter.

Radiated Zeolite, at Livingston, New-Jersey.

Red Oxide of Titanium, at Cummington, Massachusetts.

Sulphuret of Molybdena, at Chesterfield, Massachusetts.

Localities of Minerals, by Prof. F. Hall, *Middlebury, Vt.*

Ammonite, or Cornu Ammonis, on the surface of secondary limestone, in several places, in the vicinity of the fortifications on Crownpoint, N. Y. They are from half an inch to two inches in diameter; are very frangible, and cannot be detached, entire, from the rocks, without a mallet and chisel.

Massive Garnet, containing magnetic oxide of iron, crystalized in regalar octaedrons, which are about the size of a large pea, and of a brilliant, steel gray colour. Chester, Vt.

Red Sandstone, between the village of St. Albans and lake Champlain, where are extensive quarries of it. It is used by the inhabitants of St. Albans as a building stone.

Steatite, of a very excellent quality, Fletcher, Vt.

Epidote, crystalized and massive, Middlebury, Vt.

The crystals are small, of a light green colour, and striated.

Epidote, filling cavities in a stone, which appears to be quartzeous.

In some instances, the Epidote forms only the lining of the cavity, leaving a smaller cavity in the Epidote itself.—This Epidote is all amorphous, and of a lamellar structure.

Epidote, massive and in crystals, Chester, Vt. This is connected with hornblende, some parts of which are in very beautiful crystals, grouped together in a form resembling a sheaf of wheat.

Hornblende Slate, on the turnpike road, one mile south of Proctorsville, Cavendish, Vt.

Marble, wrought at Swanton, Vt. of two kinds. The one is black, and is brought principally from Missisque Bay, within the Canadian territory. The other, which is dove-coloured, occurs about one mile south of Swanton village; in which village is a large establishment for sawing and polishing this substance. Both kinds are susceptible of an excellent polish, and are manufactured into tombstones, chimney-pieces, window-caps, &c. &c.; and the marble is transported, for sale, to Montreal, Quebec, Boston, New-York, and various other places.

Greasy Quartz, Mount-Holly, Georgia; Middlebury, and Chester, Vt.

Favosite, Champlain, N. Y.

Fluate of Lime, a few rods below the bridge, Bellows-Falls. Also one mile N. W. of the Falls. It is green, not crystalized, in quartz. Rock crystal is very abundant in the same locality. The Fluate of Lime, at this place, was discovered by Mr. Hezekiah M. Wells.

ART. VI.—*Account of the Roxbury Rocking Stone, extracted from letters to the Editor by* J. PORTER, H. U. Cambridge, and T. H. WEBB, Providence, R. I.

This moveable rock is situated in Roxbury, Mass. about one mile, nearly south from Dr. Porter's Meeting-House, and about three fourths of a mile east of the Dedham turnpike; about one and an half mile south of the Boston line, and about five miles from Cambridge. It is easy of access, and stands with a majestic aspect, on an eminence in an open field; but it is not seen from the street, which passes within a few rods, on account of intervening trees. It is composed of the Greywacke, or Puddingstone, so predominant in that region. It rests on two points, on a large rock of the same kind *in situ*, whose gently rounded top rises eight to sixteen feet from the earth in which it is imbedded. It is oblong and very irregular, but resembles an egg in its general outline. Upon the north eastern side the lower part bears some resemblance to a shoe.

Mr. W. observes, " the lower side, on the East, is arched from the middle to the northern end, where in descending it terminates in a short rounded projection, upon which this end is supported, as may be seen in the N. E view :* from the middle to the southern end, it is nearly upon a straight line; the point upon which this end rests is not so evident as the other. It is marked by the letter A in the N. E. view. The average elevation from the lower rock, on the east, is about an inch and a half. On the west the lower side is gradually elevated from the northern to the southern end, where it is raised a foot and a half from the supporting rock. On the western side of the northern end the weightiest part is at the bottom, but on the eastern side at the top."

By a line drawn around it, from end to end, Mr. P. found its largest circumference to be thirty seven feet and four inches; its smallest twenty feet and eight inches. From its irregularity, he could not obtain its cubic dimensions with accuracy; but concluded that it was equal to a regular solid of fifteen feet in length, six in breadth, and six in thickness; equivalent to five hundred and forty cubic feet. A small stone of a regular form composed of the same ingredients as the moveable stone, and containing by admeasurement thirty six cubic inches, he found to weigh four pounds; which is at the rate of one hundred and ninety two pounds the cubic foot. Consequently, the weight of the rocking stone is one hundred and three thousand, six hundred and eighty pounds, or forty six tons and upwards. A child six years of age can easily move it with one hand, and any adult person with a single finger; indeed Mr. P. could move it very perceptibly with the little finger without much exertion. Mr. W. represents its motion more difficult. " By using some exertion and pushing forcibly against the northern end, it may be made to rock a foot or more. It is not attended by any noise, and the friction is so very little, a person would not know that it was moving, unless he kept his eye fixed upon it." While in motion it has a terrifying appearance to the bystander, and seems ready to tumble and crush him to atoms.

When set in motion, it vibrates nearly a minute before it becomes poised in its accustomed situation. I have no doubt, says Mr. P. that it is agitated by every strong wind,

* See Plate I. Fig. 4.

though I know not that any one has been present in boisterous weather to observe it. Near it, is a fragment of stone of the same composition, weighing eight or ten tons, which, doubtless, at some distant period, has fallen from one end of it; for one of its faces exactly corresponds to a face exhibited by the moveable stone, and the latter has a seam in it which may hereafter occasion it to lose another portion.

Last year, when Mr. P. saw it, there were lying about it, props and levers, which were evidently the instruments of some persons, who had tried in vain to overturn it. Fortunately, there is a projection on each side at the bottom, which will sustain it in its upright position, unless a force be applied sufficient to raise about twenty tons of its weight. No commanding position can be selected so as to see the two points upon which it is poised, on account of the irregularities upon the surface of the lower rock, which obstruct the view.

This rock has been noticed in the neighbourhood for at least six years, but although in an open field, in the immediate vicinity of Boston and Cambridge, it has hitherto attracted very little attention among the lovers of curiosities. No account of it has been hitherto published, as far as our information extends.

"These rocks," Mr. W. observes, "are not so rare as has been generally supposed. There was formerly one upon the Salem turnpike road, which was so nicely poised, that a child might move it. There are three at different places in the vicinity of Providence, all still moveable; also one in Framingham, Mass. that was a few years since, and probably still is moveable, and one in Foster, R. I. about twenty two miles from Providence."

BOTANY.

Art. VII.—*Notice of four new species collected in Alabama; by* M. C. Leavenworth.

Acacia Lutea—Inermis, glabra. Foliis bipinnatis; Partialibus numerosissimis, lineari-oblongis. Spicis subglobosis, solitariis. Pedunculis axillaribus, longissimis. Legumine magno, obovato.

This plant is found in company with the A Glandulosa in the prairies* of Green county, Alabama. In habit it considerably resembles the Schrankia Uncinata, for which it might be mistaken by a superficial observer, when not in flower; flowers golden yellow; stamens, longer than the corolla, ten in number; peduncles about an inch and a half in length; first found in August, probably in flower also in the month of July.

Malva Triangulata.—Hirsuta, subdecumbens. Foliis, inferioribus triangulari-cordatis; superioribus 3-ad 5-lobatis, irregulari-dentatis. Floribus racemosis.

This plant is found in Montgomery county, Alabama. a foot or more in height, somewhat pubescent. Flowers purple, handsome; found in July. This may be the M. Triloba of Nuttal, of which I have not seen any description. It is however probably a different species.

Dentaria Dissecta.—Glabra, erecta. Caule, foliis duobusmultifidis; laciniis linearibus: floribus racemosis.

Flowers in March; about four or five inches in height, slender. Leaves many parted; segments three fourths of an inch in length, perfectly linear. Flowers in long slender racemes which are somewhat secund; flowers of a middle size, purplish; found in the Cherokee country.

Silene Axillaris.—Viscosa, pubescens. Caule ramoso. Foliis ovalibus, subdentatis, petiolatis. Floribus sessilibus, solitariis, axillaribus.

Found in the prairies of Green county Alabama, August. In general habit considerably resembling the Cuphea About eight inches in height, stem much branched, leaves ovate acute at the base, flowers purple.

* The prairies of Alabama rest on a soft limestone rock abounding in shells noticed in Mr. Finch's memoir (Pa. 41) as an extensive expansion of his formation of *Calcaire Ostrèe.* Their surface is rolling, soil deep black, very adhesive when wet, covered with luxuriant grasses, and in the proper season, with a profusion of gay flowers. There is wood enough on the prairies to fence them. It is arranged in lines and clumps on the lower and moister portions, dividing them into open spaces of several hundred acres. The soil is of variable depth and rests on a uniform bed of limestone. In some places the rock juts out on the surface, where it easily decomposes. There is a great deficiency of water, particularly in dry seasons, and what there is of it, is very bad. The limestone rock has not been perforated even at the depth of three hundred feet.

Cardamine Uniflora.—Well described by Pursh and Mich. Omitted by Nuttal, probably as doubtful, or perhaps inadvertently. Found in the rocky Prairies of Jefferson County, Alabama, in March.

ZOOLOGY.

HERPETOLOGY.

Art. VIII.—*Observations on several Reptiles of North-America, which seem to belong to the family of Proteus. In a letter from* Samuel L. Mitchill, M. D. *Professor of Botany and Materia Medica in the University of New-York, &c. to Charles de Schreibers counsellor to his majesty Francis Emperor of Austria, and director of the Imperial Museum of natural history, &c.; dated New-York, June* 7, 1823.

(Read before the New-York Lyceum, June 9, 1823.)

Sir,

I have long ago acknowledged the receipt of your letter from Vienna, of 17th September, 1821, by the hand of the consul Baron Von Lœderer, with the specimen and description of the *proteus anguinus* from Carniola, you obligingly sent.

Some time before, I had been invited to examine an animal from Lake Erie, which seemed to be a species of the same genus. The account I wrote of it, was read to the lyceum of natural history, on the 8th October, 1821, and afterwards printed in the American Journal of Science and Arts, vol. 4. p. 181-3. To avoid prolixity I now refer to that paper, for information I do not wish, at present, to repeat.

The creature I mean, is that which the white fishermen have called by the vulgar name of *Hell-bender*, and the Indians *Tweeg*. It is surely aquatic; but can live, it is said, twenty-four hours out of the water. Feeds upon univalve molluscas; for on dissecting one of them, I found several individuals of the lymnæa heterostropha in the mouth. Within the mouth too was a crustaceous inhabitant, of the oniscus family, a cymothoa with fourteen hooked feet, and a pair of antennæ. Often takes the bait employed to allure the silures and other fishes, and is catched by the hook. One of those I possessed was taken in this way. Swims or creeps with a slow and serpentine motion along the bottom, in which he is assisted very much by his broad, compressed and vertical tail. Acquires the length of from 12 to 18 inches, or even more. Is often killed by the gig and spear. Though the flesh is white and resembles that of the cat fish and eel, it is never eaten, there being a strong prejudice against it. Under an unfounded opinion that the creature is venomous, it is beheld with a sort of abhorrence, and thrown away. The general appearance is thick, chubby and clumsy.

Skin slimy, spotted and scaleless. The spots during life resembling those of the brook trout or salmo fontinalis. The mouth armed with two sets of pointed and somewhat curved teeth in the upper jaw, and with one set of similar sharp, uniform and pointed instruments in the lower. Tail surrounded by a skinny film or rim, but without the rays which distinguish the caudal and other fins of fish.

Four legs, each ending in four toes without claws.

Three tufts or bunches, appearing to be gills or branchiæ on each side of the neck, supported by the three branchial arches, between which there are two openings or slits, apparently for the transmission of water. These seem to be respiratory organs; and as far as the habits and manners of the creature are known, endure through life.

Two air-sacs, reaching longitudinally from the pharynx or throat, toward the vent, one on each side of the vertebral column; of such a constitution that they may be considered as auxiliary organs of respiration, or as air-bags resembling the vesica natatoria in fishes.

A persistent tail, flattened laterally, resembling in figure the temporary tails of the tadpoles, or *gyrini* of frogs, and the permanent ones of the Water-Salamanders.

With all these peculiarities of structure, I observed further that the eyes were small, destitute of lids and covered by the common integuments. Instructed by your communications, and warranted by the near analogy which I thought I perceived between my animal and yours, I ventured to introduce my new acquaintance to the public as a Proteus.

But there were difficulties in the execution of my wish to procure his reception under that title. Other animals of the same family, and supposed to belong to the same species had been observed by several of my friends. Certain of these gentlemen entertained ideas of classification different from mine. Their sentiments on this point merited due regard. Under these circumstances, I felt myself both willing and able to attempt a methodical distribution of these animals which had caused so much perplexity, and embarrassment to zoologists.

Guided by a presumption that all the individuals of the *hell-bender race* belonged to one and the same species, it has been represented that he was a TRITON.

Now, you know, that the *Triton* has been latterly discontinued as a genus; by reason of its being considered as merely the larva of the Water-Salamander. That name, if I recollect right was first introduced into zoology by Joseph Nicolas Laurenti, in his *Synopsis Reptilium*, p. 37. He defines the Triton as having " a body equal, cylindrically round, somewhat verrucose, and scaleless ; tail compressed and lance-shaped ; elegantly active in water." He enumerates eleven species.

De la Cepede in his valuable history of oviparous quadrupeds and serpents, vol. 2. p. 211, et seq. treats of Salamanders with flat tails, otherwise known as newts and water or marsh lizards. He affirms the females of this section to be so different from the males as to have been regarded a distinct species, both by Linnæus and Gronovius. And Petiver appears to have been deceived by the varieties of colour and form in the females themselves, whereby some of them were mistaken for males. He does not admit the Mexican reptile, called *Axolotl*, to be any thing more than a water Salamander. Triton and Proteus are not found in his synoptical table.

The genus, however, is retained, you know, by Dumeril in his *Zoologie Analytique*, p. 94—5. Triton embraces according to him all the species of water Salamanders. He says " they lay eggs and live in the water, at least until the time of their fecundation. The species seem to be very numerous; of which few have been described. They have been distributed under several heads; such as, 1. those having the toes of the hind feet intirely free and without membranes; 2. those having the toes furnished with separate or lobed membranes; and 3. such as have all the toes united by a single membrane, or are palmated."

The very animal before me, which has prompted this inquiry, has been called a *Salamander*. The late Professor B. S. Barton, mentions him distinctly, in the second volume p. 196 of his Medical and Physical Journal, published about the year 1806, as a Salamander. As the species of this genus are small reptiles, seldom exceeding five or six inches in length, he proposed to call him Salamandra *maxima*, or S. *gigantea*, the huge or gigantic S.; or from the dread entertained of him by the fishermen, S. *Horrida*. Cuvier has placed him accordingly, on this authority, among the Tritons or Water Salamanders, in his *Regne Animal*, vol. 2, p. 101.

The character given of Salamanders by this eminent naturalist, is "that they have a lengthened body, four feet and a long tail, giving them the general form of lizards; on which account Linnæus left them in that genus. But they have all the characters of Batracians. Their head is flattened. The ear entirely hidden under the flesh without a tympanum, but merely a small cartilaginous scale over the fenestra ovalis; both jaws armed with numerous and small teeth; two longitudinal rows of similar teeth around the palate; tongue like that of frogs; no third eye-lid; skeleton with very small rudiments of ribs, and without a sternum; pelvis suspended from the spine by ligaments; four toes before and five behind. In the full-grown state they breathe like frogs and tortoises. Their tadpoles or larvæ breathe first by gills in the form of bunches to the number of three on each side of the neck, which are afterwards obliterated. They are suspended from the cartilaginous arches, on which in the adult the parts of the os hyoides rest. A membranous operculum covers these openings; but the bunches are never covered with a tunic, and float in the water. The fore feet are evolved sooner than the hinder. The toes grow on the one and on the other in succession."

The animal under consideration being furnished with persistent gills, and having a perfect growth, cannot be a salamander.

Some creature, apparently of the same family, has been called a *Siren*. M. P. de Beauvois in the 4th volume of the Philadelphia Philosophical transactions, has described an aquatic four legged reptile, which he denominates the *Operculated Siren*. The character of this latter genus among other particulars, is to have but two feet, and these on the fore part of the body. The animal described by this observer having four feet, could not be a siren.

My inhabitant of the North American Lakes, has so many characters in common with yours of Carniola, that I feel an inclination to consider him a Proteus. Among other particulars, his two triple-bunches of external and persistent gills; his two elongated, internal air bags; his four feet with toes; and his vertical flat tail, all warrant this decision. Yet his spotted skin, flabby lips, and toes to the number of four on each of the feet, might authorize me to bestow upon him a distinct name. I am averse to the unnecessary multiplication of genera. Science has been injured by the liberty some naturalists have indulged in constituting new ones when specific distinctions would have answered a better purpose. By some these innovations have been so wantonly introduced as almost to threaten, in the end, the erection of every species into a distinct genus.

If the definition by the discriminating Daudin in his admirable history of reptiles was amended in one particular, it would comprehend several sorts of creatures which now embarrass us exceedingly. His character of the Proteus is that it has an elongated body, with persistent gills, and four legs with two toes on the foremost, and three on the hindmost; with a tongue resembling that of a frog. Now, all that is wanting is to strike out the number of the toes. and to leave them unlimited. It will then include the creature before me, and the other congeneric species. And thus modified, it will exclude the Crysadonta, Salamander and Siren: the Triton having no pretensions to be considered a genus. The generic character I propose is simply this.

Proteus.

Body long and lacertine; with a flat tail and branchial bunches both persistent; and four feet furnished with clawless toes.

Under the genus so modified and framed with logical precision, the following species seem, at least, as far as I can comprehend them, to be capable of easy and natural disposition, to wit:

Species 1. The *Proteus of New-Jersey;* with a whitish body; invisible nostrils; posterior feet five toed, anterior four toed. Described by Professor Green in the Journal of the Philadelphia Academy of Natural Sciences, as the *P. Neo-Cæsariensis*, vol. 1. No. 13; and followed by the remarks of Th. Say, in No. 14. Seems to be the same that was described and figured in Philad. Philosoph. Trans. vol. 4, as the *Operculated Siren.*

Species 2. *The Proteus of the Alleghany river,* with a black fillet passing from the nostrils through the eyes, dilating over the sides and becoming obsolete on the tail. Seems to be the *Triton Lateralis* of Say; and the animal described by Dr. Edwin James in his account of major Long's expedition to the rocky mountains vol. i. p. 4-7, with a dissection by Professor Harlan. I refer to that instructive note for the particulars. We must by further observation determine whether the Lake Champlain reptile of Schneider, belongs to this species, or where.

Species 3. *The Proteus of the Lakes,*—with spotted skin, flabby lips; a duplicature of skin under the throat; large fleshy head; and broad flattish snout. This animal is mentioned by Barton as before quoted, for the huge or gigantic Salamander; in which Cuvier has followed him. Described in my paper printed in the Amer. Journ. of Sci. as herein mentioned.

To render the subject as plain as possible and to prevent all difficulty in identifying the animal I mean, I annex drawings of his external form, executed by Issachar Cozzens, Jun. from nature. Fig. 1. Pl. 2. represents him as seen by a bird's eye view, on the bottom of a Lake or River. Fig. 2, exhibits him as beheld in a side view, after being raised from the water. And that another view may be given I add a third figure thereof, (Fig. 3,) as delineated by John Neilson, Jun. M. D. during the display of the individual which Surgeon Delavan of the U. S. army brought me a few days ago from Governor Cass of Michigan, who informs me they are common in Detroit river. In the dissection I was assisted by James E. Dekay, M. D. Corresponding Secretary to the Lyceum. The notes and sketches we made, are reserved for a future publication, after the arrival of other specimens which measures have been taken to procure.

Such is my present view of the manner in which these several reptiles ought to be disposed in zoology: observing at the same time that if they or any of them should hereafter be discovered to be gyrini, larvæ, or immature or imperfect beings, they must be referred to the genus of *Salamander*, and not to the Tritons any further than this word signifies the Salamander with a flat tail in the state of Larva.

In this attempt to disentangle an intricate subject, I have had the anatomical description of the Larvæ of aquatic Salamanders by Dr. Mauro Ruconi, in his letter to Sign. Brocchi, constantly before me; as also the monography, by the same able observer and his friend, Professor Configliacchi of Pavia, of the Proteus anguinus: together with their elegant illustrations by coloured figures.

S. L. M.

Art. IX.—*Description of five species of Chiton, by* D. W. Barnes, M. A. *Member of the New-York Lyceum of Natural History.*

The rapid advancement of Natural History, in our country, during the last ten years, has been owing, in a very considerable degree, to the zeal and liberality of gentlemen attached to the *Publick Service.* Many of the officers, both of the Army and the Navy, delight to gratify their friends at home, by transmitting the products of their researches abroad. Hence it results that specimens are aggregated, on the spot, in greater abundance than they could be, by the most laborious journeys and extensive voyages, of any individual.

Among the praiseworthy contributors, to the stock of our knowledge, in Natural History, we mention, with pleasure, *Captain C. G. Ridgely* of the U. S. Navy, who, on his late return from the Pacifick Ocean in the *Constellation*, brought as usual, his offering to science; consisting of a number of small marine animals, found attached to the rocks, and collected by himself, on the coast of upper Peru. The specimens, preserved in spirits, were presented to *Doctor Mitchill;* who, with his accustomed liberality, transferred the duplicates to the Lyceum.

Referred, as usual to a committee for examination, they prove to be five species of the genus CHITON, three of which are probably undescribed.

SPECIES.

1. CHITON MAGELLANICUS. *Chemnitz.*

Shell with a black dorsal band, edged with yellow or white.

Dillwyn p. 9 *Gmelin* p. 3204

Cabinet of Dr. Mitchill.

Hab. Coast of Peru. *Capt. C. G. Ridgely.*

2. CHITON STRIATUS. Fig. 1. Pl. 3.

Shell with eight finely striated valves, and the scaly margin of a uniform colour.

Hab. Coast of Peru. *Capt. Ridgely.*

Cabinet of Dr. Mitchill.

Length 1.5 Breadth 1.1 inch.

Shell broader in proportion to its length than *Chiton squamosus*, which it resembles in the *direction* of the striæ: the marginal triangles, being striated transversely, and the dorsal longitudinally, and the terminal valves radiated. *Striæ* very fine, somewhat cancellated and interrupted. *Margin* narrow, covered with small, round, shining, scales of a uniform dark bronze colour. Specimen dark green; in its dried state, cinereous: inside light bluish green.

3. CHITON PERUVIANUS. *Lamarck.* Fig. 2. Pl. 3.

Shell with eight valves, margin thickly set with black hairs, and a fringe at each joint.

Hab. Coast of Peru. *Capt. Ridgely.*

Length 1.5 Breadth .75

Cabinet of Dr. Mitchill.

Shell slightly striated, somewhat rough, cinereous, with a tinge of red in the center. *Margin* thickly covered with black or dark brown hairs, which, in the living specimen, are nearly half an inch long; and also a thin fringe or row of hairs between the valves, at each joint of the shell. *Hairs,* in the dried specimen, very brittle.

REMARKS.

Mr. Dillwyn has not noticed this species, though he quotes *Enc. Method.* t. 163, f. 13 and 14 for the *Chiton Crinitus* of *Pennant;* and *M. Lamarck* quotes the *same* plate f. 7 and 8 for this shell.

See Anim, sans Vert. Vol. 6 *p.* 321.

As the French Encyclopedia is a work to which few persons, in this country, can have reference, we subjoin a new and accurate figure of the shell, drawn from nature, by that excellent artist *Mr. John Rubens Smith* of New-York; to whom our thanks are due for the elegant figures illustrating this paper.

4. CHITON NIGER Fig. 3. Pl. 3.

Shell with eight concentrically striated valves: and the margin furnished with elongated scales.

Hab. Coast of Peru. *Capt. Ridgely.*

Cabinets of the Lyceum and Dr. Mitchill.

Length 2.5 inches. Breadth 1.0 exclusive of the margin. Breadth 1.5 including the margin.

Shell oblong oval, intermediate valves oblong; *colour* black or dark brown; *surface* shining; *margin* half as broad as the shell, coriaceous and furnished with elongated, reddish white scales, or irregular and interrupted longitudinal ridges. Animal pale green.

REMARKS.

This shell is fragil though not thin, and has a coarse rough appearance caused by the erosion of the back part of the valves; which are inhabited by a minute species of *Lepas,* perhaps the *Lepas strömia* of *Müller,* and the *Balanus verruca of Brugière,* having the shell white and the operculum of only two valves.

5. CHITON ECHINATUS. Fig. 4. Pl. 3.

Shell with eight valves covered with a rough, green epidermis, margin broad, coriaceous and spiny.

Hab. Coast of Peru. *Capt. Ridgely.*

Cabinets of the Lyceum and Dr. Mitchill.
Length exclusive of the margin 2.6 Breadth 1.0
Length including the margin 3.0 Breadth 2.2

Shell oblong oval, coated with a coarse, green, rough epidermis, closely adhering to the shell, and concealing the whole, except a small part of the carinated center of the back, in which the shell appears black, smooth and shining; *colour*, under the epidermis and on the inside, pure ivory white; *margin* more than half as broad as the shell, thickly studded with unequal, irregular, white, round headed spines. Animal pale green: inner margin lighter colour than the animal.

REMARKS.

The spines are *white*, in the specimen figured, or white with a black center: but the native colour is black or dark *amethystine*, and the white is a calcarious accretion, which appears to be a microscopick Cellepore.

New-York, March 3, 1823.

MATHEMATICS.

ART. X.—*A Treatise of Mechanics. theoretical, practical and descriptive:* by OLINTHUS GREGORY, LL. D.—3 vols. 8vo. London, 1815.

(Communicated.)

The science of mechanics, whether considered in its theory as a subject of curious and refined speculations, calculated for the learned, ingenious, and contemplative, or in practice as contributing to the conveniences and elegancies of life, and the wealth of nations, may be ranked the first and most important of all human acquirements. What Lord Bacon says of all true philosophy, is eminently applicable to this branch of it, "that it enlarges the powers of man, and extends his dominion in nature." By it, her most refractory and opposing powers have been subdued, and some of her most potent agents have been converted into auxiliaries for the aid and relief of man. To a nation aspiring after wealth and greatness, or to individuals aiming at the same, or the more important objects of mental enlargement, what study, what art, or science, is more entitled to encouragement, or ardent pursuit, than the science of mechanics, both in theory and practice!

Our author, who has given us two closely printed octavo volumes on this important subject, together with another of plates, has certainly been happy in the selection of a subject, which is worthy of the attention of the learned throughout the world. The theory of mechanics he considers as having been little attended to in England, a country which has been almost the cradle of the science, and which under the miraculous genius of Newton has afforded it, almost its whole vigor and expansion. Since his time, however, he thinks they have fallen short, and are behind their neighbours on the continent, in many important particulars.—Among these, he accounts their neglect of the analysis of their great countryman, which foreigners have seized, and applied, with great success, to the development of many valuable principles. Without the conjunction of theory and practice, he thinks no one can be a complete mechanician, and to deliver a system, which shall comprehend both, is his professed object. In what manner he has executed this work, is our present purpose to show.

Originality, in productions of a scientific character, which are necessarily chained to principles fixed and immutable as are the laws of nature, can be little expected. In that now before us, which is intended to comprise whatever has been discovered or investigated on the subject of mechanics, it would be impossible even for Newton himself to be more than partially original; yet our author sets out. with an appearance of originality, and would have himself considered, if not the author, discoverer, and inventor of what his book contains, at least entitled to some credit as such. This, though a common artifice with book-makers, is unworthy of one who has indisputable pretensions to the very highest attainments in science. In the introduction, he says, "In the composition of the first volume, I have derived material assistance from the labours of several of my predecessors in this department of science." Now, if there were any thing of consequence in this volume, which truly was his own, and not the property of others, such language would be excusable. The fact however is, that the materials, and in many parts, the work itself, is a literal transcript from the writings of others, and that we only see now and then remarks, notes, or observations of the compiler.

This compilation then, for it cannot with truth be called by any other name, should be estimated only by those principles, which are requisite, and applicable, in works of this kind. These are judgment in selecting, arrangement, order and connexion of materials gathered from many discordant sources. On these principles we have graduated our opinions in reviewing the present work.

The writers to whom our author is indebted for the first volume of his treatise, are Francœur, Prony, Poisson and Bossut in French; Newton, Emerson, Simpson, Hutton, Martin, Young, Vince, Smeaton, and others in English; Gallileo and Frisi, in Italian, and Don Juan in Spanish. The first sixty or seventy pages on Statics are a literal translation, without the variation of any material point, from Francœur and Prony. The next following subjects on the mechanical powers, and the strength and stress of materials are almost altogether from Emerson and Simpson; that on cords and arches from Hutton. Thus the whole subject of Statics is an *excerption* from other writers. If we consider only the subject matter, this is all well, and perhaps better than if the compiler had attempted to treat it *de novo*, for he has furnished abundant materials even for the most ambitious student; but there is a discordance in those materials, ill calculated either for taste or improvement in science.—Francœur and Prony are diffuse and prolix, and though lucid and explanatory, contain little substance in many pages; on the contrary, Emerson is concise, and often times intricate, leaving much to be supplied by the learner. These dissimilar writers are however brought together, and perhaps intermixed one with another. This incongruity appears to exist throughout the volume. The first part of his Statics is too wire drawn and trifling for a book on the higher branches of science, even though intended for beginners. In proportion as we attenuate a subject by minute details, we destroy its interest, and something always should remain for the exercise of the student's own powers of investigation. The whole subject of the reduction of forces to rectangular co-ordinates, and the formulas dependant on it, is only a simple corollary from Newton's laws of motion; and all that is said of parallel forces is but a corollary of oblique forces acting at a point.

In the preliminary remarks, the author says that *vis inertiæ* is improperly called a force, " because if it were a force it would be of some definite quantity in a given body, and an impressed force less than that would not move the body; whereas any impressed force, however small, will move any body, however great." *Force* had been previously defined to be " that which causes any change in the state of a body, whether that state be motion or rest." In the collision of bodies, there is necessarily a change in the state of the bodies, and that change arises from their inertia; is not then inertia a force according to the author's own definition? The forces of an acting, or resisting body, differ in nothing but the names which we assume, or according as we fix the idea of agent, or patient to either of them. To destroy motion, requires the same force as to produce it; and since the quantity of motion produced by a body impinging on one at rest, is precisely equal to that destroyed by the body, which was at rest, the one may as properly be said to be a force as the other; both bodies are inert, and their force consists only in the resistance which each of them makes, by reason of their impenetrability, to a change of their condition as to motion or rest. But he says, that if it were a force, it would be of some definite quantity; and an " impressed force less than that would not move the body." This will apply only to particular kinds of forces, such as that of cohesion, gravity, and active forces generally; but even these may as well be expressed by the force of moving bodies, or that of their inertia, as by any equivalent definite force. The force of inertia being that which arises from some change in the state of bodies as to motion or rest, necessarily implies some motion or destruction of motion, even by the least force, as its adequate effect; and the quantity of motion produced, or the magnitude of the change, is the true measure of that force, considered either as acting or resisting. This force, though not constant, is definite, and is used in mechanics as the measure of force generally. This is so important an axiom in the science, that it is astonishing that the author should doubt of its certainty.

If F be put for the force, M the mass, or number of particles in a body, and V its velocity, then is $F \propto M V$, and $V \propto \frac{F}{M}$. If V be constant, then is F proportional to M, the mass; but why is it so, unless it be by the inertia, or the greater force of a greater mass? If M be indefinitely small, and F be constant, then is V indefinitely great, or if the mass or inertia be nothing, the velocity would be indefinitely great, so that if there were not in matter a force of inertia proportional to its mass. the least force would cause a body on which it acts. to move with an infinite velocity; but that it is not infinite, and that the velocity is modified to a definite quantity in the inverse ratio of the mass, is wholly the effect of the force of inertia.

After delivering Newton's three laws of motion, the author goes into long arguments *a priori*, and *a posteriori*, to prove their validity. Now nothing can be more obvious, evident, and undeniable than those laws, if we except that of a body in motion continuing in motion, unless some force or power obstruct it. This is sufficiently proved by one decisive experiment of Newton, viz. that the destruction of motion is precisely commensurate with the obstructing cause and its proper effect. When therefore there is no obstructing cause, there is no diminution of motion, or it remains constant. The remarks of the author on this subject are an instance of the unnecessary and extreme diffusion in some parts of his work, when compared with the neatness and conciseness of others. In chapter 2d. Art. 36, a fundamental principle is advanced, that the resultant of two equal forces, acting at a point, bisects the angle, which the directions of the forces make with one another. No proof is given of this, but the Leibnitzean, and metaphysical one of the sufficient reason. It ought either to be proved directly, or by the *reductio ad absurdum*, or assumed as an axiom, or intuitive truth, not susceptible of demonstration. The same objection lies against another fundamental proposition, in Art. 38, which is not attempted to be proved, though it is made the basis of the succeeding proposition, intended to demonstrate the parallelogram of forces.

This demonstration, if it may so be called, appears to be compounded, of what had been done by D'Alembert and others, by the analytical and far-fetched method of the moderns, which, however valuable in itself, is certainly defective in producing mental illumination, or a complete conviction of the truth, and is therefore improper in a work calculated for learners. If, after the discovery of a mathematical truth, a demonstration be necessary at all, it is necessary that the reasoning should be clear, and evident, at every step; but the analytical process is the very reverse of this, it consisting of mechanical maneuvres of symbols and abstract quantities, the perception of whose connexion in the chain of reasoning is wholly lost: sometimes it goes farther than this; its first principles, instead of being intuitive and elementary truths, on which the pure and legitimate reasoning of the mathematics rests, are drawn from the metaphysical and refined doctrine of ultimate and vanishing quantities, which are considered as difficult of conception even by mathematicians, and wholly unintelligible to learners. Such are all those pretended demonstrations by the differential calculus, generally used by the continental mathematicians of Europe, and now without judgment attempted to be introduced among the English population throughout the world. To us there appears as much of sanity in this new fangled mathematics for demonstrations, as in endeavouring to lay the foundation of a structure at its top, or to prove obvious truths by deductions from those which are the most remote and recondite. It was against this system principally that the learned and acute Berkley raised his voice. He was an admirer of mathematics in its purity, as cultivated and delivered by the ancients, and very much regretted the vitiation of its logical demonstrations by the obscurity of the modern analytics. These, it must be allowed, are excellent tools in the hands of the mathematician, for the investigation of new truths, since they save much time, and enable him to proceed to vastly greater extent than he otherwise could do: but in delivering and demonstrating to learners, propositions of the mathematics already known, the process which leads to the result must be explained step by step, whether we assume the analytical or synthetical method of reasoning. It is not against either of these methods logically considered, that we contend, but against what may be called the algorithm or complicity of symbolical terms and expressions, maneuvered according to the rules of algebra, and assumed as mathematical reasoning and demonstration. All problems purely and strictly fluxional, cannot indeed be reduced to the Euclidean method of demonstration so much celebrated; but a great number of them may be illustrated, if not demonstrated, on principles depending on the common geometry, or those which are obvious, and universally received as incontrovertible. This is abundantly manifested by what has been done by Simpson, and the more elegant and profound Maclaurin. These remarks, though applicable to the writings of some of the most celebrated modern mathematicians, are more particularly so to those books written apparently more for the purpose of making a parade of science, than affording instruction to readers of the common class. The spirit of ancient times, when difficult arts were intentionally enveloped in mystery, has not wholly evaporated at the present time. Even mathematicians appear desirous of gaining celebrity and admiration by unnecessary and most elaborate extensions of the most recondite, and to any besides themselves, the most mysterious and unintelligible part of their noble and favourite science. How far our author has fallen under this censure, will appear more minutely in the sequel of our review. In the mean while, we wish it to be understood that we have no intention to deprecate his work, but rather are anxious to extend the knowledge of it, and of that branch of science of which it treats, hitherto little cultivated in theory, in this country, by an impartial analysis of that, which we consider, on the whole, as the best, and by far the most profound treatise on the subject, which has appeared in the English language.

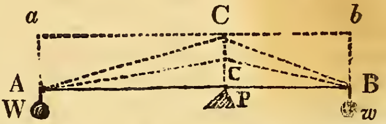
It is not within the compass of our design, to select many portions of this book which are most deserving of praise, or liable to censure. Works of science should be estimated by their effect on their ultimate objects, truth and practical utility. We shall, therefore, in our remarks, be confined chiefly to those parts of this production, which involve *principles*, as being by far the most important to the scientific reader.

In Art. 71, we have this proposition, "If two parallel forces act perpendicularly on a right line in the same direction, their resultant is parallel to them, acts in the same direction, is equal to their sum, and divides the line of application into two parts, which are reciprocally proportional to the components." This proposition, though taken from Francœur, and repeated by other French writers, we venture to oppugn, as mathematically and physically incorrect.

A force acting perpendicularly on a mere mathematical line, it is evident, can communicate no force to it, either longitudinally, or laterally, except at the very point where it acts: for the action, in such case, in the direction of the line is nothing by the principles of mechanics, and no other part of the line, admitting it to be cohesive, can be affected by a force at a distance from it, unless there be some longitudinal action; this can take place only when the line is not perpendicular to the direction of the force acting on it, or when it is oblique to that direction; but it may be maintained that by a line is meant a material substance of an evanescent breadth, cohesive and inflexible. The supposition of perpendicularity will be found, in this case, to be equally inconsistent and erroneous, and by no means according with the author's own deductions, which are grounded not on premises of a perpendicular, but an oblique action on the line perpendicular to the parallel forces. To produce the oblique action, two equal components acting perpendicularly to the parallel forces, have been introduced; we then have the problem reduced to the case of two forces acting at a point in an oblique direction. Without the consideration of an oblique force, it appears to us impossible to solve this problem, as its conditions are evidently impossible.

But supposing the line to be a physical quantity, or in the practical sense, to have length, breadth, and thickness, each of which is of some definite quantity, in this case, it is no longer a line, but a material body, possessing the properties and dimensions of a solid. If this material substance be of sufficient cohesive strength, parallel forces, acting in the manner of the proposition on its surface, will produce a lateral action, together with a longitudinal action, which, though the forces be unequal, at different distances, may counterbalance each other. But it should be distinctly observed, that this is not because the parallel forces act *perpendicularly* on the body, but because they act, in such case, *obliquely*, and may be resolved into two actions, one of which is perpendicular to the direction of the parallel forces, and the other parallel to them. The proposition taken in this sense, is simply a corollory from that of the composition and resolution of forces, and as it is that, which is fundamental in the demonstration of the principle of the lever, and other mechanical powers, some illustration of it may not be unacceptable to the reader.

Let AB be a right line, perpendicular to which two weights or parallel forces, W, w, are supposed to act,



and to be kept in equilibrio by the reaction of the prop P, the pressure on the prop would then be equal to the resultant of the two forces W, w. This supposed pressure on the prop P, when AB has no thickness, or vertical dimension, or becomes a mere mathematical line, would evidently be nothing; for the forces W, w, communicate no force, either longitudinally, in the direction AB, or laterally in that of CP. This therefore is an impossible condition. Now if we suppose AB to be a bar, or physical substance of a given or definite breadth aA, or bB, then the weights W, w, may be sustained by the strength of cohesion of the particles of the bar, on the line, or surface CP, but the action of these is not in the direction AB, but oblique to the parallel forces, and the equivalent or joint action of all these cohesive forces will be represented in direction by some oblique line, drawn to some point c, from AB. Now in these directions are the weights W, w, sustained by the cohesion of the bar at the line CP, and each is an oblique action resolvible into two others, viz. $W \times \overline{AP+Pc}$, and $w \times \overline{BP+Pc}$, whereof $W \times Pc + w \times Pc$, are annihilated by the reaction of the prop, and there remain only $W \times AP$ and $w \times BP$: but when AB is in equilibrio about P, these forces are equal, and $W \times AP = w \times BP$, or $W : w :: PB : AP$, or the length of the arms of the lever are inversely, as the weights or forces.

If the resolved parts of the forces, viz. AP and BP, which are in one continued line, be what was intended by their action on a straight line, even in this sense the proposition is incorrect; for the forces in the direction of AP, and BP do not act in the line AB, at P, but at c, and prevent the bar from turning about the point P.

This principle of oblique action, and the equilibrium of its components, is in our opinion the only one, on which the theory of the lever, and the other mechanical powers depends. If it be asked, why a less weight on the longer arm of a lever, will counterbalance a greater weight on the shorter arm, if their distances from the prop be in the inverse ratio of the weights attached to them, the answer is very ready, viz. that the action which supports the weights is oblique, and the less oblique it is, the greater is the force, which by the resolution of forces is necessary to support any weight; and that, as has been shown, will be in proportion to the distance of the weight from the fulcrum, or prop. If this force be made constant, so as to balance any given opposite force, the weight must be diminished in proportion to the length of the arm on which it acts.

The case of a cord fastened at its ends, and acted on by a weight between them, is precisely identical with that of the lever which we have been considering, the tension of the cord, when perpendicular to the direction in which the weight acts will have no tendency to support it, or the least weight will produce an infinite tension in the cord ; it is only when the cord and weight act obliquely, that a finite weight can be supported by a finite tension, and when this is given, the weight sustained by it, will be inversely proportional to the length of the cord.

We conclude therefore, that a bar, or some material solid substance, is the only right line which can be acted on in the manner propounded by our author, and this in fact, because such a physical body includes in it not a line perpendicular to the forces, but one which is oblique to them.

The next chapter on Statics, is that which treats of the center of gravity and the manner of finding it in bodies of different forms. Considering the triteness, and tediousness of this subject as handled by most writers on mechanics, and that the author's sole object must have been to select from all of them, we think he has done this with judgment if we except the solutions in articles 118, 121 ; the first is circuitous, formal, and prolix, and in the author's usual style of elaborating every thing ; the latter is erroneous either in the premises, or conclusion ; it is rather a jumble of two different solutions.

Chap. 4, treats of the mechanical powers and contains much useful, and interesting matter collected from different sources. The definition of a machine "that it is any thing which serves to augment or regulate moving forces," would be more correct by the omission of the word *augment.* In what machine, has any augmentation of force, in a mechanical sense, been produced? Estimating force as we do, by the product of mass into velocity, or time the reciprocal of the velocity, it will in all cases be diminished by the intervention of a machine, on account of its friction and the aerial resistance. The advantages of machines consist in their capacity to alter the components of force, or change their direction, or to change the magnitude of the factors M, V, T, which compounded constitute the measure of force. Thus, when we have a great velocity, and little mass, or weight, we may put in motion a great mass, or raise a great weight, with velocities, however, in the inverse ratio of the masses ; but the force. or product of velocity into the mass, disregarding friction, &c. will always be the same, so that, what we gain in mass or weight is lost in velocity.

This and the following chapter, if they had not been too much intermixed with unnecessary discussions, and experiments, we consider as valuable portions of the book.

The 6th and last Chapter on Statics, is that which treats of cords and arches. The subject is difficult, and if the author meant to be understood, he should have aimed at a good arrangement, and that *lucidus ordo*, so essentially necessary for the induction of a student into a knowledge of this intricate subject. In this he appears to have failed.

We come now to the very important subject of Dynamics. This is introduced with remarks, somewhat metaphysical, and obscure, and in our opinion unnecessary for the subject, as the whole of it is founded on principles of common sense, and common experience. It would be difficult, indeed, to conceive why Fluxions should be introduced to prove the fundamental truths of any science, when those of its own are the least evident of any of the branches of the mathematics ; this fault, and that of generalization are predominant throughout the whole work. We have already animadverted on the former, and the obscurity of its symbolic reasoning, if that can be called reasoning, of which not one step is perceived by the mind; of the latter, we shall make some remarks before we close this review.

Though the author's predilection for analytics, and abstruse theories, leads him far from that plain, and obvious course, which is adapted to the understanding of learners, there are nevertheless to be found some beautiful illustrations of principles, which serve to relieve the mind from the *tedium* produced by intense application to abstract investigations. Among these we would particularize that of D'Alembert to show that the force is as the second fluxion of the space divided by the square of the time, or in symbols, that $F \propto \frac{\ddot{s}}{\dot{t}^2}$. This, and the other fluxional formulæ in variable motion are all founded on the 39th proposition of the 1st book of Newton's Principia, which as much transcends all copies, and imitations of it, in elegance, as in the merit of originality. It may have been, however, considered as too abstruse for beginners.

Other specimens of that kind of illustration, which tends to illumine the mind of a student, and to advance the knowledge of the sciences, may be found in Art. 230, 251, 328, 370, 498, 532, and 417. I would select these as Scaliger has some odes of Horace as preeminently beautiful, and as forming a contrast to many others.

The part of Chapter 2d, on the descents down inclined planes, &c. is an old subject, and has been repeatedly demonstrated, by the plainest principles of geometry, and mechanics, and consequently established on the most certain foundation of human knowledge; yet our author in compliance with his own taste, or the fashion for analytics, has thought fit to introduce a new set of demonstrations depending on algebra, and the properties of goniometrical lines, which are inferior in evidence to the propositions themselves, which were to be demonstrated.

In Art. 277, we have the solution of the problem for finding the curve of swiftest descent; the solution given by the compiler is that of Thomas Simpson, but without any of the necessary lemmatic principles, which are absolutely necessary, for its logical, and mathematical conclusions. We consider the whole, therefore, as useless, and nugatory, but as compensated in some degree by the fine illustrations, which follow.

Chapter 3d, on contripetal forces is taken almost, word for word, from Simpson's Fluxions, with the exception of a proposition, or two, introduced by Mr. Gregory, perhaps from some other writer; that in Art. 280, to prove the equal velocities at equal distances from the center of bodies descending in curves, or right lines, is an awkward attempt by a blind, and circuitous route to supersede what had been done better by Simpson, and infinitely better by Newton. Few learners can be made to understand the jumbled solution given by our author.

Chapter 4th, treats of rotatory motion, and of the centers of Gyration, Oscillation, Percussion and spontaneous Rotation, together with other subjects connected with them. We find not much to censure, or much to applaud in this, except a more glaring instance of that pedantry, and ostentation of learning, of which there are so many in this book. After having proved, what is very easily, and evidently shown by elementary principles, that the force of bodies or the particles of bodies, in rotatory motion, is as the squares of their distances from the axis of motion; such a plain Euclidean demonstration does not appear to have satisfied the magnificent ideas of the author, who every where prefers demonstrations even of the simplest theorems, if derived from the most exalted and obscure source of Analytics. Accordingly, we have in Art. 302 a long demonstration depending on the differential calculus, and the principles of D'Alembert, to show that the force of bodies in rotary motion is truly as had been before estimated by the principles of geometry and mechanics. As the differential calculus, and D'Alembert's principles, are founded on these, if they have any foundation, it is evident that this proof is a mere *argumentum in Circulo* and therefore ostentatious, and delusive.

Chapter 5th, is a treatise on Percussion founded on the principle of its effects arising from a continued, and successive action of the particles of the bodies, which undergo percussion, and therefore, that it is in itself a kind of pressure produced in a very small moment of time. On this hypothesis, the deductions are made *a priori*, and are consentaneous to those derived from other principles. The *conservatio virium*, of Huygenius and Bernouilli, follows easily from this doctrine, but all this had been shown with much more force, and elegance by Maclaurin. The whole of this long, and elaborate investigation is taken from Don Juan's *examen maritimo.*

The 6th and last chapter on Dynamics is that, which treats of the maximum effects of machines. As this part of the work consists chiefly of problems selected from different authors we pass it over in silence.

The next great division of our author's work, which he has brought under the denomination of Mechanics, is what is usually denominated in English Hydrostatics, and Hydraulics, but by our author, and the French writers, the latter is termed Hydrodynamics. Considering fluids as subject to the laws of mechanical philosophy, the latter nomenclature is perfectly proper, and analogous to that of the first part of the work.

We might go into details of this part of our author's book, as we have into some of the first, but it would not be consistent with our prescribed limits. The same character pervades the whole, excepting, that the latter subjects are more incumbered with experiments, often of a frivolous import, than the former.

In addition to what we have before remarked, another, and very material fault of this book is the spirit of generalization,without sufficient inductive reasoning,which appears to pervade it. In philosophy,according to Baconian principles, a general principle ought never to be assumed, unless so many particulars unite in one principle as to render it wholly indisputable. But admitting the particulars are sufficiently numerous, and well selected, so as to bear the test of *instantia crucis*, or *experimentum crucis ;* yet general principles and formulæ so useful to the mathematician, who must be supposed to be well versed in particulars, are not those by which a subject can be best illustrated, and rendered comprehensible to a learner. This assumption of general principles, in the exact sciences, before the mind has been familiarized with the reasonings and results of particular cases, borders very near on Cartesian Hypotheses, or at least there is no great discrepancy in the two methods. We therefore agree with Dr. Watts, who, in his improvement of the mind recommends, that a student of the mathematics, proceed from practical or particular cases coming under his notice and observation, to those which require more general principles, or in other words, that he begin with practice and end in theory. This is the very order of nature, for our first notices of things, are simple, and practical, and we then proceed to enquire into their foundation, and the causes of their phenomena.

The second Vol. of our author's very extensive work on mechanics is occupied altogether with what may be denominated practical mechanics; this not only applies to practice, some of the important theories of the first volume, but goes very extensively into the description by language and drawing, of almost every machine, engine, or mechanical work of ingenuity, which as yet, has resulted from the exerercise of the human faculties in this branch of science. This portion of the work, will, we believe, be by far the most acceptable to the real mechanician, as that of the first volume can only be so for the most part, to profound mathematicians, or men of rare genius, and acquirements.

We will conclude our remarks, which we fear, have already been extended too far into details, with a concise opinion of the merit and importance, which may justly be attributed to this work as a whole, embracing a mass of scientific materials. In this respect, we consider it as the most valuable and comprehensive system of mechanics in the English language. Though the theoretical part has been studiously rendered abstruse and difficult to beginners, by the overweaning attachment of the author for analytics, and sometimes for metaphysical discussions, there is besides an abundant supply of useful theory, illustrated in a plain elementary style and method. No reader can be at a loss in selecting such portions of the book, as are within the scope of his genius and capacity. But if any can go farther, and make himself master of the whole of this work, he will have little else to search for, to obtain all the discoveries, and improvements, which have been made in this science.

Art. XI.—*On the form of the teeth of Cog-Wheels;* by Eli W. Blake, A. M. *New-Haven.*

It is very important in most kinds of Wheel Work that such a form should be given to the acting faces of the teeth that they may act with a constant and equable force, and produce a uniform velocity. Several of the most eminent mathematicians of the last century gave their attention to this branch of mechanical science. The first who came to any practical result was Olaus Roemer, the celebrated astronomer and mechanist of Denmark. He discovered that wheels possess the property of transmitting a uniform force and velocity, when sections of the acting faces of the teeth of one of them are the incipient portions of exterior Epicycloids, generated on the pitch circle by a circle whose diameter is equal to half the pitch diameter of the other wheel; and the teeth of the other, the incipient portions of interior Epicycloids, generated on its pitch circle by the same generating circle.

M. De la Hire soon afterward took up the subject, and proved that it is not necessary, as Roëmer had supposed, that the diameter of the generating circle should be half that of the circle on which the interior epicycloid is described, since the same result will follow if the generating circle be of any other diameter whatever. He also proved that it is not necessary in order that the teeth may possess the property of transmitting a uniform force and velocity, "that they should be exact epicycloids in the sense to which geometers usually restrict that term, since they will possess this property if the teeth of one wheel be triangular, circular, or of any other REGULAR FIGURE, provided the teeth of the other are of a figure compounded of that figure, and of an epicycloid."

The subject was afterward investigated by Camus, Euler, Varignon, and others on the Continent. But their labours, though they afforded some valuable elucidations of the subject, contributed nothing to extend it beyond the discoveries of De la Hire. Nor has any advancement been since made in the science, except by Professor Robison, of Edinburgh, who pointed out a single species of teeth possessing this property, which are not embraced in the epicycloidal principle of De la Hire. These teeth are in the form of the involutes of circles, smaller than the pitch circles, and concentric with them, whose diameters are to each other as the diameters of the pitch circles. Mr. Brewster has erroneously remarked that "the principle of these teeth is not new;" and classed them among the epicycloidal teeth; and in this view of the subject, the succeeding writers have hastily concurred with him. That they are entirely distinct from that principle may be seen by referring to the subsequent remarks on involutes of circles, taken in connexion with the rest of the subject.

These discoveries of Roemer, De la Hire and Robison constitute the whole extent to which the science has hitherto been carried.

I apprehend that the subject has not yet been placed on its true and proper basis, and that those who have written upon it have commenced their labours at one of the branches, and not at the root of the principle; in consequence of which they have not only failed to circumscribe it with those clear and distinct outlines which should always define the extent of mathematical truth, but, as the following treatise will show, have embraced in their views only an infinitely small part of the subject. It is true, as shown by Roemer and De la Hire, that epicycloidal curves possess the property of transmitting a uniform force and velocity; but this property does not, as they have supposed, depend at all on the circular form of the generating curve; for it will be shown that all curves possess the same property, which are generated, or are capable of being generated by any curve or line whatever, rolling on the pitch circles.—Nor is it necessary, as in epicycloidal curves, that the tracer or describing point should be situated in the generating curve, for the curve generated will possess the same property if the describing point is any where else in the plane of the generating curve.

I propose in the first part of the following treatise to set forth in a few concise propositions the true principle in its whole extent; embracing all possible curves which possess the property of transmitting a uniform force and velocity; to which will be added such remarks and illustrations as readily flow from the subject, and are thought of practical utility.

Since the principle thus exhibited will be found to embrace an infinite variety of curves, most of which are unknown to mathematicians by any appropriate name, yet all possessing one common property; to avoid circumlocution we shall call them Isosagistic curves, a term significant of their characteristic property. It is proper to remark here that it is by no means intended that all the curves which are included under this name are adapted to practical purposes, for even the epicycloidal curves are not all so.—But it is not improbable that further investigations may show that some of them are better adapted to mechanical purposes than any of the epicycloidal curves.

It is another great desideratum in wheel work that the teeth should act without friction.—But this point, though it hardly deserves less attention than the other, has been but little noticed by men of science. Some of the mathematicians before mentioned seem to have supposed that the epicycloidal curves act without friction. And the writers of practical treatises on the teeth of wheels, who have derived their ideas chiefly or wholly from the writings of these mathematicians, have, I believe, all of them, either taken the same for granted, or asserted it in unequivocal language.* I propose to show in a few remarks, under the head "Epicycloids," not only that these curves do not possess this property, but that it is impossible even in theory that any action between the teeth of wheels, whatever may be their form, should be uniform in force and velocity, and at the same time without friction.†

But dispensing with the desirable property of uniform action, it is possible to give to the teeth of wheels such a form that they will act without friction; and when practical means shall have been devised of forming them with facility, they may probably be adopted with advantage in many mechanical operations where small variations in force and velocity are unimportant. The curves which possess this property, like the Isosagistic curves, are infinitely numerous, and to avoid circumlocution I have assigned to these also a name significant of their common property. They will therefore be treated of under the head Atripsic curves, where the general principle which embraces all possible curves of this sort, will be given; together with the means of determining

* See Smith's Panorama of Arts and Sciences,—Rees' Encyclopedia; articles, *Mill Work* and *Clock Movement*,—Imison's School of Arts,—Gregory's Treatise on Mechanics, &c.

† This remark is intended to be applied to all teeth whose acting faces are made up of straight lines parallel to the axis of the wheel. It is not true of the spiral or Helicoid teeth, invented a few years since in France, and now used with great success in some branches of mechanics in this country.

whether any given curve possesses this property, and of finding its Atripsic fellow.

In pursuing this plan, I shall endeavour to advance nothing which is not susceptible of rigid mathematical demonstration, and to take no point for granted without proof which will not be sufficiently obvious upon slight consideration, to those who are versed in mathematical and mechanical science.

Isosagistic Curves.

Prop. I.—If two circles which are in contact have equal power at the point of contact to revolve about their centres in opposite directions, and if a curve be attached to one of them, acting on a curve attached to the other, the circles are in equilibrio when the curves are perpendicular to a line drawn from their point of contact to the point of contact of the circles.

Let the two circles (Fig. 1, Pl. IV.) have an equal tendency at *e*, their point of contact, to move in opposite directions, the one in the direction *eh*, the other in the direction *ef* and let the curve *gh* attached to the circle *b*, act on the curve *gi* attached to the circle *a*, and at the point of action or their point of contact *g* let them both be perpendicular to the line *ge*. These circles will be in equilibrio. Draw the lines *bc*, *ad* perpendicular to the line *ge* produced, and let the power at *e* in the direction *eh* be *P*, and at *c* in the direction *cg*, *p*; and let the resistance at *e* in the direction *ef* be *R*, and at *d* in the direction *dg*, *r*.

By the principles of mechanics $P : p :: bc : be$ and $R : r :: ad : ae$. But by similar triangles $bc : be :: ad : ae$. Therefore $P : p :: R : r$. But by the hypothesis $P = R$. Therefore $p = r$. That is the power at *c* in the direction *cg* is equal to the resistance at *d* in the direction *dg*. But these forces are respectively the same at *g* as at *c* and *d*. Therefore the forces are equal and opposite at *g* and the circles are in equilibrio.

Definition.—Curves attached to circles, acting upon each other, we shall call acting curves, and the point at which they are in contact, the point of action.

Prop. 2.—If the acting curves are such, that while one drives the other, they both keep constantly perpendicular to the line which joins their point of action to the point at which the circles are in contact, and if the driving circle be moved with a uniform force and velocity, the other will move with uniform force and velocity.

First. Let *gi*, *gh*, Fig. 1, be curves so constructed as to answer the condition of the proposition. By the preceding proposition, when the circles are acted upon by forces which are equal in opposite directions at the point *e* they are in equilibrio. Let an additional force be exerted upon the circle *a*. Then the equilibrium will be destroyed, and the curve *gi* moving toward *e* will drive the curve *gh*. before it. It is evident from Prop. 1, that when the curves are both perpendicular to the line *ge*, an equal additional force applied to the circle *b* will restore the equilibrium; but by the Hypothesis the curves are constantly perpendicular to the line *ge*. Therefore if the additional force exerted upon the circle *a* be uniform and constant, it will constantly require an equal additional force upon the circle *b* to resist it; that is it will move with uniform force.

Secondly. Since the corresponding points *g* in both curves are in contact with each other, their velocities at any given instant of time in the direction *ge* are equal. But the velocities at *d* and *c* in the direction *ge* are respectively equal to the velocities at *g* in the same direction. Therefore while one curve drives the other the velocities of the circles at *c* and *d* are equal. But the velocity of the circle *a* at *d* is to its velocity at *e*, as *ad* to *ae*, and the velocity of the circle *b* at *c* is to its velocity at *e* as *bc* to *be*. But *bc* : *be* : : *ad* : *ae*. Therefore the velocities of the two circles at *e* are to each other as their velocities at *c* and *d*. But it has already been shown that their velocities at *c* and *d* are equal. Therefore their velocities at *e* are also equal. Consequently if one be uniform the other is also uniform.

Definitions.—When a circle moving about its centre with a uniform force and velocity drives another circle by the acting curves, with uniform force and velocity, we shall call the acting curves Isosagistic; and with reference to each other, fellow isosagistic curves.

When two curves roll together without sliding and any point in the plane of one traces on the plane of the other, another curve, the curve thus traced is said to be generated; the point by which it is traced is called the describ-

ING POINT; the curve to whose plane the describing point is attached, the GENERATING CURVE; that upon which the generating curve rolls, the BASE CURVE; that part of the base curve with which the generating curve comes in contact, the BASE OF GENERATION.

COR.—During the action of isosagistic curves, the velocities of their circles are equal at their point of contact.

PROP. 3.—Any curve generated by one curve rolling upon another is at every point of it, perpendicular to a line drawn from that point to the point in the base, which was in contact with the generating curve when that point was described.

Let *a b*, Fig. 2. be any base curve; *c d* any generating curve rolling upon it; *f* any point in the plane of *cd*, and *gh* the curve described by *f*. Now during the time when a small part *f* of the curve *hg* is described, the describing point revolves about the point *e* as a centre. Therefore if a circle be described from *e* as a centre with a radius *ef*, the circumference of the circle will coincide at *f* with the curve *hg*. But the circumference of a circle is every where perpendicular to the radii. Therefore the curve *hg*, which coincides with the circumference of a circle whose radius is *fe*, is perpendicular to *fe*.

COROLLARY.—Hence it is manifest that no curve on the plane of a circle is susceptible of being generated by another curve, rolling on the circle, unless perpendiculars from every successive point of it, commencing at one extreme, fall on corresponding successive points of the circle.

PROP. 4.—Any curve whatever being taken as a generating curve and rolled upon any two circles with one side toward the centre of one, and the other toward the centre of the other, will by any point in its plane, as a describing point, trace on the planes of the base circles, fellow isosagistic curves.

Let the two circles, whose centres are *a* and *b*, Fig. 3. and any generating curve *cde* touching each other at the point *d*, be rolled together in such a manner that their mutual point of contact shall be kept constantly in the point *d* of the line *a b*, until the generating curve come into any other position as *fdg*. Then if the point *d* in the curve *cde* be taken as the describing point, it will have moved to *p* and described the curve *pi* on the plane of the circle *a* and the curve *ph* on the plane of the circle *b*. These curves are isosagistic.

For the line *pd* is constantly the describing radius to the successive points of both curves *pi*, *ph*. These curves are therefore both constantly perpendicular to the line *pd*. Hence the curves *pi*, *ph* are constantly coincident at the point *p*. Consequently the point *p* is constantly the point of action. Therefore the curves are constantly perpendicular at their point of action to the line *pd*. Wherefore (Prop. 2.) they are isosagistic.

Cor. 1.—Any curve on the plane of a circle which is susceptible of being generated by another curve rolling on the circle is isosagistic.

Cor. 2.—The base circles being considered as the pitch circles of two wheels, the curves generated are sections of the acting faces of fellow isosagistic teeth.

Cor. 3.—When the base circles and generating curve simultaneously roll together, the describing point and point of action constantly coincide.

Scholium.—When the generating curve is a circle, and the describing point its centre, the curves generated are circles concentric with their bases. These are manifestly incapable of acting on each other, and therefore, though they are rather *in* than beyond the limits of the principle, they will not be considered as included in the general term, *isosagistic curves*.

Prop. 5.—Any curve on the plane of a circle is susceptible of being generated by a curve rolling on the circle, when perpendiculars from every successive point of it, commencing with one extreme, fall on corresponding successive points of the circle; and its generating curve may be found.

Let *a*, Fig. 4, be the circle, and *bc* any curve on its plane answering the condition of the proposition. It is required to find the curve which rolling on the circumference of the circle *a*, will generate the curve *bc*.

From the points *b* and *c*, draw lines perpendicular to *bc*, meeting the circle at *d* and *e*. Divide the arc *de* into indefinitely small equal parts, and suppose lines to be drawn from each point of division perpendicular to *bc*. From any point *o*, with each of the perpendiculars successively as radius, describe concentric circles. From any point *p*, in the circumference of the first concentric circle as a centre, with a radius equal to *dm*, one of the divisions of the arc, intersect the next concentric circle at *i*; and from the point *i*, with the same radius intersect the next, and so on, till all be intersected. Then, if a curve be traced through these several points of intersection, and applied at the point *p* to the point *d* of the circle, and rolled round upon it to *e*, the point *o* in the plane of this curve will trace the curve *bc*.

Take *or* equal to *op* and join *p*, *r*; and take *np* equal to *db*, and join *d*. *n*. If *dm* is infinitely small, *pi* is also infinitely small, and they may both be taken as straight lines. The angle *por* is also infinitely small. But since the three angles of the isosceles triangle *por* are equal to two right angles, when the angle *por* is infinitely small, or vanishes, the remaining angles are equal, each to one right angle. Since therefore *pro* is a right angle, *pri* is also a right angle. Again; when *dm* vanishes, *mh* coincides with *db*. Therefore, when *dm* is infinitely small, *mh* may be taken as parallel to *db*, and *bh* will be infinitely small, and may be taken as a straight line. But *nh* is equal to *db*, therefore *dn*, *bh*, are parallel. Consequently the angle *dnm* is a right angle. Since by the construction *po* is equal to *db*, and *mh* to *io*, and since *nh* equals *db*, and *or* equals *op*, *nh* is equal to *ro*, and the remaining parts *mn*, *ir*, are equal. In the two triangles *dmn pir*, *dm* is equal to *pi* by the construction, and it has been shown that *ir* is equal to *mn* and that the angles at *n* and *r* are right angles. Hence the angle *mdn* is equal to the angle *ipr*. To the angle *mdn* add the right angle *ndb*, and to the angle *ipr* add the right angle *rpo*. Then the angle *mdb* is equal to the angle *ipo*. If therefore, the point *p* of the curve be made to coincide with or touch the circle at the point *d*, *po* coincides with *db* and *o* is in *b*. If the curve and circle toucheach other in any other corresponding points, it may be shown in the same manner that the point *o* is in a corresponding point of the curve *bc*. Now let the point *p* of the curve touch the circle at the point *d*, and let the curve be rolled round upon the circle to *e*. Since the small arcs of the curve *pi* &c. are by the construction equal in length and number to the small arcs *dm* &c. of the circle, the corresponding points *p*, *d*, *i*, *m*, &c. will successively coincide. But it has been shown that when these points are in contact, the point *o* is in a corresponding point of the curve *bc*. And since the equal arcs are by the construction indefinitely small, the point *o* is constantly in the curve *bc*; first at *b*, and lastly at *c*. Therefore the point *o* describes the curve *bc*.

Cor. 1.—Curves are susceptible of being generated by two different curves, rolling on different arcs of the circle as the base of generation, when their perpendiculars produced fall on another part of the circle, in the same order of succession.

Cor. 2.—Any curve being given on the plane of a circle, it may be ascertained whether it can be generated, and if it can be generated, its generating curve may be found.

Prop. 6.—All isosagistic curves are susceptible of being generated by curves rolling on their pitch circles.

Let the point *g*, (Fig. 1.) be the extremity of the isosagistic curve *gi*, in action at the point *g*, and let the curve *gi* drive the curve *gh* toward *e*, and let *ei* be the arc which rolls on the fellow-circle during the action of the curve *gi*. By prop. 3. Cor. the perpendiculars from every part of *gi* fall on *ei*. Now, from the nature of curves the perpendiculars from two adjacent points make an infinitely small angle with each other, and consequently can intersect but an infinitely small portion of an arc between them. Therefore the perpendicular from the point *n* (not given in the figure) adjacent to the point *g*, in the curve *gi*, either falls on the point *e*, or on a point *x*, (not shown in the figure) adjacent to *e*, between *e* and *i*. Now when the point *n* is in action, the point *x* is in the line *ab*. But the point *x* is the next point of the arc *ei*, which in the progress of the action comes into the line *ab*. Therefore the point *n* is the next point of the curve *gi* which is in action. In the same manner it may be shown with regard to every successive point of the curve, that it is in action when the next successive point of the circle is in contact. But the perpendicular from the point of action falls on the point of contact. Therefore, since the successive points of the circle come successively in contact, perpendiculars from the successive points of the curve fall on successive points of the circle. Therefore (prop. 5) the curve *gi* is susceptible of being generated by a curve rolling on its circle. The same may be shown of any other isosagistic curve.

Prop. 7.—Any curve being given on the plane of a circle it may be ascertained whether it is isosagistic and its fellow isosagistic curve may be found.

For since all isosagistic curves can be generated (prop. 6.) and all curves which can be generated are isosagistic (prop. 4. Cor. 1.) the given curve is isosagistic if it can be generated and not otherwise. But it may be ascertained whether it can be generated, and if it can be its generating curve may be found (prop. 5. Cor. 2.) And this being applied in the prescribed manner to any other circle will generate a fellow isosagistic curve.

Cor.—It may be determined with regard to any given tooth-wheel whether its teeth are isosagistic. For they are so then, and then only, when sections of their acting faces can be generated on the given pitch circle, if it be given; or on any circle concentric with the wheel assumed as the pitch circle, when it is not given.

Prop. 8.—In simultaneously describing any corresponding portions of fellow isosagistic curves, the describing point does not constantly remain in the line of centres.

If the describing point remains in the line of centres, it is either at rest or in motion in that line. First, let *d*, Fig. 5, be the describing point, and let it be at rest while the circle *a* turns on its centre through the arc *eh*. Then the generating curve is necessarily a circle, and the describing point, its centre, and an arc *di* of a circle concentric with the circle *a* will be described on the plane of the circle *a*. This, as has already been shown, is not an isosagistic curve.

Secondly, during the same motion of the circle *a* let the describing point *d* move through a segment *dg* of the line *ab*. Then the curve described will be *ig*, which when the arc *eh* is taken infinitely small, may be considered as a straight line. Now since *i d* is the arc of a circle whose centre is *a*, it is perpendicular to the line *a d*. Therefore the angle *i d g* is a right angle. Consequently the angle *i g d* is less than a right angle. But *g* being the describing point and *e g* the describing radius, *i g* is perpendicular to *eg*. Therefore the angle *igd* is a right angle. But it cannot be both equal to, and less than, a right angle. Wherefore the describing point cannot remain in the line of centres and move in that line while it traces isosagistic curves.

Cor.—Since (*prop.* 4. *Cor.* 3.) the point of action and describing point constantly coincide, the point of action or contact of the acting curves does not constantly remain in the line of centres.

Prop. 9.—No Isosagistic curves act upon each other without friction.

Let *gi*, *gh* Fig. 6. be two isosagistic curves in action at the point *g* and attached to the circles *a* and *b* in contact at *e*. Now (by prop. 2. Cor.) during the action of the isosagistic curves the velocities of the circles at *e* are equal. Consequently the circles may be considered as rolling together at the point *e*. Then (by prop. 3.) the point *a* considered as a describing point traces a curve *ad* on the extended plane of the circle *b* which is constantly perpendicular to the line *ae* —that is, to the line of centres. Now let it be granted that in the mean time the curve *gi* rolls on the curve *gh* without sliding or friction. Then the point *a* considered as a describing point traces on the extended plane of the circle *b* a curve which is constantly perpendicular to the line *ag*. But the line *ag* does not constantly coincide with the line *ae*, for (prop. 8. Cor.) the point *g* is not constantly in the line *ab*. Therefore the curve *ad* is constantly perpendicular, at the same point of it, to two different lines which do not constantly coincide. But this is impossible. Therefore the curves *gi*, *gh* do not roll upon each other without friction. The same may be proved of any other fellow isosagistic curves.

Epicycloids.

Scholium.—When the generating curve is a circle and the describing point is in the circumference, the curve generated on one of the fellow circles is an exterior epicycloid and that on the other is an interior epicycloid. When the diameter of the generating circle is half that of the circle on which the interior epicycloid is described, the interior epicycloid is a straight line tending to the centre of the circle; and the forms traced on the planes of the circles are those which are recommended in the practical treatises, for fellow teeth which are designed to act either wholly before or wholly after the line of centres. When the interior epicycloid is the driving curve the action is before the line of centres, and when it is driven the action is behind the same line.

When the generating curve is made up of the arcs of two circles, one of which is convex and the other concave toward the centre of one of the base circles, the diameter of each of these arcs being half that of the base circle toward whose centre it is concave, and the describing point being at their point of junction, the forms traced are those which are recommended for fellow teeth which are designed to act both before and behind the line of centres.

Prop. 10.—In the preceding instances and also in all others, when the interior epicycloids are generated by circles less than the base on which they roll, the friction between the interior and its corresponding exterior epicycloid is as the difference of their lengths; and when the generating circles of the interior epicycloids are larger than the base on which they roll, the friction is as the sum of their lengths.

For in the first case, every part of the shorter curve is applied to a corresponding part of the longer one. Now if the shorter merely rolls on the longer without sliding, it is applied to it only to the extent of its length. Consequently the shorter curve must slide upon the longer to the extent of their difference. In the second case the interior epicycloid is on the exterior of its base, and it is evident that each curve slides entirely over the whole of the others. Consequently the friction is as the sum of their lengths.

Cor.—Hence the friction is the same, whether the action is before the line of centres or behind it.

Scholium.—The rule for determining the quantity of friction between epicycloids, as exhibited in the preceding proposition, is applicable to all isosagistic curves whatever. The rule may be thus stated: The friction between any two fellow isosagistic curves is as the difference of those parts of them, which are described by a generating curve more concave than the circumference of the base circle toward whose centre it is concave, added to the sum of the other parts.

INVOLUTES.

Scholium.—When the generating curve is a straight line, the isosagistic curves generated are involutes of the pitch circles. (See Fig. 7.) If the generating straight line be considered as a circle with an infinite diameter, the curve described on one circle may be considered as the last of the exterior epicycloids, and that on the other as the last of the interior epicycloids, and their action is strictly epicycloidal.

Another mode of action between involutes of circles was discovered by Professor Robison of Edinburgh, and recommended to be adopted in the formation of the teeth of wheels. Let *a* and *b* be the centres of two circles whose circumferences are at any short distance asunder, and let a line *cd*, touching them both, move forward and drive them by simple contact. Then any point *p* of this line traces on the planes of the circles, involutes capable of transmitting a uniform force and velocity. It will be observed that these involutes are not generated on the pitch circles, and therefore do not come within the limits of the principle of epicycloidal action, as given by those who preceded Professor Robison: for they had only shown that epicycloids were isosagistic when generated on the pitch circles. The Professor was therefore clearly entitled to the credit of having made a new discovery, though Dr. Brewster and others were disposed to withhold it from him; for no connection can be traced between these involutes and epicycloids, in general, as it regards their isosagistic properties, except through the medium of the general principle, as given in the preceding propositions. And it is to be observed that these involutes are not excepted out of the general truths already proved with regard to isosagistic curves; for though they are not generated on the pitch circles, as we have thus far spoken of them, yet like all other isosagistic curves they are susceptible of being generated by a curve rolling on the pitch circle. It is worthy of remark, that the curve by which these involutes might be thus generated is the Logistic or Logarithmic Spiral. This truth might be easily demonstrated, were it not going farther than I had intended into the minutiæ of the subject.

Atripsic Curves.

Prop. 11.—If a describing point be made to move in a line which joins the centres of two circles, and if at the same time the circles be made to revolve in such a manner that the velocities of their planes at the describing point shall be constantly equal, two curves will be traced on the planes of the circles which will drive each other without friction.

Let *a* and *b*, Fig. 9, be the centres of the two circles, and *p* the describing point moving towards *b*; and let the space described in a given time on the plane of *b* by the motion of *p* be *pf*; and let the space described in the same time in a direction perpendicular to *pb* by the motion of the circle *b* about its centre, be *fc*. And let the corresponding spaces described in the same time on the plane of *a*, be *de*, *ep*. Then the spaces described by the combined motion of the point and circles will be *pc*, *pd*.

Now, if the time be taken indefinitely small, *pfc* and *ped* may be considered as right angled triangles; and since the motion of the point *p* in the direction of the radii of the circles is common and simultaneous on both circles, *pf* and *ed* are equal. And since the velocities of both circles about their centres are constantly equal at the point *p*, *pe* and *fc* are equal. Therefore the third sides *pc*, *pd* of the two right angled triangles *pfc*, *ped* are equal, and the angles *cpf*, *pde* are equal. Therefore the angle *cpf* is the complement of the angle *dpe*. Wherefore the angle *cpf* is equal to the angle *dpf*. Hence the curves *pc*, *pd* are coincident at the point *p*, and since *p* is any position of the describing point, the curves are constantly coincident, or in contact in the line of centres. Now sinne *ed* is equal to *pf*, *ad* is equal to *af*. Therefore, in the progress of the motion or action, the points *c* and *d* meet and coincide with each other at *f*. But it has been shown that these two points are equidistant from the point *p*. In the same manner it may be shown that any other points which are equidistant from *p* meet and coincide with each other. Therefore, in any given space of time, equal quantities of the two curves *pc* and *pd* pass through the point of contact *p*. Wherefore they roll upon each other without silding, and consequently without friction.

Cor.—By varying the relative velocities of the circles and describing point, an infinite variety of atripsic curves may be produced.

Schol.—By a similar process of reasoning it may be shown, that no curves are atripsic, but such as are described, or are capable of being described in this manner.

Prop. 12.—If the velocity of the circles be uniform at the point of contact, and the velocity of the describing point be also uniform, the curves described are Logistic Spirals.

For since the velocity of the circle *a*, Fig. 9, is uniform at *p*, the lines *pe*, *di*, &c. described in successive equal portions of time, are equal to each other. And for the same reasons, since the velocity of the describing point *p* is uniform, the successive lines *ed*, *ih*, &c. are equal. Therefore, in the two right angled triangles *hid*, *dep*, the sides which inclose the right angles, are respectively equal to each other. Wherefore the angles *ihd*, *edp* are equal to each other. Hence all lines drawn from the point *a* to the curve *ph* make the same angles with the curve. Let *a* and *b*, Fig. 10, be the centres of the circles, and *ce* the curve described on the plane of *a*, during the uniform motion of the circle at the point *p*, and of the point *p*. Divide the arc of a circle *gf*, into indefinitely small equal parts, and through the points of division draw the lines *ad*, *ap*, &c. Now in the triangles *aed*, *adp*, *apc*, the angles at *a* are equal, because they subtend equal arcs, and the remaining angles have already been shown to be respectively equal. Therefore the triangles are similar each to each. Hence *ac* : *ap* : : *ap* : *ad* : : *ad* : *ae*, &c. That is, the radii *ac*, *ap*, *ad*, *ae*, &c. are continued proportionals; which is the fundamental characteristic of the Logistic Spiral. The same might be shown of the curve *hi* on the plane of the circle *b*.

Schol.—The Logistic Spiral is perhaps the most simple form for atripsic teeth of wheels.

Prop. 13.—Any curve on the plane of a circle may be driven by some other curve without friction, when every successive part of it, commencing with that extreme which is nearest the centre, recedes continually both from the centre and from the radius in which it commences.

Let *a*, Fig. 11, be the centre of the circle, to the plane of which is attached the curve *pe* answering the condition of the proposition. Through *p*, the nearest extremity of the curve *pe*, draw the line *ab*, and through the other extremity *e*, draw the arc *ec* of a circle whose centre is *a*. Now if the circle *a* revolve on its centre till the point *e* comes into the line of centres at *c*, the point of intersection between the curve *pe* and the line *ab* will advance from *p* to *c*. If therefore the point of intersection be considered as a describing point, and if in the mean time another circle be made to revolve about a centre b in such a manner, that its velocity shall be constantly equal at the point p to the velocity of the other circle at the same point, then the point of intersection will simultaneously trace the curve pe and another curve on the plane of the circle b. These by proposition 9 are fellow atripsic curves.

Cor.—Many curves may have either an atripsic or an isosagistic fellow; for many of the isosagistic curves recede continually both from the centre and from the radius in which they commence.

Definition.—The CORRESPONDING POINTS of fellow atripsic curves are those points which come in contact with each other.

Cor.—Since the contact of fellow atripsic curves is always in the line of centres, the sum of the radii drawn from the centres of the circles to any two corresponding points of the curves, is equal to the distance between the centres of the circles. Hence it is evident, that a fellow atripsic curve may be described for any curve whatever which is capable of having one, in the following manner.

Let a, Fig. 12, be the centre of a circle to whose plane is attached a curve 1 4 capable of acting without friction. Divide the curve 1 4 into any number of indefinitely small equal parts by the points 1, 2, 3, 4, &c. and join those points with the centre a of the circle.

From b as a centre describe concentric circles whose radii are equal to the successive differences $ab—a$ 1, $ab—a$ 2, $ab—a$ 3, &c. From any point in the first concentric circle with a radius equal to one of the divisions of the curve, intersect the next concentric circle; and from the point of intersection with the same radius intersect the next, and so on till all be intersected. Then a curve traced through the several points of intersection will be a fellow atripsic curve for a circle whose centre is b.

PHYSICS, CHEMISTRY, &c.

Art. XII.—*An Essay on the Question, whether there be two Electrical Fluids, according to Du Faye, or one, according to Franklin.* By Robert Hare, M. D. Professor of Chemistry in the University of Pennsylvania.

By those who allege the existence of two electrical fluids, much stress has been laid on the fact, that light bodies, when negatively electrified, separate from each other no less, than when in the opposite state. The absence and presence of a fluid, cannot, it is said, have the same effect of producing repulsion. To this, it has been answered, that the separation of such light bodies is not the effect of repulsion, but of an attraction between them and the surrounding medium; which must equally ensue, whether they be electrified minus or plus: since, in either case, that diversity of electrical excitement between them and the surrounding medium, arises, which is always productive of attraction.

In support of this view of the question, I propose to make a few observations. In an electroscope with moveable coatings, like the galvanometer of Mr. Pepys,* the divergence of the leaves is facilitated, in proportion as the coatings are approximated to them. In this case, it must be admitted, that there is an attraction between the coatings and the leaves; for, were repulsion between the leaves the cause of their divergence, the approach of the coatings would not increase it.

It may, however, be supposed, that the repulsion between the similarly excited leaves, being counterbalanced, more or less, in all cases, by the electric tension of the surrounding medium, the coatings may permit the electric fluid to recede through them with greater facility; and thus lessen the electric tension, in the direction in which they are situated.

Were this supposition to avail in the case of an electrometer with two leaves, it cannot apply in the case of an in-

* See Tilloch's Philosophical Magazine, vol. x. p. 38.

strument, lately contrived by me, in which, uninfluenced by the idea, that repulsion is the cause of electrometrical indications, I suspend only a single leaf. A brass ball, one-fourth of an inch in diameter, is so situated, that it may be made to touch the leaf, or retire from it to the distance of and inch, by means of a screw which supports it. (See plate—fig. 1.) This instrument is evidently more simple, and is far more sensitive, than any instrument with two leaves heretofore contrived.*

It will be admitted, I presume, that the contact between the ball and the leaf must result from attraction, whether the leaf be minus or plus; and that this would not cease to be true, although a second leaf were, as usual, suspended beside the first.

In a common electrometer, it is usual to have pieces of tin foil pasted on the glass case opposite the gold leaves. If attraction be exercised between the leaves and coatings, when moveable, it must also be exercised by the fixed coatings thus pasted on the glass. It is therefore established, that when coatings, whether moveable or fixed, are employed, the divergence is not caused by repulsion. It cannot, then, be reasonable to ascribe it to repulsion, though no coatings should be present, as when the leaves are suspended where nothing can attract them unless the surrounding air; especially as the air may be shown competent to perform the same office as the coatings, though not so well, on account of its presenting less matter within the same space. The lightness and mobility of the air, is no obstacle to this conclusion. When equally acted upon in all directions, as it must be in the case in point, air resists like an arch, or an elastic solid. The electric attraction may have a tendency to condense it about the sphere of excitement, but cannot move one portion more than another. This opinion of the agency of the air, is supported by the fact, that, in proportion as an exhausted receiver is larger, so will the difficulty of producing a divergency in the electrometrical leaves, situated within it, be increased. It would be difficult to procure a receiver so large, that gold leaves might not be made to diverge electrically in it, when exhausted; but leaves of light paper, which will easily be

* By means of an instrument with a single leaf, since constructed, I am enabled to detect the electricity produced, by one contact, between a copper and zinc disk, each six inches in diameter.

made divergent, in pleno or in vacuo, in a small vessel, will cease to be affected by a like influence, if suspended in an exhausted receiver sufficiently large. I am aware, that the air prevents the electric fluid from escaping, by its insulating power, and that when it is removed, electrometrical leaves cannot be sustained in a state of excitement much higher than the rare medium about them. Thus situated it may be alleged, that repulsion can no more act between them, to produce separation, than it does without them to keep them together. But this reasoning would apply, equally, whether they be in a large, or a small receiver; and, of course, does not account for the influence which the size of the receiver has on the divergency.

I will now adduce some additional facts and arguments, in opposition to the doctrine of two fluids.

According to Franklin, positive and negative, as applied to electricity, merely designate relative states of the same fluid. If, of three bodies, the first have more electricity than the second, and less than the third, it will be positive with respect to the second, and negative with respect to the third. According to Du Faye, there is a radical difference between vitreous and resinous electricity; and though separately exercising intense action, they neutralize each other by union. It is universally admitted, that the fluid evolved by the prime conductor of a glass cylinder machine, and that evolved by the cushion, are of different kinds or states. According to the American theory, the first is positive, the last negative. According to the French theory, the first is vitreous, the last resinous.

Let there be two machines, No. 1, and No. 2, so arranged,* that the positive or vitreous conductor of one, may communicate with the negative or resinous conductor of the other. In this case, the conductors, thus associated, form effectively, but one conducting mass; and one body, with a cushion on one side, and collecting points on the other, might be substituted for both. When this compound apparatus is put into action, it will be found that the intermediate conductor, tested by the resinous conductor of No. 1, is vitreous: but that it is resinous, when tested by the prime or vitreous conductor of No. 2. This result agrees

* See Plate—Figure 2.

with Franklin's doctrine, as above stated: but how can it be reconciled with the idea that the electricities are radically different, that the same state of excitement may be confounded with either. It may, indeed, be alleged, that the fluid is never completely vitreous, or resinous, or neutral; that although the proportion of either fluid be great, it may still be increased : that one conductor may be more vitreous than a second, but less so than a third—or more resinous than a second, but less so than a third ; and hence in either case, may give sparks with either. This is, to me, nevertheless, a complicated and unsatisfactory solution of the difficulty.

Pursuant to the Franklinian theory, there can be no really neutral point; though the earth, as a reservoir, infinitely great, compared with any producible by art, furnishes an invariable standard of intensity, above and below which, all bodies electrically excited, are said to be minus or plus.* It is perfectly consistent with this theory, that sparks should pass, as they are often seen to do, from conductors in either state ; not only from one to the other, but to bodies nominally neutralized by their communication with the earth. As the difference between the electrical states of the oppositely electrified bodies, must be greater than between either of their states, and that of the great reservoir, the sparks between them will be longer, but, in all other characteristics, will be the same. This practical result is irreconcileable with the doctrine of two fluids, according to which, there can be no electricity in the earth, which is not in the state of a neutral compound, formed by these opposite electricities. For it would be an anomaly, to suppose the reaction between a neutral compound, (a tertium quid,) and either of its ingredients, to resemble in intensity, and in its characteristic phenomena, the reaction which arises between the ingredients themselves. As well might we expect aqueous vapour to explode with hydrogen or oxygen gas, as

*In some discussions which took place some years ago, between Mr. Donovan and Mr. De Luc, in Nicholson's Journal, it was erroneously charged against Franklin's doctrine, that he supposed that there was an absolute state of neutrality. The doctrine of one universal fluid, is, to me, obviously irreconcileable with that idea, otherwise than as above explained. The quantity of electricity in the globe, is as unalterable in any sensible degree, as the quantity of water in the ocean; and it may therefore be assumed to be invariably the same.

they do with each other. Nothing can be more at war with the doctrine of definite proportions, of multiple volumes, and every analogy established by the chemistry of ponderable matter, than that two substances should combine, in every possible proportion, and with precisely the same phenomena; that they should be capable of neutralizing each other, and yet eagerly act as if never neutralized.

An argument in favour of the existence of two fluids, has been founded on the appearance of two burs, when a card is pierced by an electric discharge. This phenomenon is as difficult of explanation, agreeably to Du Faye's Theory, as Franklin's. If a current of electricity, flowing in one direction, should produce a bur, in piercing a card on the side towards which it flows, two currents should be productive of none, one current being precisely adequate to neutralize the other, according to the premises. The appearance may be explained by either doctrine, as resulting from intense attraction between the paper and the knobs transmitting the discharge.

It has been observed, in favour of the French theory, that, when the hands are made the medium of a feeble discharge, a shock is felt simultaneously in the fingers only of each hand; that, as the shock is made stronger, it affects the wrist, the arm, and finally the chest. This is considered as proving the operation of two distinct fluids; for, were the shock the effect of one current, it would be experienced equally, though feebly, throughout the whole of the circuit. Admitting that such a current were necessary to the discharge, agreeably to Franklin's theory, it ought to be felt most in the fingers, where it is most concentrated, as torrents flow with greater violence in proportion as their channels are narrowed. A current passing from one coating of a Leyden jar to another, is far from being necessary to restore the equilibrium of its surfaces. As soon as a circuit is established between them by the hands, the electricity in the hand which touches the negative surface, flows into it to supply the deficiency; while the hand which touches the positive surface, receives from it a surcharge. It is a case analogous to that of a syphon, in which a fluid, forcibly displaced from the level, is suddenly relieved from restraint; both columns would move at the same time, and with a velocity greater in any part, in proportion as the diameter should be less. The deficit caused in the hand in contact with the negative coating, is supplied by electricity from the arm; and this, again, from the body, where if the charge be inconsiderable, it is so much diffused as not to be perceived. In like manner, a *slight* surcharge received by the hand in contact with the positive coating, is diffused, as it proceeds up the arm to the chest, so as to be too feeble to be felt there.

A piece of tin foil, interposed between paper, has been found not to be perforated by a charge, which had pierced the paper on both sides of it.

If there were but one current, it is alleged that tin foil, situated as above mentioned, would be pierced during its passage from one coating to the other—*a fortiori*, then, it should be pierced, if two currents be necessary, passing each other. Besides, the explanation afforded, in the case of a shock received by the hands, applies to this: owing to its great conducting power, the tin foil diffuses the attraction from each side, so much, as not to be damaged by it.

Art. XIII.—*Description of an Electrical Plate Machine, the Plate mounted horizontally so as to show both negative and positive Electricity. Illustrated by Engravings.* By Robert Hare, M.D. Professor of Chemistry in the University of Pennsylvania.

The power of electrical plate machines, has been generally admitted to be greater, than that of machines with cylinders. The objection to the former has been, the difficulty of insulating the cushions, so as to display the negative electricity. Excepting the plate machine contrived by Van Marum, I have read of none in which this difficulty has been surmounted. It is still insisted upon, by respectable electricians, as if it had not been sufficiently removed by his contrivance.

I presume, therefore, that a description of a plate machine, by which both electricities may be shown, and which, after two years' experience, I prefer on every account, may not be unacceptable to the public.*

*See Plate —Fig. 3.

My plate (thirty-four inches in diameter) is supported upon an upright iron bar, about an inch in diameter, covered by a very stout glass cylinder, four inches and a half in diameter, and sixteen inches in height, open only at the base, through which the bar is introduced, so as to form its axis. The summit of the bar is furnished with a block of wood, turned to fit the cavity formed at the apex of the cylinder, and cemented therein. The external apex of the cylinder is cemented into a brass cap, which carries the plate. The glass cylinder is liable to no strain; it is only pressed where it is interposed between the block of wood within, and the brass cap without. The remaining portion of the cylinder bears only its own weight, while it effectually insulates the plate from the iron axis. The brass cap is surmounted by a screw and flange; by means of which, a corresponding nut, and disks of cork, the plate is fastened. A square table serves as a basis for the whole. The iron axis, passing through the cover of the table, is furnished with a wooden wheel of about twenty inches diameter, and terminates below this wheel in a brass step, supported on a cross of wood, which ties the legs of the table diagonally together. The wheel is grooved, and made to revolve by a band, which proceeds from around a vertical wheel, outside of the table. This external wheel has two handles; it may of course be turned by means either of one or both. It is supported on two strips of wood, which, by means of screws, may be protruded, lengthwise, from cases, which confine them from moving in any other direction. By these means, the distance between the wheels may be varied at pleasure, and the tension of the band duly adjusted.

Nearly the same mode of insulation and support which is used for the plate, is used in the case of the conductors. These consist severally of arched tubes of brass, of about an inch and a quarter in diameter, which pass over the plate from one side of it to the other, so as to be at right angles to, and at a due distance from each other. They are terminated by brass balls and caps, which last are cemented on glass cylinders, of the same dimensions, nearly, as that which supports the plate. The glass cylinders are suspended upon wooden axes, surmounted by plugs of cork, turned accurately to fit the space which they occupy. The cylinders are kept steady, below, by bosses of wood, which surround them. In this way, the conductors are effectually insulated, while the principal strain is borne by the wooden axes.

I consider this mode of mounting an electrical plate preferable to any with which I am acquainted. The friction arising from the band may render the working of the machine a little harder for one person, with one hand; but then it affords the advantage, that two persons may be employed for this purpose, or one may use both hands at once. The intervention of the band, secures the plate from being cracked, by a hasty effort to put it into motion, when adhering to the cushions, as it does at times; and the screws, by means of which the distance of the wheels is increased, obviate the liability of the band to slacken with wear.

ART. XIV.—*Description of an improved Blowpipe by Alcohol, in which the inflammation is sustained by opposing jets of vapour, without a lamp: Also, of the means of rendering the flame of Alcohol competent for the purpose of Illumination.* Illustrated by an Engraving. By ROBERT HARE, M. D. Professor of Chemistry in the University of Pennsylvania.

IN the ordinary construction of the blowpipe by alcohol, the inflammation is kept up, by passing a jet of alcoholic steam through the flame of a lamp, supported, as is usual, by a wick—otherwise, the inflammation of the vapour does not proceed with sufficient rapidity, to prevent the inflamed portion from being carried too far from the orifice of the pipe; and being so much cooled by an admixture of air, as to be extinguished. By using two jets of vapour in opposition to each other, I find the inflammation may be sustained without a lamp. If one part of oil of turpentine, with seven of alcohol, be used, the flame becomes very luminous.

In order to equalize and regulate the efflux, I have contrived a boiler, like a gasometer. It consists of two concentric cylinders, opening upwards, leaving an interstice of about one quarter of an inch between them; and a third cylinder, opening downwards, which slides up and down in the interstice. The interstice being filled with boiling water, and alcohol introduced into the innermost cylinder, it soon boils and escapes by the pipes. These pass through stuffing boxes in the bottom of the cylinder. Hence their orifices, and of course the flame, may be made to approach nearer to, or recede further from, the boiler.

The construction of this instrument, which I call the compound blowpipe by alcohol, may be understood from the engraving (Plate — Fig. 4.)

The idea of making the flame of hydrogen gas, or alcoholic vapour, more luminous, by an admixture of oil of turpentine, occurred to me in 1819; and I put the idea into practice, in the summer or succeeding winter of that year, when my pupils witnessed the result.

It seems, that Mr. Morey, by another catenation of ideas, was led to a similar inference, employing, in an alcohol blowpipe, whiskey and turpentine. He endeavours so to regulate the efflux of a single jet of the vapour of these fluids, as that it may continue to burn, when once lighted.

This process is too troublesome and precarious, for ordinary use. A mixture of alcohol and turpentine, are burned with a wick in a lamp, in the same way as oil, according to my plan. It is of course perfectly practicable, and I shall be surprised if it be not adopted in the western country, where alcohol may be had very cheap, and oil must be comparatively dear.

Art. XV.—*Description of Mr. Perkins' New Steam-Engine, and of the application of his Invention to Engines of the Old Construction.* (Edinb. Philos. Journal, No. xvii, p. 172.)

We have already communicated to our readers in the two last Numbers of this Journal, all the authentic information which we could obtain respecting Mr. Perkins' new Steam-Engine; and we have used the utmost diligence to obtain such farther information as may, in some measure, gratify that curiosity which these imperfect notices have excited. There never has been in our day an invention which has created such a sensation in the scientific and in the manufacturing world. The steam-engine of Mr. Watt had been so long considered as the greatest triumph of art and science, that it was deemed a sort of heresy to regard it as capable of improvement; and, notwithstanding all that has been done by Mr. Woolff, and other eminent engineers, the undoubted merit of their engines has scarcely yet been admitted by the public. Under such circumstances, Mr. Perkins' claims were likely to meet with various kinds of opposition. Instead of hailing it as an invention which was to do honour to the age in which we live, and to add a new and powerful arm to British industry, imperfect experiments and confined views were urged against the principle of its construction, the jealousies of rival traders were arrayed against it, imaginary apprehensions of danger were excited, and short sighted politicians sounded the alarm, that such an invention would precipitate our country from its lofty pre-eminence among the manufacturing nations of the world.

Most of these grounds of opposition have been now removed by direct experiment. Mr. Perkins' engine is actually at work. Its operations have been witnessed, and minutely examined by engineers and philosophers of all kinds; and the most unreasonable sceptics have been compelled to acknowledge the justness of its principles, as well as the energy of its operations. The active and inventive mind of Mr. Perkins, however, did not remain satisfied with this experiment. He has discovered a method, which we consider equal in value to his new engine, by which he can convey the benefit of his original principle to steam-engines of the old construction; and this has been recently succeeded, we are told, by a most extraordinary discovery, that the same heat may be made to perform its part more than once, in the active operations of the engine.

In order to convey to our readers some idea of these great inventions, we have obtained a drawing, made by M. Montgolfier, jun, and given in plate IV. Fig 16.* which, though it does not represent the actual machine, yet contains such a view of its parts as is necessary for understanding its principle.

The generator, which supplies the place of the boiler in ordinary steam-engines, is a cylinder ABCD, made of gun-metal, which is more tenacious, and less liable to oxidation, than any other. The metal is about three inches thick; and the vessel, containing eight gallons of water, is closed

* See Plate V.

at both ends, with the exception of the five openings for tubes, shewn in the figure. The generator is placed vertically in a cylindrical furnace EF, whose chimney is G, the heat being sustained by a pair of bellows, H, wrought by the engine, and conveying its blast in the direction IK to F. A heat of from 400° to 450° of Fahrenheit is thus applied to the generator, which is entirely filled with water. The valves in the tubes *m*, *n*, which are steel cylinders working in hollow steel-pipes, are loaded, the one with 37, and the other with 35 atmospheres; so that none of them can rise till the heat creates a force greater than the least of these weights.

Let us now suppose, that, by means of the compressing pump L. whose handle M is wrought by the engine, water is forced into the generator; this opens the valve above *n*, loaded with 35 atmospheres, and instantly a portion of the heated and compressed water *flashes* out in the form of steam of high elasticity, and of a temperature of 420°; and communicating by the steam pipe 2, 2, 2, with the valve box V, it enters the cylinder PP, lying horizontally, and gives motion to its piston PQ, which performs 200 strokes in a minute, and drives a crank R, which gives a rotatory motion to a fly wheel, as seen in the figure*. When the eduction-valve is opened, the steam, after having produced its stroke, is carried by the eduction-pipe 3, 3, 3, into the condenser STXV, where it is condensed into water at a temperature of about 320°, and under a pressure of 5 atmospheres; from thence, by the pipe 6, 6, 6, it is drawn into the pump L, whence it is forced along the pipe, 4, 4, 4, to the generator, thus performing a complete circuit.

The forcing-pump acts with a presure exceeding 35 atmospheres; consequently, when the water received in it from the condenser is urged into the generator, it must expel a portion equal to itself in volume: this portion, as above described, flashes instantly into highly elastic steam. The forcing-pump, too, is so contrived as to act with a a steady force, and, consequently, the expelled water must be driven from the generator in a steady current, and thus

* The parallel motion represented at PQ, is not the correct one used by Mr. Perkins. The piston-rod is connected by a flexible joint, with a sort of carriage with four wheels at each end, and working in a strong horizontal box of steel.

steam of constant elasticity is supplied to produce the power.

Some philosophers are of opinion, that the heat of the portion of water which escapes, is of itself sufficient to maintain the steam at that high degree of heat and elasticity with which it reaches the piston, and, consequently, that this engine is nothing more than a High Pressure Engine. Other persons, however, have supposed, and we confess we are among that number, that the portion of water which escapes, must necessarily carry off a quantity of heat from the adjoining stratum (the temperature of which *may be* thus reduced below the freezing point.) But it is more likely, that in virtue of some new law of the transmission of heat under the combined conditions of elevated temperature and high pressure, while the water, also, is forced to remain in contact with the red hot generator, the whole water in the boiler may be laid under requisition to furnish the discharged fluid with its necessary supply of caloric.

It is almost unnecessary to state, that the motion of the engine is produced by the difference in elasticity between the steam pressing on one side of the piston, and that pressing on the other. In the first case, the steam recently produced acts with a force, say of 500lb. on the square inch, while that on the weak side, or that communicating with the condenser, acts with only 70, the difference, or 430lb., being the true power gained.

When there is a surplus of water in the generator, occasioned either by working the forcing pump too violently, or by too vehement a heat, the water will escape by the tube *m* with a valve above, loaded with 37 atmospheres, and will pass by the pipe 5, 5, 5, into the condenser STXV.

In order to explain the ingenious manner in which the pipe 4, 4, 4 supplies the generator with water, we must observe that this pipe communicates with the pump L, which is wrought by the engine. This pump draws the water by the pipe 6, 6, 6, from the condenser STXV, and returns it by the pipe 4, 4, 4; that is to say, when the handle M is drawn up, the water rushes into the cylinder of the forcing pump, through a valve in the pipe 6, 6, 6, opening *into* that cylinder: This valve, of course, instantly closes when the downward stroke of the pump is made, and the water now escapes through a valve opening *outwards*, along 4, 4, 4; thus effectually cutting off all direct or uninterrupted communication between the generator and the condenser. In order to keep the water in the condenser at a pressure of 5 atmospheres, the blast of the bellows H goes round the condenser STXV; but when it is not sufficient for this purpose, cold water is introduced from the reservoir Z, by means of the pipe 7, 7, 7, loaded with 5 atmospheres.

From the high elasticity of the steam employed in this engine, it has been supposed to be very liable to explosion. This, however, is a vulgar error. Sincc there is no reservoir of steam exposing a large surface to its expansive force, as in the common high presure engines, the steam being generated only in sufficient quantity to produce each succeding stroke of the piston, the ordinary source of danger is entirely removed. But in order to take away all apprehensions on that subject, the induction pipe 2, 2, 2, in which the steam is actually generated, is made so strong as to sustain an internal force of *four thousand* pounds on the square inch, which is *eight* times more powerful than the actual pressure, viz. 500 pounds on the square inch, with which the engine works. This enormous superabundance of strength is still farther secured by means of the safety-pipe 8, 8, 8, provided with a thin copper "safety-bulb" *a b*, which is made so as to burst at a pressure of 1000 pounds on the square inch. In order to satisfy his friends on this very important point, Mr. Perkins has repeatedly urged the power of the steam to such a degree as to burst the copper bulb in their presence. This tube merely rends, or is torn assunder like a piece of paper, and occasions no injury either to the spectators, or to the apparatus; so that we have no hesitation in considering this engine, notwithstanding its tremendous energies, much more safe in its operations than even the common low pressure engine.

The safety tube 8, 8, 8, communicates also with the indicator *c d*, having a dial-plate *c e*, and an index *e f*, which, by means of a suitable contrivance at *v*, *v*, indicates the pressure or number of atmospheres with which the engine is working.

The cylinder and piston PPQ, have been separated from the rest of the engine, for the sake of distinctness. Their proper position, however, will be understood by supposing the two lines 9, 9; 9, 9 to coincide.

The engine which we have now described, is at present performing actual work in Mr. Perkins' manufactory. It is calculated as equal to a ten-horse power, though the cylinder is no more than two inches in diameter, and eighteen inches long, with a stroke of only twelve inches. Although the space occupied by the engine is not greater than 6 feet by 8, yet Mr. Perkins considers that the apparatus (with the exception of the working cylinder PP, and piston PQ,) is perfectly sufficient for a 30-horse engine. When the engine performs full work, it consumes only *two* bushels of coal in the day.

On the application of Mr. Perkins' principle to Steam-Engines of the old construction.

Great as the invention is which we have now described, yet we are disposed to think that the application of the principle to old steam-engines is not less important.* When we consider the enormous capital which is at present embodied in Great Britain in the substantial form of steam engines, and the admirable elegance and skill with which these noble machines impel and regulate the vast population of wheels and pinions over which they reign, we feel as if some vast innovation were proposed upon our established usages, by the introduction of Mr. Perkins' engine. The very idea that these potentates of the mechanical world should be displaced from their thrones; that their strong holds should be dismantled ; their palaces demolished. and their whole affairs placed under a more economical management, is somewhat startling to those who dread change, and admire institutions that both work and wear well. Mr. Perkins, however, has saved them from such a degradation. He has allowed them to retain all their honors and privileges, and proposes only to invigorate them with fresh influence and power.

In this new system, *the old engines, with their boilers, are retained unaltered.* The furnaces alone are removed. Mr. Perkins constructs a generator consisting of three horizontal tubes of gun-metal, connected together, filled with wa-

*This invention appears to have been fully established by direct experiment, whereas the *new engine*, with all its great promise, is still only undergoing trial.

ter, and supplied with water from a forcing pump, as in his own engine. This generator is exposed to heat in an analogous manner, so that, by means of a loaded valve, which opens and shuts, the red hot fluid may be constrained till forced out of the generator into the water in the boilers of Bolton and Watt. By this means, as much low pressure steam of four pounds on the square inch may be generated by *one* bushel of coals, as could be produced in the old engine by *nine* bushels. This most important result was obtained by actual experiment.

Since these great improvements have been effected, Mr. Perkins has made a discovery that seems, in its practical importance, to surpass them all. He now entirely dispenses with the use of the condenser, and works the engine against the atmosphere alone; and by methods with which we are not acquainted, and which indeed it would not be prudent for him to disclose at present, he is enabled *to arrest the heat after it has performed its mechanical functions, and actually pump it back to the generator, to unite with a fresh portion of water, and renew its useful labors.* In an operation like this, a considerable portion of the heat must still be lost, but the wonder is that any should be saved; and we venture to say, that the most sanguine speculator on the omnipotence of the steam-engine, never dared even to imagine the possibility of such an invention.

We are well aware that, in announcing this discovery, we are exposing ourselves to the criticisms of those whose belief is naturally limited by their own experience; but it is satisfactory to know, that Captain Basil Hall, (whose account of Mr. Perkins' discoveries and inventions, as delivered before the Royal Society of Edinburgh, gave such universal satisfaction,) has been entrusted with Mr. Perkins' discovery, and that he speaks confidently of the soundness of its principles, as well as the practicability of its application.*

We cannot quit this subject, without congratulating the country on the brilliant prospects with which these inven-

* After the 10th June, Mr. Perkins, whose address is Perkins & Co. 41, Water Lane, Fleet Street, is ready to take orders for his new engines, and his apparatus for producing low pressure steam for working the ordinary engines. The price, we believe, of the new engine, is only half that of Bolton & Watt's, with *one-third* of the savings of fuel, for a period of years which we have not heard stated.

tions promise to invest all our national concerns. At any period of the history of British industry, they must have excited the highest expectations; but, originating as they have done, when our commerce, our manufactures, and our agriculture, the three stars of our national prosperity, have just passed the lowest point of their orbit, and quitted, we trust for long, the scene of their disturbing forces, we cannot but hail them with the liveliest enthusiasm, and regard them as contributing to insure the pre-eminence of our industry, to augment the wealth and resources of the nation, and, by giving employment to idle hands, and direction to idle minds, to secure the integrity and the permanence of our national institutions.*

Art. XVI.—*Remarks on the composition and properties of the Chinese fire, and on the so called Brilliant fires:* by James Cutbush, A. S. U. S. A. acting Professor of Chemistry and Mineralogy, U. S. Military Academy.

In pyrotechny a variety of compositions are employed for the purpose of giving particular appearances to flame, and to accelerate as well as retard, according to circumstances, the combustion of pyro-preparations. The improvement in fire works depends altogether on this principle, *viz.* to vary as much as possible, with the greatest number of colours, the flame produced by the combustion of gun powder, or of charcoal, &c. in contact with nitrate of potash. Hence we find, that sundry saline and other substances are used for that purpose. By the presence or absence of particular substances, certain fires, so called, are designated. The name also is made to correspond, either with that of the inventor, the composition made use of, the appearance of the flame, or some remarkable property

*It is due to the truth and candor of philosophical history to mention, that Mr. Perkins is not our countryman; but the age of jealousy against America has happily gone past, and we hail, with sincere pleasure, any circumstance which contributes to the scientific renown of our great descendants, and companions in freedom and intelligence.†

†We cannot but respond to the generous sentiments of the Scottish Editor, and we trust that in *freedom and intelligence* we shall henceforth be indeed *companions.—Ed. Amer. Jour.*

which it exhibits when burnt. Hence the name of serpents, stars, crackers, tourmilons, ordinary and brilliant fire, Chinese fire, &c. Our object is at this time to notice in particular the Chinese and Brilliant fire, to which we purpose to add such remarks, with certain formulæ for the preparation of fire works, as to present a view of the subject in detail.

With respect to Chinese fire, it appears that a missionary in India, by the name of Incarville, discovered the composition, and mode of making it—a composition, which imparts so much splendour and effect to their fire works, and which seems to have been also used by other oriental nations.

What is denominated *brilliant fire*, of which there are several kinds, although partaking in a great measure of the character of the Chinese fire, differs from it nevertheless in an essential particular. Besides the usual substances, which enter into the composition of brilliant fire, it is now known, and the fact is sufficiently corroborated, that what is called *iron sand* by the Chinese, which they employ in their fire, and which imparts that particular character, is no other than cast, crude, or pig iron reduced to the state of sand or fine grains. Although I have not had an opportunity of making the experiment, yet I am of opinion, that certain ores of iron of the imperfect calciform kind, such as the magnetic iron, would produce nearly the same appearance. The menachanite I apprehend, would also answer. Crude iron seems to possess, in an eminent degree, the property of producing a very brilliant fire. The granulated iron of the Chinese, however, possesses no other properties than any other crude iron, provided it is *grained* properly, and used in a given quantity, or certain proportion to the other ingredients made use of. Their cast iron used for this purpose, was *old iron pots*, which they beat into grains not larger than mustard seed. These they separated into sizes, or numbers, in the manner of assorting shot, by means of sieves. The extraneous iron of castings, which may be obtained from the foundery, if it be free from sand (which is used in making the mould,) will answer every purpose. How far *wootz*, or the metal extracted from certain kinds of iron ore in the East-Indies, sometimes called Indian steel, would answer the purpose of ordinary cast iron, we are unable to determine; but it is certain, that it contains more carbon than steel, and less than cast iron, and hence in all probability might be used with advantage for the same purpose.

In consequence of the brilliant light produced when iron filings are thrown into the fire, an improvement in the fire of rockets was suggested. The honorary rockets, which we purpose to notice hereafter, owe their brilliancy to iron; which renders their fire much more beautiful than when gun powder, or the substances of which it is composed, is employed alone. Both iron filings and granulated cast iron have been used in the rocket-composition, not only for the so called honorary rockets, but also, occasionally, for signal rockets. There is one defect, however, in the composition, when iron is added; it is apt to rust, in consequence of moisture. To prevent which some have suggested immersing the grains. or filings in melted sulphur, which we apprehend would be almost as injurious, owing to the gradual formation of the sulphate of iron; and others, with more plausibility, have recommended the use of a few drops of oil, and agitating the filings or grains so as to receive a portionof it.

We have already mentioned the intention, or design of using iron, in the composition of Chinese fire. We may here add, that the scintillations produced by hammering ignited iron on the anvil, the combustion of steel in oxygen gas, &c. are similar instances. To combine all the effect of cast-iron, according to the use to which the composition is applied, and adapting it to different sized cases, or calibers; the Chinese, after granulating the iron, and assorting it as we before observed, separate it in numbers, as No. 1, 2, 3. The same practice is followed in Italy and France, where the most perfect fire-works are made. Indeed the experiments of the French, have confirmed very satisfactorily the account given by the French missionary.

Of the rockets, into the composition of which iron sand enters, there are two; one producing a red, and the other a white fire. The proportions of the different ingredients for such rockets, from 12 to 33 lbs. are as follows:

For red Chinese Fire.

Calibres	Saltpetre	Sulphur	Charcoal	Pulverized Cast iron, No. 1.	
Pounds.	Pounds.	Ounces.	Ounces.	Oz.	dr.
12 to 15	1	3	4	7	0
18 to 21	1	3	5	7	8
24 to 36	1	4	6	8	0

The standard proportion, according to this formula, for rockets of 12 to 15 ponds, is in the ratio of 16 oz. of saltpetre, 3 oz. sulphur, and 4 oz. of charcoal to 7 oz. of cast iron ; and for those of a larger size the quantity of cast iron and charcoal is increased, and for those still larger, the proportion of sulphur, charcoal, and iron is augmented. There are other formulæ, however, for the same purpose.

For white Chinese Fire.

Calibres	Saltpetre	powder	Charcoal		Pulverized Cast iron, No. 2.	
Pounds.	Pounds.	Ounces.	Oz.	dr.	Oz.	dr.
12 to 15	1	12	7	8	12	0
18 to 21	1	11	8	0	11	8
24 to 36	1	11	8	8	12	0

In the first formula the proportion of the cast iron to the saltpetre is as 7 to 16, 7½ to 16, or 8 to 16 ; but in the second, the quantity is greater, viz. as 12 to 16, and 11½ to 16. Now we may remark, that in the composition for white fire, not only the iron, but the charcoal is much greater, and in the place of sulphur, which is used in the red fire, meal powder is added ; which bears a greater proportion to the salt-petre than the sulphur in the first formula. These proportions, therefore, are so adapted as to produce a differently coloured flame. When the quantity of iron is considerable, with an increase of charcoal, and the addition of gun powder, besides nitre, the fire of the rocket will be white ; but when the quantity of iron is less, and in lieu of meal powder, sulphur is used, the quantity of charcoal being also smaller, the fire will be then red. There are several methods used to produce *red fire*, which we shall notice hereafter. In noticing some of the rocket compositions, it will be seen, that the ingredients themselves vary ; and in that description of rocket, denominated the honorary rocket, both iron sand and iron filings are used in different proportions.

Before we introduce the preparations for forming the different kinds of fire, according to the present improved formulæ, we purpose to notice the effect which such compositions possess, and at the same time the general rationale of their action.

It is apparent by the substances that enter into the rocket compositions already given, that when the mixture is inflamed, carbonic acid, sulphurous acid, and probably sulphuric acid, &c. are generated, and the iron in the state of combustion is thrown out. That the brilliancy of the combustion, is owing to the presence of iron, which is in its *crude* state, and therefore not converted into soft or malleable iron, is evident from the effect; and this effect is obviously more perfect than that which is imparted by malleable iron, or even by steel. The process of forming malleable iron, it must be observed, carries off a large quantity of carbon, oxygen, &c. For this reason the effect is inferior, although wrought or malleable iron will occasion scintillations, but not as brilliant; hence it is used in some of the so called *brilliant fires.* Steel, however, produces a more vivid effect than wrought iron, and hence also it is used for the same purpose. But fire workers give the preference to crude iron. The beauty and brilliancy of Chinese fire is, therefore, attributed to the peculiar state of the carbon and oxygen in the cast iron; for wrought iron, having an inferior effect for that use, is deprived in a great measure of these substances, or, in other words, the iron is rendered more pure. Steel, however, being superior to malleable iron, must owe that superiority to another state of combination of the iron and carbon, and in which the proportion of carbon is considerably less. We may thus account for the difference in the appearance of the flame in Chinese fire, and the ordinary brilliant fire.

We will not attempt to explain, or precisely account for the obvious difference in the combustion, and consequently the appearance of the flame, of crude iron, wrought iron, and steel in the respective compositions of Chinese fire, and brilliant fire. Some facts, however, may lead us to a more perfect knowledge of the subject, by considering the nature of the several sorts, or modifications of iron. In the white, grey, and black crude iron (the best of which for fire works are the two first) carbon and oxygen, with occasionally other substances, as silicium, &c. are differently combined; which, when made into malleable iron, loses from one fourth to sometimes one half of its weight.

According to Mr. Cloud, the quantity of carbon in cast iron is equal to $\frac{1}{8}$th of the whole weight, and M. Vauquelin gives the average quantity in steel at $\frac{1}{140}$th part, which differs, however, from the experiments of Mr. Mushet. Without considering the presence of oxygen, &c. in cast iron, or its agency when combined in a certain proportion with iron, we may infer from this statement that crude iron owes its superiority for fire works to its containing a *larger* quantity of carbon.

The experiments of M. M. Berzelius and Stromeyer, by which they produced a compound of iron, carbon, and silicium; of Mr. Daniell on grey cast iron, which he found to contain iron, oxide of iron, carbon, and silicium; of Berzelius, who proved the presence of magnesium and manganese, besides carbon and silicium in pure cast iron; of Mushet, who has shown the proportion of carbon in the different carburets of iron; and of Bergman and others on the existence of siderite, (phosphate, by some a phosphuret of iron) distinguishing thereby the cold-short and red short iron, are all useful in pointing out the composition, as well as the proportion of the substances, which constitute the so called carburets of iron. Mr. Mushet has shown that soft cast steel contains $\frac{1}{120}$th of carbon, common cast steel $\frac{1}{100}$th, the harder common cast-steel $\frac{1}{90}$th, and when the quantity of carbon is $\frac{1}{50}$th, steel is then too hard for drawing; and that white cast iron contains $\frac{1}{25}$th, the mottled cast iron $\frac{1}{20}$th, and black cast iron $\frac{1}{15}$th. It is found, that when the carbon amounts to $\frac{1}{50}$th of the whole, the hardness is at a maximum. In wootz, or Indian steel, there is a small quantity of aluminum and silicium. Mr. Daniell (*Quar. Jour. Science and Arts*, ii. 280) observes, that white cast iron is acted upon but slowly by acids, and exhibits a texture composed of a congeries of plates, variously aggregated; and that the grey or mottled iron, which is softer and less brittle, and readily bored and turned, affords, when treated with dilute muriatic acid, a quantity of black insoluble matter, consisting of carbon, iron, and silicium.

In all pyrotechnical compositions, therefore, into which iron enters as a component part, attention must be paid to these facts, in order to form a just estimate and conclusion of the effects they produce. In such compositions, the iron is first ignited by the heat generated in the combustion of the gun powder, or the nitrate of potash, charcoal, and sulphur, and in this state is thrown out and undergoes a complete combustion. The combustion of the iron is nothing more than its oxidizement; according to the rapidity of which, the *flame* is also rendered more or less brilliant.—This fact is obvious, but the *character* of the fire depends on the kind of iron employed, and hence the Chinese fire differs considerably from the ordinary brilliant fires. The oxidizement of the metal is never at the maximum, for when iron or steel is burnt in oxygen gas we obtain only the black protoxide, which consists of 28 iron + 8 oxygen = 36, or 100 iron + 28.68 = 128.68.

There is another fact to be observed, namely, that although the iron is ignited by the combustion of the composition, as for instance in a rocket case, the combustion of the iron itself does not take place within the tube, or only in part, but receives for the support of its combustion the oxygen of the atmosphere; for the greatest brilliancy of the fire is actually in the air, where the ignited and minutely divided iron is acted upon by the oxygen gas of the atmosphere.

As the substances which compose cast iron are chiefly iron, carbon, and oxygen, we may conclude, that as carbon by combustion in oxygen gas, or in atmospheric air, which contains it, is converted into carbonic acid, the carbon of the crude iron, during its combustion, forms carbonic acid. The products then are oxide of iron, and carbonic acid. These products are produced independently of those that result from the nitre, charcoal, and sulphur, or gunpowder, or other substancas employed.

That the heat produced, as well by the combustion of gun powder, as by that of the charcoal and sulphur in contact with the nitre, ignites the iron, and the iron, as we remarked, is thrown off in this state, and minutely divided, are facts which must strike the eye of the observer.

The quantity of iron, it will be seen, which enters into the composition of different preparations, is various according to the purpose for which they are used. The effect may be varied with the quantity of the metal. With respect to the ignition of the metal, and consequently of the combustion, these may be affected as the proportions of the nitre and charcoal are increased or diminished. In preparing the mixtures according to formulæ, attention is required in selecting pure materials. The proportions should be accurate, and the mixture intimately made, or the effect would be doubtful, and otherwise uncertain.

There are no preparations, perhaps, which require more care and exactness than pyromixtures; for their perfection depends on the quantity of the materials made use of, the exact proportion of each article, and the intimate mixture of the whole.

There is a method, however, required for preparing the composition for Chinese fire in particular. The substances, except the sulphur and pulverized or granulated cast iron, are to be passed several times (three generally) through a sieve.

The sulphur and cast iron are mixed by themselves, and afterwards with the other ingredients. They are then to be turned over frequently by the hand. Cases, which are usually made of paper, in the form of cylinders, are filled in the usual manner. These cases are several thicknesses of paper, and when filled are primed with meal powder and quick match.

In order to make the mixture of the sulphur and iron more intimate, the latter may be moistened with spirit of wine, which contains no water, as water would rust the iron, and destroy its effect. When the cast iron is reduced to powder, or rather grains, it is divided into several sorts, proportioned to the calibre employed. These sorts are marked and numbered as follows: for calibres under $\frac{7}{12}$ths of an inch in diameter, No. 1; $\frac{7}{12}$ths to $\frac{10}{12}$ths, No. 2; and No. 3 is adapted to calibres above.

In charging with the composition, care must be taken to turn it over repeatedly at every other ladle-full; because the iron, which is the heaviest substance, is liable to fall to the bottom. If the composition is not equally mixed, or diffused, the fire would be irregular, and go out by puffs.

Chinese fire, in cases, is commonly employed for *garnishing*, as it is called, the exterior circumference of a decoration in fire works, or in forming pyramids, galleries, yewtrees, cascades, palmtrees, and in short a variety of figures arrayed according to taste and fancy. Small cases are often employed in turning pieces for their last fire, in consequence of the superior brilliancy of the flame. It forms in its descent flowers of variegated beauty, which being scattered about by the rotation of the piece, to which it is attached, resembles the *pyro-hydraulic girandole* in the rays of the sun. In porportion to the velocity of which, the flame is more perfect.

There are certain compositions, commonly denominated *white-fire*, which are used in cases, and give motion to wheels and the like. This motion is on the rocket principle, and depends on the *propelling power* (gaseous products,) of the inflamed matter acting against a resisting medium, namely, the atmosphere. Chinese fire, however, possesses in this respect but little force; and hence when it is used in rotatory works, it is accompanied with two or more jets or cases of white fire. Cases charged with chinese fire, when burnt alone, will not communicate motion to a wheel. As the effect of Chinese fire on wheels, to the periphery of which the cases are usually fixed, depends greatly on the motion given to the wheel, its velocity should therefore be accelerated; which although the duration of its effect would be shorter, but more brilliant, may be produced by employing several cases of white fire, and communicating their fire one to the other by means of quick match in the usual manner.

The accelerated motion, thus given, would cause the composition to burn with more rapidity, in the same manner as a bellows would excite the heat of a furnace, and necessarily produce a more rapid oxidizement of the metal, as well as a more rapid combustion of the other ingredients

We may remark here, that with respect to the comparative force of compositions or that power by which rockets, &c. ascend, or which imports motion to vertical and horizontal wheels, it depends on the nature of the compositions, and the *recoil* in such instances is proportionate to the impelling power; for the resistance which the fire meets from the air, in the immediate vicinity of the calibre of the case, causes a reaction, that produces the recoil, and consequent motion of the wheel. The ascension of a rocket may be regarded as nothing more than its recoil, the direction of which is given by the rocket stick, which serves also as a balance.

With regard to the approved formulæ for the preparation of Chinese fire, which are said to surpass even those of the Chinese, the following are the most perfect:

*Composition of Chinese Fire for calibers under ten twelfths of an inch.**

†Meal powder - - -	16 oz.
Nitrate of potash - - -	16 do.
Sulphur - - - -	4 do.
Charcoal - - - -	4 do.
Pulv. Cast iron - - -	14 do.

Another of the same.

Meal powder - - -	16 oz.
Sulphur - - - - -	3 do.
Charcoal - - - - -	3 do.
Pulv. cast iron - - -	7 do.

Another, for Palm trees and Cascades.

Nitrate of potash - - -	12 oz.
Meal powder - - - -	16 do.
Sulphur - - - -	8 do.
Charcoal - - - - -	4 do.
Pulv. Cast iron - - -	10 do.

Another, white, for calibres of $\frac{3}{12}$ and $\frac{10}{12}$ of an inch.

Nitrate of potash - - -	16 oz.
Sulphur - - - - -	8 do.
Meal powder - - - -	16 do.
Pulv. Cast iron - - - -	12 do.

* The term calibre is here applied to the diameter of the case, or tube, in in which the composition is put.

† By meal powder is understood the granulated gun powder pulverised. The mealing of powder is sometimes done on a table with a roller, and the powder passed through a fine sieve; or it is put into a leather sack, and beat with mallets.

Another, for gerbes of ten and eleven twelfths, and one inch calibre.

Nitrate of potash - - -	1 oz.
Sulphur - - - - -	1 do.
Meal powder - - - -	8 do.
Charcoal - - - - -	1 do.
Pulv. Cast iron - - - -	8 do.

Before the present improvement took place, that of using cast iron, ordinary iron filings were altogether employed. Iron and Steel filings we remarked, were both used in the composition of brilliant fire. When iron or steel dust are used, the proportion it bears to other substances is various, *viz.* to meal powder as one to five, one to ten, &c. In one formula the proportion is still greater, and in another less; but by mixing seven and a half ounces of steel dust with meal powder, salt petre, and sulphur, in the proportion of eleven pounds, one pound two ounces, and four ounces respectively, is the best calculated to produce the ordinary brilliant fire.

With respect to what is denominated *fire jets*, or *fire spouts*, we may add that they are similar. They are cases charged solid with particular compositions. These jets are made with a calibre of one third of an inch, to one and one third of an inch in interior diameter. They are seven or eight exterior diameters in length, and are charged with the particular composition, driving each charge with twenty blows of a small mallet. The first charge is the ordinary fire composition. Fire jets are calculated for turning, as well as for fixed pieces.

Common fire for calibres of one third of an inch.

Meal powder - - - -	16 oz.
Charcoal - - - -	3 do.

Common fire for calibres of five twelfths to half an inch.

Meal powder - - - -	16 oz.
Charcoal - - -	3 do. 4 dr.

Common fire for calibres above half an inch.

Meal powder - - - -	16 oz.
Charcoal - - - -	4 do.

Brilliant fire for ordinary calibres.

Meal powder - - - -	16 oz.
Filings of iron - - - -	4 do.

Another, more beautiful.

Meal powder - - - -	16 oz.
Filings of steel - - -	4 do.

Another, more brilliant, for any calibre.

Meal powder - - - -	18 oz.
Salt petre - - - -	2 do.
Filings of steel - - - -	5 do.

Brilliant fire, more clear, for any calibre.

Meal powder - - -	16 oz.
Filings of Needle steel - -	3 do.

Silver rain, for calibres above two thirds of an inch.

Mealpowder - - - -	16 oz.
Salt petre - - - -	1 do.
Sulphur - - - - -	1 do
Filings of steel, fine - - -	4 do. 4 dr

'Grand Jessamin, for any calibre.

Meal powder - - - -	16 oz.
Salt petre - - - -	1 do.
Sulphur - - - - -	1 do.
Filings of spring steel - -	6 do.

Small Jessamin, idem.

Meal powder - - - -	16 oz.
Salt petre - - - -	1 do.
Sulphur - - - - -	1 do.
Filings of steel - - -	5 do.

White fire idem.

Meal powder - - - -	16 oz.
Salt petre - - - -	8 do.
Sulphur - - - -	2 do.

White fire, idem.

Meal powder - - - -	16 oz.
Sulphur - - - -	3 do.

Blue fire, for parasols and cascades.

Meal powder - - - -	8 oz.
Salt petre - - - -	4 do.
Sulphur - - - - -	6 do.
Zinc - - - - -	6 do.

Another blue fire, for calibres of half an inch and upwards.

Salt petre - - - -	8 oz.
Meal powder - - - -	4 do.
Sulphur - - - - -	4 do.
Zinc - - - - -	17 do.

The cases charged with this composition are only employed for furnishing the centre of some pieces, the movement of which depends on other cases, as these having no force, would not produce motion.

Blue Fire, for any Calibre.

Meal powder, - - - -	16 oz.
Salt-petre, - - - -	2 do.
Sulphur - - - - -	8 do.

Radiant Fire, idem.

Meal powder, - - - -	16 oz.
Filings of pins, (*d'epingles.*) - -	3 do.

Green Fire, idem.

Meal powder, - - - -	16 oz.
Filings of copper, - - -	3 oz. 2 dr.

Aurora Fire, idem.

Meal powder, - - - -	16 oz.
Gold powder, (*Poudre d'or.*) -	3 do.

Italian Roses, or Fixed Stars.

Meal powder, - - - -	2 oz.
Salt-petre, - - - - -	4 oz.
Sulphur, - - - - -	1 do.

Another for the Same.

Meal powder, - - - -	12 oz.
Salt-petre, - - - -	16 do.
Sulphur, - - - - -	10 do.
Crude Antimony, - - -	1 do.

We have thus introduced a variety of formulæ for the preparation of the so called *fire jets*, in order to show that artificial fire as it is termed, may be varied in its appearance not only by changing the proportions of the same ingredients, but by adding others, or abstracting one or more, according to the rules of pyrotechny.

In compound fire works, the *forms* which may be given to the flame of gun powder, or to the substances which compose it, either by increasing or retarding its combustion, or by changing the appearance of the flame, (giving it the form of jets, stars, rain &c.) are so numerous, that a knowledge of these changes and variations is considered highly important to the practical pyrotechnist. Thus we find in the composition of fire rain, that charcoal of the oak and pit coal will give the appearance of rain. The following is one of the formulæ :

Salt-petre, - - - -	8 oz.
Sulphur, - - - - -	4 do.
Meal powder, - - -	16 do.
Charcoal of Oak, - - -	2½ do.
Pit coal, - - - -	2½ do.

These substances are mixed, and put into cases, which are primed in the usual manner. The inflamed matter will resemble rain in its fall. Another composition intended for the same purpose, is similar to the Chinese fire, and contains a large proportion of the pulverised cast-iron. In the spur fire, so called from its sparks resembling the round of a spur, (used principally in theatres,) the particular appearance which characterizes it from other fires, is imparted to it simply by lamp black. The composition is

Salt-petre, - - - -	4½ lbs.
Sulphur, - - - - -	2 do.
Lamp black, - - - -	1½ do.

Besides the admixture of several saline substances, which communicate particular colours to flame, we know that the most brilliant red is given to flame by nitrate of strontian. A preparation in which it is used for theatrical purposes in France, is made as follows: take forty parts of dry nitrate of strontian, thirteen parts of finely powdered sulphur, five parts of chlorate or hyperoxymuriate of potash, and four parts of sulphuret of antimony, and mix them intimately in a mortar, observing at the same time to pulverize the chlorate of potash, separately. A little sulphuret of arsenic is sometimes added, and if the fire should burn dim, a small quantity of pulverized charcoal is added. The portable fire works made in miniature, and exhibited in rooms or close apartments, are much of the same nature as already described. Another description of fire works are made to communicate an agreeable odour, hence called *scented fires*. Vases of scent were greatly employed in the public feasts and ceremonies at Rome, Athens, and particularly in Egypt. The vessels which contained the composition, were placed by the Athenians in sculptured vases. We know but little respecting the compositions they used. Myrrh and frankincense were the most common, as well as the most prominent articles. It will be sufficient to notice two modern preparations of this kind. The *pastilles* or fire crayons, calculated for this purpose, are conical troches, which are set on fire upon a plate. They are made up of

Storax Calamit. - - -	2 oz.
Benzoin, - - - - -	2 oz.
Gum Juniper, - - - -	2 oz.
Olibanum, - - - - -	1 oz.
Mastic, - - - - -	1 oz.
Frankincense, - - - -	1 oz.
Amber, - - - - -	1 oz.
Camphor, - - - - -	1 oz.
Salt-petre, - - - -	3 oz.
Willow charcoal, - - -	4 oz.

In the *Dictionnaire de l'Industrie* is a composition for the same purpose, called the odoriferous paste; it is nearly the same as above, but contains cascarilla, cloves, oil of lemon and tincture of amber. In the *Archives des Decouvertes*, iii.

328, may be seen the account of M. Brillat Savarin's *irrorateur*, for scenting apartments.

The *vases of scent*, so much in use among the Greeks and Romans, were nothing more than earthen vessels, which contained a certain composition that was set on fire. A modern preparation of this kind is as follows:

Storax, - - - - -	4 oz.
Benzoin, - - - - -	4 do.
Frankincense, - - - -	4 do.
Camphor, - - - - -	2 do.
Gum Juniper, - - - -	1 do.
Charcoal of willow, - - - -	1 do.*

Other compositions, with regard to the additions made to gun powder, or to a mixture of nitre, charcoal and sulphur, in the formation of serpents, crackers, stars, Roman candles, rocket stars, variously coloured fire rains, white, blue, and yellow illumination port fires, &c. show that the colour and appearance of flame may be modified, with almost as many variations as the mixture of pigments employed by the painter.

Before concluding this subject, however, we may add, that the so called Bengal lights, although in some recipes orpiment is added, owe their particular character to the presence of antimony. The preparation was kept secret for some time. The true formula is the following:

Salt-petre, - -	3 lbs.	0 oz.	0 dr.
Sulphur, - - -	0 "	13 "	4 "
Antimony (the sulphuret,)	0 "	7 "	4 "

The salt-petre and antimony are reduced to fine powder, then mixed with the flowers of sulphur, and the mixture passed through a sieve. This composition is not used in cases, but is put into earthen vessels, usually shallow, and as broad as they are high. A small quantity of meal pow-

* The *Vestal Fire* of the Romans, in honor of the Goddess Vesta, was a different fire, although it was burnt in *earthen* vessels which were suspended in the air; it was under the care of the vestal virgins, who possessed extraordinary privileges, but if by carelessness they suffered the fire to go out, they were severely punished, and in the *interim* business was suspended.

der is scattered over the surface, and a match is inserted. Pots thus prepared, are covered with paper or parchment, to prevent the access of moisture, which is removed before the composition is inflamed. Blue lights, or blue fire, is a preparation in which zinc and sulphur, or sulphur alone are used. The particular colour is communicated by the zinc or sulphur. The most perfect blue is made as follows :

Meal powder, -	4 parts,	or Meal powder, -	4 parts.
Salt-petre, - -	2 do.	" Salt-petre, - -	8 do.
Sulphur, - -	3 do.	" Sulphur, - - -	4 do.
Zinc filings, - -	3 do.	" Zinc, - - -	17 do.

The representation of cascades and parasols are made with the above or similar compositions as already noticed ; but the ordinary blue lights, used sometimes for signals, and adapted to any calibre of a case, is composed of sixteen parts of meal powder, two parts of salt-petre, and eight parts of sulphur. Copper and zinc in the alloy of brass are added in the sparkling and green fire. To prepare which about three parts of brass filings are mixed with sixteen parts of meal powder. The amber lights are constituted of amber and meal powder, in the proportion of three of the former to nine of the latter. Copper communicates a green colour to flame. Verdigrease and antimony are frequently joined for that purpose. In the green match, for cyphers, devices, and decorations, the rule is to melt one pound of sulphur, and add one ounce of pulverized verdigrease, and half an ounce of crude antimony; cotton loosely twisted is soaked in the mixture when melted. When used, it is fastened to wire, and the wire is bent in the particular shape required. It is *primed* with a mixture of meal powder and alcohol, and a quick match is tied along the whole length, so that the fire may communicate to every part at the same time. A strong decoction of *jujube*, treated with sulphur, imparts to cotton the property of burning with a violet coloured flame. Sulphur alone, or zinc and sulphur, gives a blue device.

As to rocket compositions, more attention has been paid than to any other. The formulæ are, therefore, numerous. M. Morel, who has made many experiments with sundry compositions, has given the following as the most approved.

1. *For Summer.*

Salt-petre, - - - -	17 oz.
Sulphur, - - - - -	$3\frac{1}{2}$ do.
Meal powder, - - - -	$1\frac{1}{2}$ do.
Charcoal of oak, - - -	8 do.

2. *For the Same.*

Salt-petre, - - - -	16 oz.
Sulphur, - - - - -	4 do.
Charcoal, - - - -	$7\frac{1}{2}$ do.

3. *For Winter.*

Salt-petre, - - - -	17 oz.
Sulphur, - - - - -	3 do.
Meal powder, - - -	4 do.
Charcoal of oak, - - -	8 do.

4. *For the Same.*

Salt-petre, - - - -	44 oz.
Sulphur, - - - - -	4 do.
Charcoal, - - - -	16 do.

5. *For the Same.*

Salt-petre, - - - -	16 oz.
Sulphur, - - - - -	2 oz 3 dr.
Charcoal, - - - -	6 do.

6. *For the Same.*

Sulphur, - - - - -	3 oz.
Salt-petre, - - - -	20 do.
Charcoal, - - - - -	$8\frac{1}{2}$ do.

For the rockets of honor, which are a particular kind, either cast iron or antimony are used. The Chinese composition is the following:

Salt-petre, - - - -	5 oz.
Sulphur, - - - - -	$1\frac{1}{4}$ do.
Charcoal, - - - -	$2\frac{1}{2}$ do.
Meal powder, - - - -	1 do.
Pulv. cast iron, - - -	$2\frac{1}{2}$ do.

The charcoal is not pulverized very fine; the most impalpable part is not used, except for small works.

M. Bigot has given an improved formula for the same purpose, viz.

Meal powder, - -	2 parts.
Salt-petre, - - - -	10 do.
Sulphur, - - - -	$2\frac{1}{2}$ do.
Charcoal, - - - -	5 do.
Cast iron, pulverized, - -	5 do.

He has also given a *particular* composition, in which antimony is added in lieu of iron. It consists of

Salt-petre, - - -	16 parts.
Sulphur, - - - -	4 do.
Charcoal, - - - -	9 do.
Antimony, (crude) - -	2 do.

It was not our intention to have noticed at this time the war or incendiary rockets, and particularly the so called Congreve rockets; but as the composition of the Congreve rocket is supposed to differ from the ordinary kind in many essential particulars, the analysis which we subjoin, refutes such an opinion.

General de Grave transmitted to Paris, a Congreve rocket, found on the French coast. The case was made of grey paper and painted. The larger sort are usually made of sheet iron.

The inflammable matter was of a yellowish grey colour, and the sulphur was distinguished with the naked eye. It burnt with a quick flame, and exhaled sulphurous acid gas. The examination was made by Gay Lussac. According to his analysis (*Archives des Decouvertes*, ii, 303.) the composition is

Nitrate of potash, - - -	75.00
Charcoal, - - - - -	1.6
Sulphur, - - - - -	23.4
	100.

Gay Lussac, after determining the proportions, made a composition of a similar kind, and charged a case with it, which had the same properties as the English rocket. The proportion of charcoal is too small.

Having taken a general view of the nature and properties of some pyrotechnical compounds, we may here remark, that most, if not all the compositions used in fire works, including military pyrotechny, were more the result of the labours of the artisan, who was neither directed by fixed principles, nor by a knowledge of the effects and properties of bodies, than of the systematic experiments of the chemist; and yet, in consequence of some fortuitous and repeated trials, we find that he has been successful, and moreover has presented a body of facts, which, we may reasonably infer, may either be rendered more perfect, or enlarged and improved upon by the direct aid of chemical science.

The Chinese have been longer acquainted with the art of preparing fire works than the Italians or French. Barrow, in his *Travels in China*, mentions particularly some of their exhibitions. After stating the appearance of their different fires, he remarks, that "the diversity of colours with which the Chinese have the secret of clothing fire, seems one of the chief merits of their pyrotechny."

It was not, however, until 1739, in consequence of the peace which took place in that, or the preceding year, that fire works in Europe were rendered more complete. Very splendid exhibitions were made at the *town-house* of Paris, at the *Pont neuf*, and at *Versailles*.

The duke of Sully in 1606 made an exhibition of fireworks at Fontainebleau; and in 1612 Morel, commissary of artillery, prepared also an exhibition.

The art of communicating fire from one piece of firework to another, as is now done in a system of mutations, was discovered by Ruggeri, artificer to the king at Boulogne in France, in 1743. The Italians however, preceded the French in the knowledge of pyrotechny.

Pyrotcheny is at present considered under two heads, *viz.* fire works for exhibition, and military fire works. The latter is unquestionably the most useful, as it embraces a variety of preparations calculated for attack and defence, both for naval and land service.

The ancients do not seem to have been much acquainted with fire works, and this may be attributed to a variety of circumstances. Nitre, if we believe Professor Beckman was either not known, or, if it was, its properties, as its decomposition by charcoal, &c. were not investigated; and he infers, as the only certain mention of salt-petre is to be found in the manuscript containing directions for preparing gun powder, that our salt-petre was not known to the ancients. The knowledge of gun powder, however, produced a new era in pyrotechny.

The fire works of the ancients consisted for the principal part of illuminations, and the use of some particular compositions, in which certain oils, as naptha, were employed. Alexander the Great, witnessed some experiments with naptha at Ecbatana.

Sundry tricks, by fire, were performed by the ancient jugglers. Had the work of Celsus, which he wrote against the *Magi*, been preserved, it is highly probable we should have been in possession of a variety of facts, connected with their rites and ceremonies. Of their rites, whether religious or otherwise, they appear to have made use of fire under some particular form.

The representation of figures *in fire*, still practised by the Chinese, was common with the ancients. When Henry II. entered Rheims, there was an exhibition of that kind, in honor of his entré.

The ancients, however, had two descriptions of fire works; one of which they set off by hand, and threw among the people, and some were merely illuminations. Of this description were cardons, stars, and fire balls. A writer of antiquity observes, in speaking of these exhibitions, that "he has seen a great many of these artificial machines, but to speak the truth, few which have succeeded, and it is commonly after acclamations of joy, the spectacle is finished by the destruction of some, and the wounding of a great number."

The other description of fire works was calculated for theatrical exhibitions, which consisted of illuminations, transparencies, various figures of man and beast clothed with fire, &c. The art of representing figures in fire, seems to have been the most perfect. The figure according to modern art, is first covered with clay, or stucco (plaster,) to prevent the action of the fire, and then *decorated* with a multitude of small cases charged with sundry compositions that produce, if so required, variously coloured fires. These cases are so connected by means of quick match, as to communicate their fire to each other, in succession or otherwise.

Another mode consists in mixing sulphur with starch into a paste with water, and covering the figure with the mixture, observing previously to coat it with clay or plaster. While moist, the coat of sulphur and starch is sprinkled over with gun powder. When dry, matches are arranged about it, so that the fire may speedily communicate on all sides. Garlands, festoons, and other ornaments may be represented in this manner, using such compositions as produce differently coloured fires. In connection with this, cases of one third of an inch in diameter and two and a half inches in length, may be employed, charging them with different compositions. These would produce an undulating fire. The charge may consist of Chinese fire, formed for this purpose of one pound of gun powder, two ounces of sulphur, and five ounces pulverized cast iron, No. 1, or of the so called ancient fire, composed of one pound of meal powder, and two ounces of charcoal, or of brilliant fire made of four ounces iron filings, and one pound of gun powder. To these respective charges, the addition of *sparks* may be made by using at the same time the saw dust of fir, poplar, &c. previously soaked in a saturated solution of nitrate of potash, and when nearly dry, sprinkled with sulphur. Bearded rockets (*fusèe chevelue* of the French,) are sometimes employed for the purpose of producing undulations, filamentous appearances, &c. in the atmosphere, resembling frizled hair, which terminate in a shower of fire. These are made of quills filled with the usual rocket-composition, and primed with a little moist gun powder, both to keep in the composition, and serve as a match. It is to be observed, however, that a rocket charged in the usual manner, and *loaded* in its cap or head, which is conical, in the same way as with stars, serpents, crackers, &c. would so disperse them, on the termination of its flight, as to produce in the atmosphere the appearance we have mentioned.

It has been supposed, that some of the ceremonies of the ancients, such as the feast of the lamps, *lampadaria*, *lamptericeæ*, &c. were exhibitions of the same character, in which however lamps were used. But such feasts or celebrations appear to have been confined to the mere exhibition of lights. The inhabitants of some of the cities in Egypt were obliged, on such occasions, to illuminate with a great number of lamps placed before their houses. Herodotus (*lib.* ii.

cap. 62) notices this festival, and that it extended throughout the country, and the lamps were kept burning during the whole night.

In the *festum encœniorum*, or the feast of the dedication of the temple, which was celebrated in December, and lasted eight days, lamps were also lighted. In Greece and Rome such illuminations were common, and mostly in honor of Minerva, Vulcan, Prometheus, Bacchus, &c. Such were he lampadaria and lampterice*œ* of the Greeks and Romans.

Among the oriental nations, there is even at the present day a celebration in which lamps are lighted. In China, in particular, it is general throughout the whole empire, and the celebration is conducted with great splendour.

While noticing this subject, we may remark also, that, as the now common practice of lighting the streets of cities was not in use some few centuries since, Caligula caused the streets of Rome to be illuminated on certain occasions, as when games were exhibited. After Cataline's conspiracy had been defeated, and Cicero was returning home, lamps and torches were lighted in honor of that great orator. The emperor Constantine caused the city of Constantinople to be illuminated with lamps and wax candles. The primitive christians, either dictated by policy, or compelled by authority, often illuminated their houses on idolatrous festivals in a more elegant manner than the heathens. On birth days, the ancients illuminated their houses by suspending lamps from chains. These facts show, that illuminations are of great antiquity, and celebrations in that way not a modern practice. With regard, however, to fire works proper, if we judge correctly, the ancients were very deficient for the principal reason, that they were unacquainted with gun powder.

West Point, *Dec.* 31, 1822.

Art. XVII.—*Cryophorus of Dr. Wollaston.* Editor.

We procured this instrument, with the balls one inch and a half in diameter, and the connecting tube fifteen inches long; the water was in such quantity, as to fill full half of one of the balls. The empty ball was immersed in snow, and diluted nitric acid; a distillation of aqueous vapor took place; water condensed in the empty ball, and soon froze into a film, lining its interior. A few minutes after, a film of ice began to form on the *upper* surface *only*, of the water in the other ball, and gradually increased, till it was a quarter of an inch thick. All this is what might be expected. But on gently moving the instrument, (it was merely lifted, and not shaken,) the ball in which the water was freezing suddenly burst with a considerable explosion, and a pretty loud report.

The apparent cause of this event, (which we have not heard of before, as occurring with this instrument,) appears to be, that as the water filled a full hemisphere, (and we believe a little more,) the film of ice first formed, and occupying an equatorial plane, and therefore the largest diameter in the sphere, could not recede in order to give room for the expansion of the water, as it froze beneath. It would therefore, in all probability, have burst, had it not been moved; but, it is also probable, that the water beneath the ice had been cooled to a point below 32°, and perhaps several degrees below; when moved therefore, (agreeably to what happens commonly in such cases,) the water below the film of ice probably shot very suddenly into crystals, and thus, not having room to admit of the requisite expansion, the ball of course exploded.* This little occurrence was thought worthy of being mentioned, both as affording illustrations of laws and facts before known, and as suggesting an obvious caution in forming the cryophorus—to introduce less water than what will fill half the ball.

Art. XVIII.—*Remarks on the Patent Water-Burner;* By Samuel Morey, (*in a letter to the Editor.*)

Orford, July 30th, 1823.

Sir,

Trusting that I have in some measure reduced the Patent Water Burner, or Vapour Lamp, to a form that unites utility with convenience, for general and domestic purposes, I again wish to submit to your perusal, for a place in your

* It is possible that adhesion between the glass and the ice might have contributed to the effect.

Journal, if thought worth inserting, an account in part of those improvements, including a few remarks and experiments.

If we put into one of these lamps two parts water, and one spirits turpentine, and raise the temperature to about 204° or 206°, the water boils, and the vapor that comes over is composed of about equal parts of each; or if we put in two parts water, two of alcohol, and of one spirits turpentine, they boil at about 180°, and the vapor comes over nearly in that proportion; or if eight parts of alcohol, and one of the oil is put in, they boil at about 160°, and the vapor comes over in about that proportion. All these vapors, when made to issue through small openings, like gas for lights, burn with a pleasant white flame, free from smoke or smell. The water and oil give evidently the most intensely white flame, but it is somewhat difficult to make them burn without a sensible agitation of the flame, and a constant detonating noise, evidently arising from the perpetual decomposition, and recomposition of the water. The addition of alcohol adds much to the bulk and mildness of the flame, but nothing to its intensity. The proportions in which these substances will come over, can be made to vary by varying the proportions in the lamp, and also by its construction. It was desirable to have as small a proportion of the oil come over, as would give sufficient whiteness to the flame. For that purpose, the lamp is generally so constructed as to have the boiling round a tube, or on one side. Whenever there is a proportion of water in the lamp, the oil floats on the surface, and by the current created at the point of boiling, it is carried as far off as it can recede, when it will be less agitated, and of course will evaporate the slower. In this way, when I have put in a quart of water, and only half a gill of the spirits turpentine, the proportion of the former that came over, was nearly two to one of the latter, and I thought the flame to be more intensely white than I had ever observed it before. There is no pretension to exactness in these estimates; by knowing the quantity of each that was put in, from the appearance of the residuum after burning, an estimate was formed of what had been consumed. When water and oil only are used, the latter never all comes over. It appears to be perpetually changing to a resin, by the decomposition of the water. For common use, the common tin plate answers well for making nearly the whole of the lamps. A conical form is the most convenient. When used, it may be placed on a stove over a cylinder of charcoal, or in any situation where the heat will be sufficient to keep up a gentle distillation. The vapor then may issue above. If intended to support its own evaporation, the vapor will issue from a tube, projecting from one to two inches below the bottom, and about one back of the front side, opening forward, so that if it inclines to boil too fast, the flame will be pushed out so as to lose its heating effect in some measure, on the bottom, by which means it will perfectly regulate itself. To insure a regular issue of the vapor, we pass it one or more inches through a tube, one fiftieth or one sixtieth of an inch bore, and which we also fill with very fine wire, if a light is wanted not greater than three or four candles. These tubes, when thus filled, appear to answer every purpose of the gasometer for gas lights, as respects the regular issue of the vapor. The temperature of the vapor must be preserved until it issues and is inflamed. A half gill of common proof rum or whiskey, and about one eighth of a gill of oil of turpentine, will burn, supporting its own evaporation, four or five hours, giving the light of a good candle. If we divide one of these lamps near the middle, leaving a small hole at top in the partition, and insert the tube to let out the vapor in the front part, and put into the back part oil of turpentine, and into the front part, equal parts of alcohol and water, and apply heat until the water boils, the flame will be entirely blue and scarcely visible; but if we add water to the oil of turpentine in the back part, the flame will then be a very white pleasant one, that can scarcely be made to smoke. This shows, at least, I should think, that the water was convenient and useful. If the temperature of water in a tumbler is raised to a little above 200°, having a small ball of charcoal suspended in it, there is no appearance of boiling; but if a small quantity of spirits turpentine is added to the water, the ball of coal will in a few seconds commence, and continue sending up a column of steam, nearly of its own bulk, while the bottom of the vessel where the heat is applied, and balls of wood and of metal suspended on each side of the ball of coal, furnish none. Why is it so? The water's temperature is not high enough to form steam until it comes in contact with the ball of coal. Can that add any thing to its temperature, as its own is raised solely by the water? This experiment, I have thought, as well as very many others, looks much as if there was some action between the water and oil, as well as coal, independent in some measure of caloric. In the practical use of the pitch pine for light, and light and heat, nothing more is necessary than to distil it by a gentle heat, suffering the vapor to escape pretty freely through parallel flattened tubes, surrounded by a quick current of hot air; the light will be as clear and white as Argand's lamp with oil. If inflamed tar in a shallow pan is raised to a high temperature, and a very fine spray of water is thrown over it, for every particle of water that falls into the tar, there will shoot up a vivid white needle-like flame. The spray may be so fine as to fall quietly into the tar; it then burns with innumerable white shooting flames, about one eighth of an inch long, giving the surface of the tar a most beautiful appearance.

If we take a conical formed lump of moistened clay, and immerge it in burning tar, nearly of the boiling point, and suffer it to remain a few seconds, then raise it about three fourths of an inch above the tar, beautiful white needle-like flames will continue for some time to issue from the clay, and from the tar directly under it, giving sometimes such an intense white light that the eye can scarcely bear it. The flame too, appears to be pushed out in every direction, to the exclusion of the atmospheric air.

As good and steady a fire, for light and heat, as pleasant perhaps as any other, and cheaper and easier made, it is thought, can be furnished from tar, by putting a quantity into a metal vessel, three or four inches deep, and setting that vessel in a pan of water. Drop on to the tar three or four drops of spirits turpentine, apply a flame and your fire is made, and will continue to burn with little (or not any) smoke, if a strong draft, until the whole is consumed, leaving very little residuum, and that apparently a good japan. The water appears to preserve the tar at a low temperature, prevents a possibility of its boiling over, causes the evaporation to be much slower, thereby allowing the atmospheric air to mix more freely with that of the tar, as well as the vapor of the water, which certainly contributes much to the consuming of the smoke. Sometimes the current of air carries over the vapor of the tar, and mixes it with that of the water; when the proportions are right, it is then curious to observe the very white, silver-like appearance of the flame. When the snapping of the tar would be inconvenient, it may be prevented by boiling it a few minutes before it is used, to get rid of the coarser particles of water. But when it is desired to give a steady, durable light of any size with tar, the best mode I have yet tried is to raise the tar by machinery to the upper part of the tar vessel, passing it off through a small tube into a small cup, say to hold half a gill. Another small tube from near the bottom of the tar vessel, passes upward through this little cup, about two thirds the way to the top. The machinery for raising the tar may be kept in motion by connecting it with any moving power. The tar, when raised, flows out into the small cup, is there inflamed, and then continues to burn, without any further attention, so long as the supply is kept up. It is furnished faster than it is consumed, but the overplus flows out before the small cup is full, down the small tube into the tar vessel at bottom, where, by its high temperature, it preserves the body of the tar at a temperature that makes it flow freely if ever so cold. As the tar in this little cup is all that is, or can be inflamed at a time, it renders it perfectly safe, and the time of burning in a sense unlimited.

Yours very respectfully

SAMUEL MOREY.

PROF. SILLIMAN.

ART. XIX.—*Analysis of the Pyroxene, found at the Franklin Iron Works, near Sparta, Sussex Co. New-Jersey, by* HENRY SEYBERT.

AN account of this mineral, by Messrs. Wm. H. Keating, and Lardner Vanuxem, was published, in the Journal of the Academy of Natural Sciences in this city.* After an attentive examination, they decided, that it was a *new species*, and called it *Jeffersonite.* Mr. Keating analysed it, and this they observe "fully confirmed the conclusions drawn from its mineralogical characters." His analysis gave the fol-

* Journal of the Academy, Vol. 2, p. 194.

lowing results per 1000, viz. "Silica 0.560; Lime 0.151; Protoxide of Manganese 0.135; Peroxide of Iron 0.100; Oxide of Zinc 0.010; Alumine 0.020. Loss by calcination 0.010=0.986;" and the substance was accordingly determined to be a *Trisilicate.* This mineral was separated by these gentlemen from the Pyroxene of Haüy, because they say "its cleavages are essentially different;" that it is remarkably different from pyroxene in being decidedly harder; that these minerals differ in their specific gravities, and add, "the chemical analysis offers another important difference, in the *absence of Magnesia, which appears to be essential to pyroxene.*"

Dr. Troost, of this city, has lately paid particular attention to the crystallographical characters of this mineral, and found, that they perfectly coincide with those of well characterized pyroxenes; a full account of his investigations, will, very soon, be published in the Transactions of the Academy of Natural Sciences.

Mr. Keating's memoir was republished in the Annales des Mines, Vol. 7, p. 415, and in a note, p. 419, we have the high authority of Professor Berthier, for considering the *Jeffersonite* a new mineral species; his opinion is however, entirely founded on the results of Mr. Keating's analysis: he says, "La composition de la *Jeffersonite* ne permet de confondre ce mineral avec aucune espece connue. Cette pierre différe essentiellement du pyroxéne quoiqu' elle s'en rapproche par sa forme, en ce qu'elle est composée de *Trisilicates,* tandis que les pyroxénes ne contiennent que des *Bisilicates.*"

I was, therefore, anxious that a further examination of this subject should be made, more especially, as so much depended upon the results of the chemical analysis. It would have gratified me very much, if this could have been done by Mr. Keating; but his absence, from this city, will, probably, continue several months; I therefore determined to undertake it myself.

The specimen, which I examined was shown to Mr. Vanuxem. Without any hesitation, he said it was well characterised *Jeffersonite* from New-Jersey. The recent fracture, of this mineral, is of a very deep olive colour; the external surface, owing to exposure, is deep brown; colour of the powder, yellowish brown. Externally, it is dull; its recent fracture is resinous. Opake, crystalline, presenting two easy cleavages in opposite directions. When fractured, it frequently yields very regular rhomboidal fragments. Scratches glass, and scintillates with steel. Its specific gravity is 3.407. It is not magnetic. Before the blowpipe, it readily fuses into a black vitreous globule.

ANALYSIS.

A. 3 Grammes of Pyroxene, finely pulverised, after exposure to a red heat, became a shade darker, and weighed 2.965 grammes; therefore the dimunition by calcination was 1.166 per 100.

B. The product of the calcination (A,) was mixed with 9 gr. of caustic potash, and exposed to a red heat, during thirty minutes, in a silver crucible. The matter did not enter into perfect fusion, but assumed a pasty consistence; when cold it was of a very deep green colour, which it imparted to the water used to dissolve it: an excess of muriatic acid was added, when heat was applied a perfect solution was formed with the evolution of chlorine. The solution, of a lemon yellow colour, was evaporated to a dry gelatinous mass, which was treated with acidulated water and again moderately evaporated; more water was then added and the liquor was filtered; the Silica, remaining on the filter, after perfect edulcoration and calcination weighed 1.36 grammes on 3 gr. or 45.333 per 100.

C. Caustic potash was added to the liquor (B,) to neutralise the excess of acid. On the addition of hydro-sulphate of Potash, a black precipitate was obtained, which was well washed and treated with nitro-muriatic acid, the iquor was evaporated to dryness to expel the excess; when the residue was treated with water, it appeared that a portion of the precipitate had resisted solution, the liquor therefore was filtered, the residue was moderately calcined, to expel the sulphur, and after being heated to redness weighed 0.06 gr. This product was Alumina, and as it will appear, that no Alumina was taken up by the acid, the quantity contained in the mineral amounts to 2.00 per 100.

The filtered liquor was boiled, during thirty minutes, with a considerable excess of caustic potash; it was filtered, to separate the fluid from the dark coloured precipitate which was formed; it was supersaturated with muriatic acid and then treated with an excess of ammonia: a white precipitate was formed, which entirely redissolved in the excess of Alcali; therefore no Alumina was dissolved by the nitro-muriatic acid. The ammoniacal liquor was supersaturated with muriatic acid, and boiled with an excess of subcarbonate of Soda; the white precipitate of sub-carb. of zinc thus formed, after being well washed and strongly calcined, yielded 0.06 gr. of oxide of zinc on 3 gr. or 2.00 per 100.

The dark coloured precipitate was dissolved, in the humid state, in acetic acid; the solution was evaporated carefully to a perfectly dry mass, which, after ebullition with water, was filtered: the peroxide of iron collected on the filter, by calcination with caustic potash, was found to be perfectly free from manganese; it weighed 0.28 gr. on 3 gr. or 09.333 per 100.

The manganese was precipitated from the liquor by ebullition with an excess of sub-carbonate of soda; the precipitate, which was colourless, was strongly heated and afforded 0.43 gr. of Tritoxide of Manganese, equivalent to 0.397 grammes of Protoxide on 3 gr. or 13.233 per 100.

D. The liquor (C), from which the black precipitate was obtained, when treated with oxalate of potash, afforded a precipitate which, having been decomposed by a strong calcination, gave 0.62 gr. of lime on 3 gr. or 20.666 per 100.

E. An excess of caustic potash, added to the liquor (D), gave rise to a precipitate of magnesia, which, after exposure to a high temperature, weighed 0.140 gr. on 3 gr. or 4.333 per 100.

The constituents of this pyroxene therefore are,

	per 100 parts,	containing oxygen
A. Loss by calcination,	01.166	
B. Silica	45.333	22.802
C. Alumina	02.000	
C. Oxide of Zinc	02.000	———
C. Peroxide of Iron	09.333	02.861
C. Protoxide of Manganese	13.233	02.900
D. Lime	20.666	05.805
E. Magnesia	04.333	
	98.064	11.566
	100.000	
Loss	1.936	

According to this analysis, the essential constituents of this mineral are *Bisilicates*, and its mineralogical formula is, $FS^2 + mg\ S^2 + 2\ CS^2$.

The results of my analysis differ materially from those of Mr. Keating's, especially in the proportion of the *Silica*, and in my having found *Magnesia* in this mineral.*

The constituents of this mineral being *Bisilicates*, it cannot, therefore, constitute a *new species*, but must necessarily be ranked with the *pyroxenes*. Mr. Rose examined many pyroxenes, in the laboratory of Professor Berzelius, and he observes, that the analyses of different specimens show, "that all minerals which have the crystalline form of pyroxene are *Bisilicates*."† This chemist does not consider *Magnesia* essential in the composition of pyroxenes†; when treating of the "Black crystallized pyroxene from Taberg, in Wermeland," which yielded 4.99 per 100 of Magnesia, he says expressly, "if the magnesia is not taken into consideration, this pyroxene belongs to the second division," viz. to that of "pyroxenes with lime and protoxide of iron as bases."‡

ANTIQUITIES.

Art. XX.—*On the Celtic Antiquities of America.* By John Finch, F. B. S. &c. *Professor of Geology and Mineralogy.*

From our earliest infancy we are accustomed to admire every thing connected with ancient times. The sentiment seems implanted in our nature, and if the monuments we

* The proportions of the silica obtained from three different trials, were per 100, 1st. 45.333—2d. 45.000—3d. 45.333. In my preliminary experiments, the magnesia was detected, after the silica had been separated, by treating the liquor with an excess of sub-carbonate of ammonia; after separating the precipitate, the liquor was treated with ammonia, and phosphate of soda; ammoniacal phosphate of magnesia was precipitated.

† Annals of Philosophy, new series, for March 1823, p. 224.

‡ Annals of Philosophy for March 1823, p. 227.

see, or those we read of, belong to our native country, or even to one which we have made our home, the interest becomes more intense, and every faculty of the mind is exerted, to trace their origin and investigate their use.

With communities of men, as with individuals, great importance is attached to a long line of glorious ancestry, and the first desire of all civilized nations has been, to investigate the history of the tribes who first visited the countries they inhabit, and it is an honorable feeling which prompts men to ascertain the history and migrations of the ancient inhabitants of the earth.

While the people of Europe boast their descent from the Goths, the Celts, and a hundred other barbarous tribes which the page of history has immortalized; the natives of America are considered as "*novi homines*," because their existence can be traced only during two or three centuries of years. It is the duty of Americans to refute this groundless accusation, and at the same time fill up a chasm in the early history of their country; this may be effected by calling their attention to the rude stone monuments with which their country abounds, although they have hitherto escaped their notice, or been passed over as unworthy of regard.

Who is there within the limits of the wide world, that has not heard of the name and fame of the Druids, of their religious sacrifices, and of their instruments of gold, with which they severed the sacred mistletoe from the venerable father of the forest, the wide-spreading oak. The object of the present essay is to extend their empire a little farther than has hitherto been imagined, and to suggest that the Aborigines of America were of Celtic origin, that their monuments still exist in the land, and are the most ancient national memorials which America can show, and that if antiquity is to be a boast, this continent can produce monuments nearly as old as any in Europe, and derived from the same common ancestry.

Man lives a few years; but he erects monuments, and thus survives in the recollection of posterity, and the various tribes who have successively inhabited the world may be traced by the peculiar features of their architecture. That of barbarous nations was distinguished by its simplicity, and large massy stones were the first objects of attention and respect. The primitive families of the earth were destitute of tools with which to shape and polish masses of rocks; and the first national monuments we read of in sacred writ, were rude stones, either placed alone, formed into a circle, or piled into a heap.

These shapeless stones are proofs of the highest antiquity in any nation where they are found, and were erected by men of whom tradition has scarcely preserved even the name; they remind us of times to which our calculations and our history do not reach.

The Celts or Scythians, who gradually migrated from the borders of Assyria and Palestine, have left remains of their language and religion, in the central and northern regions of Asia, in England, France, Germany, Russia, and Scandinavia. Let us ascertain if no memorials of their residence can be traced in this country.

The monuments which they erected, while in distinct hordes they successively traversed the various quarters of the world, may be divided into five species. 1st. Cromlechs. 2d. Stones of memorial or sacrifice. 3d. Circles of memorial. 4th. Rocking Stones. 5th. Tumuli or Barrows.

1. We begin with the ancient and venerable cromlechs, by which, as an unerring guide, the tribes of men who erected them may be identified; they are of a peculiar structure, one huge stone, elevated two feet or more above the ground, higher at one end, and supported by several stones placed underneath. In England, some of the top stones, or rather rocks, are of an enormous size, and similar structures are found in various parts of Europe and Asia. These majestic and durable stone monuments appear built to defy the knowledge and foil the curiosity of the present race of men; the purpose for which they were erected is unknown, and various have been the opinions upon this subject.

They have successively been called tombs, small temples for the residence of country divinities, and altars contaminated with the dreadful sacrifice of human victims.

> "The barbarous priests some dreadful God adore,
> And sprinkle every stone with human gore."

The voice of history, with perhaps too just a decision, affixes the perpetration of this enormity upon all the tribes who departed from the land of Scythia; but whether these were the altars consecrated for such purposes, is one of those secrets which perhaps even time can never solve.

On my arrival in this country, I thought I had left the land of Celts and Druids far behind me, and great was my astonishment, on a perusal of Silliman's Philosophical Journal, when I read in the second volume, page 200, to which the reader is requested to refer, the description of a most noble cromlech, although the writer, the Rev. Elias Cornelius, is evidently not aware of the valuable relic of antiquity which he has described. It is mentioned by that gentleman on account of a geological fact supposed to be connected with it; the highest stone is of granite, and the pillars which support it are of primitive limestone, which is therefore supposed to be of equal age with the granite above; but in fact, it is a magnificent cromlech, and the most ancient and venerable monument which America possesses, and establishes a common origin between the Aborigines who erected this monument, and the nations who erected similar cromlechs in other parts of the world.

It is thus described :—"In the town of North-Salem, and State of New-York, is a rock which, from the singularity of its position, has long attracted the notice of those who live in its vicinity; and being near the public road, seldom escapes the notice of the passing traveller. Although weighing many tons, its breadth being ten feet, and greatest circumference forty feet, it stands elevated in different parts, from two to five feet above the earth, resting its whole weight upon the apices of seven small conical pillars. Six of these, with their bases either united or contiguous, spring up like an irregular groupe of teeth, and constitute the support of one end of the rock. The remaining pillar supports the other end, and stands at the lowest part of the surface over which the rock is elevated.

"Notwitstanding the form of the rock is very irregular, and its surface uneven, its whole weight is so nicely adjusted upon these seven small points, that no external force yet applied, has been sufficient to give it even a tremulous motion. There is no mountain or other elevation near it, from which the rock could have been thrown."

The Geologists in Europe have made an attack upon some of these ancient monuments, and assert that they were produced by the decomposition of rocks of granite; but in this instance, the pillars underneath being of limestone, and the large stone on the top of granite, we cannot consider it as the production of nature, because those rocks seldom or never occur in that relative situation. It may also be supposed that it is a bowlder of granite, deposited by diluvian torrents in its present situation; but against this opinion, it may be asserted with some confidence, that primitive limestone never appears above the surface of ground in the shape of small conical pillars, but in large massy blocks, which may be readily seen at some distance. Others may suppose that some ardent admirer of Celtic antiquities erected this monument for his own amusement, but the immense weight of the upper stone renders this improbable.

2. *Stones of Memorial or Sacrifice.*—Mr. Kendall, who travelled in the northern parts of the United States, seems to have had a very correct idea of the value of these monuments in an hostorical point of view; and mentions some of those which occur in Massachusetts. He says: "In different parts of the woods are six or seven masses of stone, on which the few Indians who still hover around their ancient possesions, make offerings; and on this account the name is given to them of Sacrifice Rocks. Two of these are on the side of the road leading from Plymouth to Sandwich; one of them is six feet high, the other four, and they are ten or twelve feet in length. They differ in nothing as to their figure from the masses of granite and other rocks, which are scattered over the surface of the surrounding country. All that distinguishes them are the crowns of oak and pine branches which they bear, of which some are fresh, others are fading, and the rest decayed."

Captain Smith, in his description of Virginia, relates that the Indians had certain altar stones, which they call Pawcorances; these stand apart from their temples, some by their houses, others in their woods and wildernesses, where they met with any extraordinary accident or encounter. As you travel by them, they will tell you the cause of their erection, wherein they instruct their children as their best records of antiquity, and sacrifices are offered upon these stones when they return from the wars, from hunting, and upon many other occasions.

Charlevoix mentions the worship of rocks as one of the superstitions of the Northern Indians.

In Messrs. Lewis & Clarke's Travels there are noticed several of these rocks.

Stone Idol Creek, on the Missouri, derives its name from three rude stones which the Ricaras, a tribe of Indians, worship. Whenever they pass by, they stop to make some offering of dress, in order to propitiate these sacred deities.

On the bank of the Chissetaw Creek is a rock which is held in great veneration by the neighbouring savages, and is visited by parties who go to consult it as to their own and nation's destinies.

The fate of the Mandan tribes depends upon the oracular responses of another sacred rock, whose commands are believed and obeyed with the most implicit confidence. Every spring, and on some occasions during the summer, a deputation from the savages visits the sacred spot where there is a large porous stone, twenty feet in circumference.

In Major Long's Tour to the Rocky Mountains, it is stated, that the Minnitaree Indians worship the Me-mo-ho-pa, a large, naked, and insulated rock in the midst of a small prairie, about two days' journey from the village of that nation. In shape it resembles the steep roof of a house; and the Minnitarees resort to it for the purpose of propitiating their Great Spirit by presents, fasting and lamentation, which they continue for a space of three or five days.

Under this class of Indian monuments may be arranged the figured rock at Dighton, in the State of Massachusetts, which has been described in various publications; also the sculptured rocks that occur in many parts of the American continent, at Tiverton, Rutland, Newport, Scaticook, Brattleborough, Ohio, &c. &c.

It is to be regretted that a manuscript of the late Dr. Stiles, which is in the possession of the American Academy of Arts and Sciences, and contains an account of many of these remains, has not yet been published.

Perhaps the intricate question of American ancestry might be solved by the annals of Mexico, or the histories of Peru, and a deep research into the books of those countries, would no doubt amply repay the toil.

Acosta relates that, amongst the ancient Mexicans, worship was paid to rocks or large stones, and that in the highways they found great heaps of them, which had been offered to the gods; but he adds, that in his time, this superstition of worshipping great stones had altogether ceased.

Gomara, in his account of Peru, mentions the same practice as still continued amongst the old inhabitants in that country.

Thus in the various regions of America, the natives had carefully preserved the stones of memorial and sacrifice, in the use of which they had been instructed by their Celtic ancestors, and which in some instances may have been the individual monuments erected by that people.

If accurately examined, there can be little doubt that America contains an abundance of these rude stones, which were erected by the ancient inhabitants as memorials of their history and exploits in war, or as altars on which to sacrifice to the Deity. The books of the first historians of America, contain many accounts of the homage which was paid by the natives to shapeless rocks, and the sacrifices offered upon them; but in the lapse of time, the Indians being nearly destroyed by diseases or by war, and these stones offering no particular feature to the common observer, scarcely a trace of their present position can be distinctly marked; but to the historian these rude stones are objects of the highest interest, and every exertion should be made to identify the situations where they occur.

3. *Circles of Memorial* were the next monuments erected by the ancient Celtæ; they consist of nine, twelve, or more rude stones, placed so as to form a circle, and were generally placed upon an eminence.

They answered several purposes; they were dedicated to religious services, and sacrifices were made either within the sacred circle, or in its vicinity; at the election of chiefs and leaders, the nations assembled here, and public business was supposed to be sanctioned by the gods, if transacted within the boundary of their temples. They were also used by the priests for astronomical purposes.

There appear to be at least three of these sacred circles in America. I have been informed of one by Dr E. James, the scientific tourist to the Rocky Mountains. It is situated upon a high hill. one mile from the town of Hudson, in the State of New-York, and attracted his notice many years ago, on account of the remarkable size of the stones, and their position.

In Machenzie's tour from Quebec to the Pacific ocean, there is noticed a circle of stones, artificially laid on a high rock, upon the banks of the river Winnipigon, which discharges itself into a lake of the same name. The Indians are accustomed to crown this circle of stones with wreaths of herbage, and with branches; for this reason, the carrying place which passes it has received the appellation of Le Portage de Bonnèt.

In Purchas' Collection of Voyages, vol. 3, page 1052, one of the historians of Peru, in describing the manners and customs of the children of the sun, says: "To make the computation of their year sure and certain, they did use this industry; upon the mountains which are about the city of Cuzco, where the kings held their court, there were twelve pillars set in order, and at such distance the one from the other, as that every month one of these pillars did note the rising and setting of the sun. They were called Succanga, and by means of these stones, they taught the seasons fit to sow and reap, and other things; they did certain sacrifices to these pillars of the sun."

These are no doubt connected in their history with the other Celtic remains, and resemble those druidical circles, which are so common in Europe and Asia, and which from their immense size and the majesty of their appearance, received from Tacitus the expression "rudes et informes saxorum compages," and from Cicero the appellation "mirificæ moles. But the scientific assistance of individuals who reside near these monuments is requested, that an accurate account of them may be published, and thus a small ray of light be thrown over the history of the Aborigines of America.

Tradition sometimes conveys along the stream of time a name attached to these stone monuments, which informs us of their use. In Erin's bright green isle, which was a favorite resort of the Druids, these stone circles, placed upon an eminence, are called in the Irish language Carrich Brauda; and in Wales, similar structures have retained the name Cerrig Brudyn, to the present time; the appellation is the same in both countries, and means Astronomer's circles. And thus in ages long since past, perhaps at the same instant of time, though under different skies, the Druids of England, and the priests of Cuzco, the astronomers of

Ireland, Hudson, and Winnipigon, seated upon the lofty hills, and surrounded by their sacred circles of stone, were calculating the progress of the seasons, the revolutions of the planets, and the eclipses of the sun, by the same formulæ which their ancestors had first practised in the central plains of Asia.

4. *Rocking Stones*, are memorials raised by the same people, and the same race of men, who elevated the cromlechs; they consist of an enormous stone so equally poised upon its base, that a very small force is sufficient to move it; sometimes even the touch of a finger will cause it to vibrate.

There are several of these memorials of a former race, in the United States of America, but of the origin of the whole of them we cannot be certain, until an accurate account is published of their size, appearance, and situation, and it would be desirable if they were illustrated by correct drawings. In the State of New-York there are probably three or more. Professor Green has described one, in the American Journal of Science, vol. 5. page 252. It is situated near the top of a high hill, near the village of Peekskill, in Putnam county; the moveable stone is thirty-one feet in circumference; the rock is of granite, but the mica contained in it being schistose, gives it some resemblance to gneiss, and it is supported by a base of the same material. This rocking stone can be moved by the hand, although six men with iron bars were unable to throw it off its pedestal. From the drawing which accompanies the description in Silliman's Journal, this rock presents every appearance of an artificial monument, and may perhaps with safety be classed amongst the celtic antiquities of North-America.—Putnam's rock, which was thrown from its elevation on one of the mountains in the Highlands during the revolutionary war, may have been a rock of this description.

There is also a rocking stone in Orange County, State of New-York, of which no account has yet been published.

In the State of Massachusetts, I have heard of some near Boston, between Lynn and Salem, but do not vouch for the accuracy of the statement, until they undergo a careful examination.

There is one at Roxbury, near Boston, described in the Journal of Science, edited in that city.

A small rocking stone occurs at Ashburnham, in the same State.

In New-Hampshire there are two; one at Andover, weighing fifteen or twenty tons, and the other at Durham. This was a short time since a very splendid rocking stone, weighing between fifty and sixty tons, and so exactly poised, that the wind would move it, and its vibrations could be plainly seen at some distance. But, two years ago, a party from Portsmouth visited it, and after several hours of labor succeeded in moving it from its position. A proper feeling on the part of the persons who effected this mischief, would cause them to restore it to its original place. The rock is forty five feet in circumference and seven in thickness.

5. *Tumuli* or *Barrows*, are found in every part of the immense expanse of American territory, from the Lakes of Canada to the Mexican sea, from the shores of the Atlantic, to the borders of the Pacific ocean, and they may be considered merely a continuation of the same monuments which extend from the icy promontories of Kamschatcka, through the barren steppes of Tartary, the level plains of Russia, and all the northern regions of Europe.

These tumuli were the simple repositories of the Celtic dead, the tombs of their warriors, the last resting place of those who were wise in council and valiant in war, and an enlightened people should respect the remains of the former chieftains of North America.

It is a spot upon the escutcheon of Virginia that a tumulus which had belonged to an ancient Indian nation, and been described by the pen of the philosophic Jefferson, should now be nearly destroyed by the encroaching spirit of agriculture, and the bones of Celtic warriors allowed to blanch under a meridian sun, but in the western states this may be said to occur every day, and thus the vestiges of former times are effaced by the advance of the plough, and even Antiquarians have assisted to open and rifle these sanctuaries of the dead. Surely the land has been acquired cheap enough from its aboriginal possessors, and humanity might dictate that their tumuli, their mounds, their camps, their altars, and the bones of their warriors should be allowed to rest in peace.

It seems probable that if these untutored nations wished, in a more particular manner, to perpetuate the memory of some one, who was near and dear to them, who had given his nation important councils in peace, or raised the fame of his country in war, then they thought the mound of earth too humble a covering for his remains, and raised high a pile of stones, to mark to future times, the tomb of their favorite chief. In the Celtic language, these were called Cairn.

J. C. Atwater mentions them as occurring near Newark, and in the counties of Perry, Pickaway and Ross.

In Dr. Dwight's travels in Connecticut, there are noticed two of these stone tumuli, which appear to have been erected over offenders against the law.

Adair, in his History of the North American Indians, says, "in the woods we often see innumerable heaps of small stones in those places, where according to tradition. some of their distinguished people were either killed or buried. There they add stone to stone, still encreasing every heap, as a lasting monument and honor to the dead and an incentive to great actions in the survivors."

In the same volume it is said, "the Cherokees continue to raise and multiply heaps of stones, as monuments for their deceased warriors."

Mr. Jefferson says they occur in Virginia;—they are also mentioned by other historians, and tradition relates that the Indians in passing these tumuli still add a stone to the heap to shew their respect to the memory of the heroes of other times, the ancient Celtic chiefs.

These monuments of the aborigines, carry with them undoubted evidence of their Celtic origin, and although few are at present described, yet when the country is fully explored, many other remains of the same character may be observed. Moderns build their temples in crowded cities, and the talent of eminent architects is put in requisition, to erect the most splendid edifices that skill and taste can produce, but the wild and untutored Goth, Celt, Scythian, Indian, and Druid, thought it a disgrace that their Gods, who created the immensity of the heavens should be confined in buildings made by the hands of men. They worshipped them in the solitude and silence of retired groves and woods, and it is there we must look for the remains of their altars and cromlechs, their kistvaen and Tolmin.

It may be asked if these are really druidical remains, where are the Stonehenge, or the Abury, or the Carnac of America, the reply is that the insular situation of Britain, and the mountainous country of Bretagne were favorable to the institutions and genius of the Celts, and it was in those countries alone that the Druids erected those more splendid monuments of their religion, which have attracted the most powerful feelings of admiration and awe from passing ages.

What connexion can there be between the ancient Celts and Germans, who have been described by the pencil of a Tacitus, and the wandering tribes who now inhabit the interior parts of America?

Beneath the majestic language of the Roman historian, you may discover a picture of uncivilized tribes, varying not much from the North American Indians. But these scorned even the slight trammels, which must be the bond of any civilized society, and wished to be as free as the air they breathed; the love of liberty was to these poor savages a meteor light, which divided them into weak, independent tribes, who were continually at war.

Before I close this essay, may I be allowed to say one word to plead for the preservation of these monuments, which should be to all Americans a subject of the most anxious care.

In other climes, superstition and despotism have contributed to the overthrow of many a noble Celtic monument, but in this land of freedom, it would be well, if legislative power, or better still, if public opinion would throw its shield around these remains, and protect the last monuments of a former race. Americans should consider that one of these cromlechs or Cairns, does more to elucidate the history of their native country, than the learning of Robertson, or the genius of Buffon.

The Celts erected these monuments in order that they might speak to their children.

> " Quid nobis dicunt isti lapides?
> Positi sunt in monumentum."

They prove that a nation of Celtic origin once inhabited this continent.

NOTE. In concluding this essay, I wish to express my obligatios to the members of the New-York Historical Society, for the very liberal manner in which they have allowed me access to the valuable library, collected under their auspices, which is extremely rich in all works connected with American Antiquities.

New-York, No. 126, *Broadway.*

EDUCATION.

ART. XXI.—*Notice of a new work on Public Education, entitled "Plans for the government and instruction of boys in large numbers: drawn from experience."* London 8vo. 1822.

(Communicated for this Journal.)

OF the two great divisions of Education, namely, government and instruction, the former has had, at least in schools, far less than its due share of attention.

It has indeed been considered at all only because a certain degree of order is necessary in the little community before the teacher can insure the attention of the scholar to his proffered lessons. More than this, however, few masters have attempted. Docility and submission, with a certain degree of ardour to acquire information and deserve their praise, form in the minds of instructors in general, the *beau ideal* of a pupil, and many of our readers will perhaps feel astonished that we should require any thing more. But we cannot forget that we are members of a free country, and we examine with great and solemn interest, the habits and influences under which they are educated to whom we must eventually resign the guardianship of the free constitution, which it hath pleased Almighty God to bestow upon us as his choicest blessing.

It may perhaps to many minds, be a new mode of considering the subject, but the fact undoubtedly is that our method of teaching our children to sustain their parts in a country of liberty is by placing them during some of the most important years of life under a despotism—not a Turkish or a Russian depotism, we grant.

The genius of Education no longer bears the rod. The best gift of one generation to another is not forced upon the recipient with blows nor received with tears and execrations. But the rule, though mitigated, is nevertheless a mitigated despotism; not a particle of real freedom has yet found its way into these important microcosms.

The causes of the general neglect which the subject of *boy-government* has so long endured, while every other part of the field of science is teeming with improvement, are worthy of consideration. In the first place, it is only among the few nations which can really be called free, that improvements would be encouraged or perhaps endured. Where the fashionable creeds teach that man cannot be entrusted with government, unless endowed with such a stock of hereditary wisdom as is possessed only by the descendants of a line of rulers, it would be no welcome discovery to find the profound mysteries of legislation and jurisprudence fathomed by children. Another cause is to be found in the feelings and inclinations of those by whom experiments must be made. Schoolmasters like other men are far from being insensible to the blandishments of power. It is so pleasant to see our will carried into prompt and complete effect: so delightful to pronounce our opinions *ex cathedra* without fear of dissent; that he who can resolve to forego such enjoyments and encounter opposition, must be actuated by motives which it would be idle to expect, should impel the actions of men in general.

Thus, without an attempt to overcome the difficulties naturally attendant on such an undertaking, it has been set down (*sub silentio*) by almost every man, as an impossibility that boys should ever be able to form self-governing communities.

We have however, evidence before us, which will we think shew the contrary, and that most satisfactorily, but before we enter upon it, we had better perhaps make a few observations on the desirableness of a free government for boys; for so much are even the most enlightened under the dominion of custom, that whatever is new is sure to be opposed and stands in need of defence.

It is an excellent rule in education, so to teach as that the pupil may have nothing to unlearn. What then more important than for the freeman to grow up without the associations of tyrant and slave; without the habit of truckling to power on the one hand, or on the other of aspiring after the means of tyranny?

The excellence of a popular government will always be in proportion to the knowledge possessed by the people of the art of ruling. Can their minds then be called to the subject at too early an age. Government is an art as well as a science: does not he who is to practice it in after life, require some practical experience to preserve him from error?

But let the subject be considered only in its most confined point of view; let the government of boys be thought of importance, only as it facilitates or impedes the acquisition of such information as the teacher may wish to impart; even then there is much to be said in favour of freedom.

Even if a despotism were in the nature of things unavoidable, it were much better that the despot should not be the instructor. Where the burden of government rests altogether on his shoulders, his attention must necessarily be much drawn from his duty of imparting knowledge. But this is the least inconvenience. A line of demarcation is drawn between him and his pupils. He is the fountain of reward and punishment—judge without appeal—often witness and executioner. His *fiat* is law. His words are the sentence of fate. How is it possible that his subjects can be at ease in the presence of such an absolute monarch? With what unfortunate associations are all his lessons surrounded. Can we wonder that so many persons shut their books for ever when they leave school? It ought to be more matter of surprize that the love of knowledge can in any case survive the shocks to which it is so constantly exposed.

Another objection to the despotic system is that it checks all voluntary action on the part of the pupil. Fielding was of opinion that if a perfect monarch could be found a despotism would be the best of all forms of government. It should follow that if such a position were correct that to have a Mentor at hand to direct the actions of each individual would be highly favorable to human happiness. But who does not see that such a system would reduce us to automata. All mental pleasures would be destroyed, for the mind itself would die away for want of exercise. The ordinances of nature have irrevocably decreed that labour and enjoyment cannot be long separated with impunity. Now a despotism, in as far as it interferes with human actions at all, has the degrading effect consequent on such a separation. Indolence and apathy have always been its constant and inevitable accompaniments. Fielding forgot that the science of government, while it furnishes a high and ennobling exercise for the human mind, excites it strongly to action. And it will be with schools as with nations—keep them in continual coercion, and they will become like soldiers at a drill, mere machines, moving only as they are moved, and containing within themselves no spring of voluntary exertion.

It is time however to let the author speak for himself: we shall only premise that we have obtained satisfactory proof that the system which he lays down is in actual operation.*

"The principle of our government is to leave, as much as possible, all power in the hands of the boys themselves: to this end we permit them to elect a Committee, which enacts the laws of the school, subject however to the *veto* of the Head Master. We have also Courts of Justice for the trial of both civil and criminal causes, and a vigorous police for the preservation of order.

"Our rewards consist of a few prizes, given at the end of each half year, to those whose exertions have obtained for them the highest rank in the school; and certain marks, which are gained from time to time by exertions of talent and industry. These marks are of two kinds: the most valuable, called premial marks, will purchase holiday; the others are received in liquidation of forfeits. Our punishments are fine and imprisonment. Impositions, public disgrace, and corporal pain, have been for some years discarded among us.

"To obtain rank is an object of great ambition among the boys; with us it is entirely dependent on the state of their acquirements; and our arrangements according to excellence are so frequent, that no one is safe, without constant exertion, from losing his place.

* At Hazelwood in Warwickshire, two miles from Birmingham.

"The boys learn almost every branch of study in classes, that the Master may have time for copious explanations; it being an object of great anxiety with us, that the pupil should be led to reason upon all his operations.

"Economy of time is a matter of importance with us; we look upon all restraint as an evil, and, to young persons, a very serious evil; we are, therefore, constantly in search of means for ensuring the effective employment of every minute which is spent in the school room, that the boys may have ample time for exercise in the open air. The middle state between work and play is extremely unfavourable to the habits of the pupil. We have succeeded by great attention to order and regularity, in reducing it almost to nothing. We avoid much confusion by accustoming the boys to march, which they do with great precision, headed by a band of young performers from their own body."

The outline which we have here given is followed by a minute detail of the means by which his principles are carried into operation.

Chapter 3d, is a review of the system examining and defending the principles of the work. We give the following extract, because it furnishes additional reasons to those which we have enumerated for a popular form of government among boys.

"We shall be disappointed if the reader has not already discovered, that by the establishment of a system of legislation and jurisprudence, wherein the power of the master is bounded by general rules, and the duties of the scholar accurately defined, and where the boys themselves are called upon to examine and decide upon the conduct of their fellows, we have provided a course of instruction in the great code of morality, which is likely to produce far more powerful and lasting effects than any quantity of mere precept. If morality is a science as well as a practice, (and who will deny the classification?) it must assuredly be a science of the highest importance: but in every other branch of scientific education, that mode of instruction wherein the pupil is merely passive, as in listening, has been gradually exchanged for others which demand his active co-operation. Who would think of teaching arithmetic by lectures, in which he should work all the problems himself, while his pupil sat silent and inactive? or who would think the scholar likely to become a profound geometrician, whose master was contented with reading demonstrations to him? Indeed, it is an acknowledged truth among teachers, that no man can do them a greater service, than by reducing every art and science, which the extending information of society from time to time demands, to be made a part of juvenile education, under the dominion of "Practical Instruction."

"We shall not be called upon to prove that, to give a knowledge of the science of morality is an excellent means of ensuring a correct practice of it; because, the position being universally allowed as respects every other department of human learning, we may fairly call upon the objector to show why the analogy, which holds good in every other instance, should fail here. But even if the effect of this science on the conduct of the student were as remote as it is immediate, still, exercising his mind, and extending his information, it would equally well deserve his attention, with the objects to which it is usually directed.

"They, however, who will take the trouble to glance over the history of their early years, and call to mind the pertinacity with which their school-fellows screened each other from the most deserved punishment; and the many acts of oppression which remained unredressed, because the sufferers dared not to disobey the stern edict against "bearing tales,"—the only one in the community that was never violated,—will think something done towards improving even the practice of morals, when they learn, that in an experience of more than two years,* one solitary instance only has occurred, in which the verdict of the jury did not coincide with the opinion of the master. Great, but of course unexpressed anxiety, has more than once been felt by us, lest the influence of a leading boy, which in every school must be considerable, should overcome the virtue of the jury; but our fears have been uniformly relieved,

*Trial by Jury was established early in 1816. This chapter was written in November, 1818; since that time two other verdicts have been given, in which the teachers did not concur; they were appealed against, as it has been already stated, and were reversed by the committee. A remarkable instance of conscientious feeling was lately given by a jury who convicted a boy on a charge of prevarication; though they were so much moved by the distress of mind which he evinced during his trial, as to pay half his fine from their own pockets. The remainder was immediately subscribed by the spectetors.

and the hopes of the offender crushed, by the voice of the foreman, pronouncing, in a shrill but steady tone, the awful word—Guilty!

"One exception there has been, and but one; and then it was the opinion of the attending teacher, that the jury did not understand the case. The boys who composed it happened to be very young, because the number present being unusually small, the elder scholars were all engaged in the various offices of the court."

Chapter 4th is "On the best method of acquiring Languages."

The author's plan is to put the pupil to construe without much anxiety about the grammar. He also would employ him in committing to memory and performing the dramas of the language to be acquired. He defends the use of translations. He objects to urging students to converse with each other in a language which they are acquiring, lest they should form bad habits of speech.

Chapter 5th is on Elocution.

"The practice of elocution," says the author, "is intimately connected with the cure of impediments in the speech. Slight defects of utterance, as lisping, muttering, and the elision or substitution of certain sounds, yield to it almost immediately. Stammering is a more obstinate enemy, and is not subdued without much time and labour.

"It has, we think, been clearly proved by Mr. Thelwall, that the disobedience of the organs to the will of the speaker (which is the proximate cause of stammering,) proceeds from his neglect of the laws of rhythmus,—in other words, from his not speaking with due attention to measure or time. Be this, however, as it may, we have found in practice that cultivating the ear, with regard to the perception of time in speech, is an excellent means of restoring to the pupil a due control over his organs. But the mere perception of time and rhythmus is not enough, because the exercise of the faculty may be thwarted; and it will be thwarted by every thing, which disturbs the mind, and irritates the temper of the pupil. Health, employment, and order, will be, therefore, found to be very important auxiliaries in working the cure; and here we think we have some advantages.

"Frequent opportunities for exercise in the open air with companions of his own age,—a system which regulates his actions without hastily coercing them.—the spectacle of a machine working its numerous parts without hurry or confusion ;—these appear to us to be circumstances more than commonly favourable for placing the pupil in a state of body and mind to receive the lessons of the master with profit. We have also facilities for inducing the perception of time ; the pupil is constantly witnessing the measured movements of others, and is trying to act in concert with them. To learn to march he finds indispensible to his comfort. The motive to exertion thus obtained, his daily practice, and the effect of example soon overcome any natural inaptitude for making the acquisitions.

"Every stammerer, the reader will have observed, can sing ; at least the defect of stammering offers no bar to his being a singer, if he is in possession of the usual qualifications of voice and ear. The ear, we are convinced from experience, may in almost all cases be educated to a sufficient degree of accuracy for our purpose, and the voice is a matter of little importance to us, as our pupil would not learn to sing with the view of exercising the art, but simply to qualify him for learning to speak.

"In extreme cases, then, we would have the pupil taught to sing. From singing, let him pass to *recitative*, which so nearly approaches to speaking, that the Siennese, we are told, actually practice an intonation, which may be considered a species of it, in common conversation.

"The next step is for the pupil, accompanied by his master, to march along the room, and repeat a few verses chosen for the simplicity of their rhythmus, the speakers marking the accented syllables by the tread of the foot. Afterwards verse of more difficulty may be adopted ; than measured prose, as Barbauld's Hymns, Dodsley's Economy of Human Life, or (to go at once to the models from which these are imitated,) our translation of the Psalms, the book of Job, and the Prophecies. From these we would proceed to extracts from didactic works, and, lastly, to narrative and dialogue.

"In going through this course, the teacher gradually ceases to accompany his pupil, either in marching or speaking, until at length he directs the boy himself to stand still. Recitative may be sometimes changed for reading, and instead of the *sing-song* tone almost inseperable from the plan in its early stages, more natural inflections may be substituted. The pupil should now be taught to relieve his difficulty of utterance in conversation by forcible gestures, and by pronouncing his words with a cadence, marching also, or beating time, when he finds the impediment cannot be surmounted otherwise.

This plan of proceeding we have never found to fail, when a fair allowance of time has been afforded for the experiment; at least so far as giving the scholar the power of correcting utterance may be called success: but strange as it may appear, it is, frequently much more easy to induce the capacity for speaking without stammering than the inclination. The reconciling power of habit extends even to this malady, and instances are by no means rare of persons who, after becoming able to speak fluently with very slight self-command, have slid again into their former track, apparently from not feeling the importance of the acquisition which they had made.

"It is, therefore, very important that a stammerer should be put under discipline at an early age, before his habits became fixed, and while it is possible to keep him under superintendance, until the evil be quite eradicated. Except the moral habits of children, none demand a greater watchfulness than those of their speech. Practice in speaking is so constant, that habits, either for better or worse, are soon formed. A little care by the parent would prevent much labour and loss of time to his children in after life. Amongst the most baneful of all affectations is that of speaking to children with their imperfect enunciation; we are examples to them, and we cannot be surprised that they should rest satisfied with imperfection, when they find us aping it ourselves."

Chapter 6th is on Penmanship.

Chapter 7th is on Voluntary Labour. This Chapter contains the methods by which the boys are stimulated to voluntary exertion.

Chapter 8th is a Comparison of Public and Private Education. The author has entered the lists with the advocates for private education and fights his battle with great ardour.

The Appendix contains some curious papers: 1st, a Case of appeal from the Magistrate to the Committee against the conviction of a boy for climbing a tree to witness a battle, the law being that all battles shall be fought without spectators (except the magistrate and constables) to prevent the artificial incitement to boxing matches, arising from the stimulating shouts of the by-standers. The ground of appeal was want of jurisdiction in the magistrate, the tree being on land of the appellant's father, and the time being out of school hours. After a long debate, the order of the magistrate is confirmed. 2nd, An account of the erection of a tool-house, or work-shop by the boys without any assistance—"No workman having been employed either in the masonry, carpentry, slating, glazing, or painting."

There are also the answers to questions in Mental Arithmetic which have been made at public examinations. Some of them remind us of Zerah Colburn.

INTELLIGENCE AND MISCELLANIES.

I. Domestic.

1. *Notice of the late Meteor in Maine, by Prof. Cleaveland; Brunswick, Oct. 11th,* 1823.

This aerolite fell at Nobleboro', Maine, August 7th, 1823, between 4 and 5 o'clock, P. M. on land belonging to John and David Flogg. The following account of the phenomena was received from Mr. A Dinsmore, who was at work near the place, on which the aerolite struck.

Mr. Dinsmore's attention was excited by hearing a noise which at first resembled the discharges of platoons of soldiers, but soon became more rapid in succession. The air was perfectly calm; and the sky was clear, with the exception of a small whitish cloud, apparently about forty feet square, nearly in his zenith, from which the noise seemed to proceed. After the explosion, this little cloud appeared to be in rapid spiral motion downwards as if about to fall on him, and made a noise, like a whirlwind among leaves. At this moment, the stone fell among some sheep, which were thereby much frightened, jumped, and ran into the woods. This circumstance assisted Mr. D. in finding the spot, where the stone struck, which was about forty paces in front of the place where he was standing. The aerolite penetrated the earth about six inches, and there meeting another stone, was broken into fragments. When first taken up, which was about one hour after its fall, it exhaled a strong sulphureous odour. The whole mass, previous to its fracture, probably weighed between four and six pounds. Other fragments of the same Meteoric stone, are said to have been found several miles distant from Nobleboro'.

2. *Abstract of the Proceedings of the Lyceum of Natural -tory, New-York.*

January 6*th*, 1823.—Dr. Dekay read a paper on the supposed animality of sponges.

Mr. Halsey presented a number of specimens of Lichens and Fungi collected by himself at Saugatuck, (Con) among which were fourteen new species and varieties.

A memoir by W. E. Coutin was read on the means of communication between the Atlantic and Pacific oceans by the rivers San Juan and Atrato.

A verbal communication was made on the probability of the successful cultivation of cotton in this state, from sundry experiments made by Levi McKeen, Esq. of Poughkeepsie.

13th.—Dr. Torrey presented, in behalf of Dr. Barrett, a a collection of mineralogical specimens from Phillipstown, in the Highlands of New-York, among which was a beautiful white Coccolite; being a variety not hitherto noticed.

27th.—Pres. Mitchill communicated the substance of a letter from M. Thebaud de Berneaud, Perp. Sec'y. of the Linnæan society, Paris, containing wishes for a friendly understanding and liberal intercourse between that institution and the Lyceum.

Mr. I. Cozzens presented some handsome specimens of minerals.

Mr. Halsey presented shells from Saugatuck, (Conn.)

February 17th.—Specimens of the minerals, petrifactions and shells of Antigua, were laid on the table, a donation from Capt. Redwood.

Specimens were received from M. Milbert illustrating the geology of the island of St. Pierre Miguelon, near Newfoundland.

Dr. Van Rensselaer presented specimens of the marbles and of the iron ores of Vermont and Crown point.

24th.——Mr. Halsey presented several specimens of worms. Dr. Dekay offered drawings and descriptions of two of them, supposed to be new species of intestinal worms, inhabiting the body of the common cricket. They were described under the names of ascaris grylli, and fissula grylli.

This being the Anniversary meeting of the Lyceum, the following officers were elected for the ensuing year:

President, *Samuel L. Mitchill, M. D. LL. D. &c.*
1st. Vice President, *John Torrey, M. D.*
2d. Vice President, *Rev. D. H. Barnes A. M.*
Corresponding Sec'y. *J. E. Dekay, M. D.*
Recording Sec'y. *A. Halsey, Esq.*
Treasurer, *L. Bull, Esq.*

Mr. Barnes,
Mr. I Cozzens,
Dr. Dekay, } Curators.
Mr. Halsey,
Dr. Van Rensselaer,

Anniversary Orator, *Dr. Van Rensselaer.*

March 3d.—Mr. Barnes reported on specimens of Chiton, animal and shell, from Peru; he considers them as two new species, and describes them at length under the name of Chiton niger and C. Echinatus.

10th.—A translation was read by Dr. Dekay of a letter from Mons. Geoffroi relative to the organization of diadelphous animals, in which he proposes as subjects of enquiry, 1st. To verify at any period of gestation, the existence of a fœtus in either uterus. 2dly. To ascertain whether the ovula is found in the fallopian tube or ovary. 3dly. If this product is discovered, to note its characters: is it an egg, i.e. with centre yolk and exterior white, or only an ovule?

17th.—Mr. Barnes read an Essay on the genus Alasmodonta of Say, and described three new species, A: arcuata; A: rugosa; A: complanata. (Published in No. XIV of this Journal.)

24th.—The Anniversary Oration was pronounced by the Rev. Mr. Schaeffer.

A note was read announcing the receipt of zoological specimens brought by Mr. A. Vaché from the S. Atlantic and Pacific ocean.

31st.—Mr. Barnes delivered an Introductory Lecture on the study of *natural history.*

April 7th.—Dr. Dekay reported on the scutella quinquefora, and on the ophiura tetragona.

Mr. Barnes presented a specimen of an extinct animal, (so supposed,) and described by Say as the pentramite, commonly called althea bud.

Dr. Dekay delivered a Lecture for the evening, being a Dissertation on the *Literary History and Anatomy of Fishes.*

14th.—A paper was read from Dr. E. James on the Pumice, as it is called, of the Missouri, accompanied with specimens. Bradbury and others supposed it to be produced by the combustion of coal beds. Dr. James calls it amygdaloid ; vast deposits of which are found along the base of the rocky mountains. It is infusible, a character in which it differs from the pumice of volcanic or pseudo-volcanic origin. It strongly resembles in external appearance the amygdaloid from Patterson, N. J.

Dr. Akerly delivered a Lecture on *Polyps* or *Zoophites,* illustrated by splendid transparent figures.

21st.—Dr. Mitchill read a Lecture on *Parasitical Animals* which he divides into molluscous, arachnidal, crustaceous, insects, and zoophites.

28th.—Dr. Mc Nevin read a Lecture on *Electrick Magnetism.*

May 5th.—A suite of minerals was received from Mexico, illustrating the geology of Mont Catherine de Crevas.

Mr. Cozzens presented some interesting shells from Wappenger's Creek.

Dr. Mitchill read an analysis of a work lately published in Paris, on Fossil Trilobites by M. Brongniart, and Fossil Crustacea by M. Demarest. It is a matter of regret that so few of the N. American Trilobites are known to the distinguished author.

12th.—Dr. Van Rensselaer read a Lecture on the Salt Formations of America.

19th.—A suite of minerals, consisting of petrifactions, agates, jaspers and madrepores from Antigua, was presented by Capt. Redmond.

Mr. Halsey reported on the Kalanköe Pinnata of Lamark, which possesses the singular property of sending out gemmæ from the dentations of the leaf, which take root and become new plants.

3. *Velocity of the Mississippi.*

To Professor Silliman.

Sir,

I take the liberty of calling your attention to a passage in a notice of Dr. Beck's Gazetteer, published in the Journal of Science. Speaking of the Mississippi, the writer remarks, that "the velocity acquired in falling without resistance through $5\frac{1}{4}$ inches, is about one foot and a half a second, and would be the velocity of the river if there were no resistance." The velocity was supposed to be that which it acquires in running one mile. Another passage contains a similar estimate. But here no regard is had to the continual acceleration of water, descending without obstruction a series of inclined planes. Why is the descent in one mile arbitrarily assumed as the datum from which to estimate the velocity of the stream? The bottom of a river may be considered as consisting of a plane, or series of planes. Now if these all incline the same way, (which is not generally true,) and if the water descended them without resistance, it is evident that its velocity at any given place, would be equal to that acquired by a body in falling perpendicularly through a space equal to the height from which the water had descended. This velocity would, however, be diminished by short tributary streams, in a manner which I will not stop to explain. If freed from all these causes of retardation, the Mississippi at its mouth must have the amazing velocity acquired by water in falling perpendicularly 1330 feet.

But even admitting the correctness of the hydrodynamic principles assumed by your correspondent, still is there not a great mistake in the estimate? For it is generally known that a body falls without resistance about one foot in the first quarter of a second; in which case its mean velocity is 4 ft. per sec. and the last acquired velocity being double of the mean velocity is, in this case, 8 feet per second. But the spaces described are always as the squares of the last acquired velocities. Hence,

	inch.		sqr. of vel.		inch.		sq. of vel.
	12	:	$8 \times 8 = 64$	::	$5\frac{1}{4}$	:	28.

Hence $\sqrt{28}=5.29$ feet per second, or upwards of $3\frac{1}{2}$ miles per hour, is the velocity acquired in falling $5\frac{1}{4}$ inches, instead of $1\frac{1}{2}$ feet per second, and $1\frac{1}{4\,4}$ miles per hour, as estimated by your correspondent. B. F. J.

June, 1823.

4. *New Mineralogical Hammer, by Rev. E. Hitchcock, A.M.*

"I have lately constructed a geological hammer* on such a plan as to embrace three or four of those used in Europe, both for convenience and economy. Fig. 1 is a side view of the hammer. The lower part *a* of the head *a b*, is a little rounded to endure a heavier blow. Yet this curvature ought not to be very great, as a flat surface is often advantageous. The upper part *b*, of the head, is brought to an edge: the direction of the edge coinciding with that of the handle, as shown in Fig. 2. In the handle, a hole six or eight inches deep, and half or three quarters of an inch in diameter, is made to receive a steel drill, *e f*. This, when not wanted, is confined in the handle by a spring *d*, closing down so as to cover the hole at *e*. The hammer without the handle, weighs about two pounds. The handle should be made rather larger than is common, as it is liable to split when heavy blows are struck while the drill is inserted in it.

The rounded face of the hammer *a* is used in breaking specimens from the obtusely angular surfaces of rocks; the edge *b* serves to cleave schistose or laminated specimens, and to break common specimens in the cabinet, and the drill is often wanted to assist in disengaging petrifactions or minerals deeply imbedded in their matrix."

5. *Navigation of Rapids.*

Mr. Edward Clark has recently published in Philadelphia, a "Description of a plan for navigating the rapids in

* See Plate 5.

rivers, with an account of some experiments instituted to establish its practicability," in a pamphlet of 11 pages, 8vo. He has taken out a patent for his method, and has put it in successful operation at the rapids of Columbia, on the Susquehannah. His principle is the following:—If a water-wheel be attached to a boat at anchor in a rapid, or to any other fixture, and a rope be made to revolve around its windlass, the current of the rapid will turn the wheel, and will cause a boat attached to the rope to ascend the rapid. This is certain; but it has this inconvenience, that it is applicable only to a rapid in one direct line; and in such rapids as make one or more curves in their course, two or more such wheels, or a system of pulleys would be necessary.—Mr. C. obviates these inconveniences by the plan he has here explained. The wheel is attached to a boat moving against the current; the rope is fastened at the upper end of the rapid to a fixture, (a pier, anchor, &c.) and is made to coil around the windlass; in this way, by inverting the process of the former method, the attachment of the rope being fixed, and the rope continually shortening by the revolution of the windlass, the boat moves, and is carried up against the current to the head of the rapid. Where the rapid is crooked, a fixture may be placed at the head of every reach, and all that will be necessary will be to detach the first rope, and pass the second around the windlass, and so on to the head of the rapid. The machinery is very simple. It consists of an oblong frame laid across the middle of the boat, with a shaft supporting two paddle-wheels, as in steam-boats, and a windlass within the body of the boat, and moving in pivot boxes on either side of the frame, and on two rests raised above the gunwales by the frame, so as to form intermediate pivot boxes. The wheels are seven feet ten inches in diameter, each with twelve paddles three and a half feet long and one foot broad. The rope is made to pass round the windlass, and then over the stern of the boat, so that it may be attached to a second boat if required. To prevent the folding of the rope on itself in its passage over the windlass, a drum may be put both before and behind the windlass. The size of the machinery will depend on that of the boat. It is only necessary that the paddles expose a greater surface to the action of the current than the transverse section of the boat. The force with which the boat may be made to ascend will be as the difference between the surface of the paddles, and the transverse section. Consequently it may be increased at pleasure by increasing the surface of the paddles. The force thus obtained may be employed in moving a tow-boat (and in this way a heavy-loaded river boat, seventy feet long, and a canoe almost as large, were moved against the current almost with the facility of the tow-boat alone); or the machinery may be attached to the common river-boats, (as it will be no great incumbrance) and nothing more will be necessary than to fasten the rope around the windlass, at the foot of the rapids, where the rope may be sustained by a buoy. The same rope may be made to move several boats at the same time, each furnished with the proper machinery. A chain would be preferable to a rope, as it would wear less, and would oxidate very slowly under water.

6. *Furnace for Ventilating Sewers.*

Mr. R. Bulkley has recently proposed, in a memorial to the Mayor and Common Council of New-York, to remove the foul air of sewers by means of *purifying* furnaces. His plan is, to construct furnaces above the sewers, so that their draft may be supplied by the air of the sewers; consequently currents of air will be made to set towards these furnaces through the openings of the sewers, instead of the exhalations which now escape from them. The air of the sewers will have to pass through the fire and the chimney of the furnace before it can mix with the atmosphere; of course it will be deprived of its noxious properties by the decomposition it will undergo in the furnace. This is a subject of no little importance, since these exhalations when concentrated have been known to kill instantly, and when more diluted to cause malignant fevers, particularly around the openings of the sewers. Mr. B. contends that no other effective plan of removing the evil can be devised since the tide waters cannot be depended upon for cleansing the sewers, on account of the small rise of the tides, (only five feet) and no other means of forming a head of water sufficiently powerful can be adopted.

7. *A Flora of the Middle and Northern States.*

Dr. Torrey of New-York has now in the press a Flora of the Middle and Northern sections of the United States, being a systematic arrangement and description of all the plants hitherto discovered in the United States, north of Virginia.

This work will contain original descriptions of all the species which have come under the observation of the author, to which will be added copious synonyms and localities. Its plan will be nearly similar to that of Mr. Elliot's valuable Flora of the Southern States, and will with that work and the promised Western Flora of Mr. Nuttall, form as complete an account of the plants of the United States as our present knowledge will afford.

8. *Finch's Geology.*

Mr. J. Finch intends soon to publish *An Introduction to the Study of Geology*, designed to facilitate the acquisition of that highly interesting branch of Science.

II. Foreign.

1. *Analysis of a Treatise,* "*Sur la Classification et la distribution des vegetaux Fossiles, (On the Classification and distribution of fossile vegetables,) par M. Adolphe Brongniart.*"

(Communicated by James G. Percival.)

After a few general observations, and an enumeration of authors who have written on the same subject, the most important of whom are M. Schlotheim and Sternberg of Germany whose works are in the German Language;* the author proceeds in his first Chap. to his Classification of fossile vegetables, of which he gives a tabular view and a detailed exposition. In the second Chap. he gives a descriptive account of the fossile vegetables discovered in what he calls the formations of superior sediment or tertiary formations, which extend from the plastic clay and the lignites which

* Die Petrefactenkunde (The science of Petrifactions) von Schlötheim; Flora der vorwelt (Flora of the ancient world) von Sternberg.

cover the chalk to the surface of the earth, or the most recent alluvions, and are formed either of marine or fresh-water deposites. In the third and last Chap. he compares the fossile vegetables of these formations, with those of earlier formations—viz those of middle and inferior sediment, including chalk, oolite, *alpine limestone*, and their subordinates—and those of Coal and Anthracite with the copper lignites of Catherineburgh.

His classification is artificial, but in his detailed account of the particular Genera, he points out their affinities with existing families and genera of vegetables. He also proves in his second Chapter, that there are many fossile vegetables, in the superior formations, which are referable to genera if not to species still existing. We will give a tabular view of his Classification with the principal facts referable to each genus gathered from his chapters.

Class I. Stems, whose internal organization is recognizable.

Genera. 1. Exogenites. Wood formed of regular concentric layers. These must have belonged to arborescent dicotyledonous plants—they cannot be referred to any known species. They are chiefly found in the superior formations, where they occur in the state of lignite, or in a silicious state, (as in resinites, wood-opal,) they are also found in the state of lignite in the formations of inferior sediment. They are not found in the coal formations.

2. Endogenites. Wood composed of insulated bundles of vessels more numerous at the circumference than the centre. These must have belonged to arborescent monocotyledonous plants such as the Palms, the Dracœnas, Yuccas, &c. There are also distinct contorted fibres found in masses of lignite, which seem to have been formed of decomposed Endogenites and probably of the central looser fibres of Palms. The Endogenites are found in the superior formations, where their trunks in one species are covered with imbricated scales formed by the bases of the leaves. They are generally scattered and in small quantity. They occur in the state of lignite or silicious. They are not found in the inferior sediment nor in the coal formation.

Class II. Stems whose internal organization is no longer distinct, but which are characterized by their external form.

Genera. 1. Culmites. Stems articulated smooth, only one impression at each articulation. They sometimes want this impression, but have then many cicatrices on the internodes. They are considered analogous to the grasses and the last variety to the creeping roots of grasses. They are found only in the coarse limestone of the superior sediment near Paris.

2. Calamites. Stems articulated, regularly striated, impressions rounded small numerous, forming a ring around each articulation, or sometimes wanting. They are referred to the Genus Equisetum, to which they are at least analogous, although arborescent in size. They are found only in the coal formations, and in the copper mines of Catharineburgh.

3. Syringodendron. Stems channelled not articulated, impressions punctiform or linear, disposed in a quincunx. They cannot be satisfactorily allied to any known plants. Found only in the coal formations.

4. Sigillaria. Stems channelled, not articulated, impressions in the form of a disc disposed in a quincunx.

5. Clathraria. Stems neither channeled nor articulated, impressions in the form of rounded discs disposed in a quincunx.

These two Genera are referred to the Arborescent ferns—found only in the coal formations.

6. Sagenaria. Stems neither channeled nor articulated, covered with rhomboidal conic tubercles, disposed in a quincunx, bearing at their summit an impression in the form of a disc.

These are referred to the Lycopodia, although arborescent. Found only in the coal formations.

7. Stigmaria. Stems neither channeled, nor articulated, impressions rounded, far apart, disposed in a quincunx.—Their analogy is doubtful, but considered nearest to the arborescent Aroidæ, viz. the Dracontia, Pothos, &c. Found only in coal formations, and in the copper mines of Catharineburgh.

Class III. Stems and leaves united, or leaves insulated.

Genera. 1. Lycopodites. Leaves linear or setaceous, without nerves, or traversed by a single nerve, inserted all around the stem or on two rows. There are four very distinct sections. 1. Leaves narrow, lanceolate, inserted all around the stem, which probably belongs to G. Sagenaria. 2. Leaves setaceous arranged in two rows and not appearing to leave reticulated impressions. 3. Leaves broad, without apparent nerve, scattered and inserted without order all around the stem. These are found only in the bituminous schists of Mansfeld. 4. Leaves obtuse short applied exactly against the stem. Found in the superior freshwater formation near Paris, resembles somewhat some of the aquatic mosses. Only the last section is found in the superior formations. In the inferior sediment, the third section is found at Mansfeld and a species with thrice pinnate divisions in the Oxford oolite. The true Lycopodites or those of the second section are very abundant in the coal formations, but are not found in any more recent formations. The Lycopodites are not all distinctly referable to the Lycopodia; but the two first sections may be considered analogous.

2. Filicites. Frond disposed on the same plane, symmetrical; secondary nerves simple, dichotomous, or rarely anastomosed. These plants are all referable to the true ferns. There are five sections. 1. Glossopteris—frond simple, entire, traversed by a single median nerve, without distinct secondary nerves; resembles ophioglossum, but in other respects is little like the ferns. 2. Sphenopteris—Pinnulæ cuneiform, rounded or lobed at the extremity, nerves palmated or radiating from the base of the pinnula; analogous to Asplenium and Adiantum. 3. Neuropteris—Pinnulæ rounded, never lobed, not adhering to the rachis by their base; nerves expanding from the point of insertion, generally very distinct and dichotomous. 4. Pecopteris—pinnulæ adhering by their base to the rachis, traversed by a median nerve, and by secondary pinnated nerves; the most numerous and most like the commonest fronds of existing ferns. 5. Odontopteris—pinnulæ adhering to the rachis by their whole base, without median nerve; secondary nerves all perpendicular to the rachis; frond very delicate, analogous in structure, though not in form, to G. Hymenophyllum. Only one specimen of filicite has been observed by M. B——, in the superior formations, and this very doubtful—not found at all in the inferior sediment. Extremely abundant in the coal and anthracite formations to which they seem peculiar. There is no certain example of them in any more recent formations.

3. Sphænophyllites—Leaves verticillate, cuneiform, truncated, with radiating dichotomous nerves. Analagous to the Marsileaceæ, (a family allied to the true ferns,) and although not referable to G. Marsilea, yet near it. Found only in the coal and anthracite formations.

4. Asterophyllites—Leaves verticillate, with a single nerve, linear, lanceolate. Not referable to any known family of plants; found only in the coal formations, except one species found in the superior formations, very unlike the more ancient specimens, and analogous to the G. Ceratophyllum.

5. Fucoïdes—Frond not symmetrical, often disposed on the same plane; nerves wanting or indistinct—distinctly referable to the unarticulated Algæ or Fuci. A few species are found in the superior formations, very similar to existing Genera and even species; found principally at Monte Bolca in the Veronese, a limestone formation abounding in remains of fishes. In the inferior sediment found with great masses of carbonated exogenite, in Isle d'Aix. Also in several localities in France, Italy and Austria, all similar in their geological character. These three classes of Fucoïdes are entirely distinct. They are not found in the coal formations.

6. Phyllites—Leaves with distinct nerves, many times divided or anastomosed. Far the greater part are referable to dicotyledonous plants—a few specimens with confluent nerves are rather referable to certain monocotyledonous families, viz. Aroïdes, Piperaceæ, Dioscoreæ, &c. They might form a distinct Genus. The Phyllites are found only in the superior formations accompanying the Exogenites. They are analogous to none of the plants now growing in Europe, and rather belonged to trees and shrubs than to herbs. They are scarcely ever amplexicaul.

7. Poacites—Leaves linear, with parallel nerves. These belong to many families of monocotyledonous plants, such as the grasses, sedges, flags, typhæ, &c. They are found in the superior formations, and more abundantly in the coal formations. The two classes are very distinct.

8. Palmacites—Leaves flabelliform—distinctly referable to the palms. They cannot yet be referred to any known Genus or species. They all belong to the existing division with flabelliform leaves, while the fossile fruits of palms

belong to the division with pinnate leaves. The leaves and fruits are found in distinct localities. They are altogether confined to the superior formations.

Class IV. Organs of fructification.

Order 1. Carpolithes. Fruits and Seeds.

2. Antholithes, Flowers.

Many fruits have been found in the mill-stone rock (meuliere) near Paris, and in the fresh water formation of I. Wight, in clay. They are referred to G. Thalictrum. Fossile flowers have been found only in the superior sediment at Monte Bolca. They are very rare, and hard to be recognized. They preserve only the envelopes; one, however, has an ovary with three stigmas, and six divisions to the envelope, three exterior and three interior, resembling the Liliaceæ.

Appendix. Fossils referable to known Genera found in the superior formations. Three species of fruits referred to G. Chara, two found in the mill-stone of the superior fresh water formation, and one in the fresh water formation inferior to the coarse limestone near Paris. A species of Juglans intermediate to the regia and nigra found in the superior sediment near Turin. Three species of cones, of G. Pinus, one found in the sea-shell formation, at the foot of the Appenines in Placentia, carbonated and mixed with sea-shells, bones of cetacea and carbonated wood. 2d found in the coarse limestone at Arcueil, entirely destroyed, leaving only its impression in the mould. 3d in the superior sediment in Ardeche, only an imperfect mould remaining. All the fruits of the superior formations are distinctly referable to known Genera; of stems and leaves only a few species can be so referred, viz. the Equisetum Brachyodon, found in the coarse limestone near Paris—and a specimen in the mill-stone of Lonjumeau, resembling very exactly the creeping submerged roots of Nymphea Alba, after the fall of the radicles and petioles.

Recapitulation. 1. The formations of superior sediment including plastic clay resting on chalk, the coarse limestone, mill-stone rock, and gypsum of Paris—the limestone of M. Bolca, the shell-limestone of the Appenines, the fresh water formations above and below the coarse limestone, lignites, &c. contain fossile vegetables belonging to the G. Exogenites, Endogenites, Culmites, Lycopodites, Palmacites, Fucoïdes, Poaeites, Phyllites, and the orders Carpolithes and Antholithes, beside nine species referable to existing Genera. The Palmacites are found only in this formation.

2. The formations of middle and inferior sediment, including chalk, Jura limestone, oolite, alpine limestone, some lignites, and the bituminous schists of Mansfeld, contain specimens of only three Genera, Exogenites, Fucoïdes, and Lycopodites.

3. The formations of coal, anthracite and copper lignite, contain specimens of Calamites, Syringodendron, Sigillaria, Clathraria, Sagenaria, Stigmaria, Filicites, Sphenophyllites, Asterophyllites, and the true Lycopodites, which are all unknown in the more recent formations. The Filicites are far the most abundant; they almost give a character to the coal formations. Poacites are also found in these formations, more abundantly than in any other. The copper lignites contain only Calamites and Stigmarias similar to those in the coal formations. The anthracite formations only Calamites, Filicites, Asterophyllites, Sphenophyllites, and Poacites. The coal formations contain all the Genera in this division.

If we compare the fossil with the living vegetable kingdom, we shall find that the Acotyledons, (Mosses, Fuci, Lichens, &c.) which now form an eighth part of vegetables, did not exist in the earliest periods, but are found in the second and the most recent. The Cryptogamic Monocotyledons, (Ferns and their allies,) now forming hardly the thirtieth part, comprised nine tenths in the first periods, and are scarcely, if at all, present in the more recent. The Phanerogamic Monocotyledons, now comprising the sixth part nearly, included scarcely the thirtieth part in the earliest periods, viz. the Poacites, while the great family of Palms appeared only in the most recent periods. The Dicotyledons now including almost three quarters of vegetation, constituted only one twentieth in the earliest periods, and became very abundant in the form of exogenites and phyllites in the more recent.

The author thinks the coal beds were formed by plants, growing on the spot, and not brought from another place and deposited there; while the more recent formations are partly formed of plants growing on the spot, as Fucoïdes in marine formations, and Charas, Nympheas and Poacites, in fresh waterformations, and partly by plants brought from a distance by floods, and deposited. Hence the more delicate parts are generally destroyed in the more recent formations, while in the coal beds the finest leaves and nerves are exactly preserved. As the cryptogamic monocotyledons which constitute nine tenths of the coal fossils are not articulated, but continuous throughout their whole structure, they could not have been detached from their roots without a destruction of their organization. He therefore supposes they grew where they are now found.

The volume is illustrated by six lithographic plates, illustrating the Genera and Species described in the text, and exhibiting some of their analogies with existing vegetables.

2. *Carlsbad Waters and Uranium.*

Extract of a letter from M. Berzelius, Stockholm, March 20, 1822.

"I have nothing of importance to communicate from my own laboratory, except an analysis of the waters of Carlsbad in Bohemia, which I visited last summer. I have found in them many substances, which had not hitherto been found in mineral waters, viz. *fluate af lime, Carbonate of strontian, phosphate of lime, and phosphate of Alumine.* These substances are found there dissolved in carbonic acid uncombined. The tufas, deposited by these waters, are arragonitic, which corroborates the idea of M. Stromeyer that it is the carbonate of strontian, which determines the *arragonitic form* of this species of carb. of lime.

M. Arfredson, who has been engaged in researches on Uranium, has just found, that this metal is very reducible, by means of Hydrogen gas at a temperature scarcely equal to *redness.* The combinations of the yellow oxide of Uranium, with barytes, lead, and iron, are reducible in the same way and give metallic *Uranures*, which take fire when they come in contact with the air, and burn like pyrophori. The experiments are so easy that they can be made during a lecture."

3. *Drought in Sicily.*

Extract of a letter from Abbe F. Ferrara, Palermo, Oct. 10, 1822.

"There has been an extraordinary heat, and dryness, throughout the whole island, during the present year. (1822.) The harvest has been almost nothing in Eastern, Sicily, where there has been no rain from Dec. 1821 to Oct. 1822. They have lost a great many trees, and the water has failed in a great many fountains. The thermometer has stood at Palermo, in the months of June, July, Aug. Sept. and Oct. at 80°—100°, Fah."

4. *Secondary Granite.*—M. Marzari has observed in the vicinity of Recaro, in Italy, the following arrangement, proceeding from below upwards: 1. Mica Slate; 2. Dolerite; 3. Red sand-stone, with coal and bituminous marls; 4. Alpine or magnesian limestone; 5. Porphyritic syenite. In the valley of Lavis (Aviso) he observed the following succession of rocks from below, upwards: 1. Grey-wacke; 2. Porphyry; 3. Red Sandstone; 4. Alpine Limestone; 5. Jura Limestone; 6. Granite and augitic masses, without olivine. And Brieslac, in a memoir lately published, says, that the secondary granite, placed upon alpine limestone, is the same as the beautiful granite of Egypt, and contains great masses of quartz, with imbedded tourmaline.

Edin. Philos. Jour.

5. ***A new Fluid, with remarkable Physical properties discovered in the cavities of Minerals.***—Dr. Brewster, in a paper before the Royal Society of Edinburgh, has given a detailed account of a new fluid, of a very singular nature, which he has recently discovered to exist in the cavities of minerals. It expands about *thirty* times more than water; and by the heat of the hand, or between 75° and 83°, it always expands so as to fill the cavity containing it. The vacuity thus filled up, is of course a perfect vacuum; and at a temperature below that now mentioned, the new fluid contracts, and the vacuity reappears, frequently with a rapid effervescence. These phenomena take place instantaneously in several hundred cavities, seen at the same time.

The new fluid is also remarkable for its extreme volubility, adhering very slightly to the sides of the cavities; and is likewise distinguished by its optical properties. It exists not in sufficient quantities to admit of chemical analysis. It is almost always accompanied by *another fluid* like water, with which it refuses to mix, and which does not perceptibly expand at the above mentioned temperature.

In a specimen of *cymophane*, or *chrysoberyl*, Dr. Brewster has discovered a stratum of these cavities, in which he has reckoned in the space of $\frac{1}{7}$th of an inch square, *thirty thousand cavities*, each containing this new fluid; a portion of the fluid like water; and a vacuity besides. All these vacuities disappear simultaneously at a temperature of 83°.

If such a fluid could be obtained in quantities, it is observed, that its utility in the construction of thermometers and levels would be incalculable. There are many cavities in crystals, such as those opened by Sir Humphry Davy, which contain only water, and which, of course never exhibit any of the properties above described.

Edin. Phil. Journ.

6. *Pyro-citric Acid.*—A new acid has been thus named by M. J. Lassaigne who discovered it. It is produced by the distillation of citric acid. It is white, inodorous, and of a strongly acid taste, and occurs generally in a white mass, composed of fine small needles. It melts, and is converted into very pungent white vapours, leaving traces of carbon. It is very soluble in water and in alcohol. At 50° Fahr. water dissolves one-third of its weight. It is composed of carbon 47.5, oxygen 43.5, hydrogen 9.=100. With the oxides it forms salts, differing in their properties from the citrates. M. Lassaigne has examined the pyro-citrates of potash, lime, barytes and lead.

Journ. de Pharm.

7. *Hydro-carbo-sulphuric Acid.*—Dr. Zeise of Copenhagen has discovered and named this new acid, which bears the same relation to sulphuret of carbon, that hydro-cyanic acid has to cyanogen. It may be procured by pouring a mixture of four parts of sulphuric acid and three of water, on the salt of potash, and adding much water in a few seconds. The acid collects at the bottom, in a transparent

slightly coloured oil, which must be freed from sulphuric acid by washing. It is acid and astringent to the taste. It reddens litmus paper. It burns readily giving out sulphurreous fumes. Its odour differs from that of sulphuret of carbon, and is decomposed by heat. Its compounds have been termed *Hydro-carbo-sulphates.*

Ann. of Phil. new series.

Articles of Foreign Literature and Science, extracted and translated by Professor Griscom.

8. A work has been published in France, by M. Brard, late director of the mines of Servoz, entitled *Mineralogie Appliquée Aux Arts.* It is in 3 vols. 8vo. with plates, price 21 francs.

The style and arrangement is rather severely criticised in the Rev. Ency. but the reviewer admits that it contains much useful matter, facts and observations hitherto but little attended to, and that the author has evinced extensive knowledge in many branches of physical science and of the useful arts.

9. *Fumigation.*—The Swedish public have been much interested lately in a new medical discovery of considerable importance. It had been known for some time that Pehrs Anderson of Sudermania, who had attended one of the late diets as a deputy from his class, was curing, in his province, the most inveterate syphilitic diseases, and even those that had been considered as incurable, by means of *fumigations.* The college of health, desirous of examining for itself, this process and its results, sent for Anderson to Stockholm, and engaged him, on the payment of his expences, to undertake the treatment of various individuals, affected with those diseases in the hospital of that city. Eight of them, on whom mercurial remedies and a strict diet, had produced no effect, were completely healed in two, three or five weeks according to the extent of the disease. Six new patients are now under the operation of the new remedy. M. De Weigel, president of the College, and several other physicians of the city, who have observed this curative process with the greatest attention, bestow upon it a just tribute of praise, and have induced the Directors of

the hospital to make the discoverer a present of three hundred and sixty-six rix dollars *de banque* and to ensure him an equal sum in addition, in case that the health of those whom he has cured, should in two years undergo no alteration that can justly be attributed to their former malady. The memoirs of the Medical Society will doubtless soon furnish a detail of the method of M. Anderson.

10. *The Society of Christian Morals* at Paris, having appointed very respectable Committees on the subjects of Gaming and Lotteries, an unknown person, under the modest title of a Christian, has deposited with the society one thousand francs, to be adjudged in equal portions to the authors of the best essays or memoirs against those enormous evils.

Each memoir must consist of not less than one hundred nor more than one hundred and twenty pages 12mo. The author is advised to take the excellent work of Lèmontey on Savings Banks, or Franklin's Poor Richard, as the model of his essays.

11. *Flour or meal from leguminous fruits.*—A manufactory of this kind has been established in France, and the benefits of it have obtained the decided approbation of chemists, public economists and of the society of encouragement. The flavour of the different fruits and roots is completely preserved, and it is believed that in the state of meal their farina is more digestible and wholesome than when dressed in the usual way. They are first cooked by steam to a sufficient extent, then kiln dried so far as to be easily ground in a mill, and boulted in the usual way.

At the suggestion of M. Darcet, the ingenious manufacturer, Duvergier, prepares also flour of different kinds combined with five per cent of gelatine, to render it more nutritious and more useful to seamen.

A few minutes only are sufficient to convert this flour into soups and pottage, instead of four hours which are necessary in the boiling of the dried roots and legumes. Hence there is an economy of time and fuel in the use of this new product. The prices in Paris of these articles are as follows. Potatoe flour $3\frac{1}{2}$ lbs. for a franc, (=$18\frac{3}{4}$ cent.) Flour of large beans, 3 lbs. do. Ditto of Peas 2 lbs. do. Garden beans $1\frac{1}{2}$ lb. do.

Chesnuts $1\frac{1}{4}$ francs per lb. &c. Combined with gelatine the prices are 20 per cent higher.

12.—An *American Plough* was presented to the Society of Encouragement at Paris, by J. C Barnet, Esq. the U. S. Consul, and by the Society it was referred to a special committee, who engaged M. Benoist, postmaster at Villejuif, to make a trial of it. This was done on the 13th of June last, in presence of the committee and a number of farmers and friends of M. Benoist. Two French ploughs were tried at the same time, for the purpose of comparison. The committee admit that the American performed extremely well, cutting the sward smoothly, and laying a neat and well-turned furrow. But on trying it with the *Dynamometer*, it was found to require a draught of 180 to 190 kilogrammes, while the plough in common use there, required only 130 to 140, and one of a newer kind, with an *avant train* moved with 110 to 120 kilogrammes. They attributed the greater draught of the American plough to the manner of conducting it, and to the irregularities of its motion, which, they say, could not be avoided after a long trial. A neat figure of the American plough is given in the Bulletin of the Society for August, 1822.

13.—*Improvement in Metallic Casting*.—Iron and metallic castings are said to be very much improved, by subjecting the metal, when in moulds, to pressure. This is done by making a part of the mould of such a form as to receive a piston, which, on the metal being introduced, is made to press on it with any required force. It is stated that castings obtained in this way are not only free from the imperfections generally incurred in the usual mode, but have a peculiar soundness of surface and closeness of texture, qualities of the utmost importance in ordnance, rolling cylinders, &c. The improvement belongs to Mr. Hollingrake, who has obtained a patent for it.

14. *Canal Navigation.*—The tread-wheel has been applied by M. Van Heythuysen, to the propelling of barges of canals. The object is to obviate the use of horses. The apparatus is made light and separable from the barge, and it is found that two men can propel a barge by it, at the

rate of five miles per hour. The saving of the expense of horses and track-roads promises to make this application of human power very valuable.

15. *New mode of Printing Designs.*—A discovery has been made in the department of Calvados in France, by which the finest strokes of the crayon or pencil, upon porcelain, may be infinitely multiplied. These strokes, traced with a particular metallic composition upon the polished surface of porcelain, are incrusted by the second application of fire, without the slightest injury. The parts thus delineated acquire a sort of roughness, insensible to the touch, and only to be discovered by its perfect retention of ink, which is easily wiped off the other parts of the surface. This method seems to have decided advantages over lithography.

16. *Artificial Slates.*—Artificial slates have been used in Russia, which are said to be very valuable, as being lighter than common slates, impermeable to water, incombustible, and made of any required form or size. They have been analyzed by M. George, who finds them to consist of bolar earth, chalk or carbonate of lime, strong glue, paper pulp, and linseed oil. The earthy materials are to be pounded and sifted; the glue dissolved in water; the paper is the common paper pulp, which, after, being steeped in water, has been pressed; or it may be book-binders or stationers' shavings, boiled in water and pressed. The linseed oil is to be raw. The paper pulp is to be mixed in a mortar with the dissolved glue; the earthy materials are then added, and beaten up, and the oil mixed during the beating, as fast as it is absorbed. The mixture is then spread with a trowel on a plank, on which a sheet of paper has been laid, and surrounded by a ledge to determine the thickness of the layer, and is then turned out on a plank strewed with sand to dry. When dry, they are passed through a rolling mill, then pressed, and finally finished by a coat of drying oil. The following are some of the various proportions recommended.

2 parts paper pulp, 1 glue, 1 chalk, 2 bole earth, 1 linseed oil; this forms a thin, hard, and very smooth sheet.

3 parts paper pulp, 4 glue, 4 white bole earth, and 4 chalk, oil ? produce an uniform sheet, as hard as iron.

1 paper pulp, 1 glue, 3 white bole earth, 1 linseed oil; a beautiful elastic sheet.

When these plates or slates were steeped in water for four months, they were found not to alter at all in weight, and when exposed to a violent heat for five minutes, they were hardly altered in form, and were converted into black and very hard plates.—*Tech. Rep.* 11. 421.

17. *On the porosity of glass and siliceous bodies.*—Mr. Deuchar, in a paper on the occasional appearance of water in the cavities of crystals, and on the porous nature of quartz and other crystalline substances, read before the Wernerian Natural History Society, suggests that the crystals which are found to contain these portions of water, were probably once hydrated, or rather contained throughout their mass an excess of water, and that this fluid having afterwards separated from the crystals, passed by capillary attraction, either to the surface, or to any accidental *void* space within them.

Mr. Deuchar, thinks it obvious that the water might pass through the crystals, not only from the porous nature of their particles, but also from their temporary display of rents, during the applicatiou of a *high* temperature. It is supposed that all siliceous bodies, even glass &c. are porous, and the author thinks that the filling of well stopped bottles when sunk to great depths in the ocean, depends on the water passing through the glass, and not through the materials used to stop the bottles, though these were only cork, sealing-wax, and oil-cloth. We would, however, refer our readers to the paper itself in the Phil. Mag. Vol. 60, p. 310, but wish them at the same time to read one by Mr. Scoresby, in the Edin. Journal, VI, 115, also relating to sunken bottles.

18. *Metallic Titanium.*—Dr. Wollaston has lately discovered that the small cubic crystals of a metallic lustre and reddish colour, which are occasionally found in the cavities of the slags from iron furnaces, are pure titanium.

19. *Congelation of Mercury.*—M. Gay Lussac states in a memoir on the cold produced by the evaporation of

fluids, that he has readily frozen mercury, by surrounding it with a frigorific mixture of ice and salt, in the apparatus in which aqueous vapour is produced and absorbed by the process of Mr. Leslie, and he has no doubt that with analogous means and very volatile liquids, a degree of cold might be produced below that produced by mixtures.—*Annales de Chimie.*

20. *New Electro-Magnetic experiments.*—The following is a very curious and simple electro-magnetic experiment made by Dr. Sebeck of Berlin. Take a bar of antimony, about eight inches long, and half an inch thick; connect its extremities by twisting a piece of brass wire round them so as to form a loop, each end of the bar having several coils of the wire. If one of the extremities be heated for a short time with a spirit lamp, electro-magnetic phenomena may be exhibited in every part of it.—*Ann. Phil.* iv, 318. We have repeated this experiment with every success. The brass is in that state which would be produced by connecting its heated end with the negative pole of a voltaic battery, and its cold end with the positive pole.—*Editor.*

Electrical Effect.—The following effect is attributed by Mr. Fox, who observed it, to electricity. A piece of iron pyrites was fastened with a piece of brass wire in a moss house, the moss being damp. On the following day, the wire was found broken and excessively brittle, and in those parts in contact with the pyrites much corroded. On one occasion, after the brass wire had been fastened once or twice round a piece of iron pyrites, and had remained for some days enveloped in damp linen, the constituents of the brass wire were separated, and it was converted into copper wire, *coated with zinc.*—*An. Phil.* iv. 449.

21. *Employment of Potatoes in Steam Engine, and other boilers, to prevent the calcareous Incrustations on their bottoms and sides.*—The practice of adding about one per cent. of potatoes to the bulk of water contained in a Steam-Engine boiler which has been long practised in this country, has been recently introduced into France, and merits the encomium which is bestowed on it by M. Payen, in a letter to the Editor of the Jour. de Phar. Oct. 1822. He explains the true cause of the beneficial agency of the root. The

potatoe dissolves in the boiling water, forming a somewhat viscid liquid, which envelopes every particle of the precipitated calcareous salt (usually Selenite, sometimes Carbonate of Lime) renders them slippery, so to speak, and prevents their mutual contact and cohesion. After a month's service, the boiler is emptied, and new potatoes added along with the charge of water.

22. *Flowers of the common Mallow (Malva Sylvestris) an excellent Test of Alkali.*—M. M. A. Payen and A. Chevalier state, that an alcoholic infusion of these flowers (previously dried by a steam heat out of contact of light) gives a sensible tinge of green on being mixed with water containing $\frac{1}{200,000}$ part of potash, $\frac{1}{1000}$ part of Carbonate of Soda and $\frac{1}{25}$ of lime water.

According to the same chemists, the colouring matter of the fruit of the *Cerasus Mahaleb* (wood of St. Lucie,) is an excellent test of acids, but inferior in delicacy to litmus. Infusions are more sensible to change of colour than coloured paper.

23. *Method of colouring Alum Crystals.*—In making these crystals, the colouring should be added to the solution of alum in proportion to the shade which it is desired to produce.

Coke, with a piece of lead attached to it, in order to make it sink in the solution, is the best substance for a nucleus; or if a smooth surface be used, it will be necessary to wind it round with cotton or worsted; otherwise no crystals will adhere to it.

Yellow.—Muriate of iron.

Blue.—Solution of Indigo in sulphuric acid.

Pale Blue.—Equal parts of alum and blue vitriol.

Crimson.—Infusion of Madder and Cochineal.

Black.—Japan ink, thickened with Gum.

Green.—Equal parts of alum and blue vitriol with a few drops of muriate of iron.

Milk white.—A crystal of alum held over a glass containing ammonia, the vapour of which precipitates the alumina on its surface.

24. *Green Ore of Uranium.*—R. Phillips has ascertained that the green ore of Uranium from Cornwall, contains

phosphoric acid, and not merely the oxide of Uranium and copper combined with water.

25. *Prussian travellers*.—The Prussian naturalists, Drs. Ehrenberg and Hemprich, in their tour in the interior of Northern Africa, arrived safely at the celebrated Dongola, the capital of Nubia, on the 15th of February. These zealous collectors have sent six remittances to Berlin, and have again accumulated more than they can pack in twenty chests. Their collection consists of mammalia, birds, amphibia, insects, plants, and what are more rare, fishes and insects of the Nile.

26. *An Electro-Magnetic Apparatus* of extraordinary dimensions has been constructed at the London Institution, by W. H. Pepys, Esq. F. R. S It consists of two plates, the one of copper, and the other of zinc, each two feet wide, and fifty feet long, giving a total surface of two hundred square feet. These plates are wrapt or coiled round a common center, and are prevented from contact with each other by the interposition of three cords of hair line, and also of notched slips of wood placed at intervals. Two conductors of copper wire, nearly three fourths of an inch in diameter, are attached, one to the zinc, and the other to the copper plate. In order that so large a mass may be readily employed for experiment, the apparatus is suspended by means of pulleys and a counterpoise, and so let down into a tub of acid, or, when not in use, into one of water. It requires fifty five gallons of fluid.

This instrument exhibits very powerful magnetic effects: when the contact was made, a change in the direction of compass needles was produced, at the distance of five feet; steel bars enclosed in cylinders of glass, with a spiral of wire round them, were rendered magnetic, and several were suspended together; when the contact was broken, the bars fell, but one of them was immediately taken up again on restoring the contact, though it weighed above 270 grains. The electric intensity of the apparatus is very slight; it has not any decomposing action, and will not make a spark with charcoal, nor will it deflagrate the metals.

27. *Instrument for measuring the compression of water.*—Professor Oersted uses a very simple instrument for

measuring the compression of water. After having deprived the water of atmospheric air by ebullition, he fills a glass cylinder with it, whose upper part is mounted with a brass cover, hermetically sealed, and which is traversed by a screw, with a small brass piston at its lower extremity which presses upon the fluid. In the cylinder is placed a ball with a small thermometer tube, both filled with the water of the cylinder, except that in the upper part of the tube, which remains open, there is a small column of mercury, which on account of the extreme fineness of the tube, keeps its place without falling into the ball.

Now suppose that the water is compressed by turning the screw of the piston; this pressure being equal both within and without the ball and its tube, they will undergo neither expansion nor contraction, and consequently the position of the mercury above the water in the thermometric tube will immediately indicate the compression. Mr. Oersted previously determined the capacity of the tube and that of the ball, by taking the weight of the volume of mercury which fills them. The pressure exerted upon the water by the screw is measured by a tube filled with air and likewise enclosed in the cylinder. He has ascertained by this instrument that the compressibility of water diminishes very rapidly as the pressure increases, and that the mean compressibility under a pressure of three or four atmospheres is $\frac{45}{1000000}$ for each atmosphere, a result which very nearly accords with the experiments of Canton.

28. *A superior Green Dye.*—M. Noël who has a fine manufactory of paper hangings at *Nancy*, put into the hands of H. Braconnot a specimen of a superb green colour, which within a few years has acquired much reputation in commerce, and the secret of which is known only to a colour manufacturer at Schweinfurt. Braconnot easily discovered, by analysis that it consisted of arsenical acid, deutoxide of hydrated copper, and acetic acid; thus approaching in its composition to Scheele's green. But this skilful chemist found it not so easy to recombine the materials so as to equal the Schweinfurt colour. After persevering efforts, he at length succeeded. The process which he adopted, is, 1st. to dissolve in a small quantity of warm water, six parts of sulphate of copper; 2nd to boil eight parts of oxide of arsenic with eight parts of potash of com-

merce in water until no more carbonic acid is disengaged. 3d, mix this solution while hot and concentrated, by a little at a time, with the former; continually stirring it until effervescence ceases. Care must be taken not to add the arsenite of potash in excess. An abundant precipitate is formed of a dirty yellow colour. 4th, add acetic acid, (about three parts) or such a quantity that there may be a slight excess of it sensible, by its odour after the mixture; by degrees the precipitate diminishes in volume, and at the end of a few hours there is spontaneously deposited a powder of a slightly crystalline texture and of a very beautiful green. 5th, separate the supernatant liquor, (which by remaining too long on the colour, might deposit oxide of arsenic, which would render it pale,) and then treat the colored deposite with a large quantity of boiling water, to remove the last portions of arsenic which are not held in combination.

It is better (Braconnot observes,) to make use of an arsenite of potash, well saturated with arsenic. It is true, that part of the arsenious acid remains in the mother waters, but this may serve for the preparation of Scheele's green, which is commonly employed for paper of an inferior quality. It seems to me that when we added to the mixture a small quantity of this green, it favored the production of the superior color, somewhat in the same manner as a crystal attracts its kindred molecules in a saline solution.

The colors which we obtained by the preceeding method were judged by several persons to be more lively than that of Schweinfurt.

29. *Artificial formation of Formic Acid.*—Dobereiner has discovered that when tartaric acid, or cream of tartar, peroxide of manganese and water, are heated together, a tumultuous action begins, a large quantity of carbonic acid is disengaged, and a liquid acid distils, which, on superficial examination, might be taken for acetic, but which, on a stric er enquiry, proves to be formic acid.

If to the materials above described, there be added sulphuric acid, the tartaric acid will be entirely converted into carbonic acid, water, and formic acid, and there will consequently be obtained a larger quantity of the latter. The best proportions of the mixture are—

1 part crystallized tartaric acid, $2\frac{1}{2}$ peroxide of manganese, $2\frac{1}{2}$ sulphuric acid, diluted with two or three times its weight of water.

Gay Lussac confirms this interesting result of Dobereiner.

30. *Saw moved by Mechanism.*—It is stated in an official report made to the Society for the Encouragement of National Industry, Paris, that the mechanism invented and applied by *Brunel*, in England, has been ascertained (according to an investigation made by order of the British admiralty,) to produce an annual saving to the government of seven thousand pounds sterling; and as a mark of benevolence and esteem for M. *Brunel*, this sum has been guaranteed to him, notwithstanding he has for a long time derived a liberal benefit from his useful labors.

31. *The Society for the Encouragement of National Industry in France*, expended during the year 1821, in the various objects of its association, the sum of $43,955\frac{55}{100}$ francs. Its income during the same year was $49,838\frac{46}{100}$ francs. A benevolent individual (M. Jollivet,) who died in 1818, bequeathed to this Society the sum of about 300,000 francs, one half the income of which is to be at the disposal of the Society in the delivery of annual premiums for the encouragement of national ingenuity and enterprise. The other half is to be applied, during sixty years, to the augmentation of the capital, at the end of which time the patriotic testator hoped that the Society would be in possession of a fund sufficient to enable French industry to triumph over all foreign competition. If this Society should cease to exist, the fund is to pass over to such other analogous institution as the government may appoint to receive it.

32. *Portugal.*—Public instruction is very far from being as defective in this country as the superficial remarks of travellers would represent it. Within this little kingdom there are 873 elementary schools, 266 for the Latin language, 21 for Rhetoric and Greek, 27 for rational and moral philosophy, a university at Coimbra with six faculties, and a college for preparatory studies. The university and the college enumerate, annually, from 1280 to 1600 stu-

dents. All these establishments were frequented, in 1819, by 31,401 pupils. These institutions are under the *direction general des etudes*, but there are many others devoted to special instruction. The Royal Academy of Sciences at Lisbon, publishes every year a volume of transactions.

33. *Contagion and Infection.*—The Royal Society of Sciences at Rouen, in France, offer a premium of 300 francs, or a gold medal of that value, to the person who shall best solve the following question.

"Is it proved by exact observation that there are fevers which can be communicated by infection, without being contagious? In admitting the existence of these fevers, what are the principal causes which give rise to their developement, and to their propagation? What are the means proper to prevent them, or to arrest their progress?" The memoir is to be addressed to the perpetual secretary of the class of sciences, before the 1st of June, 1823.

34. *Public Instruction. Method of M. Ordinaire.*—In conformity to a special ordinance of the Rector of the Academy of Paris, the pupils of the Institution Morin, instructed upon the method of M. Ordinaire, were examined with the most scrupulous attention on the 23th of September last. The results even far surpassed the expectations that a knowledge of the theory had excited. It appears to be proved that, by the employment of this method, a child may acquire in fifteen months all the positive knowledge usually required of a pupil of the fifth year. It is to be remarked that this method changes neither the customary denominations, nor the class book actually in use, and that it does not oppose the progress of the course of instruction generally established.

35. *The Society for promoting elementary instruction* in France held its annual meeting at Paris on the 10th of April 1822. The Count de Chabrol, prefect of the Seine, and the Duke de Rochefoucauld each pronounced a discourse relative to the object of the society. M. Jomard, the secretary, gave a luminous account of the proceedings of the past year. He congratulated the society on the establishment of 156 schools during the year 1821, notwithstanding

the unjust opposition which checks the progress and tends to paralyse the generous efforts of the friends of instruction. At the school of Auzin the teacher fell sick and was detained from his class for three months. During this time the school was conducted by the monitor general in perfect order and discipline, as if the master had been present, an evidence of docility in the pupils, and of intelligence in the child, which speak loudly in favour of the system.

Of 24,000,000 of adults in France it is calculated that there are but 9,000,000 that can read and write. Hence it may be stated that 15,000,000 of the French people are without instruction.

36. *Animal Heat.*—The French Academy offer a prize of a gold medal of the value of 3,000 francs for the determination by exact experiments of the causes, whether chemical or physiological, of animal heat. It requires, particularly that the heat emitted by a healthy animal in a given time, and the carbonic acid which it evolves by respiration in the same time, should be precisely determined, and that the heat thus set free should be compared with that produced by the combustion of carbon in forming the same quantity of carbonic acid.

The Academy also offers a similar premium to whoever shall determine by multiplied experiments: 1st. The density acquired by liquids, and especially in the case of mercury, water, alcohol and sulphuric ether, by compressions equivalent to the weight of many atmospheres; and, 2dly. The heat produced by these compressions.

37. *Necrology.*—The widow of *Condorcet*, the distinguished French philosopher, died at Paris on the 6th of September last. Her charity and philanthropy are highly eulogized in the public account of her death. She was known in the literary world by a translation of Adam Smith's Theory of Moral Sentiments.

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Art. I.—*Notice of a Rocking Stone in Warwick, R. I.*

Providence, September, 20th 1823.

Prof. Silliman, Sir,

IT has given me some satisfaction to become acquainted with the particulars which Mr. Moore has given us in the last number of your Journal, respecting the Durham Rocking Stone. It is true, as he intimates, that there are but few rocks of this kind as yet known in our country; still, as curiosity is continually increasing, and the votaries of geological science daily becoming more numerous, it will not be long, it is believed, before they will be found to exist here in considerable numbers. I have recently visited one which is found in this State, and from its interesting character, have been induced to forward to you a description of it, together with a drawing by Mr. Moses Partridge.

It is in the town of Warwick, about two hundred yards south-west of the village of Apponaug, and twelve miles in the same direction from Providence. In form, it resembles a turtle, although it is convex on the bottom and somewhat concave on the top. It is about ten feet in length, six in breadth, and two in thickness. It reposes upon another rock, which rises a few feet above ground, touching it in two points—the one under A, the other under B.* Uponthese points it is so exactly poised. that it moves with the gentlest

*Fig. 1, Plate 1.

touch. A child five years old may set it a rocking, so that the side C will describe an arc, the chord of which will be fifteen inches. The easiest method to rock it is by standing upon it, and applying the weight of one's body alternately from one side to the other.

What renders this rock peculiarly interesting is, that when the side D descends, it gives four distinct pulsations, hitting first at E, next at F, then at G, and lastly at H. The sound produced, is much like that of a drum, excepting that it is louder. In consequence of this sound, it has very appropriately entailed upon itself the name of "The Drum Rock." It has been heard in a still evening at the distance of six miles. In the summer season, it is a place of fashionable resort for the people of Apponaug, and of the town generally.

The weight of this rock is estimated at four tons—upwards of a ton heavier than the one at Kirkmichael in Scotland, and almost as heavy as the famous Logan, in the parish of Sithney, near Helston in England. Its composition appears to be an indurated ferruginous clay, with here and there small portions of quartz. Its specific gravity is 2, 5. It has long been a subject of inquiry with the inhabitants of Warwick, how this rock came here, or by what means it was placed in its present situation. A little attention will convince any one who sees it, that it was once united to the rock on which it rests. Let A be turned round to I, and it will unquestionably be in the spot where it originally belonged. But by whom it was shifted into the places which it now occupies, is a matter of uncertainty. It has been attributed to the Indians. The removal of such a mass seems however, to have required some mechanical skill, more, perhaps, than many will be willing to allow, that the savages of this region ever possessed. As we have never had any Druids* amongst us, we shall probably never know for a certainty upon whom the honour of the enterprize is to be bestowed.

This rock is surrounded with interesting scenery. South is a dark and dismal swamp, which comprises from fifteen to twenty acres, containing the birch, the hemlock, the maple and the alder. West is a side-hill, which rises at an an-

* See Mr. Finch's memoir in the last Number of this Journal. (Edit.)

gle of eighteen or twenty degrees, from the top of which we have a view of the central part of the Narragansett, with several of its beautiful islands. East, a plain presents itself, intersected by a ravine, overgrown with shrubs, along which flows a small stream of water from the swamp. North, the land rises gently, and for some extent is completely covered with huge, misshapen rocks, lying wholly above the surface; gray with moss, and exhibiting ten thousand fractures.

Very Respectfully yours,

STEUBEN TAYLOR.

Preceptor of the Charlesfield Street Academy.

ART. II.—*Review of " Outlines of the Geology of England and Wales; with an Introductory Compendium of the General Principles of that Science: And Comparative views of the Structure of Foreign Countries.* By REV. W. D. CONYBEARE, F. R. S. M. G. S. &c, and WILLIAM PHILLIPS, F. L. S. M. G. S. &c. Part I: pp. 470. London, 1822."

(Communicated for this Journal.)

PERHAPS to no science, can the poet's description of Fame be so properly applied, as to geology:

Mobilitate viget viresque acquirit eundo.

It is not much above thirty years since systematic and effective efforts were made in this science, by men of energetic minds and persevering research. Previously to that time, indeed, facts were accumulating, and some efforts worthy of praise, were made, to find out a clue to their arrangement. The names of several Arabian writers, upon the mineralogical department of geology, as early as the tenth century; of some Italians in the sixteenth century, upon fossil shells, among whom Boccacio was eminent; of Lehman the German; of Palissey, Rouelle and Guettard, in France; and of Owen, Woodward, Llwydd, Lister, Mitchell, Holloway, Packe, Strachey, and others, in England, will always be remembered with respect in the history of this science. Still however, until the time of Hutton and Werner, geology consisted of little else than mere *membra disjecta;* and it demanded no small share of anatomical skill to bring "bone to his bone." Before their day also, appeared many an *aeroscopic* phantom, called *a theory of the earth;* to which, with literal propriety, we might apply another line of the poet:

Monstrum horrendum, informe, ingens, *cui lumen ademptum.*

In a subsequent part of this article, we may say something concerning the leading points of the Huttonian and Wernerian theories. But however they may be viewed in other respects, it will be allowed by all, that they form an important epoch in the history of geology; and that they drew the efforts of subsequent observers towards two grand foci, from which a stream of light has been issuing, with increased splendour ever since: and should the brightness at these centres decline and even be extinguished; yet have their beams been shed so copiously on the regions around them, that there would be little danger of universal night. In English history the name of William Smith, as "a great original discoverer," as a matter of fact-man unincumbered with theories, is held in high estimation, and his extensive and accurate researches laid the foundation of the work at the head of this article. While he was pursuing his investigations in England, the pupils of Werner, on the European continent, were imbibing the zeal of their master in observing, and his accuracy in their arrangements and descriptions; while Saussure was examining the Alps, and Pallas, the Russian empire. It was not long however, before the present constellation of European geologists arose. It was a new and interesting field, and many a gentleman of distinguished talents and science was allured into it. It is sufficient to mention in Great Britain, the names of Jameson, Playfair, Mac Culloch, Greenough, Webster, Conybeare, Buckland, Phillips, Aikin, Weaver, Seymour, Griffith, Farey, Bakewell, Parkinson, Sowerby, and Miller; and on the continent of Europe, those of Cuvier, Brongniart, Daubuisson, Humboldt, Von Buch, Brocci, De Luc, Brochant, and Delametherie. In the hands of such men, geology, for the last twenty years, has outstripped even chemistry in its progress. Instead of a few unassisted individuals, struggling with almost every difficulty, and producing as the result of a life of laborious, self denying effort, a single volume, which, in the opinion of the world, placed its author among the candidates for Bedlam; we now find in the "crystal hunter," many a Reverend, and many a Right Honourable: while numerous respectable societies, pour forth their splendid annual, and semiannual quartos, rich with subterranean intelligence. So rapidly do facts accumulate, so imperfect are the former definitions found to be, so many old principles are overturned, and so many splendid hypotheses exploded, that it is hardly safe for a geologist in this country, who has not a very direct communication with London or Paris, and who has not read the European Journals of the preceding quarter, it is hardly safe for such an one to describe a geological fact, if he would not stand corrected for ignorance in the next review. And even if all things be favourable, he cannot be without some well grounded fear, that the next arrival from Europe will throw all his efforts into oblivion

In this country, geological science was not commenced until a period still later than in Europe. Most of those, who bore the heat and burthen of the day of its introduction, still live and continue to devote their talents and fortunes to the promotion of their favourite science. By one of these, a few years ago, (1818) the following testimony was given. "Only fifteen years since, it was a matter of extreme difficulty to obtain, *among ourselves*, even the *names* of the most common stones and minerals; and one might enquire earnestly, and long before he could find any one to indentify even *quartz*, *feldspar*, or *hornblende*, among the simple minerals; or *granite*, *porphyry*, or *trap*, among the rocks. *We speak from experience*, and well remember with what impatient, but almost despairing curiosity, we eyed the bleak, and naked ridges, which impended over the vallies and plains that were the scenes of our youthful excursion." (Introductory discourse to the Am Jour.)

But notwithstanding the little encouragement to such pursuits afforded by our country, at the period above alluded to, the zeal of such men as Maclure, Mitchell, Gibbs, Bruce, Cleaveland, Silliman, Waterhouse, and Seybert, who led the van in this effort to conquer the rocks, and what was worse, the indifference, prejudices and sneers of their countrymen, were not to be damped, or disheartened. They have presented to the world the grand outlines of the geology and mineralogy of this vast country, and left nothing to be done by the numerous geologists, who have sprung up under their patronage and instruction in almost every part of the land, but to supply the local details and put a finishing hand to the picture. It is in our newer, or, as they are sometimes called, the tertiary formations. that the greatest deficiency exists.

The work, at the head of this article, comes to us under circumstances calculated to excite high expectations of its interest and value. It is the joint production of two gentlemen, with whose names we have been familiar in the later publications in Europe, on mineralogy and geology: and it professes to embody all that has hitherto been ascertained by themselves, or others, relative to the internal structure of a country, which, as a whole, has probably been more thoroughly explored, than any other on the globe. The volume before us is only the first part of the work; and embraces a description of all the rocks in England and Wales, above the coal formation, (that being included,) in the order in which they occur, reckoning downwards. "The present part," says Mr. Conybeare, "has been presented to the public without waiting for the completion of the second, chiefly because it contains the history of those formations which have been as yet fully examined in England alone, and of which a detailed description was required to fill an important chasm in the science of geology." The definiteness and accuracy, with which these formations are described, have really delighted and surprized us. We were not aware, from consulting the detached papers in the Transactions of the London Geological Society, and in the public Journals, that such a degree of perfection had been attained in the history of the secondary and tertiary rocks. Several important and extensive series are described, which are wholly unknown to most of our recent elementary treatises on geology.

We have not read this work with the eyes of verbal critics, and we confess ourselves to have had some prejudices in favour of the writers, from what we had seen of their earlier productions; too well known to need enumeration. With the purity and neatness, not to say occasional elegance of style, in which this work is mostly written, we are much gratified: especially when we recollect, how often works of merit, in this department of knowledge, give pain to the classical man, by the homely and uncouth dress in which they are presented. In this work "a satisfactory proof has been afforded in opposition to the misrepresentations of shallow sciolists, that the institutions of academical education are far from being unfavourable to the cultivation of the physical sciences, and that an ignorance of the rules of classical composition, and of the languages and philosophy of polished antiquity are by no means essential advantages in researches of this nature." (p. 48. Introd.) We think however, that we discover some marks of haste in the putting together of this work. For the sake of perspicuity, we could wish to see many of its unusually long sentences divided; and we are rather surprised at the number, of what appear, for the most part to be errors of the press. It ought, however, to be remembered, that a part of the work was not examined in proof by the writer.

We shall for the present, omit giving any notice of the Introduction, and proceed to exhibit the several series of rocks in England and Wales, in the order which this work assigns to them; with a reference to the same formations in this country, so far as geological writers, or our own observations, enable us to indentify them. To ascertain how far the rock formations in the different parts of the globe coincide with those of Europe, is now the leading object, to which European geologists are directing their attention. Let not our readers suppose, that we refer merely to that division of the formations denominated primitive, transition, and secondary. These are merely the *first lines* of geology; and to arrange the rocks of a country according to them, is a task, which, though demanding labour and patience, is yet small in comparison with that of correctly referring them to those more numerous divisions which recent discoveries have rendered necessary, and which the work before us recognises. When those divisions shall have been carried so far that no two species can be blended together, and all the rocks of the globe are referred to their proper degrees in the scale, then will geology have reached the *ultima Thule* of her dominions.

We must advert a moment in this place, to the introduction of the work before us, to exhibit the general classification of rocks, which the authors have made the basis of their arrangement of the strata of England and Wales. The following sketch, taken from page 7th, will give at a glance, a comparative and synoptical view of their plan.

Character.	Proposed Names.	Wernerian.	Names by other Writers.
1. Formations (chiefly of sand and clay) above the chalk.	Superior Order.	NewestFloetz Class.	Tertiary Class.
2. Comprising *a* chalk, *b* sand and clays beneath the chalk, *c* calcareous free-stones (oolites) and argillaceous beds, *d* New red sandstone, conglomerate and magnesian limestone.	Supermedial Order.	Floetz Class.	Secondary Class.
3. Carboniferous rocks. comprising *a* Coal Measures, *b* Carboniferous limestone, *c* Old red Sandstone.	Medial Order.	Sometimes referred to the preceding, sometimes to the succeeding class by writers of these schools; very often the coal measures are referred to the former—the subjacent limestone and sandstone to the latter.	
4. Roofing Slate, &c. &c.	Submedial Order.	Transition Class.	Intermediate Class.
5. Mica Slate. Gneiss. Granite,	Inferior Order.	Primitive Class.	Primitive Class.

Such an utter exclusion of all hypothesis, as this arrangement exhibits. may startle the man, whose thoughts and feelings have long run in the channels of a particular system. We cannot. however, but be pleased with its remarkable simplicity; and do not see but it answers every purpose of primitive, transition, and secondary; without conveying, to the mind of the student, any of those false, or to say the least, hypothetical views, which such terms are apt to impress upon him; and which exert an undesirable influence on all his researches.

The strata in England and Wales, described in that part of the work under review, are, as already remarked, the coal measures and all above these. In other words, it comprehends the three first orders in the preceding table. Those in the Superior Order embrace all above the chalk; viz. the Alluvial and Diluvial; the Upper Marine Formation; the Fresh Water Formations; the London Clay, and the Plastic Clay. The Supermedial Order comprehends the Chalk; Beds between the chalk and Oolitic Series; the Oolitic Series; and the formations between the Lias and coal. The Medial Order embraces the Independant Coal Formation of Werner; viz. the Coal Measures; the Millstone Grit and Shale; the Carboniferous or Mountain Limestone; the Old Red Sandstone, and the Trap Rocks occurring occasionally in the coal fields.

The mode of description, adopted in this work, is systematic in a high degree. The different orders are divided into several distinct series, and these, into many species or varieties. In entering upon a description of these orders and series, we have first presented a general view of the formation, not only in England, but also in other countries. The writers next proceed to describe the different species and varieties; adopting in most instances, the following division for each: *a* chemical and external characters; *b* mineral contents; *c* organic remains; *d* range and extent; *e* height of hills, &c. *f* thickness, &c. *g* inclination &c. *h* agricultural character; *i* phenomena of springs and wells in this formation. Other particulars are sometimes added, and often, some of the above are omitted. After the description, embraced under these heads, is finished, local details, concerning the formation, are frequently subjoined; often embracing important additional facts. There are many obvious advantages attending such a mode of description: but for some reason or other, in the work before us, it has often cost us considerable labour, to obtain a complete and distinct view of a formation.

We now proceed as proposed, to give a short sketch of the English formations as exhibited in the work before us; beginning with the Superior Order.

Alluvial. This formation embraces only those depositions, that result from causes still in operation. The principal agent employed in its production is rivers; but the sea, rain, frost, wind, vegetation, &c. exert also a very small influence in modifying the face of the globe. Those coral reefs and islets, formed by the labours of "millions of marine Zoophytes," as well as volcanic products, are not reckoned as alluvial. In the work before us, particular descriptions of this, as well as the next formation, are reserved for the second part ; because a knowledge of the regular strata, from which they are derived, seemed previously requisite. We perceive, however, that no place is given, on the map accompanying this work, to alluvial*; we suppose because its extent, in great Britain, is so extremely limited.

Were the geological maps of North-America, that have been published, to be made a standard, we must conclude, that the alluvial is one of the most extensive of our formations. There can be little doubt, however, that under this term our geologists have included *all those strata, that are not consolidated.* If so, not one thousandth part of those tracts, marked as alluvial in this country, really belongs to that formation. It cannot be doubted however that along our rivers, especially the larger ones, and at their mouths, examples of alluvium are not very unfrequent. The delta of the Mississippi furnishes a noble instance.

Diluvial. Immediately below the alluvium " we find a mantle as it were of sand and gravel indifferently covering all the solid strata, and evidently derived from some convulsion which has lacerated and partially broken up those strata, inasmuch as its materials are demonstrably fragments of the subjacent rocks, rounded by attrition." " The fragmented rocks constituting these gravel deposites are heaped confusedly together, but still in such a manner that the fragments of any particular rock will be found most abundantly in the gravel of those districts, where the parent rock itself appears, *in situ*, among the strata. In these deposites, and almost in these alone, the remains of numerous land animals are found, many of them belonging to extinct species and many others no longer indigenous to the countries where their skeletons are thus discovered." (p. 4.). We can only add the concluding remark : " It has therefore, from the most probable views concerning the nature of this great catastrophe, been proposed to designate these formations, which naturally constitute the second term of our geological series, *Diluvial.*"

* We believe this is a mistake. The Fens of Lincolnshire, and Ely, and some parts of the coast of Lancashire are so characterised.—[*Ed.*]

This term may, at first thought, seem to savour of hypothesis; and thus be liable to the very objections which these writers feel against the Wernerian nomenclature. But, we believe, that all geologists agree, in imputing the stratum here denominated *diluvial*, to the agency of a deluge, at one period, or another; and it would seem that this agreement takes away from the term all objection derived from this source.

A fuller and very satisfactory account of the diluvial formation is given in the Introduction: (p. 28 et Seq.) And although it occurs in every part of the globe, covering probably more surface than any other; yet has it hitherto been passed, by geologists, in silence; or scarcely noticed; or blended with alluvium. It is the *geest* of Kirwan and Jameson, and the *diluvian detritus* of Buckland; (Rees' Cyc Add. Art. Geology) which, however, he has put down under the general name of alluvium. It must not be supposed, however, that all beds of loose sand and gravel are diluvial. Such beds often occur interstratified with regular strata of clay, and even consolidated rocks; as will be seen in the sequel. Deposites of sand, gravel and bowlder stones are not diluvial, unless they occur above all regularly stratified beds, and the ingredients are confusedly mingled together. This formation exists abundantly, in the United States. In what places it is found sufficiently thick to require a place on a geological map, may be a question of some difficulty. Martha's Vineyard, Elizabeth Islands and Long Island, with perhaps some spots along the southeastern coast of Massachusetts, and the region a few miles west of New-Haven, are the only instances of this kind, which we, at this moment, mention with confidence.

We are pleased to find the diluvial formation so definitely described and limited in the work before us: and we cannot but earnestly recommend to American geologists to make that work, in this particular the standard of their descriptions.

Strata above the chalk. "These consist of various beds of sand, clay, marle, and imperfectly consolidated limestone." (p. 6.) "No superior or more recent regular formations are known to exist in any part of the earth yet examined, with the exception of some trap rocks probably of volcanic origin." (Note.) These strata are subdivided as follows, reckoning downwards: 1. Upper Fresh water Formation: 2. Upper Marine Formation: 3. Lower Fresh Water Formation: 4. The London Clay: 5. Plastic Clay and Sand between the London Clay and the chalk. The reader will recognise, in these divisions, a resemblance to the basin of Paris, so ably described by Cuvier and Brongniart. They are, indeed, identical; and the same series occurs in several other places in France, in the Netherlands, Germany, Switzerland, Hungary, Moravia, Italy, Sicily, Dalmatia, Greece, Spain, Norway, Iceland, Hindoostan, Lower Egypt, and we find the following remark relating to North America.

" In North America the tract extending between the Atlantic and the Alleghany mountains, appears to be composed principally of formations of this character: organic remains from this quarter are preserved in the Woodwardian collection at Cambridge." p. 9.

We have not personally examined that vast region south of New-York, bordering on the Atlantic, which is marked as alluvial by our geologists. But, as already remarked, regular strata of clay, sand and gravel have universally been regarded in this country as alluvial, provided they were not consolidated. And it is impossible to believe so extensive a tract, as that above named, can be alluvial, in the modern restricted sense of that term; since no alluvial district of one hundredth part its size occurs in any other part of the globe. There can be, therefore, but little doubt that much of it answers to the strata in England above the chalk; although a part of the series may be wanting. And since it is certain that regular, interstratified beds of clay, sand, and gravel exist in almost every part of the United States, we may conclude, with a good degree of certainty, that some of the members of this series are abundant among us. We do not recollect a more striking display of these strata, (or rather a part of them, not improbably the Plastic Clay formation,) than is presented on Martha's Vineyard; where the high, perpendicular banks afford a fine opportunity for observing, beneath the diluvium, alternating beds of red, yellow, brown, white, and black clay, ochres, sand, ferruginous sand, gravel, and included lignites; none of them being consolidated, except the feruginous gravel in an imperfect degree. Many other islands along the coast of Massachusetts and Connecticut, obviously belong to the same series of strata.*

It is important in this place to remark, that the various beds above the chalk, and, indeed, of almost all the secondary strata below this, are identified, in different countries, not so much by any resemblance in external, or chemical characters, as *by the similarity of the organic remains found in them.* The discovery of this principle, (to be credited to William Smith,) is one of the most fortunate achievments of modern geology. For it would be wholly impossible, in many cases, for the most experienced eye to discriminate between hand specimens from strata widely separated in the earth. But here we have a clue, that rarely misleads; and it shows us the importance and necessity of a study of organised remains:—a subject which is yet in its infancy, even in Europe; and still more so in this country.

In the work under consideration, fifty pages are devoted to a consideration of the strata above the chalk; and many interesting details are furnished. We have room to add only a few remarks concerning the several members of the series.

The Upper Marine Formation occurs in three places in England: viz. the Crag of Suffolk,† Bagshot Sand, and a basin in the Isle of Wight. The first of these consists of nearly horizontal beds of sand and gravel, and friable masses of ferruginous sand, somewhat cemented together, all of them enclosing shells: the second consists of siliceous sand and sandstone without any cement, but containing shells; and the third consists chiefly of a light green marle, embracing immense quantities of shells. In all these beds, the shells are of marine origin, and hence the name of the formation.

The Fresh Water Formations, so called because they contain only fresh water shells, are divided into Upper and Lower. These are separated by the interposition of the Upper Marine Formation, which leads us to the certain conclusion, that these different beds must have been de-

* Since the above was written, we have been much interested in reading, in the last number of this Journal, an Essay by Mr. Finch, on the Tertiary Formations in America. The above suggestions are confirmed and extended: and an attempt is made to refer us to the localities of seven distinct members of the formations above the chalk. We trust our geologists will not disregard the important hints that Essay presents.

† "Crag is a local name for gravel."—p. 11.

posited by successive inundations of salt and fresh water. The fresh water formations consist of marle, argillaceous limestone and sand, traversed by veins of calcareous spar; but they want the gypsum beds, so numerous in these formations around Paris, and in which are found the bones of unknown birds and quadrupeds.

The London Clay is an extensive formation in England, and it is made up principally of a tough, bluish, or blackish clay, occasionally marly, and embracing septaria, and beds of sandstone, and green earth, which contain lime. It corresponds, probably, to the well known *Calcaire grossier* of Paris. The organic remains in this formation are extremely interesting: among these are the crocodile, turtle, several species of vertebral and crustaceous fish, numerous testaceous molluscæ, rarely a few zoophytes, masses of charred wood, and many other vegetable remains. Mr. Crowe procured 700 specimens of ligneous seed vessels in one spot, none of which were duplicates. Mr. Defrance, at a place near Grignon in France, found 500 species of shells in this formation. Among Mr. Crowe's specimens, are many which appear to have belonged to tropical climates.

The Plastic Clay Formation is "composed of an indefinite number of sand, clay, and pebble beds, irregularly alternating." It embraces a few layers of coal, fuller's earth, some shells, teeth of fish, vegetable remains, and it is said, also, fossil bones. We have already suggested that this formation not improbably exists in Martha's Vineyard, and in several other islands along the coast of New-England.

The Supermedial Order comes next in the descending series; and comprehends the chalk, Beds between the chalk and Oolitic Series, the Oolitic Series, and the formations between the Lias and the Coal Strata. These distinct groups of strata have many general relations and analogies, that justify their arrangement into a distinct class. One distinction between this and the Superior Order, is, that in the latter, the organic remains are merely preserved and not petrified; while in the supermedial order, they are all lapidified. The account of this order occupies nearly three fifths of the volume under consideration.

Chalk Formation.—This lies immediately beneath the Plastic Clay: but a bed of debris, made up of rounded fragments of chalk and flint is interposed; leading us to the conclusion, that after the consolidation of the chalk, a partial destruction took place by running water, and that, of course, a considerable period must have elapsed between the deposition of the chalk and the plastic clay.*

Subordinate beds of chalk, marle, and fuller's earth, and thin partings, or seams of clay, are found in the chalk strata. The numerous layers of nodular flints, and veins and tabular masses of the same, so characteristic of this formation, are most abundant in the upper layers; and hence the distinction into *Upper and Lower Chalk.* We extract the following ingenious hypothesis of the original production of these flints.

"The chalk even yet, often contains a mixture of silex; at the period of its formation, a considerable quantity appears to have been precipitated with it, in a state of such minute division as to allow the chemical attraction of its molecules to have effect; these (from the same causes which produced the formation of layers of calcareous concretions in beds of clay) separating from the cretaceous pulp, and uniting together, particularly where the presence of any imbedded organic remains, (e. g. alcyonium, sponge, or shell) offered a nucleus for them to form upon, constituted the layers of nodular siliceous concretions in question." p. 70.

The organic remains are not so numerous in the chalk, as in some other formations; but are very interesting. In all the strata above the chalk, the genera, and some of the species agree with those now existing on earth: the extinct species, however increasing in number as we descend. But in the chalk, many unknown genera occur, and probably not one species of which we have any account in a living state. Among these relics are a species of shark, several genera and species of univalve, bivalve, and multivalve shells, echinites, asterites, encrinites, madreporites, and numerous remains of alcyonium and spongia. The aggregate thickness of the chalk beds in England is between 600 and 1000 feet.

The chalk strata, with all the strata above them, are

*There are also numerous ravines on the surface of the chalk, and beneath the upper or tertiary formations, which appear to have been formed by the action of currents of water, perhaps diluvial.—[*Ed.*]

generally nearly horizontal; but not always, as the following extract will show.

"But crossing to the Isle of Wight, the chalk re-emerges from the superstrata near its eastern point, and rises with its usual magnificence into Culver Cliffs. Here, indeed, appearances of more than usual interest occur; for here we first enter upon that remarkable district in which these beds so generally characterised by their horizontal position, assume that vertical arrangement which has been hastily assumed as peculiar to older and more chemical depositions, and as resulting in such from the circumstances of their original formation; but which, as we shall hereafter have occasion to show, are limited to no single geological era, and in the great majority of instances, if not in all, have been demonstrably produced by the mechanical force of subsequent convulsions."—p. 106.

The chalk formation has not been discovered beyond the boundaries of Europe: but since we have reason to conclude that the Plastic Clay formation exists extensively in the United States, and the chalk in England lies immediately beneath this; we ought by no means to despair of finding it in this country. Indeed, appearances are so favourable in some places, (e. g. Martha's Vineyard,) that we should suppose it would justify an exploration by boring. The thickness of the Plastic Clay in England, is not commonly above 100 feet; although in one instance it is 1,100.

Beds between the Chalk and Oolitic Series.—"Viewed on the large scale, the interval between the chalk and Oolites may be described as occupied by a series consisting principally of beds of siliceous sand, which probably have an aggregate thickness in the greater part of their course of not less than 1,000 feet and form that extensive sand tract which is universally to be traced beneath the escarpment and inferior terminations of the chalky ranges."—p. 11.

The subdivisions of this series are 1. Chalk Marle; 2. Green Sand; 3. Weald Clay; 4. Iron Sand.

The chalk marle consists of cretaceous, argillaceous, and sandy matter, often sufficiently consolidated for architectural purposes, and sometimes forming a fine grained gray sandstone of loose texture. Its minerals are iron pyrites, septaria, calc. spar, selenite, and sulphate of lime; and its fossils (all of marine origin) are vertebral animals, fish, wood, zoophites, and testaceous molluscæ.

"*The Green Sand* consists of loose sand and sandstone;" the cement to the latter being calcareous. It contains particles of a green substance, probably green earth:* and hence its name. Subordinate beds and masses of chert and limestone, with veins of chalcedony, fuller's earth, sulphate of barytes, quartz, &c., occur in it, with numerous petrifactions. Among these are echini, alcyonia, some unknown genera, and various testacea: a single quarry furnishing 150 species.

The Weald Clay has not been thoroughly explored: but it consists of a dark tenacious clay, and a blue, or grey, calcareous marle, often hard enough to admit a polish. It has been suspected, that it is a fresh water deposite; but the question is by no means settled, as its organic remains have never been described.

Iron sand "is composed of a series of strata, in which sand and sandstone prevail, occasionally alternating with subordinate beds of clay, loam, marle, fuller's earth, and ochre." These strata contain brown oxide of iron, in considerable proportion, so as sometimes to be wrought as an ore. "The texture of the sandstones is evidently mechanical, and they often, indeed, form coarse grained conglomerates." Ferns, charred wood, and even a kind of cannel coal, occur in these sandstones. Their organic remains have yet received but little attention: but they are probably sparingly dispersed.

We have no means of determining whether any members of this series of rocks exist in this country.

Oolitic series.—This is an important series in an economical view, as it furnishes the best architectural materials in England. It consists "of a series of oolitic limestones, of calcareo-siliceous sands and sandstones, and of argillaceous and argillo-calcareous beds, alternating together, and generally repeated in the same order; i. e. a formation consisting of many beds of oolitic limestone, resting upon one of calcareo-siliceous sand, and that again upon an argillo-calcareous formation." The whole series is divided into the Upper, Middle, and Lower Oolitic System; and these are subdivided.

*This has been ascertained by Berthier to be a hydrate of iron, and not an earthy chlorite. It accompanies the lower chalk beds throughout France, and is found in a marly Limestone, resting on Jura Limestone, at the *Perte du Rhone* See Brongniart *sur la craie.* (Ed.)

Upper division of the Oolitic Series.

The first subdivision of this series is the *Purbeck beds.* From these beds is obtained the Purbeck Marble, and they consist of thin strata of argillaceous limestone, alternating with schistose marbles. This rock contains subordinate beds of workable gypsum and numerous shells; some of which are said to be fresh water shells: also beautiful impressions of fish, and the head of a crocodile.

The Portland Oolite. the next member of the upper oolitic system, consists of several beds of coarse, earthy limestone. It is quarried extensively and constitutes most of the building stone in the vicinity of London. The organic remains are fish, shells, and wood.

The third member is the *Kimmeridge Clay*, being composed of a blue slaty, or greyish yellow clay, which contains selenite, and sometimes beds of highly bituminous shale Extinct genera, allied to the order Lacerta, are among the fossils of this clay; and also a species of Ichthyosaurus, a variety of Plesiosaurus? bones, apparently of cetacea, and numerous shells.

Middle Division of Oolites.

The Coral Rag occurs first in this division. It comprises a series of beds from 100 to 200 feet thick; the calcareous matter prevailing in the upper part, and the siliceous in the lower. The upper beds are a calcareous freestone, full of comminuted shells: the middle part is a loose, rubbly limestone, almost entirely made up of a congeries of several species of madrepores; and the lower beds are a thick deposite of yellow colored, quartzose sand, usually containing about one third of calcareous matter, and abounding in fossils. This is the newest rock in England, in which madrepores occur in any considerable variety, or quantity.

The Oxford clay, the second member of this division, forms beds of a tenacious and adhesive clay, of a dark blue color, of immense thickness: the lower part occasionally containing irregular beds of limestone. "Iron pyrites and selenite occur abundantly in this as indeed in all argillaceous formations." The organic remains are peculiar and characteristic; consisting of bones of the Ichthyosaurus and numerous shells.

Lower Division of Oolites.

This division far exceeds the two preceding, in thickness and importance. The subdivisions, which might with propriety be made in it, are so numerous, that the writers very wisely refer the whole to two sections, viz. its upper and lower beds: all the upper beds being subordinate to the great oolite; and the lower, to the calcareo-siliceous sand, which forms their base. Viewed generally, both these series of beds consist of one vast oolitic mass, resting upon calcareo-siliceous sand. These oolitic beds, however, embrace several varieties, characterized principally by being more or less argillaceous. These are denominated, in a descending order, *Cornbrash, Stonesfield Slate, Forest Marble, and Great Oolite.* The inferior members of the third, or lower system of Oolites, are the *Fuller's Earth, Inferior Oolite Sand, and Marlstone.* The inferior is distinguished from the Great Oolite, by the larger proportion of brown oxide of iron, that is disseminated through its mass. The sand and sandstone are slightly calcareous, highly ferruginous, and frequently micaceous; containing but few fossils The marlstone is sandy, gritty, micaceous, and of a green color; presenting but few organized remains.

The lower division of the oolitic series, however, is peculiarly interesting for the richness and variety of its fossils. The testacea are very abundant: and a more complete and extensive list of these is given in the work before us, than of any other formation. Echinites, encrinites, corralloides, madrepores, tubipores, millepores, and alcyonia are also found. But the Stonesfield slate, which is with great probability referred to the Oolitic series, is most remarkable for its petrifactions. Here occurs a species of Didelphys, one of the Opossum tribe; an immense animal, resembling the Monitor, 40 feet long and 12 feet high; two or three species of tortoise; teeth, palates, and vertabrae of fishes; leg and thigh bones of birds; two or three species of Coleopterous insects; two or three varieties of the crab, or lobster; and ferns, flags, and mosses. This remarkable assemblage is thus noticed by the writers of the work before us:

"If the *calcareous slate of Stonesfield* be correctly assigned to this part of the series, (which is rendered still more probable by the occurrence of the same teeth and palates in both instances,) we here find the only known instance in which the remains of birds and terrestrial animals have been found in beds of antiquity at all approaching to these; they here occur mingled with *winged* insects, amphibia, sea shells, and vegetables, presenting at once the most interesting and difficult of problems connected with the distribution of organic remains."—p. 207.

"We must account for the presence of the Didelphys, birds, and coleopterous insects, in the same manner as we do for the wood and remains of land vegetables, not unfrequent in the strata: the amphibia may have belonged to species principally marine. It is evident from peculiarities in their structure, that many of the fossil animals, generally resembling the amphibia, lived entirely or almost so in the sea, and were to the now existing amphibia what the cetacea are to mammalia."—p. 209.

Lias.—This rock lies immediately below the Oolites, and is made up of thick, argillaceous deposites, in which are placed limestone beds, increasing in frequency, in descending, and presenting at length " a series of thin stony beds separated by narrow argillaceous partings"—" the peculiar aspect which characterizes the lias." The beds of this formation are nearly horizontal, and the organic remains unusualy interesting. More vertebral animals are found imbedded in it, than in any other English formation, excepting the Stonesfield slate. Among these, are two remains of extinct genera of *marine Lacertæ*, whose osteology presents new and interesting links in the chain of animated nature. Two or three species of a singular animal, denominated *Ichthyosaurus*, or fish-like *lacerta*, and of another peculiar genus, called *Plesiosaurus*, are found in the lias. It furnishes also the Turtle, several species of fish, one or two Crustacea, several Molluscæ, numerous Testacea, Echini, Encrini, Pentacrini, Corals, fossil wood, ferns, flags, &c.

It may be doubted whether the Oolites and lias series occur in North America.

Red Marle, or New Red Sandstone, or Red Rock, or Red Ground.

This formation comprehends the variegated sandstone of Werner, and is described as "a series of marly and sandy beds intermixed with conglomerates derived from older rocks containing gypsum and rock salt and in one instance amygdaloidal trap." The red marle, containing gypsum, usually lies highest, the sandstone in the middle, and the conglomerate lowest. These beds are argillaceous, and argillo-siliceous, with a variable proportion of calcareous matter. The colours of the marle and sandstone are of a red chocolate and salmon colour; exhibiting streaks of light blue, or verdigris, or buff, or cream colour.

"Some of the sandstone beds of this formation bear so near a resemblance to some of the grits associated with the coal formation, and to the softer strata of the old red sandstone underlying the mountain limestone, that a cursory observation of them would often lead to fallacious conclusions. It may however be generally recognized without much difficulty by the following distinctive characters; 1st, its containing gypsum; 2ndly, by the inferior consolidation of its stony beds; 3dly, by the regularity of its stratification, and the general parallelism of its beds to the horizon." pp. 280 and 281.

Many other distinctive characters of this formation are given; but we have not room to quote them. It is highly interesting, not for its organic remains, for it contains none; but because it includes the great rock salt formation of England, and also extensive beds of gypsum. The latter is not wrought extensively; but the former is dug at Northwich and Droitwich. At the latter place, it exists in two beds, not less than sixty feet in thickness. These are supposed to form a large insulated mass of this mineral, about a mile and an half long, and 1300 yards in breadth.

The subordinate conglomerate of this formation has an argillo-ferruginous cement and embraces rounded and angular masses of granite, calcareous spar, feldspar, chert, greywacke, yellowish limestone, porphyry, pieces of a compound porphyritic rock, and steatite.

The amygdaloidal trap, occurring in the same connection, sometimes covers, and at other times is covered, by the sandstone. Its base may be hornblende, augite, bronzite, or hyperstene ; and in this paste are imbedded calcareous spar, mica, or chlorite, and indurated clay.

Newer Magnesian, or Conglomerate Limestone. Synonyme, *First Floetz Limestone of Werner.*—This is the oldest rock of the supermedial order. It is distinct from the older rocks of similar composition, associated with the mountain limestone, though sometimes blended with them. It has a granular, sandy structure, a glimmering lustre, and a yellow colour ; and is associated with conglomerate limestone The organic remains are not numerous : but they may serve to distinguish it from the older formations. They consist of fish, shells, &c.

In giving the foreign localities of the Red Marle and Newer Magnesian Limestone series, we perceive the German fetid limestone, cellular limestone, compact marly limestone, and bituminous marle slate, to be included near the centre : rocks, whose relative position has long perplexed geologists. Reference is of course made to all other countries, where rocksalt, or gypsum occurs ; since, in every known locality, these minerals, certainly the latter, are accompanied by the red marle, or as it is sometimes called, the *saliferous sandstone.* North America is among these references ; as Louisiana, the banks of Hockhocking, Sciota, Wabash, Tenessee, Kanaway, Great Sandy, &c. and the Salines, near Onondaga and Seneca lakes, in New York. We have seen a specimen of the rock from which the salt springs issue at the latter locality, and have no doubt it is the red marle ; and we are informed, that the gypsum lies above this rock, and the coal beneath it. It will be of great importance to American geology, to have this rock identified with the English red marle ; as it will furnish a convenient starting point, from which geologists may proceed to identify other strata above and beneath. Should the New York rock and the English rock prove to be the same, the clue will at once be furnished, for assigning to their proper series, all the other formations of the great secondary and tertiary tract, between the Alleghany and the Stony mountains ; and when this is done, the smaller basins will be easily determined. We shall expect to find this point settled by Mr. Eaton, in the Geological Survey of the great western canal, he is now prosecuting, through the libcrality of Gen. Van Rensselaer.* Our geologists will thus be prevented from assigning new names to those numerous aggregates, which occur in the United States, to which no specific designation has yet been given; and be also saved the mortification, of seeing their new terms treated as the offspring of ignorance, or arrogance. We trust, however, that no man will attempt a new nomenclature of our secondary rocks, until he has proved, that they cannot be referred to any of the series of formations which the work under review presents.

A rock occurs in New-England, along Connecticut river, which agrees in external characters with the red marle; and it has a similar relation to the old red sand stone with that rock, and beneath it are found fish impressions, said by Mr. Brongniart to resemble exactly those found in the bituminous marle slate of Germany. But there are found, in the series of rocks with which this is connected, no traces of salt, or gypsum, and very little limestone; so that it is very doubtful whether this rock be the red marle.

MEDIAL OR CARBONIFEROUS ORDER.—This embraces the rocks usually known by the name of the Coal Formation; together with two or three others beneath them, and so intimately connected with them, both geographically and geologically, that they cannot be separated.

COAL MEASURES.—These comprehend that great and principal deposit of coal. which lies between the newer red, or saliferous sandstone, and the great carboniferous limestone and older sandstone formations. This, it is well known, is the Independent Coal Formation of the Wernerians. "The coal measures consist of a series of alternating beds of coal, slate clay, and sandstone; the alternations being frequently and indefinitely repeated."

"The slate-clay of the coal-measures differs from clay slate by its less solid and indurated state; it is known in different collieries by the names of black or blue metal, shale, clunch, cleft, bind, etc."

"The sandstones of the coal measures are usually gritty, micaceous, and tender; they afford freestones for buildings,

*We have been authentically informed, that Gen. V. R. enquired of Mr E. what might be the probable expence of such a survey; and on being answered, that it would not exceed $5000, he directed the work to be undertaken. Such munificence certainly deserves this public mention of the fact; and it augurs well for the cause of geology in this country.

whetstones, grindstones, &c. ; some varieties of a large schistose structure are raised as flag-stones for paving ; others, more finely laminated, as roofing slates." p. 333.

These are the only rocks in which coal occurs sufficiently pure, or abundant, to be profitably wrought. Carbonaceous matter, however, of inferior quality, and sometimes used as fuel, is found in thin seams, in other deposites. It may be useful to present a view of the several formations in which coal, or carbonaceous matter has been found.

1 *Alluvial.*—This furnishes peat ; which is formed by the accumulation of *sphagnum palustre*, or other mosses, or maritime plants : the lower parts of the mass gradually undergoing a change into peat, and even into a substance not differing essentially from jet.

2. *Diluvial.*—Contains beds of fossil wood, passing, by a series of gradations, into jet.

3. *Basaltic Formation, or Newest Floetz Trap.*—In Ireland and Germany, a species of lignite, similar to that just mentioned, is associated with this formation.

4. *Plastic Clay.*—The coal in this formation occurs in beds, is obviously of vegetable origin, and is of little value.

5. *Sand immediately below the Chalk.*—This has all the appearance of an imperfect coal formation ; the coal existing in the form of fossil wood, and in distinct beds ; but it is very poor.

6. *Oolitic Series.* The Kimmeridge Clay embraces bituminous shale, which is sometimes used for fuel ; and the sands, resting on the lias, present regular beds of workable coal.

7. *Newer Red or Saliferous Sandstone.* On the continent of Europe, this rock contains thin seams of coal; but they have not been noticed in England.

8. *The Great Coal Formation.* This is the next deposite of coal in the descending series.

9. *Transition Slates, (Gray Wacke Slate, &c.)* Sometimes beds of anthracite are contained in these rocks, as in Devonshire. A fine example exists also in Rhode Island in this country.

10. *Mica Slate.* This and other primitive rocks furnish beds of anthracite and plumbago.

That coal, with the exception of the non-bituminous varieties, is of vegetable origin, seems now to be generally granted. But it may be asked, "how are we to account for such a surprising accumulation of vegetable matter arranged in repeated strata (sometimes to the number of sixty and even more in a single district) separated from each other by intervening deposites of clay and sand?" Let us hear these authors in reply.

"Now the partial filling up of lakes and estuaries offers us the only analogies in the actual order of things with which we can compare the deposites of coal; for in such situations we often find a series of strata of peat, and sometimes submerged wood, alternating with others of sand, clay, and gravel, and presenting therefore the model of a coal field on a small scale, and in an immature state." p. 346.

Dr. Mac Culloch has instituted a series of experiments to ascertain the nature, and account for the formation of coal. The following are the general results to which they conducted him.

"Examining therefore the alteration produced by water on common turf or submerged wood, we have all the evidence of demonstration, that its action is sufficient to convert them into substances capable of yielding bitumen on distillation.—That the same action, having operated through a longer period, has produced the change on the brown coal of Bovey is rendered extremely probable by the geognostic relations of that coal. From this to the harder lignites, surturbrand and jet, the transition is so gradual, that there seems no reason to limit the power of water to produce the effect of bituminization in all these varieties, nor is there aught in this change so dissonant from other chemical actions, as to make us hesitate in adopting this cause." *Geol. Trans. Vol.* 2. p. 19.

Dr. Mac Culloch, however, does not decide positively, that beds of bituminous lignites were changed into coal by the agency of water alone. By the application of heat to jet under compression, it was fused into perfect coal; and he admits, that this might have been the process through which the beds of coal, found in the earth, have passed; though of opinion, that the agency of water is all that is necessary to account for the change: and Mr. Conybeare does not "consider this as a sufficiently 'dignus vindice nodus' to evoke the god of fire for its solution."

The coal measures are remarkable for the great abundance of vegetable remains found in them; the animal relics being limited to a few testacea. The trunks, leaves, and, more rarely, the pericarps of various vegetables occur in this formation; and all of them are very different from known genera and species, and apparently the growth of a hot, rather than a temperate, climate; and of moist, rather than dry, situations. The trunks, that have been discovered, belong to a peculiar order of plants, "distinguished by the cortical part being entirely covered by regular impressions resulting from the petioles of fallen leaves, ranging around them in spiral lines." These remains form but few genera, and, at the most, not above 400 species.

Trap rocks abound in the coal fields; and this "affords the first instance in descending the series, in which any of the great formations in England appear to be strikingly connected with rocks of this family." These traps are either of the class of greenstones, or of the dolerite class of the French, which is the augite rock of Mac Culloch, in which augite predominates. Varieties of these rocks are a porphyroidal trap and toadstone. They are connected with the coal measures, either as overlying masses, resting unconformably on the subjacent strata, or as dykes, or as beds, conformably interstratified and regularly alternating with the other strata.

Dr. Mac Culloch found, in the Isle of Sky, that a single mass of trap often occupied all the three positions mentioned above; so that the relative position of such rocks furnishes no indication of their age. The greenstone, occurring in the coal formation along the Connecticut river in New-England, constitutes overlying masses, dykes, and beds, just as in Old England.

Although Mr. Conybeare has little to do with the Wernerian distinctions of transition and secondary, yet if called to decide to which of these the coal measures belong, he would have no hesitation in referring them to the former; "since at least ten characters will be found in common between the carboniferous and transition class, for one which would lead to an opposite arrangement." His reasons for this opinion are given at length, and appear conclusive; but we have not room to extract them.

The vast importance of the English collieries, to their immense manufacturing establishments, is deeply realized in Great Britain.*

Englishmen look forward, not without some anxiety, to the period, when their coal mines will be exhausted. The following calculation, from the work before us, shows that such a time is yet quite remote. It applies, however, only to the great coal field of Northumberland and Durham.

"To form an idea, says Dr. Thomson, of the quantity of coal contained in the formation called the coal measures, let us suppose it to extend in length from north to south twenty-three miles, and that its average breadth is eight miles. This makes a surface amounting to rather more than 180 square miles, or 557,568,000 square yards. The utmost thickness of all the beds of coal put together does not exceed forty-four feet; but there are eleven beds not workable, the thickness of each amounting only to a few inches. If they be deducted, the amount of the rest will be thirty six feet, or twelve yards. Perhaps five of the other beds likewise should be struck off, as they amount altogether only to six feet, and therefore at present are not considered as worth working. The remainder will be ten yards; so that the whole coal in this formation amounts to 5,575,680,000† cubic yards. How much of this is already removed by mining I do not know, but the Newcastle collieries have been wrought for so many years to an enormous extent, that the quantity already mined must be considerable. I conceive the quantity of coal exported yearly from this formation exceeds two millions of chaldrons, for the county of Durham alone exports $1\frac{1}{3}$ millions. A chaldron weighs 1. 4 ton, so that 2. 8 millions of tons of coals

* Although an unpoetic subject, its importance drew forth a stanza from one of their earliest poets.

"Had he our pits, the Persian would admire
No sun, but warm's devotion at our fire:
He'd leave the trotting whipster, and prefer
Our profound vulcan 'bove that waggoner.
For wants he heat, or light, or would have store
Of both? 'tis here: and what can suns give more?
Nay, what's the sun, but, in a different name,
A coal pit rampant, or a mine on flame!
Then let this truth reciprocally run,
The sun's heaven's coalery, and coals our sun."

† The three last cyphers are omitted in the original work; which is obviously a mistake.

are annually raised in these counties out of this formation. Now a ton of coal is very nearly one cubic yard; so that the yearly loss from mining amounts to 2. 8 millions, or (adding a third for waste) to 3. 7 millions of yards. According to this statement, the Newcastle coals may be mined to the present extent for 1500 years before they be exhausted. But from this number we must deduct the amount of the years during which they have been already wrought. We need not be afraid then, of any sudden injury to Great Britain from the exhaustion of the coal mines. It is necessary to keep in mind, likewise, that I have taken the greatest thickness of the coal beds. Now as this thickness is far from uniform, a considerable deduction (I should conceive one third of the whole) must be made in order to obtain the medium thickness; so that we may state in round numbers that this formation, at the present rate of waste, will supply coal for 1000 years, but its price will be continually on the increase, on account of the continually increasing expense of mining." It appears that in the above estimate of Dr. Thomson all the beds of coal are calculated upon as co-extensive throughout the whole field; whereas allowance ought to have been made for the smaller extent of the upper beds which first crop out. It is also probable that the consumption of coal now materially exceeds that taken into the account: for both these reasons we must deduct a century or two from the calculation." p. 371—372.

It is unnecessary to refer to the numerous coal formations in this country. We merely remark, that a minute and scientific description of these is a desideratum in our geology; and it is high time, also, that we should make a distinction between the anthracite* and bituminous coal formations, since they are obviously referable to different epochs.

Mill Stone Grit and Shale. These rocks lie immediately beneath the coal measures and alternate with each other. The shale does not materially differ from the slate-clay of the coal formation; and the mill-stone grit is a coarse sandstone, consisting of quartzose particles of various sizes,

* That elliptical transition formation, (embracing the Rhode Island anthracite) extending from Boston to Newport, appears to us from a slight examination, to be very interesting and instructive: and since there is an University near each focus of this ellipse, may we not expect, that ere long, we shall be presented with a complete elucidation of it?

united by an an argillaceous cement. These rocks contain subordinate beds of coal and limestone; the former being thin and poor. Lead and copper and iron ores, satin spar, bitumen, petroleum, naptha, and asphaltum, also occur in the shale and grit. The fossils are similar to those of the coal measures, and are of marine origin. Indeed, if we may be allowed to form an opinion at the distance of three thousand miles from these rocks, we should say, that we can see hardly sufficient reason for separating them from the coal formation.

Carboniferous or Mountain Limestone. This rock occasionally alternates with shale, grit and amygdaloid, and some of its synonymes are *metalliferous limestone*, and *entrochal, or encrinal limestone.* We cannot here enter into a particular description of this interesting rock, but remark, that its strata are often divided by thin partings of clay, and that it contains nodules of chert, and is extremely cavernous. Between 60 and 70 caverns are mentioned, as existing in this rock, in England and Wales; and also several subterranean rivers. It is the grand depository of the English lead mines. Various copper, iron, and zinc ores, fluor spar, calc. spar, arragonite, selenite, carb. and sulph. of barytes, sulph. of strontian, also occur in it; besides various minerals in the accompanying toadstone. The organic remains are very distinct from those in the oolitic series and the lias, and belong, chiefly, to extinct genera. Vertebral animals are rare; but Zoophytes, Encrinites, Coralites, and Testacea are numerous. The strata are often highly inclined and contorted.

Old Red Sandstone. This is a mechanical rock, constituted of abraded pebbles and masses of quartz, feldspar, and mica; and containing fragments of clay slate, flinty slate, &c. "its colour is usually dirty iron-red or dark brown, but sometimes passing into gray." From the newer red sandstone it may be distinguished by its greater consolidation, but it is not so easily discriminated from the sandstones of the millstone grit series. It is, therefore, highly probable, that many rocks have been denominated old red sandstone, that really belong to formations widely removed from it. It is often asserted, that coal is contained in, or lies beneath, old red sandstone. But the authors of the work under consideration, will allow none to be with propriety thus designated, unless it underlie the coal formation. They regard even the *red dead lyer,* (rothe todte liegende,) or *first floetz sandstone* of the Wernerians, as distinct from the English old red sandstone; because the former lies above, and the latter beneath, the coal deposites; and "where external characters are nearly the same," say they, "our surest guide must be the position in the geological series; and this rule will hardly permit us to class a formation uniformly below, with one uniformly above, the principal deposite of coal."

It ought here to be remarked, as a fact of some consequence, that the real English old red sandstone has always been described on the continent of Europe, as a variety of gray wacke; and the carboniferous lime stone above it, as transition limestone.

The old red sandstone in England is almost destitute of organic remains; only a few shells and vegetable relics occurring in its lower members, where it graduates into limestone of the transition series. Its thickness, in some parts, is 2000 feet; and the height of some of its mountains, above the sea, between 2000 and 3000 feet.

An extensive deposite of this rock is said to exist in the United States; and as it was thus designated by Mr. Maclure, who is so well acquainted with the European rock, there seems little doubt but it does occur here. We suspect, however, that our geologists have included several rocks under old red sandstone; certainly, no distinction has been made between the *rothe todte liegende* and the English old red sandstone. Some of the old red sandstone in the United States, however, does underlie the coal formation: for instance, along the Connecticut river. And along the same river is a rock, which cannot be distinguished from that just named, as lying beneath the coal measures: but it probably lies above the coal measures; and in it have been found (at East Windsor, Connecticut,) the bones of a vertebral animal, five feet in length. Must not this be the *rothe todte liegende*, or even a member of a formation still newer; since no vertebral animal, we believe, has been hitherto found in any rock beneath the bituminous marle slate.

The English old red sandstone reposes upon the transition slates; and we much regret, that the work, whose analysis we are giving, does not extend, in the part published, to a description of these slates. Especially, we are anxious to learn the character and position these writers would give to "the far famed, illustrious gray wacce." Since, however, they represent the old red sandstone as reposing on this rock, we anticipate, that nothing will be called gray wacke, that does not lie between this rock and the transition argillite. We shall rejoice if it can be confined within these limits: for we really believe, that scarcely a secondary, or transition rook can be named, which has not, at one time, or another, been denominated gray wacke: and, indeed, the usual definition of that rock will comprehend them about all, without difficulty. In regard to the primitive rocks, to be described in the second part of Conybeare and Phillips' work, we do not expect so much will be presented, that is new and interesting. as in the part of the work, whose analysis we have now given.

It remains, in this place, to notice the geological map of England and Wales, and the Sections, that accompany the work. Their execution is in the elegant style of the geological Society. The map is compiled from that of Mr. Greenough; with some corrections, which subsequent discoveries have rendered necessary. The tablets appended to the map, to designate the different formations, amount to *twenty-seven*; and the following are the names attached to them. 1 Diluvial Beds, 2 Upper Marine, 3 Fresh Water Beds, 4 London Clay, 5 Plastic Clay, 6 Chalk, 7 Chalk Marle and Green Sand, 8 Weald Clay, 9 Iron Sand, 10 Purbeck and Portland, or Aylesbury Limestone and Kimmeridge Clay, 11 Coral Rag and Calcareous Grit, 12 Oxford, or Clunch Clay, 13 Cornbrash, Forest Marble and Great Oolite, 14 Inferior Oolite and Sandy Beds, 15 Lias, 16 New Red Sandstone, 17 Magnesian Limestone, 18 Coal, 19 Millstone Grit and Limestone Shale, 20 Carboniferous, or Mountain Limestone, 21 Trap of Coal and Mountain Limestone, 22 Old Red Sandstone, 23 Transition Limestone, 24 Serpentine, 25 Sienite and Trap, Transition and Primitive, 26 Slates, Greywacke and Clay Slate, 27 Granite. How immense the labour of ascertaining the boundaries of all these formations! And how great an advance, from a map, recognizing only primitive, transition and secondary! Three or four patches of no great extent are left uncolored, for reasons unknown to us.*

* If we mistake not, these patches are intended for *Alluvium*. They comprise the Fens of Lincolnshire, Ely and Somerset, a tract along the E. coast of Lincolnshire, others on either side of the Humber, and insulated tracts along the coastof Lancashire. These districts are not only left uncoloured, but are shaded like marshes in common maps. (Ed.)

The Sections are very elegant and instructive. Two of them cross the whole extent of England, in its longest directions: the one, from Land's End to the German Ocean; the other, from the Irish Sea, in Cumberland, to the Channel in Sussex. The third extends from the Irish Sea in Cumberland, to the North Sea in Durham: the fourth is a section along the Valley of the Wye in Derbyshire; exhibiting the openings of lateral dales into it, on the north, &c.: the fifth and sixth pass through the interesting islands of Purbeck and Wight.

The introduction to the work now claims some attention. It contains a general view of those principles of geology, which may be regarded, apart from all hypothesis, as established; and really, after all that has been said and written of late, upon the imperfection and falsity of geological positions; after witnessing the extensive scepticism of one of the first geologists of England, in his late work; and observing the anxious doubts his writings have infused into some, and the irritation produced by them upon others, who saw a death blow given to their favourite system; after this, we are truly happy, that there are some principles of the Science, that have lived through the furnace and come forth with additional brightness. We are glad also to see other principles, springing up and flourishing, on the mouldering ruins of former systems. We have not room to recapitulate all these principles, as the work before us presents them; but two or three points are discussed more fully than the rest, because newer and more interesting; and to these, we would pay some attention.

The first relates to the distribution and character of organick remains. It is too early to generalise much concerning these; as even in England, where they have received the greatest attention, the subject is in a mere incipient state. Yet some of the laws of their arrangement are determined to a good degree of certainty. They are confined to secondary strata, although Dr. Mac Culloch observed some appearances of them among primitive rocks; but this, as the author of this Introduction observes, might have been deceptive. Their distribution in the various strata is thus stated.

" First, we have a foundation of primitive rocks destitute of these remains; in the next succeeding series (that of transition) corals, encrinites, and testacea, different however from those now known, appear at first sparingly; the fossil remains of the carboniferous limestone are nearly of the same nature with those in the transition rocks, but more abundant; the coal measures, however, themselves, which repose on this limestone, scarcely present a single shell or coral; but on the contrary abound with vegetable remains, ferns, flags, reeds of unknown species, and large trunks of succulent plants, strangers to the present globe. Upon the coal rest beds again containing marine remains (the magnesian limestone); then a long interval (of new red sandstone) intervenes, destitute almost, if not entirely, of organic remains, preparing as it were the way for a new order of things. This order commences in the lias, and is continued in the Oolites, green, and iron sands, and chalk. All these beds contain corals, encrinites, echinites, crustacea, testacea, vertebral fishes, and marine oviparous quadrupeds, yet widely distinguished from the families contained in the lower beds of the transition and carboniferous class, and partially distinguished among themselves according to the bed which they occupy. Hitherto the remains are always petrified (i.e. impregnated with the mineral substance in which they are imbedded;) but lastly, in the strata which cover the chalk we find the shells merely preserved, and in such a state, that when the clay or sand in which they lie is washed off, they might appear to be recent, had they not lost their colour and become more brittle. Here we find beds of marine shells alternating with others peculiar to fresh water, so that they seem to have been deposited by reciprocating inundations of fresh and salt water. In the highest of the regular strata, the crag, we at length find an identity with the shells at present existing on the same coast; and lastly, over all these strata, indiscriminately, there is spread a covering of gravel (seemingly formed by the action of a deluge which has detached and rounded by attrition, fragments of the rocks over which it swept) containing the remains of numerous land quadrupeds, many of them of unknown genera or species (the mastodon and the fossil species of elephant or mammoth, bear, rhinoceros, and elk) mingled with others equally strangers to the climates where they are now found (hyaenas, &c.), yet associated with many at present occupying the same countries." p. 11, *Introd.*

The following is an account of the grouping of the organic remains into distinct assemblages, in the various formations.

"They are not irregularly dispersed throughout the whole series of these formations, but disposed as it were in families, each formation containing an association of species peculiar in many instances to itself, widely differing from those of other formations, and accompaning it throughout its whole course; so that at two distinct points on the line of the same formation, we are sure of meeting the same general assemblage of fossil remains. It will serve to exemplify the laws which have been stated, if the observer's attention is directed to two of the most prominent formations of this island; namely, the chalk, and the limestone which underlies the coal in Northumberland, Derbyshire, South Wales, and Somerset. Now, if he examines a collection of fossils from the chalk of Flamborough head or from that of Dover cliffs, or, it may be added, from Poland or Paris, he will find 8 or 9 species out of 10 the same; he will observe the same echinites associated with the same shells; nearly half these echinites he will perceive belong to divisions of that family unknown in a recent state, and indeed in any other fossil bed except the chalk. If he next proceeds to inspect parcels of fossils from the carboniferous limestone, from whichever of the above localities they may have been brought, he will find them to agree in the same manner with each other; that is, he will find the same corals, the same encrinites, the same productae, terebratulae, spiriferae, &c.; but if he lastly compares the collection from the chalk with that from the mountain lime, he will not find one single instance of specific agreement, and in very few instances any thing that would even deceive an unpractised eye by the superficial resemblance of such an agreement." p. 10. *Introd.*

Concerning those genera and species of fossils that have not been discovered in a living state, we have the following lucid remarks.

"In speaking of the difference between recent and fossil species, it becomes us to be cautious in pronouncing that the latter do not at present exist because we are not acquainted with them in a recent state, and this caution is still more necessary with regard to those genera which the "dark unfathom'd caves of ocean" may possibly conceal in their recesses : we must remember that we were long acquainted with the encrinites, in a fossil state, before the analogous beings in a recent state had found their way to our collections ; yet the general facts seem too strong to be entirely thus accounted for. With the exception of those contained in the most recent beds (the crag) only, nine out of ten fossil shells belong to species decidedly different from any known to exist. The family of ammonites, for instance, contains more than 200 fossil species according to many authors, and it does not seem possible to reduce the estimate above one half ; yet of all these not one is known recent, and the only recent species of the whole genus is a very minute shell ; yet the fossil species sometimes measure three feet in diameter. Is it probable that a genus so numerous, and having species of such large size, can have been overlooked, especially as they are furnished with an apparatus whose use was evidently to give them buoyancy, like the allied family. the nautilus ? so that it is not likely they can remain concealed from inhabiting deep waters only. The same remarks will apply to the belemnites, of which no recent species is known."

"The remains of marine oviparous quadrupeds (Ichthyosaurus, Plesiosaurus, Maestricht animal, &c.) are referable to new genera widely different from any thing with which we are acquainted, and the fossil species of crocodile are strongly distinguished from the recent. These enormous and singular animals (sometimes almost rivalling the whale in size) which must often come to the surface to breathe, cannot surely have eluded the observation of all our voyagers. The land quadrupeds found in some of the most recent strata, and many of those even mingled in the diluvial detritus with the bones of animals still existing in the same countries, are often of genera widely distinct from any with which we are acquainted (e. g. Palæotherium, Megatherium, Mastodon, &c.) or of distinct species, as the fossil bear, rhinoceros, and elephant ; and M. Cuvier has shown at large the little probability there is that any of them exist in an unknown condition. It must be carefully remembered that an accurate and rigorous knowledge of Zoology is requisite in any one who ventures to discuss this subject ; a superficial acquaintance with it can only lead into confusion and error." p. 9. Introd.

Another subject, that struck us forcibly in the introduction to this work, is the inclination of the strata of conglomerate rocks. The following remarks may not coincide with the views of the thorough-going Neptunian : but it certainly requires something more than mere assertion to set them aside.

"When beds recomposed from the fragments and detritus of older rocks (such as are called conglomerates and puddingstones) which must previous to their consolidation have existed as loose gravel, occur among vertical or highly inclined strata, we may conclude with absolute certainty that this inclined position cannot have been original, but must have resulted from subsequent disturbance ; for it is obviously physically impossible to support an aggregation of loose gravel in vertical or nearly vertical planes. A similar argument will apply when, among the inclined strata, thin beds distinguished by peculiar organic remains, are interposed." p. 16. *Introd.*

Much is said in the Introduction concerning the change of level in the ocean, which is evinced by the immense quantity of marine relics scattered over two thirds of all known continents ; and some "hasty generalizations" of the Wernerians are exposed : but we cannot stop, to exhibit the writer's ingenious train of remark. The subject of the formation of vallies is also treated with ability : and the conclusion is, that the agency of existing streams is by no means sufficient to account for the phenomena these vallies present. The proof of this, is not merely the inadequacy of the cause to produce the effect, but, more eminently, the occurrence of transverse, as well as longitudinal vallies ; both of which could not possibly have been excavated by the present streams ; and, therefore, it seems necessary to call in the aid of diluvial currents. This subject, we believe, has received little or no attention in this country.

We should gladly notice particularly some other points brought forward in the Introduction. But this article has already swelled so much, that we can only observe, that the subject of diluvial and alluvial deposites is clearly exhibited, and the whole closes with the connection of geology with religious enquiries, especially with the Noachian deluge and the age of the world. We cannot avoid ex-pressing a wish, that this part of the work, especially, should meet the eye of our divines ; since we know not any other work in which these points are exhibited more clearly and candidly.

Upon the whole, we cannot but look upon the work whose analysis we have attempted, as among the ablest and most interesting the age has produced ; and as exhibiting much, which can no where else be found, in a connected form. It clears away much of the obscurity that hung over some parts of geology ; and brings forward the newer formations, from the caves of oblivion, where they have too long been suffered to lie. We rise from its perusal, with an impression, that we are much better qualified to examine the rocks around us than before ; while we are more sensible, how vast is the field of American Geology, that yet remains unexplored. We cannot judge of the accuracy of the local details in this work ; but from the character of the writers ; from their situation in the midst of an host of able geologists, who will be jealous of misrepresentation ; and from internal marks of verisimilitude, we place much reliance upon their faithfulness. Their freedom from doubtful theoretical views is not among the weakest of these internal evidences of fidelity. It is astonishing how attachment to a particular system will warp the judgment of a geologist in his observations. It has caused many "to see what was not to be seen ;" to discover particular strata, where no such strata existed ; to present us with maps, and sections, and profiles, that would apply to the moon, as well as to the district they were intended to illustrate. It was said by some one, we think by Hume, that a man, in order to be an impartial historian, should be of no religion and a citizen of no country. And the principle, on which the remark is founded, applies to natural, as well as to civil, history. We may learn something of the professed views of the writers of the work before us on this subject, from the following extract from the writings of Lord Bacon ; which they, and the other members of the London Geological Society, have chosen for their motto : Quod si cui mortalium cordi et curae sit, non tantum inventis haerere, atque iis iti, sed ad ulteriora penetrare ; atque non disputando adversarium, sed opere naturam vincere ; denique non belle et probabiliter opinari, sed certo et ostensive scire ; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjungant ; ut omissis naturae atriis, quae infiniti contriverunt, aditus aliquando ad interiora patefiat. *From Title page of Geolog. Trans.*

But though these authors thus cautiously avoid enlisting themselves into the ranks of system, yet we think it is obvious, that, so far as the origin of trap rocks is concerned, they (certainly Mr. Conybeare,) lean to Huttonian views. He presents us, in a note, with a succinct statement of the arguments for the hypothesis, that ascribes important modifications of the earth's surface to volcanic agency ; and observes in the text, that "the weight of geological authorities decidedly preponderates, at present, in favour of the igneous origin of these (trap) rocks." We have already observed, that the trap rocks of this country, certainly the greenstones, so far as they have been examined, present appearances very similar to those in Europe ; occurring in the form of beds, dykes, and overlying masses: and really, we do not see how any man, who will candidly examine all the phenomena they exhibit, can avoid the conclusion, that a volcanic agency has been empoyed in their production : or, at least, in their modification. The most unpractised observer will be struck with the marks of the former action of heat, which they present ; while the most acute examination serves only to bring more of these marks to light. The resemblance of the amygdaloidal traps to certain varieties of lava ; the convulsion and distortion of other strata in their vicinity ; the change in other rocks in connection with trap dykes, answering precisely to the action of heat ; and the fact, that the strata, through which these dykes pass, are often bent upwards, near the line of contact, to what, but a volcanic agency, can such circumstances lead the mind ?

It may here also be mentioned, that many of the ablest geologists of Europe, (such as Dr. MacCulloch, Von Buch, Necker, &c.) so far as they have adopted any hypothesis on the subject, are disposed to impute an igneous origin to granite as well as to trap rocks. Indeed, consistency seems to demand such a conclusion. For although the proofs of such an origin may not be so numerous in regard to granite as to trap, yet the most important ones are common to both. Granite exists in the form of beds, veins, and irregular masses, like trap; and if we can judge from the confusion of the strata in the vicinity of these masses, we must conclude, in many instances, that they were protruded through these strata. We are acquainted, also, with instances, in which granite veins have dislocated the strata, through which they pass, in the same manner as trap dykes. We are inclined, also, to believe, that in the granite of New England, veins may frequently be found connecting the beds, as is sometimes the case with trap. We happen to live in a part of the country where our daily walks present to us granite veins, beds, and protruding masses; and we formerly had frequent opportunities to examine our greenstones: (we speak here only of secondary and transition trap:) and we commenced these examinations with prejudices in favour of Wernerian views. But we have been insensibly led to lean to the conclusions above noticed. We might have studied hand specimens in cabinets forever, and remained firm to the Neptunian theory in all its length and breadth. But really, nature's cabinet seems to teach a different lesson.

We mention such views as these, however, with a great mixture of remaining scepticism. We say only, that after an examination, of the rocks that have fallen under our notice, we are led to refer some of them to an igneous origin, (trap and granite for instance,) and others to aqueous deposition. For we consider the evidence of the agency of water in the formation of many series of rocks, to be quite as strong, as of the agency of heat in others. In stating these two general results, we would by no means be understood, that we are advocates for all the minutiae of the Huttonian hypothesis. We are indifferent whether we are called Neptunians, or Vulcanists; and also, whether we have any general theory on the subject, or only some points of apparently contradictory theories. Just so far as undeniable facts lead us, we wish to follow; but no farther. We do not believe the time has yet arrived, in which it is possible to make any very extensive, correct generalizations in regard to the original formation of rocks. Let any man compare the geology of England, as the work we have been considering, presents it, with the comparatively scanty materials yet collected in most other countries, (several parts of the continent of Europe, of course, excepted.) and will he not be satisfied of this ? When the whole world shall have been as thoroughly explored as England has been, then, but not till then, can it be expected any general geological theory will be formed, which will stand the test of ages. Ere two decades of years are gone by, we trust the geologists of the United States will have done their part of this great and interesting work.

ART. III.—*Notices of the Geology of Marthas's Vineyard, and the Elizabeth Islands.*

A short visit to the island of Martha's Vineyard, in the summer of the present year, (1823,) enables me to say something of its geology ; with that of the adjacent islands. I am the more induced to do this, since those islands are not coloured in the map of Maclure; and they may not soon be visited by a geologist, who will have any better opportunity to examine their structure than I had, although I confess my researches were hasty and imperfect. This sketch however, may furnish some assistance to succeeding observers.

Martha's Vineyard is about twenty one miles in its greatest length, and from six to eight in its greatest breadth. It is divided into three townships, Edgartown, the most populous, occupying the south eastern part of the island ; Tisbury, embracing the north western part, and Chilmark the western and southwestern parts. The name of this island, given by the aborigines, is Nope, or Capawock. These natives have long been celebrated in the annals of missions. But those, whose blood runs pure from foreign mixture, are now nearly extint. A hybrid race, however, descended chiefly from the intermarriages of negroes and indians, are yet considerably numerous, perhaps about four hundred, who inhabit the western extremity of the island, in the vicinity of Gay head; and among them, there exists an organized christian church. The small island of Chabaquiddick, lies at a little distance from the east end of the vineyard, and Noman's land, not far from the south western extremity. The Elizabeth islands being about sixteen in number, are situated a few miles from the north west end of Martha's

Vineyard; and form a part of the south east barrier of Buzzards Bay. They contain a few scattered inhabitants.

In my route from the city of Boston, I passed over the well known puddingstone of Roxbury and Dorchester; the argillite and greenstone of Quincy; the sienite and sienitic granite of Braintree and Weymouth, with its beautiful dykes of basalt, or greenstone; the gray wacke slate? of Abington; the diluvium of East and South Bridgewater; the gray wacke slate, diluvium and singular talcous rock, containing feldspar, of Middleboro; and struck at New Bedford, upon mica slate, hornblende slate, and gneiss, inter-stratified, and containing beds and veins of granite. In sailing out of New Bedford harbour, these latter rocks appeared occasionally, for several miles along the shore; and I was led to anticipate their continuance as far as Elizabeth Islands and Martha's Vineyard: but on passing the former, I perceived a diluvial coat to be spread over their somewhat hilly surface; while the shores, in many places, exhibited steep declivities of sand. And on reaching the north western shore of Martha's vineyard, I found its aspect to be very similar These islands so far as I have examined them, appear to be made up of the three following formations: 1 Alluvial: 2 Diluvial: 3 Plastic Clay. I use these terms in the Modern restricted sense; that is, as the latest writers employ them, in describing the strata of England and France. I take for a standard, the late work of Conybeare and Phillips, on the geology of England and Wales.

1 *Alluvial.*

This formation occupies a considerable portion of the southern part of the Vineyard; reaching in some places, even beyond the centre of the island. Where I crossed it, it consists of a perfectly level, sandy tract, uninhabited and uninhabitable. I have rarely seen as extensive a region, that was so cheerless and barren. It is covered by stinted shrub oaks, rarely exceeding five feet in height, and when I saw them, they were entirely leafless, presenting to the eye, a cheerless, wintry waste. On my right as I crossed this plain, at a distance, appeared a ridge of high land and rounded eminences: but on my left, nothing was to be seen, except this uniform unrelieved barrenness. I was immediately struck with the idea, that this sandy desart must have been formed by the action of the waves of the vast Atlantic, which have beat upon this shore, without obstruction, for so many centuries. In the south westerly part of the island, the high perpendicular cliffs indicate that the waves have encroached upon the hilly part of the island; and it would seem not altogether improbable, that the sands and clays, thence worn down, might have been driven by tides and currents, into this their retired bosom. I am aware, however, that no instance is known, in any other part of the world, of so extensive an alluvial deposition from this cause: and perhaps if I had been able to spend more time in its examination, especially its south eastern margin, I might have discovered positive proofs of the incorrectness of such an hypothesis. In short, although this part of the island is coloured as alluvial, I am strongly inclined to believe, that it is referable to an older and distinct formation. Its inferior level, however, the perfect evenness of its surface, and the entire absence of diluvial detritus, so abundant in every other part of the island, clearly discriminate this from the Plastic Clay Formation, about to be described. But as I am not prepared, even to conjecture, with what other European stratum this is identical, it must, for the present, be denominated alluvial.

2 *Diluvial.*

This formation invests, in a very conspicuous manner, the whole of the Vineyard, with the exception of the part just described. All the north western extent of the island, several miles in width, is hilly and uneven: with no abrupt precipices, however, but rising into rounded eminences, which together constitute a ridge of considerable extent, and nearly as long as the island. I should judge that in some places, this rises three hundred, or even four hundred feet above the ocean; and the quantity of huge bowlder stones, scattered over these hills on every side, is immense. The land is mostly cleared, and the rounded masses are chiefly granitic, and of course, of a white colour; so that they may be seen at a great distance to good advantage. I had no doubt, for a time, that the bowlders I saw so numerous, and so large, on the remote hills, were ledges of granitic rocks;

and I could hardly believe the inhabitants who told me, that no rocks were found in place on the island. But wherever I had an opportunity to examine, these ledge like appearances vanished on a nearer approach; and the diluvial character of the surface became manifest. So that I feel a good degree of confidence, that the same will be found to be the case, with those eminences, that I did not visit. These loose stones vary in size, from that of the smallest pebbles, to that of masses, ten or even fifteen feet in diameter. They are almost without exception, of a primitive character; consisting of granite, gneiss, mica slate and quartz. I saw a few masses of a pudding stone, similar to that of Roxbury; but no other secondary rock. In short, the detritus of this formation appears obviously, to have been derived from the rocks, that occur in place along the coast, on the mainland.

The thickness of this diluvial mantle is not great. The sand from the plastic clay formation beneath it, is indeed so mingled with this, as to give a predominant character to the soil, and even the clay beneath the sand, is sometimes seen at the surface. In some tracts of considerable extent, little else, but the sand is seen: the diluvial bowlders and pebbles being very rare. It is obvious from this description that the soil of the island must be very light and poor, and so indeed it is. Some fertile tracts, however, occur along the margin of the small streams, or brooks, and also in some instances, in the immediate vicinity of the sea: and probably the soil in general, is of much the same character, as that along the adjacent shores of the continent.

The character of the diluvium of the Elizabeth islands, appeared so precisely like that of the Vineyard, that I have no doubt of their indentity I say *appeared*, for I did not land on these islands; but having passed among them at two places remote from each other, and approached often within a few rods of the shore, I could not but be struck with their exact resemblance to the Vineyard, in the contour of the hills and vallies, in the colour, size, and quantity of the bowlder stones, in the sandy aspect of the soil, and in the high sloping sand banks so frequent along the shore. I have accordingly coloured several of these islands on the subjoined map as diluvial. It may be thought I do this on very slight grounds, but as I have plainly stated what those grounds are, geologists will place that degree of confidence in the opinions advanced, which they consider them as deserving. Besides it must be recollected, that this paper does not profess to give a finished sketch of the regions it embraces, but only to furnish hints towards their geology.

The diluvial bowlders, occurring along the south-eastern coast of Massachusetts, are often in immense quantities; and of a character, very similar to those on the above named islands.

I was told, by unquestionable authority, that a rocking stone exists in Chilmark, a mile or two south-west of the congregational meeting-house. But I could not visit it.

3. *Plastic Clay Formation.*

The Plastic Clay Formation in England, is composed of an indefinite number of sand, clay, and pebble beds irregularly alternating. It contains also, lignite, imperfect coal, amber, organic remains, &c. Taking these characters as the criterion of that formation, we must conclude, that it underlies all the diluvial of Martha's Vineyard. Where-ever the shores of that island are elevated, and the ocean has encroached upon them so as to present perpendicular cliffs, a series of strata answering to the above description, are exhibited usually in great perfection and beauty. Gay Head is well known for the bright and variegated colours of its clay, sand and pebble strata; which present a naked front, of 200 feet in height. I was so unfortunate, however, through circumstances beyond my controul, as not to be able to visit those cliffs; although I passed within two or three miles of them. But I felt my disappointment somewhat mitigated, by having an opportunity to examine, what I suppose to be a continuation of these cliffs, in Chilmark, five or six miles from Gay Head, and probably near their north-eastern termination. Immediately beneath a thin stratum of diluvial soil, lies a bed of shells, only a few inches thick, and mostly in fragments. Below this is a stratum of white sand, with some pebbles, often several feet thick. Next occur irregularly alternating beds of variously coloured clays, sand, ferruginous sand, pebbles, clay and pebbles, and clay and sand intermixed. The clay beds are white, brown, blackish, red, light and deep yellow, and finely variegated with spots of white, red, and yellow. The ferruginous pebble beds are brown, or reddish, sometimes a deep blood red, and they are generally cemented by the oxide of iron, so as, in some instances, to require a considerable blow of the hammer to separate the fragments. This is particularly the case in the lower part of these strata; where the iron ore, which appears to be the argillaceous, is sufficiently pure to be wrought, although penetrated by pebbles throughout. Some of the clay beds are nearly half made up of small plates of silver coloured mica, intimately mixed with the clay, which appears to be kaolin. In this clay, beneath the ferruginous pebble beds, I found good specimens of well characterised lignite. It consists of flattened trunks, or branches, several inches in diameter, of a clove brown colour, retaining, very distinctly, its longitudinal, fibrous structure: but the cross fracture is conchoidal and shining, and the concentric rings are invisible. The bark is a mere line in thickness. It burns without much difficulty, with considerable flame, and emits a pungent rather unpleasant odour. It lies horizontal in the bed of clay, and is one of the exogenites of A. Brongniart, (vid. Vol. VII, No. 1, Journ. Sci. p. 178.) In other beds of clay, small masses of lignite occur, some of which exactly resemble common charcoal, and burn as freely. I saw no other organic remains in these strata, except a single shell, in the ferruginous sand, which I lost.

Viewed on a general scale, the beds, above described, are nearly horizontal. But numerous minor irregularities, in the dip of the strata, occur in the cliff, which I examined. Indeed, instances may be seen of almost every possible degree of declination: in some places, the beds arch upwards, and in others they arch downwards. Whether this irregularity does not proceed from a partial sliding down of large masses of the cliff, I could not determine; though inclined to believe it does not.

The above description, it will be perceived, corresponds in its general characters, to the European Plastic Clay Formation; and therefore the strata it embraces have been thus denominated. But in order to establish their identity with perfect certainty, a comparison must be instituted between the organic remains, occurring in each series of strata. It is not therefore, without some doubt, that I have denominated the formation, above described, the Plastic

Clay Formation.* It cannot, however, be referred to any other European formation, of which I have seen a description. It is coloured, on the accompaning map, only as a belt along the coast, in those parts where I have noticed it to be more or less distinctly laid bare; although, as before observed, it probably constitutes the basis of all the diluvial part of the island. But the diluvial is so remarkable, that it seemed to deserve a place. Probably, also, the Plastic Clay underlies the diluvium of the Elizabeth Islands: although the clay beds are not so distinct in the cliffs, and are in general, hid by the sand. And from all I can learn of Natucket, this island is, with little doubt, referable to the same formation: if so, where, but to the same place in the geological scale, shall we refer the sands of Cape Cod? unless, indeed, they may belong to a formation still more recent. Long Island, in those places where I have seen it, is unquestionably very similar in its geological structure to Martha's Vineyard; and probably belongs to the same era. I take it for granted, that the vast region along the sea coast in the middle and southern states, marked on Maclure's map as alluvial, can no longer be considered such, in the modern sense of that term. He describes a part of it, at least, as consisting of sandstone and limestone, and regular beds of sand, gravel and clay; and some of this gravel is cemented by oxide of iron: and, therefore, it cannot be alluvial; but agrees with the European strata above the chalk. If we take his map, and prolong the line, or rather curve, that separates the alluvial tract above named from the primitive towards the north-east, we shall find that it passes between Martha's Vineyard and the continent, and crosses Cape Cod, leaving us to conclude that the Vineyard and Nantucket are a continuation of that extensive formation, hitherto called alluvial, of which Long-Islanh has been regarded the north-eastern limit. If we prolong this curve still further, it will include within it Nova Scotia, and, at least, a part of Newfoundland. Here we are reminded of the vast sand banks along that coast, and

* The remarks of Mr. Finch, (who appears to be occularly acquainted with similar formations in England,) on the tertiary formations of North America in Vol. VII No. 1 of the Journal of Science, tend very much to remove these doubts, and to establish me in the belief of the existence of the Plastic Clay Formation in the Vineyard. I feel indebted to that gentleman for the important hints he has thrown out.

also, of the cliffs of gypsum and sandstone in Nova Scotia, and the enquiry arises whether that gypsum is not identical with the same rock in the vicinity of Paris, where it occurs in the lower Fresh Water Formations? If so, it forms a continuation of the vast tertiary formations, stretching through the eastern border of the United States, and embracing some of the West-India Islands, and adds to them an interesting link. Finally, if we carry this curve across the Atlantic, it will pass not far from the northern extremity of Great Britian, and include within it the tertiary formations of England and France, and, indeed, of all Europe. The enquiry then, immediately suggests itself, can it be, that the tertiary formations of Europe and of the United States, are merely the extremities of the same vast basin; the intermediate parts of which, have been swept away by the currents and waves of the ocean, or by some mighty catastrophe? Whether such questions deserve any serious consideration, or not, it is obvious, that there are facts enough brought to light, to induce our geologists to subject those parts of our country, hitherto called alluvial, to a thorough re-examination. And there is reason to anticipate, as the fruit of such researches, the discovery of many more beds of gypsum, than are now known; and also, of chalk? If this latter substance exist immediately below Plastic Clay in England and France, why may we not expect, that when the same formation in this country is penetrated, chalk will be found beneath it? In England, the Plastic Clay is not usually more than 100 feet in thickness: but in Martha's Vineyard, (if it really exist there,) the ocean has already laid open this formation nearly 200 feet in depth; so that the bottom of it might probably be reached without much difficulty.

I visited the Vineyard in the early part of June; and the season being unusually late, I am unable to say much of its botany, if it be proper, in this place, to say any thing. A species of oak exists abundantly there, which I have never seen upon the continent: but it was not the season of its flowers, or fruit; and the leaves were but just opening, so that I could determine nothing concerning the species. A species of *Ranunculus* also occurs, which, is stemless, and, I believe, undescribed. Very many of the bowlder stones contain, on their surface, large quantities of the elegant *Borrera chrysophthalma*:—a lichen very rare in most parts of New-England. Associated with this, is abundance of yellow and beautiful species of *Parmelia*, with which I am unacquainted : the same, that is so frequent on the pudding-stone of Roxbury, and the petrosilex of Lynn. On the south-east shore of the island, where the waves of the Atlantic incessantly beat, I observed an unusual number of species of Fucus, Ulva, Spongia, and other genera of zoophytes, unknown to me. The testacea were neither numerous nor interesting.

It may not be amiss to remark, that in passing from New-Bedford in Massachusetts, to Tiverton in Rhode Island, in a pond, nearly on the line between the states, I found a delicate species of *Hottonia*, that answers well, to the *H. inflata* of Elliot; but is certainly not the H. *palustris* of Linnæus.

Art. IV.—*Additional Notice of Argentine, by Professor* Dewey.

To the Editor, Sir,

Since the account of the argentine from the mine in Southampton was published in Vol. VI. p. 333 of this Journal, I have examined several more specimens from the same locality. Indeed, this is the only locality of any consequence, I believe, yet discovered in this country. The mineral has been seen by several distinguished mineralogists the past summer, who supposed it to be from Europe, from its resemblance to European specimens. Besides the silvery white, it ocours of a *greyish* aspect, not appearing to be smoky throughout, though it looks as if it had been slightly smoked. This appearance, however, seems not to be accidental, or induced in blasting the rock, but to belong to the mineral. All the specimens I have examined, are beautifully *phosphorescent* on a hot iron or coals. The light is a bright and strong yellow, slowly increasing for some time unless the mineral is reduced to powder. The mineral rapidly decrepitates before the blow pipe, and the fragments of the laminæ evidently tend towards the rhomboidal tabular form. The laminæ often pass into a relatively compact mass, so that the laminae cannot be seen. I have lately analyzed another specimen, which seemed to be very free from quartz, but I found nearly the same proportion of *silex* as before, so that silex seems to enter into the composition of the mineral. There is also about three per cent of water liberated by a nearly red heat continued for some time. The proportion of ingredients will be affected only in a slight degree by this fact. It is only necessary to observe that the proportion of lime is to be diminished by the quantity of water, and this will leave the carbonic acid very nearly in the proportion required from the composition of carbonate of lime. This mineral has been found in abundance in Williamsburgh. It occurs in considerable masses of a beautiful pearly lustre, and laminated like the other.

Art. V.—*Notice of a Silicious Petrifaction, from N. Carolina.*

[Extract of a letter from Mr. Thomas Strode.]

Fayetteville, No. Caro. 3d July, 1823.

I send you some specimens of petrifactions; they are common through the union, but this appears to be from a pine tree, the first I ever saw, and what is remarkable, it is on a high dry sand hill, elevated about ninety feet above the level of the river, in a situation that would seem almost to preclude much moisture. Mr. Eccles, an intelligent and respectable gentleman in the neighbourhood, recollects it thirty years past, when it was nearly the entire tree; the change of wood into stone is certainly a chemical process, and nature does not seem to use costly materials to effect it; why then may it not come under human agency, and be applied to useful purposes? I send you also a specimen of sand and turpentine, which appears in the incipient stage of petrifaction.* I will remark that the stone in this vicinity is sand united by the oxide of iron, of which I send you a specimen. I am of opinion from some, though not decisive experiments, that by pulverising this stone, and mixing it

* We believe this to be a mistake; it is partially mixed with sand, (a very common occurrence in pine forests,) and partially in a state of extreme desiccation, from the exhalation of the volatile oil of the turpentine by the heat of the sand. (J. G. P.)

properly with lime, &c. that a valuable and cheap water-proof mortar might be obtained.

N. B. The specimen of petrified wood is about eighteen inches by six inches. It is entirely silicious, a part of it resembling the coarser varieties of wood opal, generally opaque white, but in some portions stained of a rust or violet colour by oxide of iron. The wood is unquestionably pine. The layers and fibres are distinctly preserved. There is a knot, very exactly imitated, and on the outside of this knot, there is a collection of resinous matter, such as is common in similar situations in decayed trees now standing. It belonged to a dry tree, from which the bark had fallen, and its surface exactly resembles the half decayed surface of dried trees. It is worm eaten, and the intervals between the outer layers are filled with the dust deposited by the larvæ of insects. Though most of the specimen, particularly the firmer parts, is flinty or opaline, (there is a clear line of separation between the opaque white and semi-translucent violet coloured portions of which it is chiefly composed,) yet the open spaces between the layers, and particularly around the knot, are lined with minute quartz crystals. The specimen is said to have been taken from an entire tree, which lately stood erect and imbedded in a hillock of loose sand. It probably grew on the spot, and was killed and gradually covered by the blowing sand. The specimen of the rock is a sand stone cemented by oxid of iron, formed of the common coarse sand of the southern pine forests. Such sand stones are common all over the Southern states, from N. Jersey to Alabama, particularly near the borders of the primitive. They form entire hillocks in the barrens opposite Philadelphia, where they have a striking resemblance to sand hardened by frost. (J. G. P.)

Art. VI.—*Miscellaneous Localities of Minerals.*

1. *Yenite and Green Feldspar.*

Amherst, (Mass.) Dec. 10th, 1823.

To Prof. Silliman, Sir,

About eighteen months ago, I visited Cumberland, (R. I.) for the purpose of obtaining the interesting minerals, which are found in that place. Among the specimens which I then obtained, there was one which escaped my notice, until very lately. Upon examination, I do not hesitate to call it the *Yenite* of Haüy. Its character is as follows. It occurs massive, and crystallized. Its crystals are scattered over the surface, crossing each other in all directions. They are generally from three quarters of an inch to one inch in length, and about one eighth of an inch in diameter. Their form is that of four sided prisms, with angles of 112° and 68°; terminated by four sided pyramids. They are opaque; and of a greenish black colour,—having a lustre somewhat glistening, and approaching to metallic. They are of sufficient hardness to scratch glass, but may nevertheless be scratched by Adularia. When exposed to the heat of the blow pipe, they readily melt into a dull opaque, black globule. The matrix of this mineral is a compound rock; consisting chiefly of quartz, epidote, and magnetic Oxide of Iron. The part of the town, in which I found the specimen, is generally known by the name of Tower hill; where a number of fine specimes might be obtained. The precise spot I am unable to designate.

I am likewise happy in being able to increase the already numerous catologue of Chesterfield minerals. While on a visit to the locality of Sappare in that place, in the month of May last, I found near the spot where the Sappare is obtained, fine specimens of Green Feldspar. It occurs in a rock of granite, in crystalline masses; is translucent at the edges, having a deep apple green colour Associated with this Feldspar, I found the Siliceous Oxide of Manganese. It has a deep rose-red colour, and is slightly translucent at the edges. It is in masses composed of fine granular concretions, with a somewhat glistening lustre. It contains occasionally, small octahedral crystals of magnetic oxide of iron. Should you deem this notice worthy of a place in your Journal, you are at liberty to insert it.

Respectfully yours,

CHARLES U. SHEPARD.

Beautiful green feldspar has been recently found at Beverly Mass. by the Rev. Elias Cornelius; small portions of purple fluor spar are disseminated in its fissures. *Edit.* See the Boston Journal.

2. *Localities of Minerals, principally in Massachusetts.* By JACOB PORTER.

Calcareous tufa, fine, and exhibiting distinct impressions of vegetables, at Semphronius, New York. Dewey.

Limpid quartz, in good crystals, at Saratoga Springs; also at Sand Lake, New York.

Blue quartz, at Lenox.

Ferruginous quartz, amorphous and crystallized, at Pittsfield. The colour is yellow, or red tinged with yellow; the crystals small, well defined, and possessing a strong vitreous lustre. Also at Worthington, often crystallized.

Fetid quartz, at Lenox and Chesterfield.

Chalcedony, at Cummington.

Hornstone, well characterized, at Pittsfield.

Jasper, generally of a gray or bluish colour, sometimes red, at Pittsfield. Red jasper is also found on the banks of Westfield River at Cummington.

Prismatic mica, abundant at Chesterfield and Goshen, in granite. It separates very easily into beautiful prisms; the fibres between them, resembling those of the finest amianthus.

Black tourmaline, in milky quartz, at Cummington; the crystals are well defined, and uncommonly beautiful, and as both minerals are perfect of their kind, the contrast between the pure white of the quartz, and the long glossy and finely striated crystals of the tourmaline, is very striking. Also at Washington, near Pittsfield.

Scapolite, of a silver gray colour, associated with quartz, at Chesterfield. The surface of the crystals is longitudinally striated, and generally dull; but on being broken, they exhibit a structure distinctly foliated, with a shining lustre.*

Black hornblende, well crystallized, at Washington near Pittsfield.

Graphite, at Lanesborough.

Oxide of manganese, yielding vital air in abundance, at Plainfield.

Plainfield, September, 1823.

3. *Miscellaneous Localities by* Mr. Steuben Taylor; *extract of a letter to the Editor.*

Providence, Nov. 18*th*, 1823.

"In the course of last summer I visited the following localities of minerals. Some of them have been known a long time to individuals; but none of them have been noticed in the Journal of Science.

1. Feldspar, in regular crystals of an inch and a half in diameter, at Barkhampstead.
2. Actynolite in potstone, at do.
3. Graphic granite, at do.
4. Ferruginous Quartz, at do.
5. Black mica, at New Hartford.
6. Prismatic do. at do.
7. Radiated quartz, at Canton.
8. Kyanite, from a new locality in Chatham.

The specimens which I obtained, were taken from a ledge in the turnpike road, leading from Middletown to Middle Haddam, a few rods east of Mr. Asher Rowley's. The crystals are imbedded in quartz, and cross each other in every direction. Their colour is generally a pale blue, with occasional spots of deep blue.

9. Garnets, in mica slate, at Middle Haddam.

They are found about eighty rods east of the Landing. They occur in vast abundance, and are from one to two inches diameter. Those which have been noticed are found at the Cobalt mine, and are small when compared with these.

10. Epidote at Plainfield.
11. Gneiss curiously stratified at do. I have a specimen three fourths of an inch thick, which contains ten distinct layers.

* Published as Tremolite, in Am. Jour. Vol. VI, No. 2d.

12. Galena, at White Creek, N. Y. It was discovered about four months ago. It yields upwards of seventy five per cent pure lead. Preparations for working it were commenced some time since. For this information respecting this locality, I am indebted to one of the proprietors, from whom I received specimens of the ore.

13. Smoky quartz at Killingly.

14. Ferruginous sand, in great abundance, at Block Island.

15. Green Talc, at Smithfield, R. I. It is in the centre of a public road, about a mile west of Cumberland Hill. It was discovered nearly a year and a half ago, by the Hon. Samuel Eddy, and Dr. Charles B. Halsey of this town. Specimens have been taken from this locality, which weighed a hundred and fifty pounds. It is of a brilliant colour, being of a deep green, particularly when viewed in the direction of the laminae. From experiments which have been made upon this mineral, it is found to lessen friction better than graphite."

4. *Miscellaneous Localities,* by Dr. Eben. Emmons, *Chester, Mass.*

Silico Calcareous Oxide of Titanium.—Oblique four sided prisms, (rather imperfect,) of a light brown colour, associated with Augite and Actynolite ; likewise in Sienite, or an aggregate of feldspar and hornblende, not stratified. Chester.

Phosphate of Lime.—In an aggregate of gray epidote, zoisite, hornblende and quartz. Dissolves slowly in nitric acid. Colour whitish yellow. Fragments transparent. Form a rectangular four sided prism. Chester.

Black oxide of Manganese.–Dr. P. Plainfield, sent me what he calls iron ore. I have lately ascertained that it is manganese, yields a large proportion of oxigen, and comes off easily at a low red heat, and as abundant as the Bennington M. Dr. P. has not informed me whether it is abundant, but at any rate I believe it is of a good quality. Cummington or Plainfield. *Chabasie,* in cuboidal crystals, one quarter of an inch in diameter, of a straw yellow and white colour. *Stilbite,* associated with the above mineral, occurs in single oblique four sided prisms, with rhomboidal terminations and grouped, sometimes. in bundles and globular masses, and radiating from a centre &c. This Mineral Prof. Dewey calls *Zeolite*, but I cannot succeed in forming a jelly with acids.* Probably both stilbite and zeolite are found at this locality

Carb. Lime occurs at the same locality with the two last, in six sided tables and six sided prisms, truncated lightly on every solid angle. Also in lenticular crystals or thin scales, variously grouped. The three last mentioned occupy fissures and veins in the mica slate, about one mile east of the meeting house in Chester. This locality is interesting both for the minerals, and the situation and relative position of the rocks, of which something will be said hereafter. *Beryl*, Norwich, one crystal in my possession, is about five inches in diameter, and is intersected on one of its lateral faces by another at an angle of about 45°. Likewise found in Chester in an aggregate of carb. lime, chlorite and feldspar, colour yellowish green and white. The beryl in Norwich is about half a mile west from Pitcher's bridge, near a mass of white rocks, to be seen from the bridge. *Prismatic and Tabular mica* extremely abundant at those rocks, and very beautiful; rocks are a coarse granite and contain schorl (Indicolite ?) in abundance, (Powder deep blue). Garnets and staurotide, of every variety, abound in this region in mica slate. *Cyanite*, a curious variety occurs here in a very fine, soft mica slate, (resembling potstone,) often in hemitrope crystals, color greyish blue. I forwarded a specimen in the box of minerals sent sometime since. I have discovered one large specimen of *ferruginous* oxyd of titanium in granite, or, I ought to say, a mass of granite containing 20 or 30 imperfect crystals; likewise I have seen the oxyd of T. in flat plates in mica slate. Though I do not mention these as occuring here with the same confidence as I do the others.

Augite is abundant here in amorphous masses. I have found a few specimens of well characterized sahlite and coccolite. They occur in beds in the mica slate, both at Chester and Middlefield. *Magnetic oxyd of iron* is abundant, disseminated in serpentine, mica slate, &c. ; form, octaedral crystals and amorphous masses. *Rhomb spar*, (Middlefield,) in Dolomite or magnesian carb. lime; it contains a large proportion of magnesia. I have discovered a

* Perhaps the proportions were not right.

large mass or rock of rhomb spar in Middlefield, which contains fibrous tremolite. The magnesian carb. of lime in Middlefield, contains dark colored veins of the same substance, in which is imbedded *Hepatic* sulph. of iron? which on being moistened with sulphuric acid gives off sulph. hydrogen in large quantities.

Agate, one large specimen which I found near Chester village, in the sand, weighed upwards of 180 lbs. after several large fragments were broken off. It consists of yellow jasper and chalcedony. A large mass of chalcedony and jasper which is in part agatized, I have since seen not far from the meeting house, almost twice as large as the one found at the village.

ART. VII.—*Observations on Mr. Beudant's Geological Travels in Hungary,* &c. with miscellaneous remarks on coal, &c., by William Maclure, Esq., President of the American Geological Society, in a letter to the Editor, dated Madrid, Aug.* 20, 1822.

THIS whole work is a specimen of book making. All that possibly can be useful, in mineralogy or geology, might, with much ease, have been put into 50 pages, and the reader saved the labor of turning over from 1500 to 1800 pages of repetitions and descriptions of the same rocks, a thousand times over, creating confusion and fatigue, without leaving in the mind, any defined ideas of the subject. The author seems totally unacquainted with the immense variety of volcanic rocks, where age has made still more diversity and complication in their structure, as is the case with what he calls his trachite, or what Werner calls, the newest flœtz trap. It would be easy for any one who had sufficient patience to describe every Lava that has been thrown out of Vesuvius, to fill three quarto volumes by only walking three or four leagues in the vicinity of the mountain, or of any other mountain produced by fire.

* The maps were so awkwarkly placed in the atlas that they could not be opened without tearing them, which rendered it necessary to put them on canvass to preserve them.

It being the only* attempt that has yet been made on the continent of Europe to make a geological map, it will serve to show you the vast confusion and intricacy of the stratification of the old continent; how completely the different classes of rocks are mixed and thrown out of their natural positions; and what labor it will require to place them under any systematic arrangement. It will enable you to compare the fortunate regularity of the geology of our continent, and the ease with which the science can be studied from the well defined boundaries which nature has given to the different classes of rocks, running in the same direction, from one end of the continent to the other, having the line of separation so distinct between the different rocks in the limits of each class as to reduce to a certainty the place that each occupies in the natural order. This results from the fine opportunities afforded of examining the line of separation at every junction, through a distance of twelve to fifteen hundred miles, by which means any observer can obtain a more accurate knowledge of geology, in one year in the United States, than he could in a long life spent in travelling in any other part of the globe hitherto examined and described.

In the year 1815, six years after my geological map of the United States was published, in the transactions of the Philosophical Society of Philadelphia, Mr. Smith, I believe under the patronage of Sir Joseph Banks, published a geological map of England, the nomenclature of which is to a great extent composed of the local or vulgar names given to rocks by the miners or quarry-men that wrought in them. He likewise endeavored, like M. Beudant, to specify each individual rock, in colors on the map—a thing very difficult, perhaps impossible to be done, with any degree of accuracy. Since this, Mr. Greenough has published a geological map of England, which I have not seen.†

M. Beudant proves that the anthracite does not belong to the primitive class, but seems to think it may belong to the secondary. The regularity of our stratification places

* Of a *country*, we presume that the writer intends—for he is familiar with Von Buch's description and map of the environs of Landeck—Brongniart's and Cuvier's, of the environs of Paris—Brongniart's, of the Vicentin, and numerous other local continental maps. (Editor.)

† I have ordered a copy to be sent from London to the Geological Society in New-Haven.

the anthracite in the transition class without a possibility of doubt, as the same uniformity of arrangement fixes the natural position of a great many individual rocks, that remain doubtful from the deranged state of the stratification in Europe.

To be capable of applying the nomenclature of any science to the substances, on seeing them, constitutes the most laborious part of a scientific instruction. Nothing renders the learning of a science more difficult and complicated than a great number of names for the same substance. M. Beudant, following the practice of most French authors, translates all the names of rocks into French, thereby adding immensely to the difficulty of understanding him, and placing new obstructions to the learning of geology, which ought to be the most simple and easy of all the sciences, while at the same time it is perhaps the most useful.

There is considerable confusion in M. Beudant's secondary rocks. He reverses the order of Werner, as well as what I found to be the order of nature, by placing the Gres houillier, (which the English collier calls coal measures,) as the oldest secondary, putting over it the oldest red sandstone, and covering it with the compact limestone. When I first began my geological rambles (considering coal as the most useful and valuable substance that nature had bestowed on man) I followed it through all my excursions, and visited every considerable coal field in Europe, with the hope that by an exact examination of all the strata, over and under it, I should be able to predict whére coal could be found, but was at last forced to content myself with a tolerable guess, at where it most probably could not be found. The three species of secondary rocks, under which I never found it, in any quantity worth the working, were chalk, compact limestone, and the oldest red sand stone. Four fifths of all the coal beds in Europe or the United States repose on limestone, and crop out to day in the flanks of secondary shell limestone hills, compact in its structure, and often not of the oldest formation. In this position I found almost all the coal beds in England, Wales, and Scotland, all the coal around the Hartz mountains in Germany, all the coal in Silesia; even the extensive coal field in Flanders, and the north of France, lies in secondary limestone, although the quantity of mica in the coal measures, with their regular dip, gives them more the appearance of gray wacke, than I have any where else seen; for mica is rare in the slaty clay of most other coal measures. Our immense coal field above Pittsburg is 30 or 40 miles distant from Bedford, the termination of the transition formation, which space is occupied by secondary limestone full of shells, and sandstone, on the back of which the coal crops out.

M. Beudant found Gres houillier (coal measures) occupy ing the greatest part of the north and summit of the Carpathian mountains. I once went thirty or forty leagues from Villiczka, across the Carpathians, but saw nothing that I could call coal measures or Gres houillier, but immense beds of transition. From a note in page 171 of the 3d volume of M. Beudant's work, where he found the specimens collected by M. Brongniart, in the Appenines, exactly to resemble the Gres houillier of the Carpathian mountains, I suspect that what he calls Gres houillier,I have been in the practice of calling gray wacke, having passed the Appenines, in seven or eight different places, without meeting any coal measures, and having always considered them from Genoa to Florence, to consist almost entirely of transition.*

M. Beudant takes no notice of the regular dip of the transition rocks which I have always been led to consider as the most evident and distinguishing line of separation between them, and the secondary or horizontal class of rocks. This is perhaps a necessary consequence of the confused state of European stratification; it is only in the top of the secondary hills or mountains that you can discover the horizontality of the secondary, for the stratification is so deranged on the sides that the dip is in all directions, and at all angles. One of the advantages which the geologist enjoys in the United States, in consequence of the regularity and undisturbed stratification, is to be convinced of the real position of all the rocks, at the first glance, with their dip and direction, and to have no doubts concerning their actual and natural relative positions.

*When I go home I shall send to the Society specimens of the secondary compact limestone, of the coal fields above-mentioned, as well as specimens of the Appenines, as they are all at Philadelphia, besides the suite of Italian rocks which I gave to the academy.

*M. Beudant's tertiary class can be only local, confined to the basin of the north of France, and the south of England, as it consists of all the strata that lie above the chalk. As there is no chalk in the United States, there can be no tertiary class, and in many other countries, such as Norway, Sweden, &c. I found a small band of chalk between Moscow and the Black sea, in Russia, entirely surrounded by alluvion. Chalk is a very rare rock and cannot possibly be considered as a good foundation for a class.

REMARK BY THE EDITOR.

The above communication was received a good while since, and ought to have appeared before—but owing to the editor's ill health it was accidentally postponed.

Remarks on the rocks accompanying anthracite at Wilkesbarre and elsewhere, by Pres. Maclure, in a letter to the Editor dated Madrid, Aug. 20, 1822.

I observe in your Journal a description of the anthracite at Wilkesbarre, Pennsylvania, by Mr. Cist. In describing the accompaning rocks (the most essential part of Geology) he gives a very correct mineralogical description, but that is not sufficient to be comprehended by the European geologist; for all the aggregates, secondary or transition, have pretty much the same mineralogical structure; but the position and relative situation decides the class and fixes the nature of the rock. The whole region about Wilkesbarre belongs to the transition class, and all the slate he describes with spots of mica, must be gray wacke slate. Aggregates of large rounded pebbles cemented by quartz, form the

*M. Beudant mentions the carbonate of iron, accompanying his Gres houillier, and confounds it with the argillaceous oxide of iron, found in the coal measures of England, out of which the greatest part of the English iron is made. The carbonate of iron rarely, if ever, occurs in coal measures, but is often found in transition rocks, another presumption that there is some error in supposing that the Carpathian and Appenine mountains consist principally of Gres houillier or coal measures.

So greatly superior is the field in the United States for the study of geology, that it is probable when its advantages are generally known it will be visited by geologists, as Greece and Italy are just now by antiquarians.

proper gray wacke in which class all the anthracite of the United States is found, and I believe in all other countries. If the immense confusion from the derangement of the strata would permit an accurate examination, it would, I believe, be found that the dip of the anthracite on one side of the river is to the north and on the other side to the south, which is a new occurrence in regard to the transition, and seems to assimilate the anthracite to the bituminous coal basins; a fact which deserves to be ascertained.

ART. VIII.—*Miscellaneous remarks on the systematic arrangement of rocks, and on their probable origin, especially of the secondary, by* WILLIAM MACLURE, *President of the Am. Geol. Soc'y. in a letter dated Alicante in Spain, April* 29, 1823, *addressed to the Editor.*

DEAR SIR,

So much having lately occurred, in all the geological works concerning the universality of the secondary formation (called by some diluvian ;) the science having scarcely got rid of the innumerable hypothetical suppositions of the origin and formation of the earth, is I fear likely to stumble into another hypothesis, though not so far back into the dark annals of nature, yet sufficient to warp and confuse the collection of facts, on which alone must rest all rational theories. To elucidate by opposition, in hopes that the truth may be struck out by the shock of opinions, as the fire is produced by the flint and steel, not having observed in the different European countries I have examed, nor in North-America, where all the stratification is so regular and undisturbed, any general or universal formation of the secondary, I shall here enregister my opinions as being the result of what I know. I have been induced to consider the two great aqueous depositions of alluvial and secondary, as having a common origin in the aggregation of the detritus or particles of more ancient rocks, reduced to various forms by the elements ; differing only in the length of time, each formation has been deposited, and composed of the materials drawn from the disintegration or decomposition of older rocks, in the vicinity or not far distant. That the depositions of gravel, sand, or clay, formed by the sea, lakes, or rivers, or precipitations of lime from water by its evaporation or cooling, should be similar, one would as reasonably expect as that the same cause would produce the same effect, over the whole earth; but that the stratification of the different materials, follows any regular series of alternation, or that the strata are placed in the same order, one over the other, for any great extent of surface appears to me not fully established; I doubt whether the facts when fully and impartially observed in any country will warrant the reception of such a theory. Our continent is the undisturbed extensive field most likely to decide that question, from the vast continuity of alluvial from Long-Island to the Gulf of Mexico, and the immense secondary basin of the Mississippi, both of which are nearly on a level; each of them consisting of one uniform mass of the same class of rocks, undivided by any high ridge or chain of mountains, offers a situation on a great scale most likely to contain a regular series of alternating stratification, uniform and placed in the same order of superposition. The examination of the above localities is worthy the attention of our active geologists scattered over the whole surface of the United States.

The volcanic rocks, from their interfering with the two great sweeping theories of the earth's formation, have had the smallest share of impartial examination. Having been generally observed for the purpose of establishing one or other of the theories, their nature and relative position have often been misrepresented, to serve the views of the different enthusiastic supporters of the two opposite systems. The pendulum by the impulsion of Werner has been long kept in the extreme exaggeration of the Neptunian theory; now that Werner is dead, it is likely to swing as far in the opposite direction, and scorch our globe with fire, as unmercifully, as the Neptunians inundated it with water. I have always been of opinion, that there was no good reason to suppose any priority of one formation over the other, but that both were formed in succession agreeably to the uniform laws by which nature acts. Although beyond the reach of our observation, and to us as yet unknown, it has perhaps been proved by positive facts that the volcanic alternates, often, with the alluvial and secondary, and there is perhaps good reason to believe, that it has been found under the transition in some parts of this country; that is to say, rocks that from rational analogy, on the examination of their structure and component parts, would rather incline an impartial observer to place in the volcanic class than in the Neptunian, have been found, apparently alternating with the transition class, though their relative position, from the smallness of the mass, exposed by the decomposition of the superincumbent transition, cannot be so easily ascertained. Col. Silvertope lately discovered a small conical hill, rising from under the transition limestone, near Orihuela, of which he gave me specimens, which called to my recollection other localities where I discovered the same order of superposition; from which it would appear probable that the active agents of fire and water have been, alternately and successively occupied, in forming all kinds of rocks, above the primitive; and what tradition or historic page can contradict the supposition, that the same two or more active similar agents may not have been alternately and successively employed in forming all that we can see of the primitive rocks; that some agent similar to fire has formed the porphyries, sienites, hornblende rocks and granite, and some unknown agent resembling water, may have made and aggregated the rest of the primitive rocks. When we gaze through our largest magnifying telescopes, at the expanse of the heavens, or look into the past and dream of eternity; on considering the small atom of space or time that exact observation has occupied, we must be convinced that we have no right to limit either, nor to estimate with our lilliputian senses the operations of nature. All compact lavas are smooth and unctuous, losing great part of their characteristic roughness, even those full of small imperceptible pores, which in their fresh state constitute that harsh feel, which serves to distinguish volcanic rocks; through time and exposure to the elements all those small pores, as well as the large ones, are filled by depositions, and put on the appearance of that smooth unctuous fracture, so common to Neptunian rocks. From this it appears probable that lavas lose their distinguishing marks and approach nearer the state of Neptunian rocks in proportion to their age, and to the length of time they have been exposed to the action of the elements. One has only to examine any current of lava which has been for some thousand years exposed to the action of the air, to find the water has filtered by the imperceptible pores to the very centre, of the apparently solid rock. I first discovered this fact near Montpelier and have since remarked it in different places. It is therefore possible that a lava with small pores imperceptible to the eye, might in process of time, (to which we are not authorized to set any limits,) form a complete greenstone, the lava imitating the hornblende and depositions in the pores, the feldspar, which would account for the frequent presence of greenstone trap as it is called, in the newest floetz trap of Werner; this rock I should be disposed to call ancient lava.

Some of our young geologists fascinated perhaps by the brilliant wake of some Europeans, appear willing to explode the received artificial divisions: though no advocate for the infallibility of stratification, formations &c. &c. &c., yet it is probable, that some such arrangement is necessary, to facilitate the acquisition of the science, like the shelves of a library, and perhaps it is equally convenient to work with the old, until practice and observation shall supply us with a newer and better.

BOTANY.

Art. IX.—*Caricography;* by Professor C. Dewey, *Williams College.*

The genus, *Carex*, has generally been considered one of the most difficult among the phænogamous plants. The species, known under the common name of *Sedge-grass*, offer few attractions to any except the professed botanist. Interesting as they are to him, there is no small difficulty in ascertaining the species with certainty. Hence it is that so many have written upon this genus, and that synonymes have been so multiplied. In the Inledning til Coricographien of G. Wahlemberg, 142 species are described; in Rees' Cyclopœdia, art. Carex, 172 species; and in the elaborate work of C. Schkuhr, about 220 species, and of most of them very accurate figures are given. Of this genus in our country 64 species are described in Pursh's Flora; in the Descriptio Uberior Graminum of Dr. Muhlenberg, 59 species; in his genera, 1st edition, Nuttall enumerates 68 species, among which are three species described as new; in the Flora of Michaux, only 21 species are given, many of which have new names. Schkuhr quotes from various authors about 400 names of the 220 species in his work.

Distinct as the species are seen to be when once known, many of them have so great a resemblance in the characters employed in descriptions, that it has been found no easy matter to select such distinguishing characters, or to describe the *diagnostics* with such precision, that the careful botanist should not be led to erroneous conclusions. The magnitude of this difficulty will be more fully appreciated by considering the fact, that Linnæus is generally thought to have confounded some species,—that some distinguished botanists of England certainly confounded different species,—and that some of our most accurate observers have done the same, or have been obliged, upon further examination, to alter their conclusions. It is this difficulty which originated the works of Wahlemberg and Schkuhr, mentioned already; the Monograph of English Carices by Dr. Goodenough; the Caricographiam Scanensem by Agardh; and which renders a Monograph of the Carices of the United States so desirable. Such a Monograph of this genus is the more important, as there are several species which have been confounded with others, or have lately been discovered. Such a Monograph is expected from that accurate botanist, Mr. Schweinitz.

To aid the student I propose to mention some species of Carex, described by European writers, but not yet credited to our country, and to make some remarks upon some species described by the most popular authors.

Besides the works already mentioned, reference will be made to Persoon's Synopsis, and Eaton's Manual of Botany; and, for convenience, the reference will be made by mentioning the name of the author. The *specific* names are credited to the authors to whom they are ascribed by Schkuhr.

Carex *teretiuscula*. Goodenough.
C. *paniculata*, β *teretiuscula*. Wahl.
Schk. tab. D. fig. 19. and T. fig. 69. Pers. no. 76.

C. "Spike twice or thrice compound, dense, rather pointed; spikelets clustered; fruit spreading, gibbous; stem roundish."—Rees' Cyc.

As Wahlemberg considered this plant to be a variety of C. *paniculata*, L. he adds only the following character, *thyrse decompound, squarrose.* Schkuhr, however, agreed with Goodenough that they were distinct species. As they are found in the same marshy situations and often associated, and are possessed of different and constant characters, they may be considered distinct.

Like C. paniculata, it is often dioecious and polygamous. But it may be distinguished from it by its *less diffuse spikes scarcely panicled and of a darker brown; by its fruit which is darker colored, and rather more rounded or gibbous at the base, convex on the upper and slightly concave on the under side towards the tip, and more distinctly scabrous than C. paniculata.*

C. alba. Haenke.
Schk. tab. O. fig. 55.
Pers. no. 175. and Rees' Cyc.

C. alba: spicis longiuscule exserte pedunculatis sparsifloris paucifloris, bracteis vaginantibus hyalinis aphyllis remotiusculis, squamis brevibus, capsulis subglobosis cum acumine; foliis setaceis. Wahl. no. 104.

The following description is translated from Willd. Sp. Pl. *Staminate spike solitary, peduncled; pistillate in pairs, peduncled, about five flowered; fruit obovate-globose, striate, beaked, obliquely truncate; bracts membranaceous, sheathing and hyaline.*

It is found in the mountain woods of Austria, &c. It has been found in our country only at the foot of the limestone hills in Pownal, Vt.

This is a very distinct species. Four to ten inches high—leaves sub-radical, bristle-form, and rather pale-green—one staminate spike, often very nearly sessile, and frequently rising to a less height than the pistillate—pistillate spikes two or three, on peduncles, the upper two rising nearly to the same level, about five flowered—fruit ovate or slightly obovate, black when mature, longer than the ovate whitish scale—bracts white, membranaceous, hyaline, scarcely half the length of the peduncle, obliquely truncate. It agrees with the fig. in Schk. and with the popular account in Rees' Cyc.

C. ampullacea. Gooden.
Schk. tab. Tt. fig. 107.
Pers. no. 204. and Rees' Cyc.

C. "Spicis sub breviter pedunculatis cylindraceis crassis laxis, masculis pluribus, bracteis amplectentibus foliaceis distantibus, squamis lanceolatis, capsulis subglobosis inflatis setaceo-rostratis divergentibus, culmo obtusangulo, foliis subangustis marginibus incurvis."—Wahl. no. 125.

The following description is from Willd. Sp. Pl.—*Staminate spikes three—pistillate spikes cylindric, erect, on short peduncles—fruit sub-globose, inflated, with the beak bifurcate, greater than the lanceolate scale.*

This is the *C. vesicaria* of Lightfoot in Fl. Scot., and may be mistaken for *C. vesicaria* L., which is credited to our country and described by Ph. Muh. &c. But they are entirely different plants. The reference in Muh. to the fig. in Schk. is evidently an error of the press; it should be made to fig. 106, and not to 166. Both plants inhabit marshes, but they are readily distinguished by their fruit and scales. C. ampullacea has an *inflated, sub-globular fruit with an attenuated beak, longer than its lanceolate scale.* C. vesicaria, L. has an *inflated, ovate-oblong, acuminate-subulate fruit, scarcely longer than the scale.* Both plants belong to the same subdivision in Ph. &c.

C. pallescens L.
Schk. tab. Kk. fig. 99.
Pers. no. 174, and Rees' Cyc.

C. "Spicis pedunculatis subcylindraceis nutantibus, bracteis subamplectentibus subfoliaceis subdistantibus, capsulis ovali-ellipticis obtusissimis teretibus."—Wahl. no. 121.

The following account, translated from the *Car. Scan.* of *Agardh*, was taken from living specimens.

"Culm erect, a foot high, three sided, sulcate, leafy at the base. Bracts scarcely sheathing, often transversely rugose. Staminate spike lanceolate. Pistillate spikes three, ovate, obtuse, pale. Scales ovate, carinate, yellowish with a green keel. Capsules pale green and long as the scales."

Our plant agrees with the preceding description and with the fig. in Schk. except in one particular. The scales are generally shorter than the fruit. In some specimens however, they agree minutely with specimens from Sweden. The leaves and sheathes are slightly pilose, as are those which I have from Sweden and England. The bracts are often transversely rugose. The inconstant difference in the scales it shares in common with *C. pseudo-cyperus* L., which Muh. considered the same with the plant so called in our country, though he remarked the difference in the scale. I had considered the *C. pallescens* as an undescribed species until I examined the fig. of Schk. But our plant resembles the fig. in Schk. so exactly, except in the length of the scale, that I am satisfied it must be another of the European species to be credited to our country.

C. filiformis. Gooden.
Schk. tab. K. fig. 45.
Pers. no. 190. and Rees' Cyc.

C. "Spicis subsessilibus oblongis, bracteis brevissime vaginantibus foliatis remotiusculis, capsulis ovali-ellipticis villosis rostello bifurcato; foliis convolutis."—Wahl. no. 77.

Agardh gives the following popular description of this species in his Car. Scan.

"Culm two feet high, roundish, smooth; leaves channelled, destitute of a keel, smooth, scabrous on the margin. Bracts leafy, surpassing the culm. Staminate spike one or two, lanceolate, with an oblong rather acute scale having its nerve yellow; pistillate spike one, oftener two, with a mucronate scale having a green keel, capsule thickly tomentose.

Our plant, as well as the European, inhabits marshes. It has been supposed to be C. pellita. Muh. It differs from the real *C. pellita*, Muh., so well shown in the figures of Schk., especially in its leaves. The leaves of *C. pellita* are *flat;* of *C. filiformis*, are convolute. The *fruit* of the former is *ovate*, *pilose*, and *bicuspidate;* of the latter, is *elliptic*, *villose*, and *bi-furcate*. *C. filiformis* should be placed in the same subdivision in Ph. and Eaton as *C. pellita.*

C. alpestris. Allion.
Schk. tab. G. fig. 35.
C. gynobasis. Pers. no. 141.

C. alpestris: spicis subpaucifloris, infima longissime exserte pedunculata, superioribus subpedunculatis; bractea infima radicali foliata, superioribus spicæ masculæ subapproximatis brevissime vaginantibus cuspidato-subfoliolatis; capsulis oblongo-turbinatis triquetris apiculatis sub-pubescentibus ore unilobo.—Wahl, No. 99.

The following description is from Willd. Sp. Pl.

"Staminate spike solitary; pistillate spikes three, five-flowered, two approximate and sessile, the lowest radical with a very long peduncle; fruit obovate-oblong, three-sided and very short-beaked, oblique at the orifice, and equal to the oblong scale."

This is a very distinct species, growing in tufts upon hills with open woods. It has a lax culm, and is clearly distinguished by its pistillate spikes and shape of its fruit. It agrees perfectly with the figure in Schk., and answers also to the description. It has passed under several names. It is scarcely necessary to remark that *C. alpestris*, Pers. is a very different plant.

Of the species of Carex found in our country and described by various authors, some have evidently been confounded with others, and some have not been so perfectly described as to be readily distinguished from others to which they are related. Among them are the following.

1. Carex *cephalophora*. Wahl.
Pursh, Muh. Pers. Nutt. and Eaton.
Schk. tab. Hhh. fig. 133.

The name of this species, though credited to Wahl. by Schk. is not in Wahl. *Cariographien*, and I am unable to find any description of his which corresponds to it. Considerable difficulty has arisen in ascertaining this species on account of the section in which it is placed by most authors. Ph. places it in the section, *spikes androgynous*, and subdivision, *spike single*, *staminate at the apex*. Yet his description, taken like most of them from Willd. Sp. Pl. shows that the spike is *compound*, and Schk. has the popular remark upon it; "spicis sub-senis, W." It should, therefore be placed in the sub-division, *spikes many*, *staminate at the apex*. Nuttall and Eaton put it in the same place. Pursh was probably led into this mistake by considering *C. typhina*, Mx. as the same plant, for he gives it as a synonyme. The characters of *C. typhina*, prove it to be a very different plant, and it is generally considered as the C. squarrosa, L. so well described by Muh. who closes his description by the words, "*An C. typhina, Mx.?*"

C. *cephalophora* is readily distinguished, by its *small aggregated spikelets ; its compressed ovate fruit, scabrous above ;* and *its small ovate scale, scarcely half the length of the fruit and terminating in a cuspidate scabrous awn extending about to the end of the fruit.* It is said by Muh. to be from two to four feet high, but I have rarely found it to exceed twenty inches, and it is often much less.

2. C. *squarrosa*. L.
Muh. Pers. Rees' Cyc. and Schk.
C. *typhina*, Mx. var. of C. squarrosa. Pers.

There is no fig. of this carex in Schk. but it is so well described by him and Muh. that there can be no doubt about it. It should be in a new section in Ph. and Eaton, under the general division, *stigmas three*, and a new subdivision, *spike single*, *staminate below*.

Its description might then be as follows.

Spike oblong-cylindric; fruit imbricate, ovate with a long beak, two toothed, horizontal, glabrous and sub-squarrose, longer than the lanceolate scale.

C. *squarrosa* is readily distinguished by its large and thick spike covered below with the dry staminate scales, and above by its close set, ovate, long beaked, horizontal fruit; and its rather slender culm and long leaves.

Schk. inquires whether it has *two* or *three stigmas*. Muh. says it has three. and I have never found it with less than three. It sometimes has two spikes, as Muh. remarks; but they are far distant and the lower is supported on a long peduncle.

Pursh does not give C. *squarrosa*, unless he confounded it with *C. cephalophora*. It seems indeed scarcely possible that any one, who had seen both, should consider them as at all alike: and yet it is singular that C. *squarrosa* should have escaped the eye of Ph.* The fig. in Schk. is correctly referred to by Ph. under C. *cephalophora;* had he never seen the plant he describes, he could not have confounded C. *squarrosa*, if familiar with the plant, with that shown by the figure of Schk.

* It is not indeed to be expected that Pursh's Flora should be entirely free from mistakes. But in some cases, the mistake is not easily accounted for. Thus to the description of Xylosteum villosum, Mx. taken almost *verbatim* from Mx. Pursh has added a character, "*baccis distinctis*," which contradicts his *generic* description. The consequence has been, that a plant, which Sprengel in a letter, and most of our botanists call *X. villosum*, is considered in the Manual of Botany to be probably a new species, and is called *X. solonis*. The mistake is the greater in this case, as the berries of *X. villosum* are *not connate*, but adnate, much resembling those of some other plants. The *generic* description of Ph. is therefore *defective*, and requires the additional character given by Mx. viz. "baccae duae basi connatae.—aut *coadunatae in unicam supra biumbilicatam*." The phrase, *baccis distinctis*, should be omitted in the specific description of *X. villosum* in Ph.

3. *C. stipata.* Muh.
Pursh, Muh. Eaton, and Pers.
Schk. tab. Hhh. fig. 132.
C. vulpinoidea, Mx.

This very distinct species is well described, but Pursh has quoted *C. vulpinoidea* Mx. as a synonyme of *C. muhlenbergii*, Schk. There can be little doubt, however, from Mx'. description and his popular remark that it is *closely allied to C. vulpina* as well as the remark of Muh. to the same purpose, that *C. vulpinoidea*, is the same as *C. stipata*, *C. muhlenbergii* has very little resemblance to *C. vulpina*, and is readily distinguished by its *approximate spikelets, its compressed roundish ovate fruit, ciliate serrate at the apex, and its ovate scale long as the fruit and terminating in a mucronate point, extending beyond the fruit.*

4. *C. retroflexa.* Muh.
Pursh, Muh. Eaton, and Pers.
Schk. tab. Kkk. fig. 140.

This species and *C. rosea*, Schk. tab. Zzz, fig. 179, are very liable to be confounded, because one other particular has not been introduced into the specific descriptions. Muh. indeed says *it may perhaps be a smaller variety of C. rosea*. Though they resemble each other, Schk. and authors generally, consider them as distinct species. The great difference between them is the following. In *C. retroflexa, the scale of the fruit is ovate acute, ovate-lanceolate, or oblong-lanceolate, and very nearly as long as the fruit; the spikelets are nearer together, and the fruit ovate-lanceolate.* In *C. rosea, the scale of the fruit is ovate obtuse, and about half the length of the fruit; the fruit is less distinctly ovate or more nearly oblong-lanceolate.*

Muhlenberg says that *C. rosea* is *C. radiata*, Wahl. Under *C. stellulata*, Schreb. and Schk. tab. C. fig. 14, Wahlemberg describes a variety, *C. radiata*, found in this country. His description corresponds exactly to the *small sub-bristly flaccid culm—the narrow leaves—the small bristly bracts—and the sub-distant three flowered spikelets of C. rosea*, found in our woods. But in placing it under *C. stellulata*, which has *staminate flowers below* and not above, like *C. retroflexa*, and *C. rosea*, Wahl. could not have considered the different position of the staminate flowers in the two species, as an essential difference. This renders it probable that Wahl. ranked our *C. retroflexa*, and *C. scirpoides*, Schk. also under *C. stellulata*.

5. *C. Plataginea.* Lam.
Mx. Pursh, Eaton, Pers. and Rees' Cyc.
Schk. tab. U fig. 70 and Kkkk. fig. 195.
C. latifolia, Gaert. Wahl. no. 94, and Rees' Cyc.

This is among the plants that appear here earliest in the spring. It is readily known by its broad nerved radical leaves—its leafless brown culm—its pistillate spikes, whose peduncles are nearly enclosed in long brownish sheaths, rarely terminating in a short leafet, and its long cuneiform three-sided fruit, re-curved at the apex. The leaves are often nearly an inch wide, and distinctly marked by *three* or many ribs or nerves like *Plantago major*.

Muhlenberg seems not to have been acquainted with this beautiful Carex. For, in the description of *C. plantaginea*, in the Des. Ub. Gram. Muhlenberg refers to the fig. of *C. anceps* in Schk. as the plant he describes, and also says, *C. anceps Schkuhr?* He also calls the plant he describes, *C. heterosperma*, Wahl. which is most certainly C. anceps, the figure of which is accurately drawn by Schk. It is most singular that Muh. should not have seen the true *C. plantaginea*, Lam.; but the figures of it in Schk. are so distinct and so different from any other that he would have referred to them had the plant ever fallen into his hands. In Rees' Cyc. *C. latifolia*, Wahl. and *C. plantaginea*, Lam. are described as different species, and in the reference of the former to Schk. there is a mistake. The language of Wahl. and Schk. however, *asserts* the identity of the two plants, as Wahl. refers his *C. latifolia* to Schk. tab. U. fig. 70. The other part of Schk. Car. which contains the other fig. quoted above, was not published when Wahl. wrote.

6. *C. Granularis.* Muh.
Ph. Muh. Eaton. and Pers.
Schk. tab. Vvv. fig. 169.

This plant is much more perfectly described by Muh. than by the other authors. His description of the fruit, *entire at the orifice and re-curved*, is more readily apprehended than that of Willd. given by Ph, *obsoletely emarginate*, as well as nearer the truth. He has omitted to mention, however, the beak, the *very short beak* given by Willd. which is a very good character in this species. The whole plant is rather *glaucous green* before the fruit is entirely mature, and is thus coloured in Schk. The upper spikes are sometimes more clustered than in the fig. of Schk. or than the descriptions would imply. Its peculiar *roundish-ovate approximate fruit, entire at the mouth, extremely short beaked and re-curved,* becoming of a dull yellow in full maturity, and its glaucous green readily distinguishes it from the other species in the same sub-division in Ph. and Eaton.

Pursh gives *C. lenticularis*, Mx. as the same plant. The specific name of Mx. is entirely opposed, however, to their identity. The fruit of *C. granularis* can scarcely be said to approach towards the *lenticular form.* The description of the *leaves and culm* does not correspond to those of *C. granularis.* The remark of Mx. that his *C. lenticularis*, is *related to C. panicea*, will not justify the conclusion of Ph. Persoon was more cautious, and merely asks whether the two plants are the same.

At the elevated marsh in Stockbridge, Dr. E. Emmons found a Carex, growing in abundance, which seems to be the *C. lenticularis*, Mx. The locality is similar to that at which Mx. found the plant, "especially about *Swan Lake.*" For comparison, I will give the description of Mx. *C. lenticularis.* "Foliis angusto-longis, culmo gracili triquetro subæqualibus : spiculis fem. pluribus, pedunculatis, oblongis ; masculae unica : capsulis lenticularibus, brevi-ovatis, muticis." Flor. Bor. Am. 2. p. 172.

Our plant has *narrow leaves, long and about equal to the slender three-sided culm : staminate spike solitary, lanceolate, with brown oblong obovate scales ; pistillate spikes two or three, peduncled, pendulous ; bracts long as the culm with very short sheaths ; fruit ovate, compressed, lenticular, five-nerved, scarcely rostrate, shorter than the large brown carinate ovate-oblong scale.*

It is related to *C. panicea* L., but more nearly resembles *C. limosa* L. From the former it differs in many respects ; from the latter, it differs in the form of the staminate scale, and in the form and length of the pistillate scale and in the shape of the fruit. It approaches more nearly to *C. limosa β irrigua*, Wahl. But it differs in so many respects, that it is probably a different species. It must be closely related to *C. lenticularis* Mx., and is probably the same plant.

7. C. *trichocarpa.* Muh.
Pursh. Muh. Eaton. Pers.
Schk. tab. Nnn. fig. 148.
C. lanuginosa, Mx.?

This plant is very well described by Muh. But as the works of Pursh and Eaton are most accessible by the student, and as it is placed by them in a subdivision to which it will not often be found to belong. this species is very liable to be mistaken. The subdivision in Ph., *terminal spikes staminate, the rest androgynous*, is contradicted by the description of every species under it. It should be, *terminal spike staminate below, the others pistillate*, and the subdivision would then include all the species except C. *trichocarpa.* This species should be removed to the last subdivision in Ph. and Eaton, *staminate spikes several;* and the specific description of *C. trichocarpa* should be amended by the character, *staminate spikes sometimes pistillate at the apex.* Pursh indeed took his description from Schk., and in the figs. of Schk. the plant corresponds to the description. It was probably taken from the specimens most early found and forwarded to Schk. by Muh.—for Schk. acknowledges the reception of many of our species from Muh. But in his own description Muh. says that the staminate spikes are *from two to four, often pistillate at the apex.* In the specimens I have received from Pennsylvania, however, they are not androgynous, and I have rarely found any specimens of this species that had androgynous spikes. The language of Muh. indeed implies that the staminate spikes are more commonly destitute of any fruit, and authorizes the removal of this species to the proposed subdivision. It seems very doubtful whether this plant is the *C. lanuginosa*, Mx., as he says the "pistillate spikes are *closely sessile*," while those of C. *trichocarpa are peduncled;* and the "*fruit most dense and short*," while that of the latter is not very close-set and is *ovate-lanceolate, or ovate-conic, beaked, and two toothed.*

8. C. *xanthophysa.* Wahl.

Rees Cyc.

"Spicis subincluse pedunculatis sexfloris crassissimis, bracteis vaginantibus foliatis remotissimis, capsulis oblongo-conicis inflatis rostratis divergentibus ore bifido."

Wahl. Car. no. 73.

This is the *C. folliculata*, L. *β. xanthophysa* in Muh. We have his authority that it is the above named species of Wahl., and *perhaps the C. intumescens of Rudge.* Wahl. considered the two species to be distinct, and there is much reason for adopting his opinion. The Fig. of *C. folliculata* in Schk. bears no resemblance to this species.

C. folliculata. is readily distinguished by *its one to three pistillate spikes, aggregated, scarcely peduncled, supported by long leafy bracts; its close-set oval-conic or ovate-acuminate, much inflated fruit, much longer than the ovate-cuspidate scale.* The whole plant is deep green.

C. xanthophysa has two to four pistillate spikes, often on very long peduncles and very distant, staminate at the apex. inclosed in sheaths, often long, and terminating in long leafy bracts; oblong-conic. inflated fruit, close-set, horizontal, and a little longer than the ovate-acuminate, or ovate-lanceolate scale. The whole plant is pale yellow.

Both species are commonly described as having spikes *about six-flowered.* This is rather an indefinite character, and many specimens differ considerably from this number. *C. xanthophysa*, especially, often has several more. But, while both species have one staminate spike, they differ very much in the pistillate spikes, in their sheaths, in the shape of their fruit, and in the shape and length of their scales. The whole appearance of the two plants is very dissimilar. They differ much more than several of the species which are considered as distinct.

To prevent error, it may be proper to remark, that descriptions and figures of *C. folliculata and C. intumescens*, are given by *Rudge* in the Lin. Trans., and that the characters of *C. intumescens* in Rees' Cyc , which seem to have been taken from the Lin. Trans., prove that *C. intumescens*, Rudge, and *C. xanthophysa*, Wahl. cannot be the same plant. The popular characters of *C. intumescens* are there given, *pistillate spikes loosely imbricated and on short peduncles, with scales oblong-ovate, acute, and half the length of the erect, oblong-ovate, much inflated, long and acute beaked fruit.* The *C. intumescens* may be a var. of *C. folliculata* perhaps, but not of *C. xanthophysa.* Neither can the *C. intumescens* be the same with *C. lurida*, Wahl., as stated in Rees' Cyc., which is more probably the *C. lupulina*, Muh.

9. C. *straminea*, Willd.
Muh. Eaton, Wahl. and Pers.
Schk. tab. G. fig. 34, and tab. Xxx. fig. 147.

This is a beautiful carex, and is easily recognized by a character distinctly marked by Muh. alone, its *winged* fruit. The fruit is *broad-ovate, beaked, compressed, distinctly ciliate-serrate, two-toothed and widely winged, with an ovate-lanceolate scale commonly shorter than the fruit.* The diameter of the cavity occupied by the seed is about one third of the diameter of the fruit. Though the spikelets vary from five to seven or more, it has sometimes only *three* spikelets, clustered at the summit of the culm. In this state it may be the C. *leporina* in Ph.'s Fl., as it differs very little from the description he has given. Unless this be the plant intended by Pursh, it has not been found and announced by any other botanist in our country. The reference of Muh. to fig. 174 of Schk. is a typographical error, —it should be fig. 147.

10, C. *ovalis*, Gooden.
Pursh, Eaton, Pers., and Rees' Cyc.
Schk. tab. B. fig. 8.
C. *leporina*, L. Sp. Pl. 8, according to Wahl. and Agardh.

Goodenough considered this species to be different from C. *leporina*, which he supposed was a native of the Alps. In this opinion he is followed in Rees' Cyc., though the writer remarks that Wahl. considers both to be C. *leporina*, L. Much confusion of names has arisen from the fact that Goodenough seems to have referred to the C. *leporina*, Fl. Dan. t. 294 and the C. *approximata*, Hoppe. Both these are quoted by Wahl. as the same with his C. *lagopina*, of which he gives the locality, "in alpibus Lapponiarum septentr." One of the references of Ph. under his C. *leporina* is to the Fl. Dan. 294 It would seem, therefore, unless there be other species for the same reference, that the C. *leporina* in Ph.'s Fl. and C. *lagopina*, Wahl. are the same plant. In his Car. Scan. Agardh describes C. *leporina*, L. and quotes the fig. in Schk. taken from C. *ovalis*, Gooden., and subjoins the following pointed remark. "Cel. Good-enough primus statuit suam C. ovalem differre a C. leporina Linnaei quam Alpium incolam esse et spiculas tantum tres habere existimavit. Quod vero non facile credi potest, cum Linnaeus C. leporinam in Suecia vulgarem esse et spiculas 5—6 habere asserit." In comparing specimens named C. leporina in Sweden and England, they appear to agree with the description of C. leporina in Wahl. and Agardh; but they appear to differ somewhat from my English Specimen named C. ovalis, and from its fig. in Schk. The description of C. leporina in Mx.' Fl. does not well agree with C. ovalis or with the account of C. leporina by Agardh or in Rees' Cyc.

To ascertain C. *ovalis* by the descriptions in Ph. and Eaton is impossible. They do not accurately describe the fruit, and omit the scale entirely. The *fruit is ovate acuminate, or ovate-oval acuminate, two-toothed, ciliate-serrate, equalling the ovate-lanceolate acute scale scarious on the margin and keel green.* The spikelets have bracts, the lowest being long and sub-leafy, and the colour of the spikelets is "rusty-green." Muh. does not appear to have found the true C. ovalis, if indeed it be in our country. He considered the C. *scoparia*, Schk., which he has so perfectly described and which corresponds so entirely to the fig. of Schk. tab. Xxx. fig. 175. as *related to C. ovalis or leporina.* It seems, however, to differ much from C. leporina of Sweden.

11. C. *aristata.*

Terminal spike androgynous, staminate below; staminate scale lanceolate acute: pistillate spikes three, peduncled, sub-pendulous, with sheaths shorter than the peduncles and terminating in long leafy bracts; fruit oblong three-sided, acute at both ends, slightly two-toothed. a little shorter than the oblong-lanceolate awned scale. Leaves and sheaths pubescent.

This plant is undoubtedly the unnamed Carex No. 46 of Muh. It agrees most exactly with his popular description of the plant. It belongs in the same subdivision in Ph. and Eaton with C. *virescens.* It is a very distinct species, and no fig. in Schk. corresponds to it. I have given the above specific name, on account of the peculiar *awned* pistillate scale.

Culm about 20 inches high, leafy; leaves sheathing, shorter below, reddish brown at the root, linear-lanceolate, slightly scabrous on the margin, higher ones longer than the culm; sheaths white or yellowish white opposite the leaf and like the leaves, pubescent: bracts scarcely sheathing the peduncles except the lowest, leafy and longer than the culm, less pubescent than the leaves; androgynous spike from the same bract as the upper pistillate spike: spikes filiform with a flexuous rachis, alternate, somewhat pendulous and rather loose flowered, peduncles longer than the sheaths; staminate scale lanceolate, long, acute, hyaline with a green keel; pistillate scale oblong-lanceolate, extending more than half the length of the fruit and terminating in an awn beyond the fruit, hyaline with a green keel. According to Muh. the upper spike is sometimes wholly staminate and the scale shorter than the capsule. The latter variation I have rarely seen, and the former has not occurred to me.

MATHEMATICS AND MECHANICS.

ART. X.—*New Algebraic Series by Prof. J. Wallace, Columbia, S. C.*

Let $1+a\frac{z}{1}+a(a+k)\frac{z^2}{1.2}+a(a+k)(a+2k)\frac{z^3}{1.2.3}+\&c.$

and $1+b\frac{z}{1}+b(b+k)\frac{z^2}{1.2}+b(b+k)(b+2k)\frac{z^3}{1.2.3}+\&c.$

be the given series, the latter differing from the former only, in the substitution of b for a. If these two series be multiplied into each other, the resulting series will be of the same form; $a+b$ being taken for a or b in the above; or the form will be

$$1+(a+b)\frac{z}{1}+(a+b)(a+b+k)\frac{z^2}{1.2}+(a+b)(a+b+k)(a+b+2k)\frac{z^3}{1.2.3}+\&c.$$

For the series being actually multiplied and the terms placed in order, we shall have.

$$\begin{array}{l|l|l|l}
1+a & \frac{z}{1}+a(a+k) & \frac{z^2}{1.2}+a(a+k)(a+2k) & \frac{z^3}{1.2.3}+\&c. \\
+b & +2ab^{*} & +3ab(a+k) & + \qquad * \\
 & +b(b+k) & +3ab(b+k) & + \\
 & & +b(b+k)(b+2k) & +
\end{array}$$

Here the co-efficient of $\frac{z}{1}$ is $a+b$; that of $\frac{z^2}{1.2}$ may be decomposed into $a((a+k)+b)=a(a+b+k)$, and $b((b+k)+a)=b(+a+b+k)$, the sum of which is $(a+b)(a+b+k)$.

The co-efficient of $\frac{z^3}{1.2.3}$ may likewise be decomposed into

$$a\langle\ (a+k)(a+2k)+2b(a+k)+b(b+k)\ \rangle, \text{ and}$$
$$b\langle\ (b+k)(b+2k)+2a(b+k)+a(a+k)\ \rangle$$

But the multiplier of a in the first part is evidently that which would become the co-efficient of $\frac{z^2}{1.2}$; when a is changed into $a+k$, and the multiplier of b, in the second, is the same co-efficient that would result by changing b into $b+k$. It follows, therefore, that, as the coefficient of $\frac{z^2}{1.2}$, becomes $(a+k)(a+b+k)$, the multiplier of a, in the first part of the co-efficient of $\frac{z^3}{1.2.3}$, and that of b in the second, will become $a(a+b+k)(a+b+2k)+b(a+b+k)(a+b+2k)$, that is $(a+b)(a+b+k)(a+b+2k)$. Hence, from the preceding, the law is evident for the four first terms. And to show that the law will hold for any number of terms of the product of the above series, we have only to prove that if the law holds as far as the co-efficient $\frac{zp-1}{1.2...(p-1}$ inclusively, it will equally hold for the next co-

* In the actual multiplication $ab\times\frac{z^2}{1}=2ab.\frac{z^2}{1.2}$, and $ab(a+k)\frac{z^3}{1.2}=3ab(a+k)\frac{z^3}{1.2.3}$, &c. as above.

efficient, or $\frac{zp}{1.2...p}$.

Now for the first of these co-efficients we have

$$a(a+k)(a+2k)(a+3k) \quad - - - \quad (a+(p-2)k)$$
$$+\frac{p-1}{1}b.\ a(a+k)(a+2k) \quad - - \quad (a+(p-3)k)$$
$$+\frac{p-1}{1}.\frac{p-1}{2}\ b(b+k).\ a(a+k) \quad - \quad (a+(p-4)k)$$
$$+ \quad . - - \quad \&c.$$
$$+\frac{p-1}{1}.\ \frac{p-2}{2}\ a(a+k).\ b(b+k) \quad - \quad (b+(p-4)k)$$
$$+\frac{p-1}{1}\ a.\ b(b+k)(b+2k) \quad - - \quad (b+(p-3)k)$$
$$+b(b+k)(b+2k) \quad - - - - - \quad (b+(p-2)k)$$

And for the second

$$a(a+k)(a+2k) \quad - - - - - \quad (a+(p-1)k)$$
$$+\frac{p}{1}b.\ a(a+k)(a+2k) \quad - - - - \quad (a+(p-2)k)$$
$$+\frac{p}{1}.\frac{p-1}{2}\ b(b+k).a(a+k) \quad - - \quad (a+(p-3)k)$$
$$+ \quad \&c.$$
$$+\frac{p}{1}.\ \frac{p-1}{2}a(a+k).\ b(b+k) \quad - - \quad (b+(p-3)k)$$
$$+\frac{p}{1}\ a.\ b(b+k)(b+2k) \quad - - - \quad (b+(p-2)k)$$
$$+b(b+k)(b+2k) \quad - - - . - \quad (b+(p-1)k)$$

But as $\frac{p}{1}=\frac{p-1}{1}+1$

$$\frac{p}{1}.\ \frac{p-1}{2}=\frac{p-1}{1}.\ \frac{p-2}{2}+\frac{p-1}{1}$$
$$\frac{p}{1}.\ \frac{p-1}{2}.\ \frac{p-2}{3}=\frac{p-1}{1}.\ \frac{p-2}{2}.\ \frac{p-3}{3}+\frac{p-1}{1}.\ \frac{p-2}{2}$$

&c.

it is plain that the above co-efficient can be decomposed into two parts, the first of which is

$$a\left\{\begin{array}{l} a\,(a+k)\,(a+2k)\ \ -\ -\ -\ (a+(p-1)k) \\ +\frac{p-1}{1}\,b(a+k)\,(a+2k)\ ..\ (a+(p-2)k) \\ +\frac{p-1}{1}.\frac{p-2}{2}\,b(b+k).(a+k)..(a+(p-3)k) \\ +\ \ -\ \ -\ \ -\ \ \&c. \\ +\frac{p-1}{1}(a+k).(b+k)\ \ -\ -\ (b+(p-3)k) \\ +b(b+k).(b+2k)\ \ -\ \ -\ \ (b+(p-2)k) \end{array}\right\}$$

And the Second.

$$b\left\{\begin{array}{l} a(a+k)\,(a+2k)\ \ -\ -\ -\ (a+(p-2)k) \\ +\frac{p-1}{1}(b+k).a(a+k)\ -\ -\ (a+(p-3)k) \\ +\ \ -\ \ -\ \ -\ \ \&c. \\ +\frac{p}{1}.\frac{p-2}{2}a(a+k).(b+k)\ -\ -\ (b+(p-3)k) \\ +\frac{p-1}{1}a(b+k)\,(b+2k)\ -\ -\ (b+(p-2)k) \\ +(b+k)\,(b+2k)\ \ -\ -\ -\ (b+(p-1)k) \end{array}\right\}$$

In these expressions it is evident that the multiplier of a, in the first of these two parts, is that which would become the co-efficient of $\frac{z\,p-1}{1.2....(p-1)}$, when a is changed into $a+k$; and that the multiplier of b in the second, would become the same co-efficient, when b is changed into $b+k$. The co-efficient of $\frac{z\,p-1}{1.2....(p-1)}$ being therefore, reducible to the form

$$(a+b)\,(a+b+k)\,(a+b+2k)\ \ -\ \ -\ \ (a+b+(p-2)k);$$

the multipliers of a and b will each become

$$(a+b+k)\,(a+b+2k)\,(a+b+3k)\ \ -\ \ -\ \ (a+b+(p-1)k)$$

Both these multipliers being united, the co-efficient of $\frac{z\,p}{1.2..p}$ will therefore be $(a+b)\,(a+b+k)\,(a+b+2k)\ -\ -\ (a+b+(p-1)k)$.

From the preceding it follows, that if this law holds for any term, it will hold for the following term, and as it has been proved that the law holds for the four first terms, it must therefore hold for every term.

In order to abridge the above formula, let fa (function of a) be put for the first series, or

$$fa=1+a\frac{z}{1}+a(a+k)\frac{z^2}{1.2}+\text{\&c.}$$

$$\text{then } fb=1+b\frac{z}{1}+b(b+b)\frac{z^2}{1.2}+\text{\&c.}$$

$$\text{and also } f(a+b)=1+(a+b)\frac{z}{1}+(a+b)(a+b+k)\frac{z^2}{1.2}+\text{\&c.}$$

Our theorem then will be of the form

$$fa.fb=f(a+b).\quad \text{(I.)}$$

From this notation it follows evidently that $fo=1$. For making $b=o$, $a=1$, $fo=f1=1$.

If in equation (I) b be changed into $b+c$, it will become $fa.f(b+c)=f(a+b+c)$; but from the same equation $f(b+c)=fb.fc$, whence by substitution we have $fa.fb.fc=f(a+b+c)$: Again changing c into $c+d$, we have, in the same manner, $fa.fb.fc.fd=f(a+b+c+d)$

Whence in general

$$fa.fb.fc.fd+\ldots\ldots\text{\&c.}=f(a+b+c+d+\ldots\text{\&c.}$$

That is, the product of any number of series, of the form of the series fa; differs from each other only, in having a successively changed into b. c, d. . . . . or to a series into which a, b c, d . . . &c. enters in the same manner that a enters into the first series, b into the second, &c.

If in this last equation, the quantities a, b, c, d . . . . . &c. be supposed equal, and their number equal to m, then

$$(fa)^m=fma.\quad \text{(II.)}$$

That is, any entire and positive power m, of the series fa, is a series into which ma enters, in the same manner as a in the first.

From equation (I) we have $fb.fc=f(b+c)$, assuming $b+c=a$, then $c=a-b$, and by substitution $fb\times f(a-b)=fa$, whence $\frac{fa}{fb}=f(a-b)$. (III.)

That is the quotient of the series fa, divided by fb, is equal to the series into which $a-b$ enters, in the same manner as a into fa, or b into fb.

From the second equation $(fb)^m = fmb$; taking $mb=a$, we have $b=\frac{a}{m}$, whence $(f\frac{a}{m})^m = fa$, or $\sqrt[m]{fa} = f\frac{a}{m}$. (IV)

In the same manner we obtain $(fa)^{\frac{m}{n}} = \sqrt[n]{(fa)^m} = f\frac{m}{n}a$, m, and n, being any two positive numbers. The equation (II), $(fa)^m = fma$, holds therefore whether the positive value of m, be a whole number or a fraction.

By a like reasoning it may be easily proved that the same will hold when the positive value of m, is incommensurable. We have also, for any positive value of m, $(fa)^{-m} = \frac{1}{(fa)^m} = \frac{fo}{(fa)^m}$; or, from the preceding and theorem (II,) $(fa)^{-m} = \frac{fo}{fa} = f(o-ma) = f(-m)a$. Whence it follows that, whether m represents a whole number or a fraction, positive or negative, commensurable or incommensurable, $(fa)^m = fma$, will always hold, that is

$(1 + a\frac{z}{1} + a(a+k)\frac{z^2}{1\,.\,2} + \&c.)^m = 1ma\frac{z}{1} + ma(ma+k)\frac{z^2}{1\,.\,2} + \&c.$, whatever be the values of a and k.

This last equation, taking $a=1$, and $k=-1$, will become

$$(1+z)^m = 1 + \frac{m}{1}z + \frac{m}{1}\cdot\frac{m-1}{2}z^2 + \frac{m}{1}\cdot\frac{m-1}{2}\cdot\frac{m-2}{3}z^3 + \&c.$$

The formula for the *Binomial* therefore easily follows whatever be the exponent m.

Taking $k=o$, $a=1$, $z=1$, $m=Ax$, the same equation will become

$$\left(1+\frac{1}{1}+\frac{1}{1\,.\,2}+\frac{1}{1\,.\,2\,.\,3}+\cdots\right)^{Ax} = 1+\frac{Ax}{1}+\frac{A^2x^2}{1\,.\,2}+\frac{A^3x^3}{1\,.\,2\,.\,3}+\cdots$$

The series of the first member, as is well known, is incommensurable (which is easily proved, among other methods, by the theory of continued fractions) and comprised between 2 and 3. It is the base of Napier's System of Logarithms. In representing it by e, as usual, we shall have

$$e^{Ax}=1+\frac{Ax}{1}+\frac{A^2x^2}{1.2}+\frac{A^3x^3}{1.2.3}+\&c.$$

If we make $e^{A}=a$, in which case A will be the logarithm of a, according to Napier's System, (or la,) we shall have

$$a^x=1+\frac{xla}{1}+\frac{x^2l^2a}{1.2}+\frac{x^3l^3a}{1.2.3}+\&c.$$

A formula which gives the developement of exponentials into series or of any number a, in a function of its logarithm. If in this latter formula x be changed into m, and a, into $1+x$, it will become

$$(1+x)^m=1+\frac{ml(1+x)}{1}+\frac{m^2l^2(1+x)}{1.2}+\frac{m^3l^3(1+x)}{1.2.3}+\&c.$$

But it has been already shewn that

$$(1+x)^m=1+m\frac{x}{1}+m(m-1)\frac{x^2}{1.2}+\&c. \text{ whence}$$

$$l(1+x)+\frac{ml^2(1+x)}{1.2}+\frac{m^2l^3(1+x)}{1.2.3}+\&c.=\frac{x}{1}+(m-1)\frac{x^2}{1.2}$$
$$+(m-1)(m-2)\frac{x^3}{1.2.3}+\&c.$$

By making $m=o$, in this last equation, we have

$$l(1+x)=\frac{x}{1}-\frac{x^2}{2}+\frac{x^3}{3}-\frac{x^4}{4}+\&c.$$

A formula which gives the hyperbolic or naperian logarithm of $1+x$, in a function of the number x.

A variety of other important applications of the general principle, will easily suggest themselves, particularly in the developement of circular functions into series, &c. A branch of analysis of the greatest importance in modern Astronomy and Physics.

Professor Kramp of Strasburg calls the theory of these kind of series, or such as has been assumed under the form fa, the theory of *numerical faculties.* (facultes numèriques) and Vandermond reduces them to powers of the second order. Kramp has given an ingenious memoir concerning them in vol. 3. of Gergonne's Annals. He has shewn their application in the higher analysis, not only in the calculus of Lines, Exponentials, Logarithms, &c. but also in the integration of expressions of the following form $St^{m-1}e^{-t^n}dt$, taken from $t=o$ to $t=\infty$. $Sy^{m-1}(1-y^r)^n dy$, taken from $y=o$ to $y=1$ &c. These investigations arising from the theory of numerical faculties or of the doctrine of series, seem more within the sphere of elementary Algebra than those of Laplace, Lagrange, Legendre, Lacroix, Biot, Poisson, and others, in similar researches in the higher analysis, which are generally beyond the reach of ordinary readers. And as the modern improvements in Astronomy and every department of Physics are principally owing to the improvements in this analysis, whatever is calculated to throw any new light upon it, deserves the attention of men of science in general, and of Mathematicians in particular. M. De Stainville, of the Polytechnic School, has given the series in this communication in vol. 9.of Gergonne's Annals, and from the extensive application of which they are susceptible, the subject is deserving of farther investigation. It is well known that the most difficult parts of the higher analysis can be deduced from the Doctrine of Series in common Algebra. Even the whole of the abstruse *calculus of derivations* as given by Arbogast, can be deduced from the single theorem of Taylor so nearly allied to the binomial theorem of Newton, which as we have seen, can be deduced from the above series. M. J. F. Francais Professeur à l'école royal de l'artillerie, &c. has shewn this in the most satisfactory manner.

As the *Theory of numerical Faculties*, has not, to my knowledge, appeared in any English publication, and is very seldom to be found in any of the works of the European continental Mathematicians, a short view of it and of its notation, may not be uninteresting.

In the expression $a^{m|r}=a(a+r)(a+2r)\text{-----}(a+(m-1)r,)$ a is called the *Base* of the faculty, r its *Difference*, and m its *Exponent*. By reversing the order of the factors, it is evident that $a^{m|r}=(a+(m-1)r)^{m|-r}$. When $r=o$, this equation becomes $a^{m|o}=a^m$. By means of any convenient Multiplier, the Base as well as the difference may be changed at pleasure. The following equations contain the principle of this transformation.

$a^{n|r}=\left(\frac{a}{a'}\right)^n \cdot a'^n\left|\frac{a'r}{a}\right.=\left(\frac{r}{r'}\right)^n \cdot \left(\frac{ar'}{r}\right)^{n|r'}$. The equation

$a'(a'+r)\ldots.(a'+(m-1)r)\ (a'+mr)\ldots.(a'+(m+n-1)r)=$

$\left\langle a'(a'+r)\ldots(a'+(m-1)r)\right\rangle\times\left\langle(a'+mr)\ldots(a'+mr+(n-1)r)\right\rangle$; according to the notation above, will become $a'^{m+n|r}=a'^{m|r}\times(a'+mr)^{n|r}$; taking $p=m+n$, whence $n=p-m$, and $a'+mr=a$, whence $a'=a-mr$, and reversing the equation we shall have $(a-mr)^{m|r}\cdot a^{p-m|r}=(a-mr)^{p|r}$; again making $p=m$, and reducing, &c. we have $a^{o|r}=1$. That is *every faculty the exponent of which is equal to Zero, is equal to unity.* If in the same equation we make $p=o$, and, from the preceding seeing that $(a-mr)^{o|r}=1$, it will become

$$a^{-m|r}=\frac{1}{(a-mr)^{m|r}}=\frac{1}{(a-r)^{m|-r}}.$$

This gives the expression for the numerical faculties when the exponent is negative. It follows in the same manner that, $a^{-m|-r}=\frac{1}{(a+mr)^{m|-r}}=\frac{1}{(a+r)^{m|r}}$, &c.

Kramp in *his Universal Arithmetic*, proposes also this notation $1\ .\ 2\ .\ 3\ .\ 4\ \ldots.\ m=1^{m|1}=m\,!$

To extend this short sketch of the theory of the faculties of numbers any further, and show its application &c. would trespass too much on the useful pages of the journal; as it can interest but very few it might perhaps be as well to omit it entirely.

Art. XI.—*Second Memoir on Navigable Canals considered in relation to the lift and distribution of their Locks:* by M. P. S. Girard.

[Translated from the French, Annales de Chimie et de Physique, Nov. 1821:—by Isaac Doolittle.

I gave the first, in a memoir which I had the honor to communicate to the acadamy a few months since, the rigorous equation which expresses the relation between the lift of any lock whatever, the draft of water of the boats which ascend that lock, that of those which descend, and the volume of water expended in effecting this double passage.

From that equation I deduced the immediate consequence that the expenditure of water, at the passage of a lock, is positive, negative, or null, according as the lift of that lock is greater or less than the difference of draft of the boats which descend and those which ascend, or equal to that difference ; whence it is easy to conclude, not only that the expenditure of water may be rendered as small as we please, but that it is possible to raise a certain portion of water from an inferior to a superior contiguous level.

It is true that to produce the latter effect the following condition is necessary : that the draft of water of the boats which descend should be greater than that of the ascending ones ; but it is only necessary to consider the nature of the productions which the canals are destined to transport, and the situations whence those productions are derived, and where they are ordinarily consumed, to be convinced that this condition is almost always fulfilled.—Whence, *the consumption of water in navigable canals will undergo very great reductions ; and the difficulty of collecting a large volume of water in the culminating point, will no longer be an obstacle to their undertaking.*

The consequences of our new theory are, as we see, highly important ; and if, in order to render all their importance, as it were palpable, we were permitted to borrow the expressions which have been elsewhere urged as arguments against it, we should say : "that it is question of nothing less than to change the rules laid down for canals, to proscribe the present dimensions of locks, and to prove that the practice hitherto adopted has tended to deprive commerce of a portion of its natural activity, and to prevent, in many countries, an augmentation of national wealth."

A system of internal navigation susceptible of extending its ramifications through many parts of countries which nature seemed not to have destined to enjoy the advantages of this species of communication, is an object worthy of the most profound meditation, and discussion. Generally received ideas, and deep rooted prejudices may oppose its adoption. This is an additional reason for us to lose no time in developing the principles more minutely, and pointing out some new applications of it.

I preserve for the same quantities, the denominations which I adopted in my first memoir.

Thus, considering only two contiguous levels of the same canal, I make the lift of the lock which separates them, - - - - - $=x$

The horizontal section of the lock and of the boats which navigate the canal, - - - $=S$

The draft of water of the ascending boats, - $=t_{\prime}$

The draft of water of the descending boats, - $=t_{\prime\prime}$

And the expenditure of water from the upper level, occasioned by the passage of two boats in succession, $=Sy$.

The relation existing between these quantities is, as we have seen, expressed by the equation :

$$y=x-(t_{\prime\prime}-t_{\prime}),$$

which belongs to a right line, easy to construct.

We have already remarked that in all artificial canals, three causes, essentially different from each other, concur to occasion an expenditure of the water necessary to its existence :

Evaporation, filtration, and the passage of the locks.

The first cause is entirely out of our reach, and is more or less active according to climates and seasons.

The second, purely accidental, depends on localities, and may, with greater or less efforts, be more and more attenuated by art.

The third and last belongs entirely to theory : it is of this that we have undertaken the examination.

The general equation,

$$y=x-(t_{\prime\prime}-t_{\prime})$$

supposes that two boats, one descending and the other ascending, traverse, one after the other, the lock at which they meet : now. if we admit that the difference $t_{\prime\prime}-t_{\prime}$ be positive. we may substitute for it the draft of water D of a single boat which should descend, and then the above equation would become

$$y=x-D.$$

It would on the contrary. become

$$y=x+D$$

in the supposition that $t_{\prime\prime}-t$ were negative, in which case

D would express the draft of water of a single ascending boat; thus we have

$$y=x\mp D,$$

for the general expression of the expenditure of water from an upper level of a lock, when a boat whose draft of water is expressed by D passes that lock in ascending or in descending.

It is often difficult and expensive to accumulate on the summit level of a canal, a volume of water sufficient to supply the deficiency occasioned by evaporation, filtration and the passage of the locks; whilst its lower level, almost always confounded with a river, naturally contains a greater or less quantity of superabundant water. The essential object of the theory should therefore be to seek the means, if not of raising from the lower to the summit level, a quantity of water sufficient for the purposes of navigation, at least enough to supply the losses occasioned by evaporation and filtration throughout the whole length of the canal. We repeat that the only circumstances which can render the elevation of water practicable are those, where the weight of the productions which descend is greater than the weight of the articles which ascend the locks; we have therefore only to treat the case comprised in the equation

$$y=x-\mathrm{D}.$$

Now as we are always at liberty to reduce the lift x sufficiently to make it less than the draft of the descending boats, it follows that we may always render the expenditure y negative, or, in other words, raise a certain quantity of water from the lower to the upper level of the lock.

In this hypothesis, the volume of water, gained to the upper level, will evidently be S (D $-x$.) and if we designate by B the superficies of this level, it is also evident that the primitive height of water contained in the upper level will be augmented by the quantity

$$\frac{\mathrm{S}\ (\mathrm{D}-x)}{\mathrm{B}}.$$

So long as the surface B of the upper level is very large when compared to the superficies S of the basin of the lock, or which is the same thing, to the horizontal section of the boats, this augmentation of the height of water on the summit level will be insensible, so that if a second boat should follow the first in its descent through the lock, it would find the water at the same height as the first. It would therefore require a certain number of successive passages to augment the apparent height of water on the summit level; but this level would nevertheless have received a certain volume of water, which could replace, in whole or in part, that portion which should have been lost by evaporation and filtration, and which, without this, it would have been necessary to supply from the upper reservoir.

Although the levels of a canal are generally large enough, when compared with the capacity of the locks, to render the above supposition admissible, nevertheless as the most general hypothesis is that of a finite relation between the horizontal projections of the levels, and those of the locks, we shall proceed to examine this general hypothesis, and determine the law according to which the height of water augments in any level by the descent, into an inferior contiguous level, of a series of boats equally laden.

In the first place it is evident, that by introducing into the upper level of a lock a prismatic boat whose horizontal projection is S, and whose draft of water is D, the same effect will be produced, to modify the height of water in this level, as by the introduction of a volume of water=DS.

If therefore we designate by h the primitive height of water, that height, after the introduction of the boat, will become

$$h+\frac{\mathrm{DS}}{\mathrm{B}}.$$

The lift x of the lock will at the same time become

$$x+\frac{\mathrm{DS}}{\mathrm{B}}=\frac{\mathrm{B}x+\mathrm{DS}}{\mathrm{B}}.$$

In the second place, it is evident that the water in the basin S, can only be raised to the height of the level B, by operating in the latter a certain given depression z, as we may assure ourselves by the equation

$$\mathrm{B}z=\mathrm{S}\left(\frac{\mathrm{B}x+\mathrm{DS}}{\mathrm{B}}-z\right),$$

Whence

$$z=\frac{\mathrm{S}(\mathrm{B}x+\mathrm{DS})}{\mathrm{B}(\mathrm{B}+\mathrm{S})}.$$

Things being brought to this state we introduce the boat DS into the basin, and shut the upper gate of the lock, and the primitive height of the water in the upper level will be augmented by the quantity

$$u' = \frac{DS}{B} - \frac{S\,(Bx+DS)}{B\;(B+S)} = \frac{S}{B+S}(D-x).$$

We have supposed D greater than x; consequently this quantity u' will always be positive. Thus, then. the primitive depth of the water in the upper level, which was $=h$ before the introduction of the boat DS, has become $h+u'$ after it is withdrawn.

The fall of the lock, which was x, has also become $x+u'$.

Let us now suppose a second boat DS introduced in the level B, and that by repeating the manoeuvres we carry it into the contiguous level below, whose height is constant; it is easy to perceive that the height $h+u'$ will be augmented by this second passage, by a quantity

$$u'' = \frac{S}{B+S}(D-(x+u')).$$

A third passage will cause a third increase:

$$u''' = \frac{S}{B+S}(D-(x+u'+u''));$$

And, in general, the augmentation occasioned by the passage of the nth boat will be

$$u_{(n)} = \frac{S}{B+S}(D-(x+u'+u''+u'''+\ldots u_{n-1})).$$

In examining this latter expression, we perceive that the augmentation $u_{(n)}$ diminishes in proportion as the number n of passages increases, and that it is null when

$$D-(x+u'+u''+u'''+\ldots u_{(n-1)})=o.$$

That is to say, when the sum of the successive elevations and of the fall of the lock is equal to the common draft of water of the boats.

After a number n of passages, the height of the level B, which was $=h$ at the commencement, being represented by the series $h+u'+u''+u'''+u^{iv}+\ldots\ldots u_{(n)}$, their sum may be found by substituting for the successive augmentations u', u'', u''', &c. their values in functions of the known quantities D, B, S and x.

We have already found, above,

$$u' = \frac{S(D-x)}{B+S}.$$

This value of u' substituted in the second equation

$$u''=\frac{S}{B+S}(D-(x'+u'))$$

gives

$$u''=\frac{S}{B+S}\left(\frac{B}{B+S}(D-x)\right)$$

Substituting, in the same manner, the equivalent of u' and u'' in the equation

$$u'''=\frac{S}{B+S}(D-(x+u'+u'')),$$

it becomes

$$u'''=\frac{S}{B+S}\left(\frac{B^2(D-x)}{(B+S)^2}\right).$$

We shall find successively:

$$u^{\text{iv}}=\frac{S}{B+S}\left(\frac{B^3}{(B+S)^3}(D-x)\right)$$

$$u^{\text{v}}=\frac{S}{B+S}\left(\frac{B^4}{(B+S)^4}(D-x)\right).$$

Therefore the sum of the successive augmentations on the upper level B, that is to say

$$u'+u''+u'''+u^{\text{iv}}+\ldots u_{(n)}=\frac{S}{B+S}(D-x)\left(\left(\frac{B}{B+S}\right)^0 \left(\frac{B}{B+S}\right)^1+\left(\frac{B}{B+S}\right)^2+\left(\frac{B}{B+S}\right)^3+\ldots\left(\frac{B}{B+S}\right)^{n-1}\right),$$

Or, in other words, the whole elevation of the surface, occasioned by the passage of a number n of boats, is expressed by a decreasing geometrical progression, the number of whose terms is n, and whose ratio is

$$\frac{B}{B+S}.$$

Whence we conclude that whenever the superficies of the basin S is not so small, in proportion to the superficies B of the upper level, as to be neglected, the rise of water occasioned by the descent of a boat S, will always be proportionate to a certain power of the fraction

$$\frac{B}{B+S};$$

power whose value will always be so much the less as the boat approaches the numerical close of the series of descending boats.

Whence we see, further, that the passage of a boat will always produce a real elevation of water in the lock, whence it descends, unless the number of boats already gone through is infinite; and in this case the number of terms

$$\left(\frac{B}{B+S}\right)^0+\left(\frac{B}{B+S}\right)^1+\left(\frac{B}{B+S}\right)^2+\left(\frac{B}{B+S}\right)^3+\ldots\ldots$$
$$\ldots\ldots\left(\frac{B}{B+S}\right)^{n-1}=\frac{B+S}{S}.$$

Therefore

$$u'+u''+u'''+u^{iv}+\ldots u_{(n-1)}=\frac{S}{B+S}(D-x)\frac{B+S}{S}=D-x;$$

as we have already found.

The fall of the lock then becomes $x+D-x=D$. Consequently, the descent of an infinite number of boats through the lock which terminates the level B, would render the fall of that lock, equal to the common draft of water of the boats which pass through it; but it is evident that the fall can never attain that limit since the number of boats can never become infinite.

Substituting $t_{,,}-t_{,}$ for D in the general expression

$$u_{(n)}=\frac{S}{B+S}(D-x)\left(\frac{B}{B+S}\right)^{n-1}$$

of the rise on the level of B by the passage of the nth boat, it becomes

$$u_{(n)}=\frac{S}{B+S}\left((t_{,,}-t_{,})-x\right)\left(\frac{B}{B+S}\right)^{n-1};$$

and all that we have hitherto said of a simple succession of descending boats, will apply to the double passage, or to the case of boats passing alternately up and down the locks.

If all the boats are equally charged, or in other words, if $t_{,,}=t_{,}$, the preceding expression becomes

$$u_{(n)}=-\frac{Sx}{B+S}\left(\frac{B}{B+S}\right)^{n-1},$$

which is always negative, and indicates that the height of the upper level diminishes instead of increasing.

After a certain number of double passages, the primitive height of the water in the level h will evidently, in this hypothesis, be represented by

$$h-\frac{Sx}{B+S}\left(1+\frac{B}{B+S}+\frac{B^2}{(B+S)^2}+\frac{B^3}{(B+S)^3}+\ldots\ldots\right.$$

$$\ldots \frac{B^{n-1}}{(B+S)^{n-1}}\Big) = h - x + x\Big(\frac{B}{B+S}\Big)^{n};$$

making this height equal to the draft of water $t_{,,}$ or $t_{,}$ of the boats which ascend and descend, or

$$h - x + x\Big(\frac{B}{B+S}\Big)^{n} = t_{,,},$$

we shall have

$$\frac{t_{,,} + x - h}{x} = \Big(\frac{B}{B+S}\Big)^{n};$$

and therefore

$$n = \frac{\log. \dfrac{(t_{,,} + x - h)}{x}}{\log. \dfrac{B}{B+S}}.$$

This is the number of double passages after which the height of water in the level B will have become precisely equal to the draft of water of the boats, and will therefore cease to be navigable, if it has received no new supply of water.

Hitherto we have examined only the passage of the boats by a single lock, in considering the lower level as invariable, which is a very special case We shall now consider the question in a more general point of view, by supposing a series of levels $B_{,}$ $B_{,,}$ $B_{,,,}$ &c. separated one from the other by locks $E_{,}$ $E_{,,}$ $E_{,,,}$ E_{iv} &c., of which the lifts are respectively x', $x'_{,,}$ $x'_{,,,}$ x'_{iv} &c., and determine the rise of water on any one of these levels by the successive descent of a certain number of boats of an equal draft D of water.

Let u', $u'_{,,}$ $u'_{,,,}$ u'_{iv}, &c. represent the increased height of the levels $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv} &c. by the descent of the first boat through all the locks;

u'', $u''_{,,}$ $u''_{,,,}$ u''_{iv} &c., the increased height of the same levels by the descent of the second boat;

u''', $u'''_{,,}$ $u'''_{,,,}$ u'''_{iv}, &c., the increase by the descent of the third, &c.

So that the upper index will designate the numerical order of the boat in the series, and the lower one the rank of the lock in the canal, counting from the summit level; each of these quantities

$u'_{,}+u''_{,}+u'''_{,}+u^{iv}_{,}+$, &c;
$u'_{,,}+u''_{,,}+u'''_{,,}+u^{iv}_{,,}+$, &c.;
$u'_{,,,}+u''_{,,,}+u'''_{,,,}+u^{iv}_{,,,}+$, &c;
indicates the total rise of each of the levels $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv}, &c. after any number n of successive passages.

Let us follow and examine the effect of a boat going from the summit level $B_{,}$ through all the levels $B_{,,}$ $B_{,,,}$ &c. of the canal.

We have just found that the boat DS, in passing through the lock $E_{,}$, whose fall is $x'_{,}$, has produced in the first level $B_{,}$, a rise

$$u'_{,}=\frac{S}{B_{,}+S}(D-x'_{,}).$$

But the volume of water to produce this rise has been borrowed from the second level $B_{,,}$; the height of water in the latter is consequently diminished by a quantity

$$\frac{B_{,}u'_{,}}{B_{,,}};$$

whence we see that the primitive fall $x'_{,}$ of the second lock becomes

$$x'_{,,}-\frac{B_{,}u'_{,}}{B_{,,}},$$

making this fall $=z_{,,}$; and representing by $v'_{,,}$ the rise produced in the level $B_{,,}$, by the descent of the boat DS in the level $B_{,,}$.

We shall find, in applying the same reasoning as in determining the rise in the first level $B_{,}$,

$$v'_{,,}=\frac{S}{B_{,,,}+S}(D-z'_{,,}).$$

But it is evident that the final rise of water u' of the level $B_{,,}$ above its primitive state, is equal to what is gained by the passage of the boat into the second lock $E_{,}$ *minus* the quantity it lost by the passing of the same boat into the first lock $E_{,}$; that is to say, we have

$$u'_{,,}=v'_{,,}-\frac{B_{,}u'_{,}}{B_{,,}},$$

or by substituting for $v'_{,,}$ and $z'_{,,}$ their value

$$u'_{,,}=\frac{S}{B_{,,}+S}(D-x'_{,,})-\frac{B_{,}u'_{,}}{B_{,,}+S}.$$

It is evident that the volume of water $u'_{,}+u'_{,,}$ gained by two levels $B_{,}$ and $B_{,,}$ has been taken from the following level $B_{,,,}$.

But the volume of water gained by the level $B_{,}=B_{,}u'_{,}$, that gained by the level $B_{,,}=B_{,,}u'_{,,}$,

The level $B_{,,,}$ will therefore have undergone a depression

$$=\frac{B_{,}u'_{,}+B_{,,}u'_{,,}}{B_{,,,}}.$$

Consequently the fall of the lock $E_{,,,}$ will have become

$$x'_{,,,}-\frac{(B_{,}u'_{,}+B_{,,}u'_{,,})}{B_{,,,}}.$$

The descent of the boat through this lock will occasion a temporary rise of its level:

$$v'_{,,,}=\frac{S}{B_{,,,}+S}(D=x'_{,,,})+\frac{S}{B_{,,,}+S}\;\frac{(B_{,}u'_{,}+B_{,,}u'_{,,})}{B_{,,,}};$$

But we have

$$u'_{,,,}=v'_{,,,}-\frac{(B_{,}u'_{,}+B_{,,}u'_{,,})}{B_{,,,}}$$

Therefore

$$u'_{,,,}=\frac{S}{B_{,,,}+S}(D-x'_{,,,})-\frac{(B_{,}u'_{,}+B_{,,}u'_{,,})}{(B_{,,,}+S)}.$$

In the same manner we shall find

$$u_{iv}=\frac{S}{B_{iv}+S}(D-x'_{iv})-\frac{(B_{,}u'_{,}+B_{,,}u'_{,,}+B_{,,,}u'_{,,,})}{(B_{iv}+S)};$$

And, generally

$$u_{(n)}=\frac{S}{B_{(n)}+S}(D-x'_{(n)})-\left(\frac{B_{,}u'_{,}+B_{,,}u'_{,,}+B_{,,,}u'_{,,,}+}{(B_{(n)})+S)}\ldots\right.$$

$$\left.\ldots\;\frac{B_{(n-1)}u'_{(n-1)}}{(B_{(n)}+S)}.\right)$$

If we suppose the extent and rise of water in each of the levels which precedes the last $B_{(n)}$, to be given quantities, the above equation expresses, as we see, the general relationship between the indeterminate quantities $B_{(n)}$, $u_{(n)}$ and $x''_{(n)}$.

After the first boat shall have passed through all the levels $B_{,}$ $B_{,,}$ $B_{,,,}$, the falls of the locks $E_{,}$ $E_{,,}$ $E_{,,,}$ E_{iv} &c.

which, at the commencement, were $x'_{,}$ $x'_{,,}$ $x'_{,,,}$ x'_{iv}, &c. will have become x'', $x''_{,,}$ $x''_{,,,}$ x''_{iv}, &c., and by substituting these quantities in lieu of the original falls, we may, in the same manner, determine the augmentations u'', $u''_{,,}$ $u''_{,,,}$ u''_{iv} occasioned on the levels $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv}, &c. By the passage of a second boat, we shall therefore have

$$u''_{,}=\frac{S}{B_{,}+S}(D-x''_{,})$$

$$u''_{,,}=\frac{S}{B_{,,}+S}(D-x''_{,,})-\frac{B_{,}u''_{,}}{(B_{,,}+S)}$$

$$u''_{,,,}=\frac{S}{B_{,,,}+S}(D-x''_{,,,})-\frac{(B_{,}u''_{,}+B_{,,}u''_{,,})}{B_{,,,}+S}$$

$$u''_{iv}=\frac{S}{B_{iv}+S}(D-x''_{iv})-\frac{(B_{,}u''_{,}+B_{,,}u''_{,,}+B_{,,,}u''_{,,,})}{(B_{iv}+S)}$$

equations which will give the augmentations u'', $u''_{,,}$ $u''_{,,,}$ u''_{iv}, &c. in functions of the quantities S, B, $B_{,,}$ $B_{,,,}$ B_{iv}, &c. and in functions of the primitive falls $x'_{,}$ $x'_{,,}$ $x'_{,,,}$ x'_{iv}, &c. of the locks $E_{,}$ $E_{,,}$ $E_{,,,}$ E_{iv}, &c., in paying attention to the new falls of these locks

$$x''_{,}=x'_{,}+u'_{,}-u'_{,,}$$
$$x''_{,,}=x'_{,,}+u'_{,,}-u'_{,,,}$$
$$x''_{,,,}=x'_{,,,}+u'_{,,,}-u'_{iv}\ \&c.$$

The levels $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv}, &c. will be respectively raised by the quantities

$u'_{,}+u''_{,}$ . . . $u'_{,,}+u''_{,,}$ . . . $u'_{,,,}+u''_{,,,}$ . . . $u'_{iv}+u''_{iv}$, &c.

After the passage of the second boat, the falls of locks $E_{,}$ $E_{,,}$ $E_{,,,}$ E_{iv}, &c. will become $x'''_{,}$ $x'''_{,,}$ $x'''_{,,,}$ x'''_{iv}, &c. In the same manner may be determined the elevations $u'''_{,}$ $u'''_{,,}$ $u'''_{,,,}$ u'''_{iv}, &c. of water by the passage of a third boat, and the heights assigned in functions of the primitive quantities S, $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv}, &c. $x'_{,}$ $x'_{,,}$ $x'_{,,,}$ x'_{iv}, &c. in considering that we have

$$x'''_{,}=x'_{,}+u'_{,}+u''_{,}-u'_{,,}-u''_{,,}$$
$$x'''_{,,}=x'_{,,}+u'_{,,}+u''_{,,}-u'_{,,,}-u''_{,,,}$$
$$x'''_{,,,}=x'_{,,,}+u'_{,,,}+u''_{,,,}-u'_{iv}-u''_{iv}-\&c.$$
$$x'''_{(n)}=x'_{(n)}+u'_{(n)}+u''_{(n)}-u'_{(n+1)}-u''_{(n+1)}$$

Adding together all these falls of the locks from the first to the last, we have

$$x'''_{,}+x'''_{,,}+x'''_{,,,}+x'''_{iv}+,\ \&c.+x'''_{(n)}=$$
$$x'_{,}+u'_{,}+u''_{,}+x'_{,,}+x'_{,,,}+,\ \&c.+x'_{(n)}-u'_{(n+1)}-u''_{(n+1)}$$

And, since the last level $B_{(n)}$ of the canal, is the river in which it terminates, and which may be considered as an indefinite reservoir whose level is invariable, whatever may be the number of boats which enter it, we have $u' = o$, $u'' = o$, and, consequently, after the passage of any number (N) of boats;

$$(N)_{x_{,}} + (N)_{x_{,,}} + (N)_{x_{,,,}} + (N)_{x_{iv}} + \ldots \&c. + (N)_{x_{(n)}} =$$
$$x'_{,} + x'_{,,} + x'_{,,,} + x'_{iv} + \ldots . x_{(n)} + u'_{,} + u''_{,} + u'''_{,} + u_{,}^{iv} \ldots .$$
$$+ {}^{N}u_{,};$$

whence we see that after the passage of any number (N) of boats in the canal, the sum of the primitive falls of all the locks $x'_{,} + x'_{,,} + x'_{,,,} +$ &c. is increased only by the quantity $u'_{,} + u''_{,} + u'''_{,} +$, &c. which has been raised to the summit level.

What we have said of the lower level which terminates the canal, will apply equally to any intermediate level which is maintained at a constant height, by means of a feeder, whatever might be the activity of the navigation.

Thus we see that the rise of water in each level by the passage of a certain number of boats through the locks of a navigable canal, will depend on the superficial extent, and on the rise and fall which separates them respectively; so that it might happen, (if we neglected the relationship which necessarily exists between the extent of the levels, the lift of the locks, and the rise of the surfaces) that the rise would be very considerable in some and very small in others, although the latter would require the introduction of a much larger quantity of water than the former, to repair the losses occasioned by natural evaporation, and filtration through the bottom and sides.

If we suppose for example, that the canal be opened in a homogeneous soil throughout its whole length, the losses resulting from filtrations and evaporation, on any one of its levels, will be proportionate to the extent of that level, that is to say, a prism of water of a constant height, since we suppose all the levels to be of equal breadth.

This point established, it is evident that the elevations $u'_{,}$ $u'_{,,}$ $u'_{,,,}$ u'_{iv} produced by the descent of the first boat, DS, must be equal to each other; making this common quantity $=a$, we shall have

$$a=\frac{S}{B_{,}+S}(D-x'_{,})$$

$$a=\frac{S}{B_{,,}+S}(D-x'_{,,})-\frac{B_{,}a}{(B_{,}+S)}$$

$$a=\frac{S}{B_{,,,}+S}(D-x'_{,,,})-\frac{(B_{,,}+B_{,})a}{(B_{,,,}+S)}$$

$$a=\frac{S}{B_{iv}+S}(D-x'_{iv})-\frac{(B_{,,,}+B_{,,}+B_{,})a}{B_{iv}+S}$$

And generally:

$$a=\frac{S}{B_{n,}+S}(D-x'_{(n)})-a\frac{B_{,}+B_{,,}+B_{,,,}+B_{iv}+\ldots+B_{(n-1)}}{(B_{(n)}+S)}$$

Now the position of the level $B_{(n)}$, in relation to the summit level of the canal, or, which amounts to the same thing, the sum of all the levels $B_{,}+B_{,,}+B_{,,,}+\ldots\ B_{(n-1)}$, which precede it, being given and represented by (B), we have:

$$a=\frac{S}{B_{(n)}+S}(D-x_{(n)})-\frac{a\,(B)}{B_{(n)}+S},$$

or, to abridge, by making

$$B_{(n)}+S=y\,;\ D-x_{(n)}=z,$$

we have

$$a\,((B)+y)-Sz=o$$

equation of the right line, easy of construction, and which expresses the relation which should exist between the extent of any one of the levels and the fall of the sluice which terminates it, in order that this level, and each of those which precede it, shall acquire an uniform rise of level at each passage of a boat, whatever may be the number of passages.

For after the passage of the first boat, the falls of the sluices on the whole length of the canal have become:

$$x'_{,}+a-a=x'_{,}$$

$$x'_{,,}+a-a=x'_{,,}$$

$$x'_{,,,}+a-a=x'_{,,,}$$

Since nothing is changed, either in the extent of the levels, or in the primitive fall of its sluices, it is evident that the passage of a second boat will cause the same rise a. of water in each level, and so on indefinitely.

We have supposed that each level was exposed to an equal chance of deperdition of water; but if, from the effect of some particular circumstances, any one of the levels $B_{(n)}$ was exposed to a greater loss than the others, it would be necessary that its level should be raised by a quantity A, proportionate to its greater losses; whilst the levels which precede it should only be raised by the quantity a, and we shall have

$$A = \frac{S}{B_{(n)}+S}(D - x_{(n)}) - a\frac{(B_{,}+B_{,,}+\ldots \&c.)}{(B_{(n)}+S)}$$

whence we immediately conclude that the length of the level $B_{(n)}$ being given, the fall of the sluice $x_{(n)}$ should be so much the smaller as the rise of water A, destined to replace the loss attributed to this level, becomes more considerable.

If, on the contrary, the level $B_{(n)}$ were to receive a quantity of water, from some other channel, it might gain instead of losing water, and consequently preserve water sufficient for the purposes of navigation, even after being depressed as much as it had been elevated by the auxiliary stream. The quantity A changes its sign in this hypothesis and the equation

$$-A = \frac{S}{B_{(n)}+S}(D - x_{()}) - a\frac{(B_{,}+B_{,,}+B_{,,,}+\ldots \&c.)}{B_{(n)}+S}$$

shews that the fall $x_{(n)}$ of the sluice, which terminates the level, may be so much the greater as the volume of water introduced into this level, is increased.

This level, receiving an additional supply, may in its turn be considered as a culminant point of a new canal, to which all that we have heretofore said of the other may be applied without restriction; the same thing will again occur after a second, and a third supply of water, and we are thus brought back to the propositions laid down in our first memoir.

If, in the general equation,

$$u_{(n)} = \frac{S}{B_{(n)}+S}(D - x_{(n)}) - \frac{(B_{,}u'_{,}+B_{,}u'_{,}+B_{,,,}u'_{,,,}\ldots+\&c.)}{(B_{(n)}+S)}$$

we suppose the rise of water in all the levels, except the summit level u' to be null, the equation will then become

$$D - x_{(n)} - \frac{B\,u'}{S} = o,$$

which answers to the case where each intermediary level gains precisely as much water on the one side as it loses on the other; so that the whole volume of water taken in the lower level only tends to increase the quantity on the summit level.

If, in this equation, we substitute in the place of u', its value

$$\frac{S}{B_{,}+S}(D-x')$$

we can deduce from it

$$x(n)=\frac{SD+B_{,}x'_{,}}{B_{,}+S}$$

whence we see that the falls of all the sluices, whatever be their numerical rank, after the first, are equal to each other.

Preserving the hypothesis of an equal rise in all the levels of a canal, let us suppose farther that all these levels are equal to each other in extent.

The general equation

$$a=\frac{S}{B_{(n)}+S}(D-x(n))-a\frac{(B_{,}+B_{,,}+B_{,,,}+\ldots B_{(n)})}{(B_{(n)}+S)}$$

because $B_{,}=B_{,,}=B_{,,,}=\cdots B_{(n-1)}=B$;

and $B_{,}+B_{,,}+B_{,,,}+\cdots B_{(n-1)}=(n-1)B$;

will become

$$a=\frac{S}{B+S}(D-x(n))-\frac{(n-1)aB}{B+S}$$

whence $$x(n)=D-a\frac{(S+nB)}{S}$$

We have also:

$$x(n-1)=D-a\frac{(S+(n-1)B)}{S};$$

therefore $$x(n-1)-x(n)=\frac{aB}{S}$$

that is to say, the falls of two adjoining locks, taken at hazard in such a canal, differ from each other by a constant quantity, or, which comes to the same thing, the falls of all the locks of a system diminish, from the first to the last, in an arithmetical progression, the ratio whereof is $\frac{aB}{S}$.

We shall have the particular case of a number of contiguous locks (sas accolés) in making $B=S$; in which case the general expression of the fall $x(n)$ becomes

$$x(n)=D-a(n+1);$$

by means of which we may determine the height of the fall of any one of a series of contiguous locks, in order that the level of water may be raised in each of them, by the descent of a boat, by a constant quantity $=a$.

It is the usual practice to give to each basin of a series of locks, precisely the dimensions necessary to contain a single boat. This is also what we have hitherto supposed; but if, instead of representing the draft of water of a descending boat, the quantity D represents the difference of draft between the descending and the ascending boats, it will then be necessary that two boats going in opposite directions can meet in each of the basins, and as it will also be necessary that they should pass each other in the basins in which they meet, it will be proper to augment the dimensions of the basins sufficiently to facilitate their operations, which may be done by giving to the basin the capacity of three boats; we shall then have $B=3S$, and the equation

$$x(n)=D-a(3n+1)$$

will express the fall of any one of the sluices in a series of contiguous locks, according to the numerical rank it occupies in that series.

We shall extend no farther the application of our *formulæ* to particular cases, but shall content ourselves with remarking that the same equations by which we express the rise of water in the levels of a canal, give also the fall or lowering of the same levels when the quantity $D-x$ is negative, that is to say, when the fall of the lock is greater than the difference of draft of water between the boats which ascend and those which descend through those locks.

In this case we find

$$u'_{,}=\frac{S}{B_{,}+S}(x'_{,}-D)$$

$$u'_{,,}=\frac{S}{B_{,,}+S}(x'_{,,}-D)-\frac{B u'_{,}}{(B_{,,}+S)}$$

$$u'_{,,,}=\frac{S}{B_{,,,}+S}(x'_{,,,}-D)-\frac{(B_{,}u'+B_{,,}u'_{,,})}{B_{,,,}+S};$$

so that, naming generally $X_{,}$ $X_{,,}$ $X_{,,,}$ X_{iv}, &c. the falls of the locks $E_{,}$ $E_{,,}$ $E_{,,,}$ E_{iv} &c. and $V_{,}$ $V_{,,}$ $V_{,,,}$ V_{iv} &c. the difference of level produced by any number of double passages in the levels $B_{,}$ $B_{,,}$ $B_{,,,}$ B_{iv} &c. whose transverse section is supposed rectangular, the general formulæ,

$$V_{,}=\frac{S}{B_{,}+S}(\pm D\mp X_{,,,})$$

$$V_{,,}=\frac{S}{B_{,,}+S}(\pm D\mp X_{,,,})-\frac{B_{,}V_{,}}{(B_{,,}+S)}$$

$$V_{,,,}=\frac{S}{B_{,,,}+S}(\pm D\mp X_{,,,})-\frac{(B_{,,}V_{,,}+B_{,}V_{,})}{(B_{,,,}+S)}$$

will express either the rise or fall of the levels accordingly as the quantities D and X shall be affected with the upper or the lower signs ; and we may therefore, in either case deduce analagous consequences from them.

Let us nevertheless repeat what we have already stated at the commencement of this Memoir: that in projecting navigable canals, we shall much more frequently find it necessary to raise water from the lower levels, which never dry, into the upper levels which are sometimes subject to that inconveniency, than to take from the latter, the water required to render the others navigable ; it will therefore be proper, whenever circumstances will permit, to confine ourselves to the case where the difference $D-x$ is a positive quantity.

To resume in a few words what we have said hitherto :

We have first considered two contiguous levels separated by a single lock, the upper level having a determinate superficies, and the lower one indefinite. We have determined, in this hypothesis, the law which would govern the rise of water in the upper level, by the double passage of any number of boats ascending and descending through this lock, when the lift of the lock is less than the difference of draft of water in the ascending and the descending boats. We have found that, the number of double passages increasing necessarily as the series of natural numbers, that is to say, in an arithmetical progression, the successive elevations of the upper level, produced by the working of the lock, diminished in a geometrical ratio, so that the law which connects the successive elevations of the upper level, and the number of passages to which these elevations are due, may be graphically represented by the co-ordinates of certain points of the negative branch of a logarithmic curve.

From the nature of this law it follows that, continuing to pass boats through this lock, the surface of the upper level will continue to rise, though without ever arriving at a point where the difference between its level, and that of the water below the lock, will be equal to the difference of draft between the ascending and the descending boats. If that limit could ever be attained, the relative height of the two levels would change no more, and an indefinite number of boats might pass through the lock in both directions alternately, without producing either a loss or gain of water to either level.

This leads us to remark that, in all cases where we can raise a portion of water from a lower to a higher level, it is proper to profit of this faculty as far as we can dispose of it to advantage—for we raise so much the less as there is already a greater quantity above, as we may see from a single glance at the law of its augmentations.

We have thought it expedient to develope, with considerable minuteness, the consequences of the double passage through a single lock, because those consequences are simple and easy to understand ; but this supposition differs so widely from ordinary circumstances that it was not permitted to confine ourselves to the examination of this question alone. We have therefore, taking a general view, embraced the case of a navigable canal, consisting of an indefinite number of unequal levels, connected by locks of unequal lifts ; supposing first that the double passages were effected successively through each lock, beginning with the highest, we have sought the expression of the rise of water on any level whatever of the canal, and we have found that it depended not only on the extent of that level and the fall of the lock which terminates it, but also on the extent of all the levels, and the fall of all the locks situated above the one in question.

In general, the rise of water in any given level, the length of that level, and the fall of the lock which terminates it, may be considered as the three co-ordinates of a curved surface, so that from the equation of that surface, the value of one of these three variable quantities may be immediately determined, when the other two quantities are known.

Whatever may be the rise of water in each of the consecutive levels of a navigable canal, it is evident that the whole body of water which constitutes this augmentation, and is spread throughout the extent of them all, is taken from the lower level, or rather, from the river in which the canal terminates.

If, by the effect of a first double passage through all the locks of a canal, the surfaces of its different levels become elevated, the primitive falls of its locks will be altered, and we must calculate, assuming the falls as thus modified, what will be the effect of a second double passage; and so of a third, a fourth &c. whence we see that after a certain number of passages of boats the rise of water on any given level will depend not only on the rise of water on all the levels above the one under consideration; but also on the number of double passages which shall already have taken place. So that the expression of the rise on any given level, becomes so much the more complicated as that level is farther removed from the reservoir of the summit level, and as the number of boats which have already passed becomes more considerable.

But all this supposes that the levels thus raised, preserve all the water they receive, while in reality that which is raised is only destined to replace, in whole or in part, that portion which is lost by absorption or evaporation; and as the amount of these losses varies according to the nature of the ground where the canal is made, and according to the extent of its levels, it follows that the rise of water on each level should be made to vary to suit the permeability of the ground, or such other considerations as experience may prove to be necessary.

Now the most simple, as well as the most natural supposition that can be made, is that of homogeneity in the nature of the ground throughout the whole length of the canal, in which case the chances of loss would be equal in every part; and it is evident that, in this case, it would be necessary that each double passage should raise the water in each level equally, or, which comes to the same thing, that the water raised from the lower level should be divided among the higher levels in proportion to their respective lengths.

Our formulæ, applied to this particular case, shew that the same relation exists between the length of a level and the fall of the lock which terminates that level, as between the co-ordinates of the right line.

This hypothesis of an equal rise on all the levels of a canal, besides the advantage it offers of replacing the water lost by absorption in homogeneous ground, possesses also that of maintaining the falls at their primitive height, so that the succeeding double passages, whatever interval of time elapses between them, will uniformly produce an elevation of water, and this independently of the greater or less degree of activity in the navigation.

We have said that the volume of water which served to augment all the levels of a canal, was always taken from its lower level, or reservoir; we may now suppose that this volume passes wholly into the highest reservoir, or summit level, which will necessarily be the case if each of the levels comprised between the two extremes are neither raised nor depressed, that is, if they gain by the double passage through their lower lock, what they lose by the double passage through their upper lock: we may satisfy this condition in supposing the rise null in all the intermediate locks; in this case also, the equation which expresses the relation between the superficies of these levels and the fall of their lower locks, is that of a right line.

It may be advantageous to adopt this principle whenever the levels contiguous to the culminating point, are those which are exposed to the greatest losses, as is generally the case. The water raised to the summit level may then be applied to repair those losses, without descending to the lower levels which suffer less.

Retaining the same hypothesis of an equal rise on all the levels of a canal, I examine the case, where several consecutive levels are each equal in extent to the basin of a lock. And I find, by the comparison of the falls of the successive locks, in a series of adjoining locks, that they diminish in an arithmetical ratio from the highest downwards: disposing them according to this law, and keeping the connected locks filled with water to the same depth as in the canal, which is always easily effected when the falls of the locks are small, the passage of the boats through such a series of locks, will occasion no loss of water, as is the case when the falls of the locks are greater. It may even be asserted that the loss of water at the locks is less than elsewhere on the canal, since these parts are generally constructed with greater care and solidity, and no filtration is to be apprehended through the ground where they are situated.

It is nevertheless proper to observe that, to affect the double passages of a multiplicate lock, as it is done in a simple lock, each basin of that lock must be of sufficient capacity to contain two boats ; this condition may generally be fulfilled by giving to the basins the breadth of the other parts of the canal. Thus, exercising double functions, the basins of a multiplicate lock considered as basins should have only the length of a boat, whereas, considered as levels, they should preserve the same breadth as the other parts of the canal, of which they form a part.

The formulæ to which we have arrived, contain, properly speaking, the whole theory of canals of artificial navigation, and we may comprehend in a single formula the two cases of the rise and the depression of the levels, by affecting by the double sign $\pm$ the difference of the draft of water between the ascending and the descending boats, and the variable falls of the locks. From this formula we arrive immediately at the following conclusion, which besides is self evident : that when the water is accumulating on the higher levels, the quantity of water contained on those levels may be augmented in proportion as the navigation becomes more active : whilst on the contrary, when the levels are depressing, that quantity of water necessarily diminishes to a certain point, beyond which the navigation of the canal becomes impracticable. This conclusion reduced to this summary expression, shows all the advantages that may be derived from the application in practice, of the *theoretical principles*, which form the object of this memoir.

If we have been enabled to develope them with sufficient clearness, we are indebted for it to the application we have made of Mathematical analysis to a question which had hitherto appeared not be out of its reach ; and in this we believe we have rendered a real service to the cause of science ; for so perfect an instrument as analysis should always be employed when it is question of improving any useful invention; and, in our days no invention is better calculated than navigable canals, to ameliorate the condition of society by the extension and distribution of public riches.*

It will not be proper to carry the consequences of the theoretical principles which I have developed farther than I have done ; they rest on an analogy easy to comprehend, and which it is only necessary to remark, to circumscribe within just bounds every case to which those principles are applicable.

In whatever manner a certain volume of water descends from a given height, it may always be made to raise, to the same height, by means of a machine, a certain mass of water smaller than itself.

The product of the difference of these two masses of water multiplied by the vertical ascent or descent is the measure of the active force absorbed by the machine, and the machine is so much the more perfect as the loss of active force is smaller.

* What we here say of navigable canals, applies, without restriction, to every thing that can tend to render the communications between remote places, more convenient and less expensive; it also applies to all kinds of constructions, and enterprises (exploitations.) In reflecting on the different branches of industry that may be improved by the application of Mathematical analysis, we are again led to render homage to the truly philosophical views which presided at the foundation of a celebrated school where analysis is intended to serve as the basis of the instruction there received.

Nevertheless, among those who have been called to enjoy the advantages of that institution, and who might have applied very usefully the knowledge they there acquired, they do not all appear to have attached an equal degree of importance to the improvement of the professions they exercise.

Mathematical analysis is a language which we forget when we cease to speak or to write it; and as research after truth always requires a certain exercise of the mind, it sometimes happens that we had rather blindly admit received opinions, though erroneous, than substitute new truths in their place, especially when a knowledge of these new truths can only be acquired at the price of labour; besides we do not wound the vanity or self-love of any one by repeating what every body says; we thus secure ourselves from contradiction; and men may even in certain situations, believe themselves interested in being considered as the champions of custom. This is not however, the conduct which we ought to expect from those whose minds are exercised to the study of the exact sciences. We have too often had occasion to admire the success obtained by graduates of the Polytechnic School, the exact sciences owe them too much progress, the arts too many improvements, mostly obtained by the application of analysis, to leave any room to apprehend that the example of those among them who neglect the resources of this powerful instrument, will become contagious.

These reflections which I deem it unnecessary to extend, are the only answer I shall make to the observations that a young engineer has published on my first memoir. In submitting the matter which I have there treated to a more profound examination, he cannot fail to recognize that all his reasonings, however caustic his conclusions, are founded on a paradox.

Now a body which floats in a fluid, represents in weight a volume of the fluid precisely equal to that which is displaced by the floating body.

When, therefore, a loaded boat descends from a higher to a lower level, it is capable of producing by its weight the same effect as could be produced by the descent of the volume of water of which it occupies the place.

In the same manner, a boat which is raised from the lower to the higher level of a lock, is equivalent to a certain volume of water which should be raised to the same height; and as the basin-lock is such in its nature that the loss of active force, indispensable to elevate one boat and to lower another through the lock, is always proportional to the square of the height, it is easy to conceive that according to the relation which shall be established between the lift of a lock, and the draft of water of the boats which ascend and descend through it, the expense of water from the upper level may be rendered positive, null or negative : now in the latter case, which we have specially examined, it will happen, by the sole effect of the operation of this apparatus, that a certain volume of water will pass from the lower to the upper level : this ascension of water, as we see, is the immediate and necessary consequence of the fundamental principles of Dynamics; it is moreover evident that this elevation of water can only take place, inasmuch as the draft of the descending boats is greater than that of the ascending boats added to the lift of the lock.

In my first memoir, I noted some considerations on the nature of the transportations to which artificial navigation is usually applied, and proved that in general, the weight of articles which descend from the plains and the mountains into the valleys is much greater than that of the articles which ascend from the vallies to the mountains. This consideration opens a wide field for the application of our theory.

It may not be amiss to cite a few examples taken on known localities.

The Foundery of Creuzot and the coal mines which are there wrought, are situated at 10 Kilometres (about $6\frac{1}{4}$ miles) from the centre canal, (Canal du Centre,) by which the productions of these establishments descend, to the Saone on the one hand, and to the Loire on the other; but they must be transported by land to the creek of Torcy, a distance of 6 Kilometres ($3\frac{3}{4}$ miles) which occasions a considerable annual expense.

According to the most accurate information, the weight of matter annually transported from Creuzot to the creek is about four millions of Kilogrammes, or 4000 tons; while the weight of articles which ascend, and which consist principally in soda to supply to glass-works, and in castings from Franche Comté, does not exceed 400 tons. The weight of matter which descends from Creuzot into the canal, is therefore, to the weight of matter which is carried up to the establishment, as 10 is to 1.

A navigable canal which should be established from the mines and the foundery of Creuzot, would therefore require but a very small supply of water, if the proper proportions were observed between the lift of the locks and the draft of the boats destined to navigate the canal.

If, for example, the boats employed in this navigation drew, when loaded, $1\frac{30}{100}$ metres, ($4\frac{1}{4}$ feet,) these boats when returning would draw but 20 centimetres, ($6\frac{2}{3}$ inches); the difference of draft in the same boats when descending with a full charge or returning with one tenth part of a full load, would therefore be $1\frac{10}{100}$ metres. (3 feet $7\frac{1}{3}$ inches, nearly.)

The whole descent throughout the length of this canal, from Creuzot to the creek of Torcy, 6 Kilometres, is 48 metres (158 feet;) so that giving to each lock a lift of one metre ($3\frac{28}{100}$ feet, and supposing the passage of the boats to be alternate, not only the expense of water from the upper level would be null, but even a certain portion might be made to flow into it from the creek of Torcy, where the canal would terminate.

It is easy to conceive that the locks for so small a lift might be constructed at a small expense, and would be much less liable to be injured by the pressure of water, than though the lift were greater; for the pressure on the works, and their consequent deterioration, is dependant on the difference of level above and below the lock.

If it be objected that the multiplicity of locks would retard the navigation, without considering that it is here less a question of economizing time than water, it is not difficult to assure ourselves that this objection is without foundation.

We have already seen that the exportations from Creuzot, in pit coals and castings, amounted to 4000 tons per annum ; let us now suppose that their transportation should be effected in 200 days, this would be a movement of 20 tons per day ; let us suppose farther that boats of that capacity are employed, that is, of 20 tons burthen, these boats will be about 14 metres (46 feet) long, $1\frac{50}{100}$ metres (4 feet 11 inch.) wide, and will draw $1\frac{30}{100}$ metres ($4\frac{1}{4}$ feet) of water, including their weight.

The fall of each lock being fixed at one metre it would be necessary to draw from some other level 20 to 22 tons of water to fill the basin of its descending lock. This water, being introduced by orifices whose sum should be equal to $\frac{1}{5}$ of a square metre, ($19\frac{1}{2}$ inches square,) we find, after making all necessary corrections, that to empty and fill the basin, it would not require quite a minute ; adding two other minutes for lost time, we see that the passage of the boat through 48 locks would require about two hours and an half, allowing three hours for going the remaining length of the canal, and the whole duration of the passage from the lower pond of Creuzot to the creek of Torcy would be but five hours and an half ; which would permit a boat to descend and return in the shortest days of the year.

This example suffices to shew how easy it would be by establishing navigable canals, such as the one we have just described, to increase the operations of extensive iron works and coal-mines. The want of water cannot be an obstacle to this establishment ; for, in the forges divers parts of their machinery are generally moved by water, and the water drawn from the coal mines would be sufficient to supply such a canal.

If, instead of being placed at the bottom of a gorge without issue, as are the establishments of Creuzot, the coal mines, the Iron Founderies, the Marble quarries, the forests, &c. to be worked, were situated on a culminating point between two vallies traversed by navigable rivers, the canal which should unite these two rivers might be constructed according to our principles.

The cumbersome articles taken, in this case, from the culminating point of the canal must necessarily descend to arrive at the point of consumption, and will never be replaced, at the place whence they are taken, by articles of equal weight ; it is evident that, in virtue of the excess of weight in the descending boats over those which ascend, a part of the volume of water necessary for the navigation may be raised from each of the two rivers where the canal terminates, to the reservoir on the summit level. This reservoir would thus be supplied so much the more abundantly as the navigation became more active ; this is the most useful result that we can hope to obtain.

Among all the points of the kingdom where so advantageous communications might be opened, I will point out, for example, the *plateau* of St. Etienne in the department of the Loire. An interesting memoir of M. Beaunier, Engineer in Chief of Mines, shews that this plateau furnishes annually 300,000 tons of pit-coals, which descend to the basin of the Loire on the one side, and to the basin of the Rhone on the other. Now which ever way these coals descend, it is certain that their transportations on a navigable canal, established according to our principles, might not only render null the expense of water from its summit level, but might even raise a certain portion of water to the reservoir on that level from the lower levels.

The memoir of M. Beaunier furnishes the fundamental data of the project of communication between the Rhone and the Loire. These two rivers are but 54 Kilometres, or 10 leagues distant from each other in this place, 15 kilometres of which are already navigable on the Canal de Givors, which extends from Givors to Rive de Gier. The idea of uniting the ocean to the Mediterranean by this route is already very old. But what would especially characterize this communication over the plateau of St. Etienne, is that we there should find in the mass itself of heavy articles in which that section of country abounds, a part of the force necessary for their transportation, since in descending along the canal which served for their exportation they might raise from the lower to the higher levels, a portion of the water necessary for the supply of the canal. This is one of the cases where it becomes as it were indifferent whether we have a determined body of water in reserve, on the summit level of a canal, or are able to ship on this level an equal quantity of solid matter ; this is an immediate consequence of our new theory, and one of the most remarkable ones which it furnishes.

After having thus pointed out the advantages of this new theory, let us give a moment's attention to demonstrate the serious inconveniencies into which men have been led from an ignorance of the true principles.

These inconveniences exist in the canal de Briare, the oldest canal in France and the most generally known.

The number of boats which descended this canal in 1819 was 3380. These boats were of different dimensions; but we can suppose as a mean term that, loaded, their draft of water was 0.66 metres ($26\frac{1}{4}$ inches;) they are 24 metres (79 feet) long, and 3.50 metres ($11\frac{1}{2}$ feet) wide.

The mean cargo of one of these boats, is consequently about fifty tons.

The whole weight of articles brought to Paris, on this canal, during the year 1819, was, therefore, about 170,000 tons.

The far greater portion of these boats were demolished at Paris, and those that ascend the canal go empty. At all events it is certain that the goods transported from the Seine to the Loire, do not weigh one hundredth part so much as those which come from the Loire to the Seine.

The whole length of the canal de Briare, from the dividing point to the River Loing, is 34582 metres ($6934.\frac{1}{2}$ rods, or 21.67 miles); its descent, which is 78.74 metres ($258.\frac{1}{4}$ feet,) is surmounted by 27 locks, the lift of some of which is near 4 metres ($13\frac{12}{100}$ feet).

It is a long time since it has been observed that there was a great loss of water, occasioned by the passage through the locks where the lift and fall was so considerable, and so disproportionate to the draft of water of the boats destined to pass through them. But, such is the state of things: in order to appreciate the consequences, let us first determine what quantity of water would be absolutely necessary for the circulation of 170,000 tons of merchandize on the canal de Briare.

Now it is evident that if the number of locks had been quadrupled, their mean lift would have been reduced to about 75 centimetres, ($2\frac{46}{100}$ feet;) and if the draft of water of the loaded boats had been carried to $1\frac{50}{100}$ metres ($4,\frac{92}{100}$ feet,) it is also evident that in consequence of the diminution in the lift, and the augmentation of the draft of the boats, the 1350 boats, which together would carry as much as the 3380 boats which descended to the Seine in 1819, that is to say, which would displace the same quantity of 170.000 tons of water, would elevate, by their descent, the half of this volume of water from the River Loing to the dividing level; which would have augmented in so much the quantity of water in the reservoir of the culminating level which is destined to supply the navigation of the other branch of the canal, from that level to the Loire.

Supposing, as we now do, an importation from that river to the Seine, without reciprocity, it is indispensable to provide for the expense of water in the ascending navigation of that branch of the canal.

Its whole length is 32231 metres ($6407\frac{1}{10}$ rods, or very nearly 20 miles,) the whole fall is $38\frac{25}{100}$ metres, ($124\frac{36}{100}$ feet,) and is overcome by 12 locks of different lifts.

By augmenting the number of its locks so that the lift of each should be no more than 75 centimetres ($2\frac{46}{100}$ feet,) equal to what we have supposed them on the other part of the canal, there would be expended, to raise the 170,000 tons of merchandize:

1st.—85,000 tons of water, equivalent to filling the basins of the locks;

2ndly.—170,000 tons of water, representing the volume of water displaced by the whole of the cargoes.

The ascending navigation from the Loire to the culminating point of the canal de Briare, would therefore require an expense of 255,000 tons of water, which would necessarily descend from the reservoir on the summit level to the Loire.

But we have seen that the descent of the same merchandize, on the opposite side, elevated to the reservoir 85,000 tons of water drawn from the river Loing; there would therefore only require to be furnished from the ponds and feeders, 170,000 to 200,000 tons of water, or thereabouts; so that abstracting the absorptions and evaporations, that is the *minimum* quantity of water, indispensable for the annual supply of the navigation of the canal de Briare, and the volume of which it would be necessary to be able to dispose, on the dividing level.

Let us now examine the quantity of water annually expended to maintain that navigation.

The ponds indicated in the work of M. de Lalande, contain 6,080,000 tons of water, and are reserved for the supply of the canal de Briare.

If we suppose, according to an evaluation generally admitted, and which would perhaps be here too high, that the evaporation and the filtrations absorb one fifth part of this reserve, there will remain 4,864,000 tons of water for the purposes of navigation alone.

By the application of our principles to the lift of the locks, and the draft of water of the boats, we found that the expense of water necessary for that same navigation, may be reduced to 200,000 tons; whence it appears that at least $\frac{23}{24}$ of the water specially reserved for the use of this canal are consumed in pure loss, and yet, the navigation on this canal is often interrupted for several months in the year for the want of water.

This imperfection of the canal de Briare, inevitable consequence of the excessive lift of its locks, compared with the small draft of water of the boats which frequent it, is also common to some other canals of more recent construction.

The relation between the lift of the locks of a navigable canal, and the draft of water of the boats which navigate it ascending and descending through those locks, constitutes as it were the *regime* of that canal; and this regime is essentially variable. It depends not only on the disposable volume of water in different localities, but also on the territorial or manufacturing resources of the countries through which it passes, and on the nature of importations into these countries.

Thus, in passing a canal in a direction where it could receive directly a large mass of the productions of mines, quarries, forests, vineyards &c. which would descend by it into some valley where the canal should terminate, a much smaller quantity of water would be necessary than though this canal should traverse a country less productive of articles which would be advantageously exported; and as the difficulty of procuring a sufficient quantity of water on the summit level, has heretofore been the principal obstacle to their construction in many places, we can judge of the importance of our theory since it enables us to elude this obstacle, and points out the way in which the execution of navigable canals becomes easiest, precisely in the places where they will be most useful.

The better we are acquainted with the nature and extent of the exportations and importations of any section of country, the better we shall be enabled to improve the *regime* of an artificial canal which is to traverse it; thus we see that the study of statistics is indispensable to arrive at any degree of perfection, and the knowledge it procures is an essential part of the science of the engineer in tracing canals; a truth which appears to have gone unheeded until now, but which cannot be too loudly proclaimed since public attention seems specially directed to that important object.

Paris, 17*th June*, 1821.

ART. XII.—*On crank motion;* by A. B. QUINBY, *New-York.*

THE demonstration of the *crank problem*, or *problem* for determining the mechanical power of the *crank*, offered by Mr Ward in the 4th vol. of your *Journal of Science and Arts*, is, in my opinion, unsatisfactory.

It is not my wish to enter upon a review of all that Mr. Ward has written on the subject of this important problem; but I take the liberty to assert, that the principle upon which his solution is founded, has never, to my knowledge, been established.

Mr. Ward says (p. 195), "The pressure of the steam upon the piston being uniform through the stroke; it follows that the impulses (I understand upon the upper end of the shackle-bar) at all times are equal to one another; and this being the case, it is equally a matter of course that the effects produced at the several points of division of the quadrant, are as the perpendiculars repectively from those points to the line of force."

From what work on mechanics; or, at what period, Mr. Ward acquired his notions on the subjects of motion and forces, shall not be my object to enquire:—my only object is to show that the latter of the two inferences drawn in the above quoted sentence is false; and that to obtain a satisfactory result, in the case in question, we must attend to matters which Mr. Ward's demonstration does not embrace.

That the effects produced at the several points of division of the quadrant are *not* as the perpendiculars respectively from those points to the line of force, may be proved in the following manner.

Describe about C, as a centre, fig. 1, pl. 2, the circle ADBE; representing that in which the *crank* moves: suppose A and B, to be the upper and lower dead points. Join B and A, and produce the line BA to S. Assume C*a* for one position of the crank; and join S*a*: then will S*a* shew the position of the shackle-bar when the *crank* is at *a*. From C demit the perpendicular C*e*, meeting S*a* produced, in the point *e*. Assume C*d* for another position of the *crank*; and from *d* with a radius equal to S*a*, describe the arc *gh*, cutting the line of force SA, in the point *t*. Draw the line *td*; and it will represent the position of the shackle-bar when the *crank* is at *d*. From C let fall the perpendicular C*c*, meeting *td* produced, in the point *c*. From the points *a* and *d* demit upon the line of force, the perpendiculars *am* and *dn*. Put P to denote the constant force that acts always in the line SA, upon the upper end of the shackle-bar, as at S and *t*.

Now by refering to what is demonstrated in vol. 1, chap. VI. art. 195 of Gregory's mechanics, it is obvious that the value of P, estimated in the direction S*a*, or, which is the same thing, the tension of the shackle bar when in the position S*a*, is equal to $P\times\frac{rad.}{cos\angle ASa}$; and the value of P, estimated in the direction *td*, or the tension of the shackle-bar when in the position *td*, is equal to $P\times\frac{rad.}{cos\angle Atd}$: and (by mechanics) the tendency which P has to produce rotation when the *crank* is at *a*; or, the effect produced by P when the *crank* is at *a*, is equal to the tension of the shackle-bar, at that time, multiplied by the distance C*e*; *i. e.* $=\left(P\times\frac{rad.}{cos\angle ASa}\right)\times Ce$: and the effect produced at the point *d*, is equal to $\left(P\times\frac{rad.}{cos\angle Atd}\right)\times Cc$: and, now, if the inference drawn by Mr. Ward were true, then would $\left(P\times\frac{rad.}{cos\angle ASa}\right)\times Ce:\left(P\times\frac{rad.}{cos\angle Atd}\right)\times Cc::am:dn$; or, (by dividing the first and second terms by P×*rad.*, and substituting in place of *am* and *dn* their proportionals C*e* and C*c*) $\frac{Ce}{cos\angle ASa}:\frac{Cc}{cos\angle Atd}::Ce:Cc$; but, by

Euc. El V. XIV. $\frac{Ce}{\cos \angle ASa} : \frac{Cc}{\cos \angle ASa} :: Ce : Cc$; therefore ex æquo $\frac{Ce}{\cos \angle ASa} : \frac{Cc}{\cos \angle Atd} :: \frac{Ce}{\cos \angle ASa} : \frac{Cc}{\cos \angle ASa}$, that is, (since the $\cos \angle Atd$ is less than the $\cos \angle ASa$,) the same magnitude has the same *ratio* to a *greater* magnitude that it has to a *less*, which (Euc. El. V. XIV.) is absurd.

The effects, therefore, at the several points of division of the quadrant are *not* to one another, as the perpendiculars respectively from those points to the line of force.

Having now proved that the *principle* upon which Mr. Ward has founded his demonstration is false, I shall remark that an *equality* of *ratio* between the effects produced at any two points of the quadrant, and the perpendiculars drawn from those points to the line of force, has not, as I am able to perceive, any connexion whatever with a proper and scientific solution; and what consideration it was that led Mr. Ward to frame the inference, is not, I suspect, in the power of mathematics, whether "*pure*," or "*mixed*," to discover.

That *the crank motion occasions no loss of the acting power* is true; and may be demonstrated in the following manner:

Describe, fig 2, pl. 2, the circle ADBE, to represent that in which the crank moves: suppose A and B to be the upper and lower dead points: join them; and draw the diameter ED at right angles to AB. Produce BA to S. Say, now, as the quadrantal arc AD : CD :: CD : to a fourth term. Make CG=this fourth term; and suppose a wheel G*tvw*, whose radius is equal to CG, to be fitted permanently (in any way) upon the shaft or axle that carries the *crank*: suppose, also, two racks G*b* and *vd* to rest upon the teeth of the wheel G*tvw*, and to stand parallel with the line of force SA. If, now, a power P be applied upon the end of the rack G*b*, it is obvious that it will cause this rack to descend, and turn the wheel G*tvw*, and raise the rack *vd* on the opposite side; and, if a weight W,=to P, be attached to the lower end of the rack *vd* it is plain that the two masses P and W will reciprocally balance each other; and, if it be supposed to descend through any space whatever, its effect during the time of descent, will be sufficient to raise the weight W through an *equal space*.

This, I understand to be a case in which there is *no loss of power*.

Let it next be considered what effect P would have during its descent through some particular, or assumed space. Take $Py = AB$, and it will be manifest that the effect of P, during its descent from P to y, will be properly expressed by $P \times Py$, or $P \times AB = W \times BA$. Let it also be considered, that during the descent of P to the point y, the wheel and *crank* will be made to turn through half a revolution; for, since, by cons. AD : CD : : CD : CG; and by the property of circles AD : CD : : tG : CG, it follows that tG is = CG; and consequently $Gtv = 2CD = AB = Py$: and, therefore, if the *crank* be at A when P shall begin to descend, it will have described the arc ADB, and have arrived at the lower dead point B, at the time that P shall have arrived at y.

Assume, now, Ca for one position of the *crank*; and suppose a shackle bar, az, having upon its upper end the power P′, = P, to stand perpendicular, and rest upon the wrist of the *crank* at a:—it is proposed to consider the tendency that P′ would have acting upon the wrist of the *crank* at a, to produce rotation, (or to give angular motion to the wheel and *crank*); in comparison with the tendency which P has to produce rotation, acting upon the teeth of the wheel, at the point G. Produce za to n; and draw the sine am; and it will be plain that the tendency of P′, to produce rotation, will be to that of P, as Cn, or am, to CG.

If, therefore, CG be taken to express the tendency of P to produce rotation; then that of P′ to produce rotation, will be properly expressed by am; the perpendicular distance of the point a from the line ACB. And, in general, the tendency of P′ to produce rotation, at any point whatever of the semicircle ADB will be expressed by the perpendicular distance of that point from the line ACB.

Hence to determine the *mean* tendency of P′ to produce rotation, (*in terms of CG*,) during its descent from A to B, in the arc ADB, we must find the *mean distance* of the semicircle ADB from the line ACB; which, by Vince's Flux. p. 97, is $= \frac{CD^2}{AD}$; but, CG was *made* $= \frac{CD^2}{AD}$; and, therefore, the *mean* tendency of P′ to produce rotation, during its descent, (from A to B, through the arc ADB,) is equal to that of P, estimated for the same time.

And as the *effects* produced by the two equal powers, P′, and P, during any given time, will obviously be to one another, as the *mean* tendencies of those powers, (during that time,) to produce rotation; it follows that the *effect* produced by P′, in descending from A to B, in the arc ADB, will be equal to that produced by P, in the same time; or, $=W \times Py$.

Hence, if the power applied to the *crank* be supposed to act, at all times, in a direction parallel to the line SA; or, which is the same, if we suppose the shackle-bar to maintain its parallelism there will be *no loss of the acting power.*

It now remains to be proved, that in the *case in practice*, in which the upper end of the shackle-bar is confined to the same vertical line, and the lower end is made to vary from that line, there is also *no loss of the acting power.*

Repeat, fig. 3, pl. 2, the first part of the last construction. Assume the two points a and d, in the semicircle ADB, equidistant from the dead points. Join Ca and Cd; and draw the lines am and dm. Let Sa represent the shackle-bar, when the *crank* is at a. Through d draw dN, parallel to Sa; and it will shew the position of the shackle-bar when the *crank* is at d.

Produce Sa to n, and from the centre C demit upon San the perpendicular Cc. Join ad: and suppose the three powers P, P′, P″, to be all equal to one another.

It is proposed now to consider the tendency that the power P″ has to produce rotation when at the point S, or when the shackle-bar is in the position Sa; and, likewise to consider the tendency of the same power to produce rotation when the shackle bar is in the position Nd: and, secondly, to compare the *sum* of these tendencies with the sum of the tendencies of the equal power P′, to produce rotation, acting successively at the two same points a and d.

By refering again to Gregory's Mechanics, vol. 1, art. 195, the value of P″, estimated in the oblique or inflected direction Sa; or the tension of the shackle-bar when in the position Sa, will be found to be equal to $P'' \times \frac{rad.}{cos \angle ASa} =$

$P'' \times \frac{Sa}{Sm} =$ (by sim. tri.) $P'' \times \frac{Cn}{Cc}$; and (by mechanics) the tendency which the power P'' has to produce rotation when at S or when the *crank* is at a, is expressed by the product of the tension of the shackle-bar, at that time, and the perpendicular Cc, the distance between the centre of rotation and the line in which the value of the power is estimated: wherefore the tendency of P'' to produce rotation when the *crank* is at a, is properly expressed by $\left(P'' \times \frac{Cn}{Cc}\right) \times Cc$ $= P'' \times Cn$: and in a similar manner it may be shewn that the tendency of P'' to produce rotation when the *crank* is at d, is properly expressed by $P'' \times Cv$. Hence the *sum* of the tendencies of the power P'' to produce rotation, when the *crank* is at the points a and d, is expressed by $P'' \times Cn + P' \times Cv = P'' \times (Cn + Cv) =$ (because $vt = tn$) $P' \times 2Ct$.

It now remains to compare *this sum* with the *sum* of the tendencies which the equal power P has to produce rotation, acting upon the *crank* (successively) at the two same points, a and d.

From what has been already stated, the *sum* of the tendencies of P' to produce rotation, at the points a and d, is expressed by $P' \times am + P' \times dm = P' \times 2Ct$.

Whence it appears (because P' and P'' are equal) that the *sum* of the tendencies of the power P'' to produce rotation, estimated at the two points a and d, is equal to the *sum* of the tendencies which the equal power P' has to produce rotation, estimated at the same two points. And as the same may be proved to be true at any two corresponding points whatever, in the quadrants AD and DB, it follows that the tendency of P'' to produce rotation, during the time the *crank* is descending from A to B, is equal to that which P' would have to produce rotation, descending upon the crank from A to B, and acting at all times in a direction parallel to SA. But it was proved that if P' descend upon the *crank* from A to B, and act at all times in a direction parallel to SA, its *effect* during the time of decent is $= W \times BA$.

Hence the *effect* of P'', during a descent of the *crank* from A to B is also $= W \times BA$.

Wherefore in the *case in practice*, as in the one before demonstrated, there is *no loss of the acting power*. Q. E. D.

A. B. QUINBY.

Note.—Since I wrote the above solution I have learned that the N. A. *Review* contains an article in which it is stated that the *crank* motion occasions a loss of *three fourths* of the whole power employed!!

On refering to the article alluded to, (vol. 14, p. 407,) I find the following statement relative to the loss of power *supposed to result* from the reciprocating motion produced by the *crank*.

"There is in the steam engine a loss of power in changing the direction of its action from rectilinear to rotary, by the methods in common practice, not very satisfactorily accounted for, considering the magnitude of the loss, which on an average amounts to about three fourths of the whole power, as appears from the reports on the performance of the engines used at the mines in Cornwall."

"This, together with the hope of producing a more simple machine, has given rise to very frequent attempts to apply the action of the steam directly to a wheel, and by that means obtain a circular motion primarily."

With respect to the reports on the performance of the engines used at the mines in Cornwall, I have no knowledge, and am, therefore, not able to refer to the authority by which they were made out.

It must, however, be concluded that a very great blunder has, in some way, been committed by those who made the estimates, since the reciprocating motion of the steam engine does not in truth (abstractly considered) occasion any loss whatever of the acting power.

Any difference therefore between the *effect produced* by the engines used at the mines in Cornwall, and the *power employed* (to give them motion), must be refered to some other cause than that of the reciprocating motion, which has been imagined to produce it.

In reference to the "very frequent attempts to apply the action of the steam directly to a wheel," they have ever appeared to me unnecessary and idle; and, in my opinion, they can never result either in emolument to the individual engaged in them, or in advantage to the public.

The steam engine, however, (in general terms,) is, doubtless, susceptible of further improvements; and all attempts to render its construction more simple, and especially to generate steam at less expense, are highly laudable; and will ever deserve the patronage and encouragement of the public, and the auxiliary efforts of the Engineer and the Philosopher. A. B. QUINBY.

PHYSICS AND CHEMISTRY.

Art. XIII.—*On the Precession of the Equinoxes.*

To the Editor of the American Journal of Science.

Sir,

In examining the Theory, which has long been received, relative to the *Precession* of the *Equinoxes*, I have recently been induced to consider it questionable, and to account for this interesting phenomenon in a manner entirely new. Not being in a situation, however, to make accurate Astronomical observations, or to pursue the subject so far, as to form conclusions perfectly satisfactory, I transmit to you some of the objections, which I have to the prevailing theory, together with the method of accounting for this phenomenon, recently discovered; hoping, that the attention of Astronomers will be directed more minutely to this subject, and, that they will remove some of the obscurity from the old theory, if it is still considered supportable.

It is unnecessary here to give the old theory at length; as reference may easily be had to those authors by whom it is described; and I shall notice only such things as are necessary to make known my objections.

The precession of the Equinoxes has been attributed to the effect of the Sun and Moon on the superior portion of matter about the Earth's Equator, which converts it from a sphere to an oblate spheroid; and the case has been represented as nearly parallel with that of the revolution of the Lunar nodes.

The objections to this theory, are First, the precise dimensions of this ring of matter have not yet been ascertained; and different astronomers, with equal confidence form different conclusions relative to its size and shape, and until these are positively known, no rational or conclusive demonstration can be made of the nature and power of its attraction.

Again, this cannot consistently be considered as a case parallel with that of the Lunar motions. In fig. 1, pl. 3, let S be the Sun, E the Earth, S E the plane of the Ecliptick, A O the ring of matter about the Equator. Now, it is evident, that whatever be the size of the ring, equal portions of it are on each side of the Ecliptick ; that is, the centre of attraction passes through the centre of the matter of the Earth and its ring ; so that all the effect, which the attraction of the Sun can have, in consequence of the ring, arises merely from the different distances of A and O equal to the diameter of the Earth ; and such an effect as this, if it is any sensible effect, it can have only at the solstices ; for, at the Equinoxes, the portions of the ring on each side of the Ecliptick are at equal distances from the Sun ; and of course, from the solstices to the Equinoxes the effect, if any must be constantly diminishing. But while the Moon, by reason of the angle of its orbit, is at a distance from the plane of the Ecliptick on one side, there is nothing on the other side to balance it, or to prevent it from being hastened, by attraction, to the plane. In fig. 2, pl. 3, let L P be a portion of the moon's orbit, M the moon, and S E the plane of the Ecliptick. It is evident, that when the Moon is at L, there is nothing at P to balance it.

Again, suppose the orbit of the moon was a ring of moons, or any material substance, the case would be different from that of the Equatorial ring, because the greater difference in the distances of the different parts of the ring would more materially affect the ratios of gravitation.

The precession of the Equinoxes, if caused by the Equatorial ring, must arise, either from a diminution of the angle of the Equator with the Ecliptick, or from a change in the direction of the line of the Equatorial Nodes.

As to the former, we have no evidence, that there is such a regular diminution of the angle ; but on the contrary, we know that a diminution of the angle, sufficient to produce the annual precession of the Equinoxes, would have made a sensible effect upon the seasons.

With regard to the latter it is difficult, if not impossible to see any method in which a regular and successive variation of the line of the nodes should be effected. In relation to the moon, we can see no rational method of accounting for the entire revolution of its nodes, except the eccentricity of its orbit. If the Earth was in the centre of the moon's orbit, there would still be a motion of the nodes backward and forward, but no revolution. The centre of the Equatorial ring is the centre of revolution and attraction, and we know not how a revolution of the Equatorial Nodes could be effected.

As the Moon has more effect upon the Earth than the Sun has, and especially upon the Equatorial ring, it is probable, that the variation of the Ecliptick angle, and the consequent nutation of the Earth's poles are occasioned by it. But it will readily be seen, that this effect must be very irregular, and could result in nothing like the annual precession of the Equinoxes.

How far these objections affect the prevailing theory, I leave for others to judge. They certainly render it obscure, and until some of them are removed, I shall be disposed to give credence to the following simple, consistent, and interesting theory.

The precession of the Equinoxes is caused by the revolution of the Solar System round a distant centre.

In fig. 3, pl. 3, let C be the grand centre, around which the Solar System revolves ; A P L the orbis mundorum, or a portion of the circle of this revolution ; S a fixed star, and E L V the Ecliptick.

When the earth is at the first of aries E, let a spectator view the Star S carefully noting its position ; and if the system did not move, while the earth was performing one annual revolution, the star would appear in the same position again when he arrived at the first of aries. But while the Earth is performing one annual revolution in the direction E L V the system moves from O to P ; so that in relation to the Sun the revolution is completed at R, and R N T may now represent the Ecliptick. But the position of the Star S is different when seen from R, from what it was, when seen from E : of course the earth must move from R to E to complete the siderial year, and the distance R E or O P is the precession of the Equinoxes, or the difference between the Solar and Siderial year. Since, therefore, no other satisfactory reason can be given for this phenomenon, and such a revolution appears very probable from analogy, the precession of the Equinoxes is a strong proof of the revolution.

Corollary 1. The Solar System revolves from *west* to *east*, like the Earth in its orbit : for if it revolved the other way it would produce an effect contrary to that of the precession.

Corollary 2. This revolution affects all the bodies in the solar system ; and the discovery of its effect upon any one of them, would be an additional confirmation of this theory.

Corollary 3. The earth and planets, in their revolutions, never perform complete circles or ellipses; for the system moving from E to R, during one revolution of the earth, the earth cannot get back to the point E, from which it started, and of course its orbit will be a spiral line.

From the past progress of science, we may confidently expect, that the time is not far distant, when new investigations and discoveries shall not only place beyond a doubt the revolution of the solar system, but also make known the *distance* of the system from its grand centre, and the *time* of its revolution. U. C. B.

Middlebury, Ver. August 28, 1823.

Art. XIV.—*Description of an improved Rain Gage; by* Mr. George Chilton, *Lecturer on Chemistry.*

The quantity of rain that falls in any particular district being an important item in Meteorology, any improvement in the instruments of observation by which that quantity can be determined correctly, must be acceptable to the cultivators of that department of science. In the common construction of the Rain Gage several causes of error are manifest, which when taken separately, might be deemed trivial, but whose combined effect is such as every accurate observer must be desirous of avoiding. It is well known that fluids undergo changes in bulk by changes of temperature, as well as by those of barometrical pressure; and that any mode of measuring the dimensions of a fluid, exposed to the influence of these fluctuating causes, provided it does not make due allowance for them must be erroneous.

In addition to these causes of irregularity, the cohesion of the fluid, which is necessarily connected with the measurement by graduated rods, renders it impossible to determine the true height of it.

But besides these obvious causes of inaccuracy, the fluid in the common construction of the Rain-Gage, is too much exposed to spontaneous evaporation. This might, in part, be remedied by narrowing the neck of the funnel, but here another difficulty arises: if the aperture, by which the water enters the gage be too small, the funnel, in a smart shower, might be filled to overflowing; by which a part of the water would be lost.

The following is a description of a Rain Gage constructed on principles, by the help of which, the quantity of rain that falls into it can be accurately determined in inches of altitude, without being affected by the causes of error alluded to above.

An essential part of the Rain Gage is a prismatic vessel, Fig. 4 & 5, Pl. 2. whose top and bottom are, each 10 inches square, inside measure, with any convenient height.

This is all that is necessary for occasional experiments, as for instance, to determine the quantity of rain, snow or sleet, that may fall in winter when the evaporation is inconsiderable, or the quantity of rain that falls in a single shower, at any other season. But to answer all purposes, it must be provided with a cover, in the centre of which is inserted a funnel, whose top has the same area, as that of the top or bottom, of the prismatic vessel above. To prevent evaporation the orifice of the funnel is furnished with a valve against which a weak spring, attached to the inside of the cover, presses with a force just sufficient to close it, but which is overcome by the weight of a few drops of rain. It is evident that in a shower the water will open the valve, and after it has passed into the body of the gage, the valve will close the orifice again, suffering, however, the drainings of the funnel to pass along the pendant wire by cohesive attraction.

This top, with its funnel and appendages, may be fitted on the body of the gage, like the lid of a common tea canister.

The water being thus introduced into the gage, the method of determining its altitude in inches and decimal parts depends upon the following fundamental statements, in connection with the simple operation of weighing the water in the gage.

Fundamental Principle.

A cubic inch of distilled, or rain water, under a medium pressure and temperature weighs 252.525 grains; according to the latest corrections. Now this number, multiplied by 100, the area of the funnel, in square inches, or that of the top, or bottom of the body part of the gage, gives 252525 grains for the weight of 100 cubic inches of water. Supposing this quantity of water in the gage, it would, evidently, form a stratum on the bottom of one inch in height; and if we conceive this stratum to be divided, by horizontal sections, into 100 equa parts, these parts would form strata, each of which would be the $\frac{1}{100}$th of an inch in height; and, being equal to a cubic inch, would weigh 252.525 grains. Let us further suppose that one of these strata is subdivided into 10 equal parts by sections in the same direction, each of these parts would, evidently, form a stratum of water, whose height would be only the $\frac{1}{1000}$th part of an inch; and being equal to the 10th part of a cubic inch, would weigh 25.2525 grains.

Having then, the weight of 100 cubic inches corresponding to one inch in altitude; the weight of one cubic inch to the $\frac{1}{100}$th of an inch; and the $\frac{1}{10}$th of a cubic inch to the $\frac{1}{1000}$th part of an inch; it is easy to see that the height of the water in the gage may be obtained by making one, or other, of the above numbers a divisor to the corrected weight of the water, in troy grains. But this trouble is rendered unnecessary by the use of the *following tables* :—

Table 1. *Troy Weight.*

		Grains.
One pound troy,	=	5760
One ounce,	=	480
One drachm,	=	60
One scruple,	=	20

Table 2. *For Reducing Avoirdupois Weight.*

		Troy Grains.
One pound avoirdupois,	=	7000
Half pound,	=	3500
$\frac{1}{4}$ of a pound,	=	1750
Two ounces,	=	875
One ounce,	=	437.5
Half ounce,	=	218.75
Quarter ounce,	=	109.375

TABLE 3.

Corrected weight of water in grains Troy.		*Corresponding altitude in inches &c.*	*Corrected weight of water in grains Troy.*		*Corresponding altitude in inches.*
25.2525	-	0.001	2525.250	-	0.10
50.5050	-	0.002	5050.500	-	0 20
75.7575	-	0.003	7575.750	-	0.30
101.0100	-	0.004	10101.000	-	0.40
126.2625	-	0.005	12626.250	-	0.50
151.5150	-	0.006	15151.500	-	0.60
176.7675	-	0.007	17676.750	-	0.70
202.0200	-	0.008	20202.000	-	0.80
227.2725	-	0.009	22727.250	-	0.90
252.525	-	0.010	25252.500	-	1.00
505.050	-	0.020	50505.000	-	2.00
757.575	-	0.030	75757.500	-	3.00
1010.100	-	0.040	101010.000	-	4.00
1262.625	-	0.050	126262.500	-	5.00
1515.150	-	0.060	151515.000	-	6.00
1767.675	-	0.070	176767.500	-	7.00
2020.200	-	0.080	202020.000	-	8.00
2272.725	-	0.090	227272.500	-	9.00
			252525.000	-	10.00

An example shewing the use of the tables.

Suppose the weight of the water in the gage, corrected by subtracting the weight of the gage, to be 20lb. 5½ ounces avoirdupois, required the height or number of inches of rain?

1. From Table 2. lb. oz. 20 5½ =

1lb. = 7000gr. which × 20	=	14000
4 oz.	=	1750
1 do.	=	437.5
½ do.	=	218.75

The sum = the weight in grs. 142406.25

2. If the weight, reduced to grains, be found in table 3d, the corresponding height will be found opposite to it in the adjoining column; but as, in this example, it is not, take the nearest, *less*, number to it from the table, and subtract it from the weight of the water, marking the corresponding

height, in inches &c. Enter the table a second time with the difference and take the nearest *less* number to *it*, together with its correspondent height, which subtract from the difference, and with the remainder enter the table again if necessary, thus,

	Wt. of water in grains.	Corresp't height.
the nearest number in the table, less than 142406.25, which must be subtacted, is - -	126262.5	500
difference - - -	16143.75	
The next number in the table, less than the difference, is - - -	15151.5	0.60
which, when subtracted, leaves the remainder - - - - -	992.25	
the nearest number corresponding to the rem. in the table is - - -	1010.1	0.04
The sum of the corresponding heights gives—Inches		5.64

It is obviously not necessary to be restricted to either the form, or the size of the above described gage. If the cylindrical form be thought to possess any advantages over that of a square prism, it is easy to find the diameter of a circle whose area shall be equal to one hundred square inches, by the well known rule, viz. $d=\sqrt{\frac{a}{.7854}}$, where d represents the diameter, a, the area, and .7854 the area of a circle, whose diameter is unity. If any other size should be thought more convenient, as for instance, one whose area is only *half* of that of the above described gage, the same rule, if cylindrical, will give the corresponding diameter, or if a square mouthed one be preferred, the side of the square is obtained by extracting the square root of fifty. But it must be remembered that whatever relation the area, we pitch upon, may bear to one hundred square inches, the same relation will subsist between the final result, and that which is given by the tables: thus if the area of the gage be fifty square inches, as this is the half of one hundred, we must take half the sum of the tabular heights for the true altitude.

It is not necessary to be very particular in the choice of a balance; a pair of good common scales will answer, with true weights, either troy or avoirdupois. The gage may be made of tin, or sheet iron painted or japanned, but copper is more durable. The area of the funnel, and that of the top of the body part, are the only parts that need attention in the construction. These ought to be made tolerably exact. A strong hoop should be fixed around them on the outside to preserve their figure true.

In every operation of weighing, the weight of the gage, moistened in the inside, must be deducted from the gross weight; the remainder is the corrected weight of the water with which the tables must be entered.

In the case of hail, snow, sleet, or frozen water, being in the gage, it is not necessary to melt its contents into water, as the changes effected by temperature and pressure make no difference in the weight.

The use of scales and weights may be dispensed with, by substituting a steelyard, so constructed that the moveable weight on its arm might indicate by its position, *not the* weight, but the inches and decimal parts of its corresponding altitude, without reference to the tables, and without calculation.

The advantages of this method of finding the quantity of rain, in linear inches of altitude, will be appreciated by adverting to the circumstance of our having a *tangible* quantity, as an unerring guide to that which is nearly imperceptible. Twenty five grains and a half, a sensible quantity in a good balance, pointing out the difficultly visible division of the $\frac{1}{1000}$ part of an inch. Suppose the problem reversed; that the cubical contents of the water, or its weight, were required, from the observed attitude. The chances of error would all be against the accuracy of such a determination. The difficulties of the task, independently of the aforementioned causes of variation, would evidently be insurmountable.

I had a gage constructed on this principle, twelve or fourteen years ago, for my friend Dr. Akerly, who informs me that it answered the end extremely well. This testimony in its favour is not among the least of those considerations that have induced me to make it more generally known. G. C.

See plate 2, where Fig. 4 represents the rain gage in perspective.

Fig. 5 is a vertical section.

G the body of the gage, F its funnel, L the lid or cover, *v* the valve, hinged to the lower orifice of the funnel, *s* the spring to close the valve, *w* a wire to conduct the drainings of the funnel into the body of the gage.

Art. XV.—*Account of Mr. Perkins' method of applying his New Method of Generating Steam to the Boilers of ordinary Steam-Engines.* (Edinb. Philos. Journ. No. XVIII.)

Having in our last Number given a very full, and we trust perspicuous account of Mr. Perkins' new Steam-Engine, we shall now proceed to lay before the reader Mr. Perkins' own account of his method of applying the new principle to steam-engines of the old construction. This account is taken from the specification of his patent, which is now open to the inspection of the public.

In order, however, that a correct idea may be formed of the original principle itself, we shall prefix Mr Perkins' own account of the generator, although we have already given a general description of it in our last Number.

"Plate IX. Fig. 1.* represents the general construction of the apparatus; *a*, *a*, *a*, is the generator shewn in section. It is a strong cylindrical vessel, made of metal, about three inches thick in every part, which may be a guide to the comparative dimensions of the other parts of the apparatus. This vessel is to be filled with water, and heated by a furnace circumscribing it. On the top of the generator there is an escape valve *b*, pressed down by the weighted lever *c*, the pressure being adjustable by the shifting of the weight. The valve opens to the steam-pipe *d*, which is to be supposed as proceeding to the working piston of the engine. The lateral pipe *e*, extending from the generator, is

* See Plate IV. Am. Journ.

merely for the purpose of safety; and at the end of it there is an apparatus *f*, attached, by which the pressure is indicated; *g*, is the feeding or injecting pipe leading from the forcing pump *h*, which may be worked by a connexion to the moving part of the engine.

"In order to generate steam, the vessel *a* must be filled with water, or other fluid or fluids, from the pump *h*, and heated by a furnace, or otherwise: the steam, or escape-valve *b*, being loaded by means of a weight, with a pressure greater than the expansive force of the steam, to be generated from such water, or other fluid or fluids, at the time of its generation. When the water, or other fluid or fluids, in the generator, has attained the necessary degree of heat, say from 400 to 500 degrees of Fahrenheit, more or less, an additional quantity of water, or other fluid or fluids, is pumped into the generator, sufficient to force out a portion of that already heated in the generator from under the weighted-valve *b*, into the steam-pipe *d*, where it instantly becomes steam.

"An enlarged representation of the valve, and its seat, is shewn in the section, Fig. 2. The valve is a spherical bulb, falling into a concave seat, in the lower part of the square chamber; the upper part of the valve is a cylindrical rod, upon the top of which the weight of the pressing-lever is exerted; the lower part of the valve is a triangular stem, sliding up and down the cylindrical passage. When the additional quantity of water is injected into the generator, by means of the force pump as described, the bulb of the valve rises from its seat, and a corresponding quantity of heated water passes up between the cylindrical passage and the sides of the triangular stem, into the square chamber, where the pressure no longer operating upon that portion of the water, it immediately becomes steam, and passes forward through the steam pipe to the working cylinder.

"In order that the operations may be renewed, and continued regularly, I make use of an adjusting weight on the handle of the pump *i*, which is a small single-stroke forcing-pump, with a weight performing the office of an air-vessel. At the end of the pump-handle is a chain *m*, which I connect with a simple crank movement, and thus, by a corresponding adjustment between the weighted steam, or escape-valve *b*, the throttle valve, (which it is not thought necessary to shew in this drawing) and the weight on the handle of the pump *i*, a certain quantity of water is forced into the generator, at every stroke of the pump, and a corresponding quantity forced from under the weighted valve *b*, to become steam.

"These principles may be modified and applied to the boilers of ordinary steam-engines, a mode of adopting which is shewn in Fig. 3. The invention is here represented under another form, and differently employed, being a plan for heating the water of an ordinary engine-boiler, with a view, principally, to save fuel: *z*, is a tube communicating with the ordinary steam-boiler; *a*, *a*, is the generator, a cylindrical metallic vessel, of which there may be several connected together; these are filled with water as above described, having the furnaces *y*, *y*, under them; *b* is the escape-valve through which the heated water passes; *c*, is the weighted lever pressing down the valve with the required force: *d*, is the chamber and pipe, in which the heated water that escapes through the valve becomes steam, and thence passes through the tube *z*, into the boiler. This boiler (of a cylindrical form with spherical ends) is proposed to be inclosed within a cask or other vessel, and surrounded with pounded charcoal, which material being a very imperfect conductor of heat, is particularly well calculated to preserve the heat of the water and steam within the boiler; *e*, is a pipe leading from the generator, which is also filled with the heated water; and at the lower end of this pipe there is an apparatus *f*, for ascertaining the pressure of the fluid within the generator. This fluid, by exerting its force at the lower end of the pipe *e*, against the lever connected to a weighing-machine, causes the index to point out upon the graduated dial-plate the number of atmospheres under which the steam is generated. The pipe *e*, being in substance considerably thinner than any other part of the apparatus, is intended to give way, in the event of the pressure within the generator being accidentally raised to a dangerous height; the consequence of which would be, that the pipe *e* would open, and the steam blow out through the fissure, without the possibility of producing any injury; *g*, is the pipe through which the water is injected by the pump *h*, from the reservoir to the generator; *i*, represents the flue or chimney, from the furnaces below.

"The continued passage of high pressure steam (generated as above) through the tube z, heats the water, which occupies about half the interior of the boiler, and by that means a sufficient quantity of Steam may be produced in the boiler for working an engine of the ordinary construction, and with a very important saving in the quantity of fuel, compared to what would be consumed, to effect the same purpose, by any other plans heretofore adopted."

"Now, whereas the materials of which my said improvements are constructed, and the exact proportions of the relative parts, are not subjects for which I hereby claim exclusive privilege, though I have described those materials and proportions which I have found most useful; neither do I hereby claim exclusive privilege for the peculiar forms of the various mechanical agents which I employ, but only for a combination of such and the like agents as will produce the said improvements, the nature of which is herein before declared, and for which a claim to exclusive privilege is hereinafter made. *And whereas*, I have only represented in my said drawings annexed, such parts of a steam-engine as comprise my said improvements, the various mode of applying such said improvements, by means of the steam-pipe being too well known to require particular description here. *And whereas*, my said generator may be heated by a variety of known furnaces, I have not described any one in particular, but the one I have used and found to be the best is one of the cupola kind, fed by a blast. *And whereas*, I have described in my said drawing, Fig. 1, a safety-pipe and indicator, and a forcing-pump, neither of which are in themselves new, but which apparatuses, or similar ones, constitute a combination necessary to my said improvements, and are inserted as such; I therefore hereby claim exclusive privilege for the following improvements only: *that is to say*, *first*—for heating water or other fluid or fluids, for such purpose of generating steam for steam-engines, in a vessel or vessels, kept (during such process of heating) full of such water or other fluid or fluids, and under a pressure greater than the expansive force of the steam to be generated from such water or other fluid or fluids, at the time of its generation.

"*Secondly*,—For causing such water, or other fluid or fluids, so heated as aforesaid, to escape from under the said pressure, and pass at once from the generator into the steam pipe, where it becomes steam or vapour, and in that form may pass thence to the cylinder, or to any other situation connected with a steam engine, without the necessary intervention of any steam-chamber, or other reservoir of steam.

" *Thirdly*,—For the manner of causing such water or other fluid or fluids to escape as aforesaid, that is to say, by forcing other water or fluid or other fluids into the generator, until the pressure against the steam valve shall cause it to rise, the valve being so loaded as not to rise, except by means of such extra pressure as aforesaid.

" *Fourthly*,—For the general application of such water, or other fluid or fluids, so heated as aforesaid, and of the steam or vapour generated thereby ; whether such steam or vapour be employed through a steam-pipe without a steam-chamber, or reservoir to act immediately on the piston, or to be collected in areservoir or steam-chamber, and thence to act on the piston, or only for heating water to generate other steam, or for any other purpose or purposes whatsoever, provided always, that such general application as aforesaid be for the purposes of steam-engines."

The Editor of the London Journal of Arts, from which we have taken the preceding specification, informs us, that the mode of applying this principle to a variety of operations in which heating may be requisite, is embraced by a second patent to be specified in November, and that the mechanical construction of the working parts of the engine will be explained in the specification of the third patent, which will be enrolled in December.

The same writer informs us, that several of the new engines which have been ordered, are at present constructing; and particularly, that an engine of about 80-horse power, for the purposes of steam navigation, is in considerable forwardness, and will probably be in operation between London and Margate before the end of the present summer.

Art. XVI.—*Notice of a Halo, by Thomas Kendall, in a letter to the Editor.*

New-Lebanon, Jan. 1, 1824.

Sir,

On the 2nd of July last a most extraordinary phenomenon of halos around and about the sun was witnessed in this vicinity. I do not know that it has been reported by any one: thinking that it may not be wholly uninteresting to you, I shall attempt a description. The weather had been dry and warm for two or three weeks previous. On the 2nd the atmosphere was a little smoky, at 1 o'clock P. M. the sun was hid by a thin *stratum* of clouds, not very compact, and evidently assuming a more uniform appearance, which was succeeded by a few scattering drops of rain. At 2 o'clock, I first discovered the halos. The clouds had mostly disappeared or had become thin and uniform, having the common consistence of vapour which is usually accompanied with halos. The sun was surrounded by a circle or halo of the common size, but much more brilliant, resembling the rainbow quite as much as it did the ordinary halo; the area of this circle was much darker than the surrounding space. North of this, with its periphery passing into the sun, appeared another halo, once and an half the diameter of the first, not so bright as the former, but more so than usual; the area of this was darker than the surrounding space, but not as dark as the other. The north side of this halo was intersected at one place by segments of two others not quite as brilliant as the last, whose relative diameters could not be ascertained but were evidently larger, and if they were in fact portions of perfect circles, I thought at the time, that like the last they were bounded by the sun; at each intersection the brilliancy was increased in proportion to the number of circles crossing each other. A little to the East of south, and about half way from the south side of the primary halo to the horizon appeared a portion of 15 or 20 degrees of another halo apparently having the sun for its centre, and as bright as the primary one, this was mistaken by some for a rainbow; at one time I discovered (as I supposed) portions of this halo intersecting the second on the east and west sides, but at that time the intersections on the north side were not visible. These appearances were not of long continuance, nor constant in their arrangement, but, beautiful and sublime beyond description. Unwilling to trust to memory as the only memento of such extraordinary phenomena I made a sketch at the time, which, imperfect as it is, is probably the only one taken, and is now respectfully presented you. I regret that it did not fall to the lot of some person better qualified than myself to describe it. (See plate 3. Fig. 4.)

Of halos, having the sun in the centre, perhaps the cause has been satisfactorily explained, but of those whose periphery is in the sun, as respects their locality I can myself form no idea. From what was seen at that time, I am however fully satisfied there is a possibility of the atmosphere being so charged, as that the whole concave of Heaven would be covered with similar appearances. T. K.

Art. XVII.—*On the Theory of the action of the Deutoxide of Azote, or Nitrous Gas in Eudiometry;* by James Freeman Dana, *Professor of Chemistry and Mineralogy in Dartmouth College.*

The deutoxide of azote or nitrous gas appears to be the first substance introduced for the express purpose of analysing the atmosphere. It owes its application, in the processes of Eudiometry, to Priestley, its discoverer; its use is founded on the facility of its union with oxygene gas; when the two gases come in contact, red vapours are produced, which are rapidly absorbed by water.

It appears to be established, by multiplied experiments, that the atmosphere contains 21 volumes of oxygene gas in 100; yet the deutoxide of azote has sometimes indicated much more, at other times much less, and has seldom afforded uniform results. Priestley was led to suppose that there was a very perceptible difference, as indicated by nitrous gas, between the external air, and the air of his study after a number of persons had been sitting there; and that air in the neighborhood of York was not as good as that near Leeds. Yet there is not found to be a perceptible difference in the quantity of oxygene contained in the air in different places, even in situations most favorable for producing decided differences, provided no uneasiness is produced by the respiration of such air. The experiments of Cavendish are characterized by great accuracy, yet even in his hands, nitrous gas seems to have been capricious in its effects, producing at one time a diminution in a mixture of 125 nitrous gas and 100 of air of 115 parts, at other times of 121.2 parts.

Chymists seem to have bestowed peculiar attention on this subject; both to ascertain the causes of variation in the effects produced by nitrous gas in eudiometry, and to discover some method of using it with unerring accuracy in the analysis of the air; yet there are other methods which appear more eligible. Davy proposed to use this gas condensed by absorption in a solution of muriate of iron; Dalton affirms that, if *dilute* oxygene gas and *dilute* nitrous gas are mixed together in very narrow tubes over water, an uniform diminution of bulk occurs, and consequently the proportion of oxygene can be deduced; Dr. Henry denies that any reliance can be placed on the indications of nitrous gas employed in Dalton's method, when the air submitted to the examination, contains much more or much less oxygene than 21 per cent. It is unnecessary to refer to any other method of using this gas in eudiometry than that proposed by Gay Lussac; a method which is preferable to any other, since it affords uniform results. It is almost unnecessary to say, that the method consists in introducing a portion of air previously measured in a graduated tube, into a wide vessel, like a tumbler, over water, and afterwards adding an equal portion of nitrous gas; red vapours are produced; the mixture is suffered to stand one minute and then transfered to the graduated tube, and the diminution in volume noted; this divided by 4 gives the quantity of oxygene. The diminution, if 100 parts of air and of nitrous gas be used, will be nearly 84 parts; and $84 \div 4 = 21$. In my own trials of this method, there has been a close correspondence between the results, and those afforded by Hydrogene and the electric spark.

The true theory of the effect, thus produced by nitrous gas, has never yet been explained in any chymical book; authors uniformly ascribe it to the formation and absorption of *nitrous acid*. The latest chymical publication, *Ure's Dictionary of Chymistry, 2d edition, Lond.* 1823, gives the same theory of its action. To shew the explanation of the effect of nitrous gas in eudiometry, as given by chymical authors, I will quote a passage from this dictionary; and do this because the editor is not less remarkable for sound criticism, than for fulsome flattery of Davy, for cavalier treatment of Thompson, and for total silence respecting the labors of the chymists in this country.*

"Nitric acid is composed of 100 parts of azote and 200 of oxygene, or of 100 oxygene and 200 of nitrous gas = (100 *o.*+100 *az.*) Nitrous vapour, or more properly speaking *nitrous* acid gas results from the combination of 100 oxygene with 300 of nitrous gas. Hence by giving predominance alternately to the oxygene and to the nitrous gas, we obtain 300 of absorption and *nitric* acid, or 400 of absorption and *nitrous* acid. The nitrous acid is an identical compound, very soluble in water, which it colours at first blue, then green. and lastly orange-yellow. This liquid with alkalies forms nitrites. These clear and simple facts constitute the whole theory of the formation of the nitrous and nitric acids by means of oxygene and nitrous gas, and perfectly explain the differences in the results of those who have operated with them."—Ure's Dic'y. article *Eudiometer*.

Now it is perfectly well established that *nitric* acid is a compound of 100 volumes of azote, united to 250 volumes of oxygene; this appears from the experiments both of Gay Lussac and Davy. (Vide Ure's Dictionary, article *acid nitric*.)

If 300 of nitrous gas, united with 100 oxygene. produce a diminution, by absorption, of 400, it is evident that it cannot be by the production of *nitrous* acid; because, (since nitrous gas contains one half its volume of oxygene,) the nitrous acid so formed would consist of 150 azote+250 oxygene; a relative proportion of the two substances which

*In this edition of Ure's Dictionary no notice is taken of the New Galvanic Instruments of Hare, or of the splendid results obtained by them in the hands of Silliman; nor is justice done to our countrymen respecting the oxy-hydrogene blowpipe: the Editor of the Dictionary cannot be supposed to be ignorant of these subjects, and a silence respecting them, is at once uncandid, disrespectful, and disgusting.

does not exist in any known compound of oxygene with azote. It is perfectly well established that

100 vols. of	oxygene	unite with	400 vols. of	nitrous gas	and form	Hyponitrous acid,
100	"	"	"	200	"	"	Nitrous acid, and
100	"	"	"	133.33	"	"	Nitric acid.

The existence of the *hyponitrous acid*, which has been doubted, is confirmed by the observations which follow.

When we mix, therefore, 100 parts of atmostpheric air, with 100 parts of nitrous gas, the diminution in volume,

if nitric acid only be formed, should be 49 parts;
if nitrous acid only, " " 66 parts;
if hyponitrous acid only, " 105 parts:

But experiment teaches us that the diminution of volume is actually 84 parts, and that all the oxygene disappears; now this degree of diminution can be produced only by the formation and absorption of *hyponitrous acid* and of *nitrous acid*; and the oxygene present is *equally* divided between them; viz.

50 vols. of oxygene	unite with	200 nitrous gas	and form	hyponitrous acid,
50 vols.	"	"	100	"	"	nitrous acid.
100			300			

Or, as in the analysis of the air, which contains 21 per cent. of oxygene, and the diminution amounts to 84 parts when 100 each of air and nitrous gas are employed,

One half its oxygen, equal - -	10.5 vols.
Unites, to form hyponitrous acid, with nitrous gas,	42.0 vols.
The remainder of the oxygene, - -	10.5 vols.
To form nitrous acid, unites with nitrous gas,	21.0 vols.
All of which are condensed, equal - -	84.0 vols.

The theory here proposed perfectly corresponds with the fact; and the experiment confirms the existence of hyponitrous acid; the degree of diminution cannot, I apprehend, be explained on any other supposition than that now made. The fact, that the water, which absorbs the red vapours, produces *nitrites* is no proof that *nitrous* acid, alone, is formed; we know very little about the *nitrites*; but it is very easy to conceive, from the relations of *nitrous* and *hyponitrous* acids, that. in concentrating a solution containing a mixture of salts, having these acids in their composition, that the whole may pass to the state of *nitrites* by the agency of air, heat, and moisture.

Variable quantities of these two acids may be formed, under the different circumstances in which the two gases are mixed; "this perfectly explains the differences in the results of those who have operated with them."

A great degree of reliance may be placed on the indications of nitrous gas as employed in the method of Gay Lussac; but for accurate experiments it will probably never supersede the use of hydrogene and the electric spark in Volta's eudiometer, or in the improved form of that apparatus proposed by Dr. Ure.

November 12, 1823.

Art. XVIII.—*On the Cutting of Steel by Soft Iron.* Editor.

At page 336 Vol. 6 of this Journal, the remarkable fact that soft iron, in rapid revolution, will cut the hardest steel, is described by the Rev'd. Herman Daggett. This fact does not appear, as far as I am informed in books, nor have I found that it was before known to practical men; it seems to have been discovered by the Shakers, who are remarkable for the neatness and expertness of their mechanical operations. As it is desirable that the experience of others, on this subject, should be made known, I will now add, that in June last. I saw Professor Robert Hare at Philadelphia, execute, with a common foot lathe, operations similar to those described by Mr. Daggett; they were however less energetic and decisive, as the machine did not produce so rapid a motion as that of Mr. Barnes.

I have however since repeatedly seen the experiment succeed, in the most perfect manner, at the manufactory of arms, belonging to Eli Whitney Esq. near this town. As water power is here applied with great facility and energy, a wheel of soft and very thin plate iron, six inches in diameter, and furnished with an axis, was made to revolve, with such rapidity, that the motion became entirely imperceptible, and the wheel appeared as if at rest. When pieces of the best and hardest steel, such as files, and the steel of which the parts of gun locks are made, were held against the edge, of the revolving soft iron plate, they were immediately cut by it, with a degree of rapidity, which was always considerable, but which was greater as the pieces of steel were thinner. Pieces as thick as the plate of a common joiner's saw, were cut almost as rapidly, as wood is cut by the saw itself. Considered as an experiment, merely, it is a very beautiful one, and in no degree exaggerated in Mr. Daggett's account. There is a very vivid corruscation of sparks, flying off in the direction of tangents, to the periphery of the cutting wheel, and an intense ignition of the steel, extending for a considerable distance ahead of the section, and on its sides, attends the operation. The impulse against the steel, is so strong, that in several instances, it was thrown against the opposite side of the room, with a velocity that might not have been without danger to a person standing in the way. It may be said, I believe, with safety, that none of the ordinary mechanical operations commenced upon cold and hard steel, will divide it with so much rapidity, as this mode of applying soft iron. After all it is evident that it is only a peculiar method of cutting red hot, or possibly white hot steel, for the mechanical force produces these degrees of heat, and it is one of the best methods of evolving heat by mechanical impulse. The steel of course loses its temper at the place of section, and there only, for the softening extends but a little way and is limited to a narrow portion, marked by the iris colours, known to be produced by heat upon steel.

The iron plate, as Mr. Daggett states, becomes only warm, and wears away, only very slowly; yet it does wear, for the edges are left rough, and the channel of section in the steel, exhibits, with a magnifier, minute striæ or grooves, running in the direction of the wheel's revolution. I know not that there is any reason to suppose, any peculiar electrical phenomenon, except that electricity always accompanies heat. It is plain from the important use made of this mode of cutting steel by the Shakers, and by Mr. Barnes, that it may be of considerable practical importance. As a philosophical experiment it is highly interesting, and it remains yet to be shewn, why the heat evolved by the impulse, should, nearly all be concentrated in the steel, and be scarcely perceptible in the iron. Neither is it perfectly clear that even ignited steel, should be so easily cut by the impinging of soft iron. No smith probably ever thought of attempting to divide steel by applying an iron tool.

Art. XIX.—*Results of the Analysis of the principal Brine Springs of the State of New-Nork,* by George Chilton, *Lecturer on Chemistry, &c.*

TO THE EDITOR.

Dear Sir,

As far back as the year 1810, samples of the different waters from the Saline Springs in the State of New York were sent to me, for chemical examination, by Col. Gibbs, who, as I understood at that time, intended to publish some account of them in the Journal, conducted by the late Dr. Bruce.—A paper exhibiting the particulars of this examination was left with Dr. Bruce some time before his death, for Col. Gibbs, who did not receive it, and which has not been heard of since.

The analytical results of the above examination having been preserved in my note-book, I have thought that, at a time when the growing importance of these springs seems to arrest the notice of every observer, these results although unaccompanied with the processes by which they were obtained, might not be uninteresting to the public.

Col. Gibbs consents to their publication in your valuable Journal. Should you think them worthy of a place, they may be accompanied with the following brief statement of the method of proceeding, made from memory.

1. The water of each bottle, after weighing it and taking its* specific gravity, was slowly evaporated to dryness in a glass basin.

*The water from the deep well at Montezuma was neglected in respect to its sp. gr.

One or two of the samples,had the odour of sulphuretted hydrogen, which was not regarded in the examination in consequence of the bottles being imperfectly corked. I think they were those from Montezuma.

2. The deliquescent salts were extracted from the dry residuum by digestion in alcohol, and separated from each other by converting them into sulphates in the usual way.

3. The mass, after the separation of the deliquescent salts, was dissolved in water and filtered. The carbonate and sulphate of lime left on the filter were separated by muriatic acid, &c.

4. The filtered solution was treated with carbonate of soda, boiled, and filtered; the carbonate of lime left on the filter indicating the quantity of sulphate of lime, decomposed.

5. To the last clear solution, neutralized by the addition of muriatic acid, muriate of barytes was added till it ceased to yield a precipitate; the quantity of sulphate of barytes shewing that no other sulphate existed in the water.

Yours with great respect

GEORGE CHILTON.

PROFESSOR SILLIMAN.

Chemical examination of waters from the Brine Springs in the State of New-York, 1810.

Bottle No. 1, Galen.

Sp. gravity 1.0544.

10132 grains equal to 38 cubic inches, nearly, yielded by evaporation 884 grains of dry solid matter consisting of

Mur. of Lime, - - -	5 grains,
Mur. of Magnesia,. - - -	3
Sul. of Lime, - - -	21
Car. of Lime, - - - -	1
Silex, - - - - -	.50
Mur. of Soda, - - -	853.50
	884

Bottle No. 2, Montezuma.

Sp. gravity 1.0161.

10823 grains, equal to 427 cub. inches, nearly, yielded by evaporation 266 of dry solid matter consisting of

Mur. of Lime, - - -	9 grains
Mur. of Magnesia, - - -	5
Sul. of Lime, - - -	15. 50
Car. of Lime, - - - -	1.
Mur. of Soda, - - -	235. 50
	266

Bottle from the deep well, Montezuma.

Sp. gravity uncertain.

11760 grains equal nearly to 43 cub. inches yielded 940 grains of dry solid matter, consisting of

Mur. of Lime, - - -	18 grains,
Mur. of Magnesia, - - -	4
Sul. of Lime, - - -	50. 75
Car. of Lime, - - -	25
Mur. of Soda, - - -	867.
	940

Bottle No. 3, Onondago.

Sp. gravity 1.0958.

9600 grains, equal to 34. 6 cub. inches, nearly, yielded 1357 grains of solid matter which consisted of

Mur. of Lime, - - -	8 grains,
Mur. of Magnesia, - - -	2
Sul. of Lime, - - -	37
Car. of Lime, - - - -	2
Mur. of Soda, - - -	1308
	1357

Table of the whole, reduced to centessimal proportions.

	100 cub. inch. No. 1, Galen. Sp. gr. 1.0544.	100 cub. inch. No. 2, Montezuma. Sp. gr. 1.0161.	100 cub. inch. Montezuma, D. Well. Sp. gr. ——.	100 cub. inch No. 3, Onondago, Sp. gr. 1.0958
	Grains.	*Grains.*	*Grains.*	*Grains.*
Muriate of Soda,	2246.05	551.52	2016.33	3780.34
Muriate of Lime,	13.15	21.07	40.75	23.12
Mur. of Magnesia	7.90	11.70	9.30	5.78
Sul. of Lime,	55.26	36.30	118.20	106.93
Carb. of Lime,	2.63	2.24	.60	5.78
Silex,	1.30			
Solid matter,	2326.29	622.93	2185 18	3921.85

Art. XX.—*Letter to the Editor, on some improved forms of the Galvanic Deflagrator; on the superiority of its deflagrating power; and on its anomalous polarity, whether tested by water, or the magnetic needle;* by Professor Robert Hare, M. D., &c.

After I had discovered that the deflagrating power, of a series of galvanic pairs, was surprisingly increased, by their simultaneous exposure, after due repose, to the acid, various modes suggested themselves of accomplishing this object. In the apparatus which I sent you, the coils, being all suspended to two beams, could be lowered into troughs, containing the acid. In another apparatus, of which I afterwards gave you an account, with an engraving for your Journal, the troughs containing the acid, were made to rise, so that all the plates might be immersed at once. A better mode has since occurred to me. Two troughs are joined lengthwise, edge to edge, so that when the sides of the one are vertical, those of the other must be horizontal. Hence, by a partial revolution of the two troughs, thus united upon pivots, which support them at the ends, any fluid which may be in one trough, must flow into the other, and, reversing the motion, must flow back again. The Galvanic Series being placed in one of the troughs, the acid in the other, by a movement such as above described, the plates may all be instantaneously subjected to the acid or relieved from it. The pivots are made of iron, coated with brass or copper, as less liable to oxidizement. A metallic communication is made between the coating of the pivots, and the galvanic series within. In order to produce a connexion between one recipient of this description, and another, it is only necessary to allow a pivot of each trough to revolve on pieces of sheet copper, severally soldered to the different ends of a rod of metal. To connect, with the termination of the series, the leaden rods, (to which are soldered the vices, or spring forceps, for holding the substances to be exposed to the deflagrating power,) one end, of each of the lead rods, is soldered to a piece of sheet copper. The pieces of copper, thus soldered to the lead rods, are then to be duly placed under the pivots, which are of course to be connected with the terminations of the series. The last mentioned connexion is conveniently made by means of straps of copper, severally soldered to the pivots, and the poles of the series, and screwed together by a hand vice.

Fig. 1 pl. 5, represents an apparatus, consisting of two troughs, each ten feet long, constructed in the manner which I have described. Each trough is designed to contain 150 galvanic pairs. The galvanic series in the upper trough is situated as when not subjected to the acid. In the representation of the lower trough, the galvanic series is omitted, in order that the interior may be better understood. The series belonging to this trough, may be observed below it, in three boxes, each containing 50 pairs, fig. 2. In placing these boxes in the trough, some space is left, between them and that side of the trough on which the acid enters, so that instead of flowing over them, it may run down outside, and rise up within them.

The pairs of the series consist of copper cases, about 7 inches long, by 3 inches wide, and half an inch thick ; each containing a plate of zinc, equidistant from its sides, and prevented from touching it by grooved strips of wood.—

Each plate of zinc is soldered to the next case of copper, on one side. This may be understood from the diagram, fig. 3. It must be observed, that the copper cases are open only at the bottom and top. They are separated from each other by very thin veneers of wood.

Fig. 4. represents a smaller trough, differing from the others only in length. This I made, with a view to some experiments on the comparative power of the galvanic pairs of the form of copper cases, with zinc plates, above described; and those made on Cruickshank's plan, or of the form used by Sir H. Davy, in the porcelain troughs.

Fig. 5. represents a box, containing 100 Cruickshank plates, (each consisting of a plate of zinc, and copper, soldered face to face,) and slid into grooves, at a quarter of an inch distance from each other; all the copper surfaces being in one direction, and all the zinc in the other. In this case the zinc plates are exposed only on one side. The surface on which the acid can act, is therefore the same as in a deflagrator of 50 pairs, in which each zinc plate is assailable on both sides. It ought to be understood, that the box containing the 100 Cruickshank plates is open at bottom, and is of such dimensions as to occupy the place of a box, containing 50 pairs of the deflagrator, receiving the acid in its interstices from below, in the same manner, by a partial revolution of the trough, fig. 4.

Fig. 6. represents a box, containing 200 Cruickshank plates. This differs from the common Cruickshank trough only in having the interstices as narrow as those between the copper and zinc surfaces of the deflagrator pairs, represented by fig. 2; and that the mode in which the acid is thrown off, or on, the whole series, does not differ, materially from that described in the instance of fig. 1.

On contrasting the deflagrating power of the series of 50, represented at fig. 4, with Cruickshank's plates in the box, that of the latter was found comparatively feeble, and even when compared with the Cruickshank trough, fig. 6. in igniting metals, or carbon, the power of the deflagrator appeared incomparably greater. The shock from the Cruickshank trough was more severe. You must recollect, that in former experiments I found that galvanic plates, with their edges exposed as they are in the porcelain troughs, used by Sir Humphrey Davy, were almost inefficient, when used without insulation, as the deflagrator pairs are. This demonstrates, that an unaccountable difference is producible in galvanic apparatus, by changes of form or position.

Being accustomed to associate the idea of the zinc pole, in a Voltaic series, with the end terminated by zinc, and the copper pole, with the end terminated by copper, I was surprised to find that, in decomposing water, the oxygen was attracted by the wire connected with the copper end of my deflagrator, while the hydrogen went to the wire connected with the zinc end. Subsequently, however, it occurred to me, that, in the deflagrator, the zinc pole is terminated by copper, the copper pole by zinc; and hence the apparent anomaly, that oxygen appears to be attracted by copper, and hydrogen to be attracted by zinc.

The projection from the carbon, exposed between the poles, takes place at the negative pole of the pile, and not at the positive pole, as you have alleged; and thus your observation, that the current of igneous matter, is from the copper to the zinc, is rendered consistent with the Franklinian theory.

On inspecting the diagram, No. 3, plate 5, it may be seen, that by the section, each copper case, appears like two plates C *c*, of which those marked C, only appear to be soldered to the connecting straps. Removing the portions of the cases marked *c*, the series would be reduced within the definition, above given, of series used in apparatus on the principle of the Couronne des Tasses, in which the zinc is positive. It would be surprising, that doubling the extent, or varying the position of the copper surfaces, should cause any change of polarity.

The observations, which are the subject of this communication, combined with those which you have made, of the incapacity of the Deflagrator, and Voltaic series in the usual form, to act, when in combination with each other; must justify us, in considering the former, as a galvanic instrument, having great and peculiar powers.

Since the above was written, I have tried my series of 300 pairs. The projectile power, and the shock, were proportionally great, but the deflagrating power was not increased in proportion. The light was so intense, that, falling on some adjacent buildings, it had fully the appearance of sunshine. Having had another series of 300 pairs made for Dr. Macnevin of New-York, on trying it, I connected it with mine, both collaterally, and consecutively, so as to make in the one case a series of six hundred,—in the other a series, half that in number, but equal in extent of surfaces. The shock of the two, consecutively, was apparently doubly as severe, as the shock produced by one; but the other phenomena seemed to me nearly equally brilliant, in either way.

The white globules which you noticed, were formed copiously on the ignited charcoal, especially in vacuo. I have not had leisure, to test them, being arduously occupied, in my course of Lectures, and in some efforts to improve the means of experimental illustration.

Account of an Electrometer with a single leaf by which the electricity excited by the touch of heterogeneous metals, is rendered obvious, after a single contact.

Fig. 7, represents an Electrometer, with a single leaf suspended from a disk of zinc, six inches in diameter, which constitutes the top of the instrument. Opposite to this single leaf, is a ball, supported on a wire, which may be made to approach the leaf; or recede from it, by means of a screw. Above the instrument, is seen a disk of copper, with a glass handle.* The electricity produced by the contact of copper and zinc, is rendered sensible in the following manner. Place the disk of copper, on the disk of zinc, (which forms the canopy of the Electrometer): take the micrometer screw in one hand, touch the copper disk

*For the experiment with this electrometor a metallic handle would answer. Its being of glass enabled me to compare the indication, thus obtained, with that obtained by a condenser.

with the other, and then lift this disk from the zinc. As soon as the separation is effected, the gold leaf will strike the ball, usually, if the one be not more than $\frac{5}{100}$ of an inch, apart from the other. Ten contacts of the same disks, of copper and zinc, will be found necessary to produce a sensible divergency in the leaves of the Condensing Electrometer. That the phenomenon arises from the dissimilarity of the metals, is easily shewn, by repeating the experiment with a zinc disk, in lieu of a disk of copper. The separation of the homogeneous disks, will not be found to produce any contact, between the leaf and ball. I believe no mode has been heretofore contrived, by which the electrical excitement resulting from the contact of heterogeneous metals, may be detected by an Electroscope, without the aid of a condenser. It is probable, that the sensibility of this instrument, is dependent on that property of electricity, which causes any surcharge of it, which may be created in a conducting surface, to seek an exit at the most projecting termination, or point, connected with the surface. This disposition is no doubt rendered greater, by the proximity of the ball, which increases the capacity of the gold leaf to receive the surcharge, in the same manner, as the uninsulated disk, of a condenser influences the electrical capacity of the insulated disk, in its neighbourhood. It must not be expected, that the phenomenon above described, can be produced in weather unfavourable to electricity. Under favourable circumstances, I have produced it, by means of a smaller Electrometer, of which the disks are only 2½ inches in diameter. The construction, as respects the leaf, and the ball, regulated by the micrometer screw, remaining the same; the cap of a Condensing Electrometer, and its disks, may be substituted for the zinc disk.

Art. XXI.—*Abstract of Mr. Faraday's Experiments on the Condensation of Several Gases into Liquids.* Edinb. Philos. Journ. No. XVIII.

This very valuable and interesting paper, which will appear in the second part of the Philosophical Transactions for 1822, contains Mr. Faraday's Experiments on *Sulphurous Acid, Sulphuretted Hydrogen, Carbonic Acid, Eu-*

chlorine, *Nitrous Oxide*, *Cyanogen*, *Ammonia*, *Muriatic Acid* and *Chlorine*. Although these experiments are scarcely susceptible of abridgement, yet we are compelled, by want of room, to leave out the few parts of the memoir which are less essential than the rest.

" *Sulphurous Acid.*—Mercury and concentrated sulphuric acid were sealed up in a bent tube, and being brought to one end, heat was carefully applied, whilst the other end was preserved cool by wet bibulous paper. Sulphurous acid gas was produced where the heat acted and was condensed by the sulphuric acid above; but when the latter had become saturated, the sulphurous acid passed to the cold end of the tube, and was condensed into a liquid. When the whole tube was cold, if the sulphurous acid was returned on to the mixture of sulphuric acid and sulphate of mercury, a portion was reabsorbed, but the rest remained on it without mixing.

" Liquid sulphurous acid is very limpid and colourless, and highly fluid. Its refractive power, obtained by comparing it in water and other media, with water contained in a similar tube, appeared to be nearly equal to that of water. It does not solidify or become adhesive at a temperature of 0° F. When a tube containing it was opened, the contents did not rush out as with explosion, but a portion of the liquid evaporated rapidly, cooling another portion so much as to leave it in the fluid state at common barometric pressure. It was however rapidly dissipated, not producing visible fumes, but producing the odour of pure sulphurous acid, and leaving the tube quite dry. A portion of the vapour of the fluid received over a mercurial bath, and examined, proved to be sulphurous acid gas. A piece of ice dropped into the fluid instantly made it boil, from the heat communicated by it.

" To prove in an unexceptionable manner that the fluid was pure sulphurous acid, some sulphurous acid gas was carefully prepared over mercury, and a long tube perfectly dry, and closed at one end, being exhausted, was filled with it; more sulphurous acid was then thrown in by a condensing syringe, till there were three or four atmospheres; the tube remained perfectly clear and dry, but on cooling one end to 0°, the fluid sulphurous acid condensed, and in all its characters was like that prepared by the former process.

"Sulphurous acid vapour exerts a pressure of about two atmospheres at 45°F. Its specific gravity was nearly 1.42.

"*Sulphuretted Hydrogen.*—A tube being bent and sealed at the shorter end, strong muriatic acid was poured in through a small funnel, so as nearly to fill the short leg without soiling the long one. A piece of platinum foil was then crumpled up and pushed in, and upon that were put fragments of sulphuret of iron, until the tube was nearly full. In this way action was prevented until the tube was sealed. If it once commences, it is almost impossible to close the tube in a manner sufficiently strong, because of the pressing out of the gas. When closed, the muriatic acid was made to run on to the sulphuret of iron, and then left for a day or two. At the end of that time, much protomuriate of iron had formed, and on placing the clean end of the tube in a mixture of ice and salt, warming the other end if necessary, by a little water, sulphuretted hydrogen in the liquid state distilled over.

"The liquid sulphuretted hydrogen was colourless, limpid, and excessively fluid. It did not mix with the rest of the fluid in the tube, which was no doubt saturated, but remained standing on it. When a tube containing it was opened, the liquid immediately rushed into vapour; and this being done under water, and the vapour collected and examined, it proved to be sulphuretted hydrogen gas. As the temperature of a tube containing some of it rose from 0° to 45°, part of the fluid arose in vapour and its bulk diminished; but there was no other change: it did not seem more adhesive at 0° than at 45°. Its refractive power appeared to be rather greater than that of water: it decidedly surpassed that of sulphurous acid. The pressure of its vapour was nearly equal to seventeen atmospheres at the temperature of 50°.

"The specific gravity of sulphuretted hydrogen appeared to be 0.9.

"*Carbonic Acid.*—The materials used in the production of carbonic acid, were carbonate of ammonia and concentrated sulphuric acid; the manipulation was like that described for sulphuretted hydrogen. Much stronger tubes are however required for carbonic acid than for any of the former substances, and there is none which has produced so many or more powerful explosions. Tubes which have held fluid carbonic acid well for two or three weeks together, have upon some increase in the warmth of the weather, spontaneously exploded with great violence; and the precaution of glass masks, goggles, &c. which are at all times necessary in pursuing these experiments, are particularly so with carbonic acid.

"Carbonic acid is a limpid, coulourless body, extremely fluid, and floating upon the other contents of the tube. It distils readily and rapidly at the difference of temperature between 32° and 0°. Its refractive power is much less than that of water. No dimunition of temperature to which I have been able to submit it, has altered its appearance. In endeavouring to open the tubes at one end, they have uniformly burst into fragments with powerful explosions.

"Its vapour exerted a pressure of thirty six atmospheres, at a temperature of 32°

"*Euchlorine.*—Fluid euchlorine was obtained by inclosing chlorate of potash and sulphuric acid in a tube, and leaving them to act on each other for twenty four hours. In that time there had been much action, the mixture was of a dark reddish brown, and the atmosphere of a bright yellow colour. The mixture was then heated up to 100°, and the unoccupied end of the tube cooled to 0°; by degrees the mixture lost its dark colour, and a very fluid ethereal looking substance condensed. It was not miscible with a small portion of the sulphuric acid which lay beneath it; but when returned on to the mass of salt and acid, it was gradually absorbed, rendering the mixture of a much deeper colour even than itself.

"Euchlorine thus obtained is a very fluid transparent substance, of a deep yellow colour. A tube containing a portion of it in the clean end, was opened at the opposite extremity: there was a rush of euchlorine vapour, but the salt plugged up the aperture; whilst clearing this away, the whole tube burst with a violent explosion, except the small end in a cloth in my hand, where the euchlorine previously lay, but the fluid had all disappeared.

"*Nitrous Oxide.*—Some nitrate of ammonia, previously made as dry as could be by partial decomposition, by heat in the air, was sealed up in a bent tube, and then heated in one end, the other being preserved cool. By repeating the distillation once or twice in this way, it was found, on after-examination, that very little of the salt remained undecomposed. The process requires care. I have had many explosions occur with very strong tubes, and at considerable risk.

"When the tube is cooled, it is found to contain two fluids, and a very compressed atmosphere. The heavier, fluid, on examination, proved to be water, with a little acid and nitrous oxide in solution; the other was nitrous oxide. It appears in a very liquid, limpid, colourless state; and so volatile that the warmth of the hand generally makes it disappear in vapour. The application of ice and salt condenses abundance of it into the liquid state again. It boils readily by the difference of temperature between 50° and 0°. It does not appear to have any tendency to solidify at —10°. Its refractive power is very much less than that of water, and less than any fluid that has been yet obtained in these experiments, or than any known fluid. A tube being opened in the air, the nitrous oxide immediately burst into vapour.

The pressure of its vapour is equal to above fifty atmospheres at 45°.

"*Cyanogen.*—Some pure cyanuret of mercury was heated until perfectly dry. A portion was then inclosed in a green glass tube, in the same manner as in the former instances, and being collected to one end, was decomposed by heat, whilst the other end was cooled. The cyanogen soon appeared as a liquid: it was limpid, colourless and very fluid; not altering its state at the temperature of 0°. Its refractive power is rather less, perhaps, than that of water. A tube containing it being opened in the air, the expansion within did not appear to be very great; and the liquid passed with comparative slowness into the state of vapour, producing great cold. The vapour, being collected over mercury, proved to be pure cyanogen.

"A tube was sealed up with cyanuret of mercury at one end, and a drop of water at the other; the fluid cyanogen was then produced in contact with the water. It did not mix, at least in any considerable quantity, with that fluid, but floated on it, being lighter, though apparently not so much so as ether would be. In the course of some days, action had taken place, the water had become black, and changes, probably such as are known to take place in an aqueous solution of cyanogen, occurred. The pressure of the vapour of cyanogen appeared to be 3.6 or 3.7 atmospheres at 45° Fahr. It specific gravity was nearly 0.9.

"*Ammonia.*—When dry chloride of silver is put into ammoniacal gas, as dry as it can be made, it absorbs a large quantity of it: 100 grains condensing above 130 cubical inches of the gas: but the compound thus formed is decomposed by a temperature of 100° F., or upwards. A portion of this compound was sealed up in a bent tube, and heated in one leg, whilst the other was cooled by ice or water. The compound thus heated under pressure, fused at a comparatively low temperature, and boiled up, giving off ammoniacal gas, which condensed at the opposite end into a liquid.

"Liquid ammonia thus obtained was colourless, transparent, and very fluid. Its refractive power surpassed that of any other of the fluids described, and that also of water itself. When the chloride of silver is allowed to cool, the ammonia immediately returns to it, combining with it, and producing the original compound. During this action a curious combination of effects takes place; as the chloride absorbes the ammonia, heat is produced, the temperature rising up nearly to 100°; whilst a few inches off, at the opposite end of the tube, considerable cold is produced by the evaporation of the fluid. When the whole is retained at the temperature of 60°, the ammonia boils till it is dissipated and re-combined. The pressure of the vapour of ammonia is equal to about 6.5 atmospheres at 50°. Its specific gravity was 0.76.

"*Muriatic Acid.*—When made from pure muriate of ammonia and sulphuric acid liquid muriatic acid is obtained colourless, as Sir Humphry Davy had anticipated. Its refractive power is greater than that of nitrous oxide, but less than that of water; it is nearly equal to that of carbonic acid. The pressure of its vapour at the temperature of 50°, is equal to about 40 atmospheres.

"*Chlorine.*—The refractive power of fluid chlorine is rather less than that of water.—The pressure of its vapour at 60° is nearly equal to 4 atmospheres.

Mr. Faraday has made many similar experiments on other gases, but though he has not succeeded in condensing any others than those which we have mentioned, yet there is reason to hope that he will ultimately succeed with some of them.

INTELLIGENCE AND MISCELLANIES.

I. Domestic.

1. *American Geological Society.*

Since the publication of the last notice the following donations have been made to the Cabinet and Library of this Institution, viz.

From Wm. Mc Clure, Esq. President of the Society.
6 Nos. of the Journal de Physique.
6 Do. of the Revue Encyclopedique.
1 No. Magendie's Journal of Physiology.
1 Do. Greenough's observations on Geology.
1 Box Glauberite of Spain.
Beudant's Travels in Hungary, 3 vols. 4to and an Atlas.
1 Box of Lava of Vesuvius.
From Prof. Olmstead, 1 box of Minerals.
1 Do. from Doct. Porter.
3 Boxes Do. from Doct. Emmons.
1 Do. from Major Delafield illustrating the Geology and Mineralogy of some parts of the shores of the great Western Lakes.

Prof. Dutton's Conics and Spherics.

2. *In the press—A Treatise on Conics and Spherics, by Rev. M. R. Dutton, Prof. Math. and Nat. Phil. Yale College.*

This work is intended as a continuation of President Day's (excellent) System of Mathematics, which is already introduced as a text book, in this and several other Colleges in the Union. We have no doubt from our knowledge of the talents and mathematical acquirements of Prof.

Dutton, that his work will prove a valuable addition to the department of learning to which it belongs.

3. *Boston Journal of Philosophy and the Arts, conducted by Drs. Webster and Ware, and Mr. D. Treadwell.*

We owe an apology to the conductors of this valuable Journal, for not noticing it in our former No. The four numbers, which have already appeared, furnish a very interesting supply of selections from the best European Journals, and several well written original articles. The greater part of the contents is selected, but there are several contributions from the Editors of the Journal and other Gentlemen of Boston.—There are among these an elaborate memoir by Dr. Warren on Embalming, and another by Dr. Ware on the fossil remains of the Mammoth. Dr. Webster has furnished an analysis of the late aerolite of Maine, in which he has found of Chrome 4 parts, Iron 14. 9, Nickel 2. 3. There is a very interesting account of an ascent to the extinct volcanic peak of Miste in Peru by Mr. *S*. Curson, late a resident in that country. We have been much interested with the numbers already issued, and we have no doubt that the future numbers of the Journal will do much to promote the cause of Science in this country.

4. *Annals of the New-York Lyceum.*

The members of the New York Lyceum have commenced the publication of their proceedings. Two numbers of the work have already appeared. "It is intended to be published in numbers at regular periods, as materials shall offer. Each number will be accompanied by one or more plates." It is intended, more particularly, to elucidate the Natural History of our Country. The two numbers already published contain 3 articles on Mineralogy, 3 on Botany, 5 on Zoology, and an analysis of the acid of the Rhus Glabrum by I. Cozzens. The most interesting paper is a description by Dr. Mitchell, of a new species of Cephalopterus (Sea Vampire,) the animal captured last winter off the Delaware, which attracted so much of the public attention. We are pleased to see this additional proof of the attention the sciences are receiving in this country.

5. *Griscom's Journal.*

Mr. Griscom's Journal of "a year in Europe" was published last September. We have read it with much interest. It abounds in minute details, but they are generally well chosen. The author appears to have accomplished the great object he had in view, viz. to give a detailed account of his observations on the sciences and arts, the institutions of education and benevolence, and the other moral features of society in the countries he travelled over. We have rarely seen so much interesting information on the above topics collected within the compass of a single work. The whole bears the marks of an active and inquiring mind actuated by a pervading benevolence. We are not surprised at the zeal which Mr. G. exhibits in the cause of general education, when we recollect that he was himself self-taught, and owed all his public education to the common schools, which form such a peculiar feature in the character of our country. Those who are in search of a plain statement of interesting facts will not be disappointed on a perusal of Mr. G's volumes ; but we cannot promise the same treat to those who are pleased only with the delicacies of taste, or the lofty speculations of politics.

J. G. P.

6. *Dr. Van Rensselaer on Salt.*

Dr. J. Van Rensselaer has recently published an Essay on Salt, read before the New York Lyceum ; containing notices of its origin, formation, geological position and localities, with a particular description of the American Salines, and a view of its uses in the Arts and Agriculture. It embraces a very extensive collection of facts on the above topics, and ought indeed to form a text book to every individual who engages in the search of this valuable mineral.

We observe certain statements in pages 44 and 45 respecting *red sand stone*, which we think may lead to error. Dr. Van Rensselaer there says, that red sandstone may be considered the peculiar repository of salt, and then alludes to the lofty and detached columns of dark red sandstone, found by Col. Long's party at the foot of the Rocky Mountains, as a member of the salt-formation.

He appears evidently to have confounded here, the old red sandstone below the coal strata with the new red sandstone or red marl, which by the united testimony of European Geologists is the peculiar repository of salt and gypsum. The order of super-position is very clearly laid down by Dr. James in his narrative.—First, the old red sandstone in highly inclined strata and steep ridges at the foot of the rocky mountains—then an overlying mass of grey sandstone or slaty clay connected with large bodies of trapp, extending over a large district characterized by its peculiar verdure—lastly, above this, the red friable sandstone, easily crumbling into sand and forming, when disintegrated, the sandy covering of the deserts ; in which were found large beds of gypsum and the numerous salines on the Canadian and Arkansa. This new red sandstone extended across the deserts till it was overlaid by the horizontal limestone. In the last number of the Geological Transactions is an account of a journey from Delhi to Bombay. This narrative discloses a similar arrangement of rocks. The province of Agimere is occupied by a nucleus of granite, gneiss, &c. On the Eastern border of the same, is an extensive tract of inclined quartzy sandstone reaching from Delhi southward beyond Agra. West of the nucleus is the extensive saline desert of Western India, consisting of the new red sandstone or alternating horizontal beds of rubbly sandstone, marl and clay. South of the nucleus is one of the most extensive trapp formations in the world. It extends over the greater part of Central India from Malwa to Poonah and even Goa. It has this peculiarity, that the trapp is not arranged in narrow ridges with naked intervals of the subjacent sandstone, but is spread like an uniform covering over the whole country. The same peculiarity was observed, though in a less perfect degree, in the trapp rocks at the foot of the rocky mountains.

Having visited the Western part of New York, and observed the arrangement of the rocks in that interesting region, we have been led to conclude that they might be reduced to a similar arrangement with the rocks of England in the late work of Messrs. Conybeare and Phillips. The upper rock is the horizontal limestone containing hornstone, madrepores, branched corals, and numerous shells, particularly univalves. This we venture to suggest as belonging to the great Oolite including the coral rag &c. Next beneath it is a series of beds of clay and marl of various colours, red, blue, &c. (perhaps the *lias.*) Lower down is a red friable sandstone containing the salt and gypsum and nodular sulphate of barytes. Very fine sections of these may be seen at Rochester and Lewiston, particularly the latter, where the high banks exhibit a perfect display of all the strata from the limestone down to the sandstone. If you cross the country in a line from Seneca Lake to the Catskill Mountains—you find after leaving the limestone a black horizontal argillaceous slate full of small bibalves.—This slate forms the shores of Cayuga and Seneca Lakes. Then advancing East to the head streams of the Susquehannah, you find a brown and yellow slate closely resembling the former.—As you go East, it turns red; till you finally reach the sandstones of the Catskill Mountains. East of that the country is evidently transition.—We have considered the slates between the two small lakes and the Catskill Mountains as belonging to the coal strata; east of which we find, among other rocks, limestone in inclined strata, abounding in shells and hornstone, (perhaps the Mountain Limestone.) Our principal object in these remarks is to fix the exact locality of the salt formation between the coal strata and the horizontal limestone, and to ascertain the position of the latter rock in the European order. We offer these remarks only as suggestions, and we should be happy if they might aid any one in arriving at more definite conclusions.

J. G. P.

7. *New Work on Dying.*

Wm. Partridge of New York has just published a Practical Treatise on Dying, &c. Mr. P. is an experienced dyer from Gloucestershire, England, and his work bears the marks of good sense and practical acquaintance with the subject treated of. His remarks on the defects in our woolen manufactures are interesting.

II. Foreign.

1. *Dr. Brewster's Memoirs.*

We have received from Dr. Brewster of Edinburgh, the following Memoirs, which he had obligingly forwarded to us, previously to their publication in Europe. We should have noticed them in our last number, had not ill health prevented. (Ed.)

1. *Description of a monochromatic Lamp, for microscopical purposes, &c.* (Trans. R. S. Ed.)—This lamp is constructed, so as to produce a homogeneous flame by the combustion of diluted alcohol, which burns with a light almost purely yellow, and the very few green and blue rays accompanying it, may be intercepted by a plate of the palest yellow glass. The lamp may be used with or without a wick. The best wick is a piece of sponge, and the volume of yellow flame may be greatly increased by covering it with a frame of wire gauze so adapted that it may be pressed upon the sponge when red hot. If a permanently strong light is required, the alcohol should be burned without a wick in a dish of platinum, heated by a spirit-lamp beneath it. The light of this lamp gives a perfect distinctness to microscopic objects, and removes all the errors arising from the different refrangibility of light.

Annexed to this *description*, are, a number of remarks on the following points relating to the absorption of prismatic colours.—1. The manner in which coloured media absorb the different portions of the prismatic spectrum.—2. The influence of heat in modifying this absorbent power—and 3, the determination of the question, whether or not yellow light has a separate and independent existence in the solar rays. This Dr. B. decides in the affirmative, and moreover that the prism is incapable of decomposing that part of the spectrum which it occupies.

2. *Additional observations on the connection between the primitive forms of minerals and the number of their axes of double refraction.*—This is a continuation of a former paper on the same subject. Since the publication of the former paper the objections to his principle have been re-

moved by correcting the primitive forms of the minerals which then stood as exceptions.

The present paper is principally occupied by a comparison of Haüy's Primitive forms with the fundamental forms of Mohs and the Optical System of Dr. Brewster.

The following Table will exhibit the results of this comparison.

Haüy's Primitive Forms.	Mohs' Fundamental Forms.	Brewster's Optical System.
Rhomboid Reg. Hexahed. Prism Bipyramid. Dodecahed.	Rhomboidal System	Crystals with ONE AXIS of Double Refraction.
Octohedron, Right Prism } Base square	Pyramidal System	
Right Prism–Base not square Oblique Prism Octohedron–Base a rectangle or rhomb.	Prismatic System	Crystals with TWO AXES of Double Refraction.
Cube Reg. Octohedron Rhomb. Dodecahed.	Tessular System	Crystals with THREE rectangular axes in a state of equilibrium and therefore producing no Double Refraction.

3. *On the distribution of the colouring matter and on certain peculiarities in the structure and optical properties of the Brazilian Topaz.* (Trans. P. S. Camb.)—The first part of this paper, on the distribution of the colouring matter, we could hardly render intelligible without the aid of the very beautiful accompanying figures. The colours are distributed with great delicacy, and are all referable to the red, yellow and blue rays, with the exception of two specimens which exhibited the green rays. The crystals in almost all Dr. B's specimens are tesselated in a peculiar manner, not *hemitrope* or turned half way round or any determinate portion of a circle, but *polytrope*, the principal sections of different laminæ forming different angles with one another.

The Brazilian Topazes differ from the blue and colourless Topazes of Aberdeensh. and New-Holland in their optical properties. The resultant axis of the latter is about 65°, that of the former varies from 50° 5′ to 43°. The tints of the former deviate more than those of the latter from the colours of Newton's scale and are produced by a polarising force of less intensity. The Brazilian Topazes are generally phosphorescent on a heated iron. The tesselated crystals exhibit it in a peculiar manner. The light of the nucleus is less intense than that of the border, sometimes it is entirely wanting. Sometimes the greatest intensity is at the boundary of the nucleus and the outer tesselæ. Many of the crystals contain a *white powder*, resembling in its analysis, the zeolites. Others contain *a bright red* substance in thin plates between the laminæ and in long stripes parallel to the axis of the prism. Its surface has a high metallic lustre and its structure appears crystallized. Berzelius has analysed the Brazilian Topaz and has found its composition exactly the same as in the other Topazes, except a little iron as colouring matter. Dr. B. suspects an error in this analysis from the great difference in optical properties, and he quotes the authority of Mr. Gregor, who found it to contain a portion of lime and potash. The white powder in some of these Topazes was found by Berzelius to consist of silex, alumine, lime and water. Dr. B. thinks it may be the topaz not crystallized.

4. *Account of the native Hydrate of Magnesia, dicovered by Dr. Hibbert of Shetland.*—It was found (1817) in Unst, traversing serpentine in all directions, along with Magn. Carb. Lime, forming veins from $\frac{1}{2}$ in., to 8 in. broad. Structure lamellar, colour white slightly tinged with green on the edges, transparent, opaque by exposure from disintegration of the laminæ, scratches talc; several specimens crystallized in a reg. hexahed. prism. Spec. Grav. 2.336. Composition, Magn. 69.75. water 30.25. It has *one positive axis* of double refraction perpendicular to the laminæ.

[Articles of Foreign Literature and Science Extracted and Translated by Professor Griscom.]

1. *Ores of Manganese.*—Berthier has analysed nine varieties of the ores of Manganese, viz. three of the Peroxide, one of the Hydrate, three of the Barytic variety, and two of the silicate. The following table exhibits the results of this able chemist. The Peroxide from Crettnich, near Saarbruck, is that which is abundantly used at Paris and in the north of France. It is confusedly crystallized in needles. The Peroxide from the isle of Timor, is amorphous, compact, of a pure black grey, with a slight metallic lustre, and is intimately mixed with carbonate of lime. The Peroxide from Calveron is much of the same character. The Hydrate is from Lavelline, department of Vosges; it is amorphous, cellular, of a deep metallic black, its powder of a deep brown, its fracture commonly granular, and sometimes lamellar. Its numerous cavities are filled with argil and oxide of iron.

The Barytic manganese forms a thick and extensive bank at Romaniche, in the department of Saone et Loire. There are two varieties called by the inhabitants *grey stone* and *burnt stone*. The former is much employed at Lyons and in the south of France, and even at Paris. The other Barytic species, from Perigueux, has the same aspect as the compact kind from Romaniche. The silicate from Saint Marcel, Piedmont, is of a greyish metalloidal black, compact, with considerable lustre. It is penetrated with a lamellar stony substance, white and hard, the nature of which is not known. The silicate from Pesillo, Piedmont, is compact, of a slightly greyish black, but almost without metallic lustre. It is intimately mixed with magnesian carbonate of lime, white and crystalline, whence its fracture is slightly lamellar.

	Peroxide.			Hydrate.	Barytic.				Silicates.	
					Romaniche.			Perigueux.	St. Marcel.	Pesillo.
	Crettnich.	Timor.	Calveron.	Lavelline.	Compact.		Earthy.			
Red oxide of Manganese,	0.823	0.750	0.640	0.762	0.688	to .703	.703	.641	.650	.842
Oxigene,	0.115	0.090	0.087	0.055	.071	.072	.067	.075	-	.067
Water,	0.012	0.010	0.011	0.078	.050	.040	.046	.070		
Red oxide of iron,	0.010	0.020	0.010	0.055	.015			.068	.012	
Insoluble gangue,	0.040	0.040	0.012	-	.026	.020	.056	.100		
Carbonate of lime,	-	0.090	0.240							
Oxide of Copper,	trace									
Alumine,	-	-	-	.0.050	-	-	-	-	0.30	
Barytes,	-	-	-	-	.150	.165	.128	.046		
Silica,	-	-	-	-	-	-	-	-	.262	.068
Lime,	-	-	-	-	-	-	-	-	.014	
Magnesia,	-	-	-	-	-	-	-	-	.014	
Peroxide of iron,	-	-	-	-	-	-	-	-	-	.028
Oxide of Cobalt,	-	-	-	-	-	-	-	-	-	.008
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	.982	1.013

2. M. Stromeyer, a distinguished professor of Chemistry at Gottingen, published about a year ago, the first volume of a work in which he intends to communicate in due order the result of his researches. As the well known ability and accuracy of M. Stromeyer, gives a high value to his labours, we doubt not that it will afford satisfaction to our mineralogical readers, if we state the analyses of the principal substances which he has examined.

1. *Arragonite.*—It will be recollected that M. Stromeyer was the first who discovered the presence of Strontian in this mineral, and thereby explained the singular anomaly which it presented, considered as pure Carbonate of Lime. Prismatic Arrogonite from Molina in Arragon, contains, Carbonate of Lime 95.68, Carb. of Strontian 4.02, Water of Crystallization 0.30=100. Nine of the Scapiform varieties contain of Carb. of Lime, from 95.30 to 99.13, Carb. of Strontian 0.72 to 4.10, Water 0.15 to 0.60. Two of the fibrous varieties, (both from Bohemia,) Carb. of Lime 98.76 and 99.29, Carb. of Strontian 1.02 and 0.51, Water 0.22 and 0.20.

2. *Magnesite, hard*, from Baumgarten in Silesia, Magnesia 47.63, Oxide of Manganese 0.21, Carbonic Acid 50.75, Water 1.41=100.

3. *Picropharmacolite* of Rugelsdorf in Hessia. This mineral resembles in many of its properties pharmacolite, (arseniate of lime,) but the magnesia which it contains renders it remarkably distinct.

Lime, - - - - -	24.65
Magnesia, - - - - -	3.22
Oxide of Cobalt, - - -	1.00
Arsenical Acid, - - - -	46.97
Water, - - - - -	23.98
	99.82

4. *Vulpinite* from Vulpino near Bergami, called *Bardiglio Marble of Bergami.* Vauquelin found it to consist

of 92 Anhydrous Sulphate of Lime and 8 of Silex. According to Stromeyer it contains

Lime, - - - - -	41.41
Sulphuric Acid, - - - -	56.78
Oxide of Iron, - - - -	.03
Silex, - - - - - -	.26
Water, - - - - -	.94
	99.14

5. *Strontianite.*—(Carbonate of Strontian.)

	From near Freyberg	Strontian in Scotland.
Carb. of Strontian,	96.24	93.51
Carb. of Lime, - -	2.27	6.17
Carb. of Magnesia, -	0.13	0.10
Water, - - -	0.07	0.08
	98.71	99.86

6. Celestine (Sulphate of Strontian.)

	Lamellar from Suntel near Munden.
Strontian, - - - -	55.18
Barytes, - - - - -	.86
Sulphuric Acid, - - -	42.74
Oxide of Iron, - - - -	.04
Carb. of Lime, - - -	.02
Bituminous substance and Water, -	·05
Lime, - - - - -	.31
	99.20

7. Phosphate of Iron of Cornwall.

Protoxide of Iron, - - -	42.23
Phosphoric Acid, - - -	31.18
Water, - - - - -	27.48
	99.89

8. *Apophyllite.*

	Tyrol.	Greenland.
Silex, - - -	51.86	51.86
Lime, - - -	25.20	25.22
Potash, - - -	5.14	5.31
Water, - - -	16.04	16.90
	98.24	99.29

This mineral is readily attacked by concentrated hydrochloric acid. It contains about half a hundredth of Oxide of Iron and Alumine.

9. *Kieselspath* of Chesterfield, Massachusetts.
Mr Hausman received this mineral in 1817.

Silex, - - - - -	70.68
Alumine, - - - - -	19.80
Soda, - - - - -	9.06
Lime, - - - - -	0.23
Iron and Manganese, - -	0.11
	99.88

It is plain that this mineral is a species of Feldspath, with a base of Soda.

10. Tafelspath (tabular spar) of Tschiklowa, in the Bannat.

Silex, - - - - -	51.44
Lime, - - - - -	47.41
Oxide of Iron, - - - -	.40
Oxide of Manganese - -	.26
Water and loss, - - - -	.08
	99.59

11. *Hydrate of Magnesia* of New Jersey, N. America.

	Vauquelin.	Stromeyer.
Magnesia, - -	64. - -	68.34
Water, - -	29. - -	30.90
Oxide of Iron, -	2.5 - -	0.12
Silex, - -	2.0 - -	
Oxide of Manganese, - -		.64
	97.5	100.00

12. *Spodumene* from Utoe in Sweden.

Silex, - - - - - -	63.29
Alumine, - - - - -	28.78
Lithina, - - - - - -	5.63
Black Oxide of Iron, - -	.79
Oxide of Manganese, - - -	.20
Water or loss, - - - -	.77
	98.46

13. *An Analysis of Taffelspath of Pargas*, (Wollastonite of Haüy) by P. A. De Bonsdorf, gave

Silex, - - - - - -	52.58
Lime, - - - - - -	44.45
Magnesia, - - - - -	.68
Oxidule of Iron, - - -	1.13
Alumine, a trace, Volatile parts, -	.99
	99.93

The small portions of Magnesia and Oxidule of Iron, are considered as foreign mixtures, and the mineral itself is regarded as a bisilicate of Lime, hence its mineralogical Formula will be $C. S^2$.

3. *The Society at Paris for the encouragement of National industry* held a general meeting on the 17th of April 1822. M. Chaptal, president, read a discourse relative to the object of the convocation. M. De Gerando, secretary general, made a report upon the proceedings of the council of administration during the past year. Besides the inventions which have appeared worthy of the premiums which were adjudged during the session, and of which an account will be given, the persons who obtained the most remarkable success are the following:—*Lenoble*, plummer, for his sheet lead, and tubes of lead of all calibres without solder.—*Delahaye*, for his moveable press house.—*Richer*, for various mathematical instruments, very well executed.—*Larresche*, for his reveil or alarm machine, which can be immediately applied to watches of all kinds.—*Janssens*, for various improvements on the clarinet.—*Labbaye*, for his copper wind instruments, such as the ophicliede, the french horn and the trumpet: this artist knows how to bend

tubes of brass without introducing lead.—*Boucher*, geographical engineer, for a perspective instrument, and another designed for trimming crayons for the use of the pantograph.—*Clinchamp*, for an instrument destined to form perspectives, and furnish several proofs upon paper.—*Gambert*, for his admirable astronomical instruments, and particularly his repeating theodolite, a master piece of workmanship.—*Lenoir*, *Collardeau and Clouet*, for their sliding rules, and *Hoyau* for that which he imported from England for determining chemical compounds.—*Thomas*, for an ingenious system of wheel work which gives at sight the numerical result of all sorts of calculations, by simply drawing a cord which sets the mechanism in motion.—*Laujosois*, *Dumontel*, and *Gros d'Anisi* for their potteries, remarkable for elegance of form, and the enamel which adorns them.—*Garros* and *Bonnet*, for their artificial Bitumen, destined to improve the unwholesomeness of damp habitations, and prevent the infiltration of water.—*Arrago* and *Fresnel*, for their lamps with many wicks and a double current of air designed for light houses. M. De. Gerando has justly praised in this report the steam engines of *M. Saulnier*, and those of *Casalis* and *Cordier* of St. Quentin; the machines of *Risseler* and *Dickson* for spinning; the subterranean grannaries of *Ternaux*, and the methods of Count *Dejean* for the preservation of grain; the memoir of *Hericart de Thury* upon steel; that of *Valcourt* on steam engines; the collection of agricultural machines of Count *Lasteyrie* and *Le Blanc*. He has announced the commencement of a work very important to the arts in France, viz, a *new Dictionary of Technology* published by members of this Society; such a work is wanting in Europe. The report terminates in noticing the experiments of *Dartigues* on the extraction of Potash by the incineration of divers plants; those of *Despretz* on the power of metals to conduct heat: and the interesting operations of *Bréant* in the fabrication of steel, who has succeeded in forming blades of damascus equal to those of India: the process will be rendered public in conformity to those prudential measures which the interests of French commerce render necessary.

From the accounts given of the financial situation of the society, it appears that there are now near 900 subscribers, and that the capital amounts to 237,258 francs independently of the legacy of *the count and countess Jollivet*, which raises the funds to about 300,000 francs. M. De Gerando pronounced an Eulogium on these two benefactors of industry, and shewed the advantages which this rich bequest will naturally afford to the prosperity of the arts and manufactories of the nation.

The society then adjudged medals of encouragement to those whose ingenious labours appear most worthy of this honourable distinction. M. *Mollard* read a report upon the superb establishment of M. *Roguin* at Garre, for preparing and vending wood and stuff for carpentry, cabinet making, &c. This enterprise, managed upon the principles which M. *Brunel* has established in England, works by the aid of steam, in slitting fir and oak timber into boards fit for nice work, and cutting them into grooves and strips suitable for veneering and inlaying. A Gold medal was adjudged to M. *Roguin*.–M. *Hericart de Thury* made a statement of the former prosperity of the marble works of France, compared with their present condition. He announced that in 1821, France drew from foreign countries 4 millions of Kilogrammes (4000 tons nearly) of marble, notwithstanding that that of its own quarries is in no respect inferior to those of Greece and Italy. The meeting highly applauded a passage in which the reporter revived the fact that M. *Chaptal*, during his ministry, introduced many portions of architecture, made of the products of domestic marble works. A letter of Henry IV to the constable Lesdiguieres relative to this kind of industry was also received with universal applause. A gold medal was assigned to M. *Dumége* for his fine marble work at Baros in the valley of Seste, (Pyrenees.) Medals of silver were granted to the chevalier *de Quivy*, to Baron *Morel* and to M. *Tanton* for the beautiful blocks which they have drawn from their marble works at Maubeuge, at Paret and at Rubecourt.—M. *Sir Henry* received a gold medal for the happy results which he has obtained in his steel fabricks. Prizes relative to this fabrication are still open. M. *Francœur* read a report upon the typographic presses of *Amédée Durand*, which are more economical by one half, and at least as handsome as the Stanhope press. A silver medal was granted to this mechanician.—M. *Baillet* made a report upon *boring for Wells*, and a silver medal was granted to *Beurrier* father and son, who have improved the common method.—Agreeably to a report of M. *Sylvestre* a silver medal was granted to *Mad. Reine* for her Leghorn hats and the cultivation of the straw of which they are made.—M. De *Gerando* reminded the society that M. *Pradier* last year obtained the gold medal for his excellent manufactory of Razors and of mother of pearl. An honourable mention was now again made to reward the success of this fine enterprize, which now produces 9000 razors per month, and to which M. *Pradier* has added the fabrication of table knives, penknives, metallic pens and seals with changeable figures. If this artist had not received the gold medal last year, he would have been rewarded with it at the present time.—Another honourable mention was made in favour of M *Vauchelet* fo his painting on velvet

FRANCOEUR.

4. *Philosophical Instruments.*—In a report made by Francœur to the *société d'encouragement* at Paris, on a new theodolite made by Gambey, a distinguished artist, after speaking in the most favorable terms of the instruments, adds, "M. Gambey is not only an estimable artist,—his inventive powers place him in the list of Savans: he is the author of a *heliostat*, conceived upon a new plan, and very superior to that in common use; and also of a new compass of declination, the precision of which is incredible. These two instruments have been presented by the inventor to the academy of Sciences, and M. Arago, who will shortly report upon them, has spoken of them in terms of great approbation, an opinion the more flattering, as it comes from a philosopher who is known to be sparing of his praises. Baron de Zach, also, who seems to have adopted the method of praising all foreign inventions at the expense of our own, cannot refuse to acknowledge the distinguished merit of M. Gambey, and has ordered one of his theodolites. This is a mark of respect which could have been forced only by the belief that M. Gambey is the ablest artist in Europe.

5. *Astronomical observatory.*—A new observatory has just been established at Bern in Switzerland, greatly to the honor of the government, and of enlightened individuals in that canton. It is erected upon the elevated plain of a

bastion, at the N. W. extremity of the city; and it enjoys on all sides a clear and delightful horizon. Its isolated situation secures it from all agitation arising from the motion of wheels, and the ground, on which it stands, though made, has had the consolidation of 200 years, and possesses sufficient firmness for the masonry, especially as it reposes on a bed of sandstone. The observatory is a regular octagon, 63 French feet in circumference. It is exactly *orienté*; its entrance is on the east, and opposite to it is a niche, which includes a moveable stair case, and accommodations for books. The S E., S W., N E., and N W faces have large windows, before which, within, are stone brackets, which have no communication with the building. Two similar brackets are placed at each extremity of the meridian. Each of these brackets as well as the two stone columns which support the trunnions of the transit instruments, repose upon massive masonry,as does also the pedestal of the clock. The upper demi-circumference of the meridian, is exposed when the shutters are opened. The floor is raised two feet above the outside level, so that the air may pass freely under it. The two floors are eleven feet apart, and above is a wooden capula, so solid that very sensible levels, placed upon brackets provided for them, remain perfectly at rest during many series of delicate observations of the heights of the sun or stars, taken with the circle of Borda. This observatory is already furnished,—1st with a transit instrument, by Ramsden, of three feet focus. Its vertical movement is extremely easy. It is at rest in every position, its axis passing through the center of gravity of the system, its equilibrium is perfect. The meridional position of this telescope is verified by an object erected on the Gourten, a mountain distant 12,000 feet, when it is placed at an angle of 4°.23 with the horizon. 2d. *The great azimuth circle of Ramsden* three feet in diameter. This is placed between the two columns of thet ransit telescope. A description of this instrument may be seen in the Philosophical Transactions, vol. 80th, and in Adams' Essays. It arrived at Bern, from London, in 1797, and escaped, as by a miracle, in 1798. 3. The *clock*, an excellent instrument by Wulliamy, a skillful Swiss artist in London. It has a compensation pendulum. It is kept to Siderial time. 4th. The *great circle of Borda*, made by Schenk, an eminent artist at Bern, and a pupil of Reichembach, worthy of that excellent master. This instrument is considered as a Chef d'œuvre by several astronomers who saw it in 1821, among whom were Nicollet of Paris, and J. F. W. Herschel of London. 5th. A *repeating theodolite*, by Reichembach, a foot in diameter, an excellent and beautiful instrument, perfected by Schenk, who has given a double repetition by the addition of an entire vertical circle. 6th. A 3½ feet achromatic telescope, by Dolland, with four powers, viz. 38, 67, 100, and 150. 7th. An equatorial instrument of English origin, but reconstructed by Schenk. Lastly, Several smaller instruments introduced rather for the instruction and use of amateurs,—an object not foreign to such an establishment. Such are two repeating theodolites by Schenk, of 7 and 8 inches, a neat sextant by Carey, a tellurium, a beautiful armillary sphere, as well as meteorological instruments, among which is a very large and fine syphon barometer.

Bib. Univ. Sept. 1822.

The readers of this journal may ask each other with solicitude, when shall we see such an establishment as this in any part of the United States? (G.)

"Although (says the venerable Professor Pictet) the meeting of the Helvetic Society should have offered us no other object of interest, than a visit to this observatory, we should conceive ourselves amply paid for a journey of sixty leagues. We regard the time passed in this sanctuary of astronomy among the most agreeable and profitable moments that we have ever enjoyed. We feel ourselves particularly happy in belonging to a couutry favored by heaven, and whose governments manifest a noble emulation, in raising up and encouraging establishments, which have for their object the progress of the arts and sciences, and of useful and solid instruction. We have found in the government of Bern the principles and disposition with which that of Geneva is animated."

6. *Hydroxanthic Acid.*—Professor W. C. Zeise, of the university of Copenhagen, has discovered that carburet of sulpher has the power of neutralizing potash or soda, dissolved in alcohol, although it will not change turnsol, nor

affect the same alcalies dissolved in water. This phenomenon is owing to the formation of a particular acid by the reaction of the carburet and alcohol, promoted by the alcali.

The new acid contains sulphur, carbon, and hydrogene. It is probable that the two first perform the same function in this combination, that cyanogen does in the hydro-cyanic acid, and that they unite in a different proportion from that in which they are combined in common carburet of sulphur. Prof. Z. has given the name of Xanthogene, (from ξανθος, yellow, and γεννaω,) to this compound radical, because it forms combinations of a yellow color with some of the metals; and he has named the new compound, the hydroxanthic acid. At commmon temperatures it has the appearance of a colourless, translucid oil. It is heavier than water, and does not combine with it.

7. *Calligraphy.*—M. LeRoi has contrived a new and very simple method for teaching the art of writing. A thin and perfectly transparent plate of horn, of the usual size of a leaf of paper, has the polish removed from one of its sides. When laid upon the copy the hand of a child easily traces the letters upon the unpolished side, which neither absorbs the ink nor allows it to spread. When the whole plate is written over, the ink is washed off with water, and is ready for a new exercise. Thus the same horn which is not liable to break, may serve indefinitely, and by this means produce a great economy of paper—a consideration not to be neglected. Several analogous methods have been adopted both in England and France. Oiled paper, glass, a machine for guiding the pupil's hand, &c., have been used, but it is evident that the method of M. Le Roi has none of their imperfections. The minister of the interior, who has witnessed the success obtained by this invention, has rewarded the author; and the societies of encouragement, and of elementary instruction, as well as the writing academy, have expressed their approbation of this new process. Mothers may teach their children to write in the absence of the master, or even dispense with his attendance by the adoption of the horn.

8. *Feeding of Engine Boilers.*—Thomas Hall, engine man to the Glasgow Water Company, having remarked the waste of fuel which occurred at those times when a steam engine stopped working, as at night, &c., was induced to alter his mode of feeding the boilers with water, with a view to prevent as much of this waste as possible. Instead of letting in a continual supply of water, equal to the portion converted into vapor, he took every opportunity, when the engine was stopped for a sufficient time, (30 or 40 minutes,) as at meal time, night, &c., of introducing water into the boiler to as much as 18 inches above its usual level, and it was continued to this higher level as long as the engine was off work. When labor was resumed, there was therefore an abundant supply of hot water in the boiler, the steam was ready, and no increase of fire to heat freshly introduced water, required. The saving which arose from this mode of management was 25 per cent. of the fuel. The apparatus for feeding the boiler in this manner with accuracy, and without trouble, is very ingenious, and is described in the *Trans. Soc. Arts*, xl. 127.

9. *Preservation of grain, &c., from mice.*—Mr. Macdonald, of Scalpa, in the Hebrides, having some years ago suffered considerably by mice; put at the bottom, near the centre, and at the top, of each stack, or mow, as it was raised, three or four stalks of wild mint, with the leaves on, gathered near a brook, in a neighboring field, and never after had any of his grain consumed. He then tried the same experiments with his cheese, and other articles kept in store, and often injured by mice; and with equal success, by laying a few leaves, green or dry, on the article to be preserved.—*Phil. Mag.*

10. *Yeast.*—The following methods for making yeast for bread, are easy and expeditious. Boil one pound of good flour, a quarter of a pound of brown sugar, and a little salt, in two gallons of water for an hour; when milk warm, bottle it and cork it close: it will be fit for use in twenty-four hours. One pint of it will make ten pounds of bread. To a pound of mashed potatoes, (mealy ones are best,) add two ounces of brown sugar, and two spoonfuls of common yeast, the potatoes first to be pulped through a cullender,

and mixed with warm water to a proper consistence. A pound of potatoes will make a quart of good yeast. Keep it moderately warm by fermenting. This recipe is in substance from Dr. Hunter, who observes that yeast so made will keep well. No sugar is used by bakers when adding the pulp of potatoes to their rising.—*Yorkshire Gazette.*

11. *Paste.*—Dr. McCulloch, in a paper on the power of perfumes in preventing mouldiness, gives the following directions for the preparation of a paste, which, as it will keep any length of time, and is always ready for use, may be of great service to mineralogists and others. "That which I have long used in this manner is made of flour in the usual way, but rather thick, with a proportion of brown sugar, and a small quantity of corrosive sublimate. The use of the sugar is to keep it flexible, so as to prevent its scaling off from smooth surfaces; and that of the corrosive sublimate, independently of preserving it from insects, is an effectual check against its fermentation. This salt, however, does not prevent the formation of mouldiness; but as a drop or two of the essential oils above mentioned, (lavender, peppermint, anise, bergamot, &c.) is a complete security against this, all the causes of destruction are effectually guarded against. Paste made in this manner and exposed to the air, dries without change to a state resembling horn, so that it may at any time be wetted again, and applied to use. When kept in a close covered pot, it may be preserved in a state for use at all times."—*Edin. Jour.* viii. 35.

12. *Soldering Sheet Iron.*—Sheet iron may be soldered by means of filings of soft cast iron applied with borax deprived of its water of crystallization and sal ammoniac. Tubes of sheet iron have been constructed at Birmingham lately by means of a process of this kind, which according to Mr. Perkins and Mr. Gill is to be practised in the following manner:—The borax is to be dried in a crucible, not till it fuses, but till it forms a white crust; then powdered, and mixed with the iron filings: the joint is to be made bright, and moistened with a solution of the sal ammoniac; then the mixture is to be made into a thick paste with water; and placed along the inside of the joints, and the whole heated over a clear fire till the cast iron fuses.

Tech. Rep. III. 110.

13. *Plumbago in coal-gas Retorts.*—The following description of an artificial plumbago, is by the Rev. J. J. Conybeare; he is speaking of the retorts in the Bath gas-works. The unserviceable retorts, on being withdrawn from their beds, are found lined with a coating of plumbago averaging the thickness of four inches. This coating is thickest towards the bottom of the retort. The general aspect of the predominant variety may be thus described: *colour*, iron-grey, somewhat lighter than that of native plumbago; *texture* scaly; *structure* mammellated, usually in very close aggregation—some specimens exhibit this structure on the large scale, but generally it requires the lens, to be seen; *hardness* variable, but always greater than the best native plumbago—scratches gypsum, but is scratched by calc. spar; *lustre* of the fracture usually but small; *lustre* of the exterior surface sometimes very considerable; the powder uniformly resembles that of common plumbago, but is somewhat less brilliant. The quantity of iron in it seldom appeared to amount to 9 per cent. It is hardly fit for the finer purposes of art, but it is proposed to use it in diminishing friction, in making crucibles, furnaces, &c. *Ann. Phil.* v. 51.

14. *Analysis of Uranite.*—R. Philips has lately reanalyzed this mineral and very unexpectedly finds it to contain phosphoric acid; indeed, to be a phosphate. A specimen from Cornwall gave,

Silicia	0.5
Phosphoric acid,	16.0
Oxide of Uranium,	60.
Oxide of Copper,	9.0
Water,	14.5
	100.

or, neglecting the Silicia,

Phosphate of Uranium,	73.2
Phosphate of Copper,	12.3
Water,	14.5

Ann. Phil. v. 59.

15. *Leipsic Fair.*—The catalogue of the late Easter Fair (1823) at Leipsic, contains the titles of 2957 new works, which have appeared since the September fair 1822! Of this vast progeny of continental intellect, 190 are Romances, 484 on theological subjects, 136 on jurisprudence, 155 on medicine, 398 on education, 184 on belles lettres, 150 on history, 137 on natural sciences, 378 poetry and literature, 215 on politics, 159 periodical works, 30 on philosophy, 32 on the military art, 95 are in the French language, 62 in Danish, 58 in Polonese, &c. Of the works in foreign languages, many have been sent by the publishers in France, Poland &c. Of these 2957 works, exhibited at the last fair, 214 were written by princes, counts and other nobles, and 24 of the authors were females.

Of the 354 booksellers who sent their works to this fair, 8 have titles of nobility. In Germany there is nothing in the business of a bookseller which is derogatory to rank.

Rev. Ency.

16. SWITZERLAND.—*The Society for the encouragement of Agriculture, Industry and the arts*, established at *St. Gall*, has celebrated its third anniversary. The reports of the past year, read by the president Doctor Steinmuller, has just been printed. It occupies 75 pages in 8vo. and comprehends a great variety of objects which attest the useful activity of the society, whose labours extend to all the branches of rural economy. The society appears to have had particularly in view during the last year, the perfecting of all the arts which relate to the care and management of stock and cattle. The president Steinmuller, is known by his description of the Swiss Alps and their agriculture, as well as by some works upon education. He has described in his introductory discourse, the immense advantages which the cause of science and civilization, may derive from the labours of societies, established upon liberal and philanthropic principles, and the great utility which such societies have already been of, to Switzerland.

Rev. Ency.

17. *The Canton of Argow*, is perhaps, of all the Swiss Cantons that which enjoys the greatest share of liberty, industry, ease and general extension of knowledge. This canton has now 312 primary schools, (exclusive of those

which exist in manufactories,) four secondary schools or colleges, in the towns of Arau, Brugg, Lensbourg and Zoffingen; two other schools of the second degree in the Catholic towns of Rheinfield and Baden; a superior or cantonal school, in Arau, in which the history of Argow, read with interest and enthusiasm, excites in the minds of its young citizens the *Amor patriæ;* a normal school for forming teachers, one public, and various private schools for females; and a school for the deaf and dumb. In the town of Arau are three societies for public good, viz. One for *patriotic* culture, divided into sections for the different branches of agricultural and manufacturing industry. One for the assistance of *poor children*, and, a *reading society*, which has also the care of the cantonal library. Four periodical papers are published in the same town. One of them, in German, the *Swiss Messenger*, had, a few years since, more than five thousand subscribers. The inhabitants of Arau, celebrate in the month of August every year, *la Féte de la jeunesse.* The houses and the streets, on this occasion, are ornamented with garlands of verdure and flowers; and after a solemn religious ceremony, and a sermon, the evolutions of the corps of cadets, and various gymnastic exercises take place, in which young people between the age of eight and eighteen, are engaged, presenting a very animated spectacle, and attracting crowds of observers. To this succeeds a banquet in the open air, in which the children of all the schools, instructors, members of the government, and principal inhabitants take a part. These joyful repasts are sometimes followed by the flight of a balloon, or a hymn sung in concert, and the fete is terminated by a rural dance.

18. Brussels.—*Elementary Instruction.*—The King by two ordinances of the 17th of May, and 2d July, 1823 has granted to the *Society established* at Brussels *for the encouragement of mutual instruction*, a convenient spot of ground for a building destined for a school of both sexes; and has added to this grant a donation of 12000 florins from his own purse. The edifice is designed to accommodate about 1000 children.

19. *University of Leyden.*—M. Reinwardt, whose return from Batavia was expected with so much impatience,

and who notwithstanding the successive losses of his remittances, in natural history and antiquity, collected in India, has not failed to enrich his country with many very curious things, took possession of his chair as professor of Physics and natural history at Leyden on the 3d of May last, by a discourse; *De augmentis, quæ historiæ naturali ex Indiæ investigatione accesserunt.* He fills the place vacated by the death of the celebrated professor *Brugmans.* Professor Siegenbeck has celebrated this academical solemnity by a piece of latin verse in which the success of an illustrious and more fortunate traveller is finely distinguished.

Sic, meliore usus fortuna, *Humboldius*, ille,
Inclyta Germani gloria lausque soli,
Ventorum sprevit rabiem, et graviora pericla,
Barbaries hominum quæ subiunda dabat,
Et, nubes superans nunc, mox in Viscera terræ
Descendens, late qua patet orbis, opes,
Quas habet immensas rerum natura, stupenti
Intulit Europæ, nomen ad astra ferens.

20. *Public Instruction.—Method of J. J. Ordinaire.*—The unequivocal success which has attended the method of teaching latin, invented by *Ordinaire*, Rector of the Academy of Besancon, authorizes us to remind our readers, that since the publication of this method in January 1821 we have directed their attention to the importance and the happy results of the applications which it has successively received.

The theoretic principles upon which it is founded, had obtained the unanimous approbation of the members of a special commission, to whose judgment the work had been submitted by the royal council. This commission composed of inspectors-general, and professors of great learning and experience, terminated its report by proposing that a large school should be established in Paris for the purpose of applying the system under the direction of the inventor himself. Various circumstances have delayed the execution of this project. M. Ordinaire deeply convinced of the rectitude of his principles, and entertaining no doubt of the success of their application, of which he had made such rigorous trials, commenced on the first of June 1821, the application of his method at Paris in the fine establishment of M. Morin in Rue Louis le Grand. The superiority of the results of this trial was verified on the 28th of September 1822 by the inspectors of the Academy of Paris, who in conformity to the special desire of the Rector, gave it the most scrupulous and severe examination. They declared in their report, that the pupils knew and could employ, without having recourse to the dictionary, about 7000 latin words; that the whole system of latin terminations, comprising the nouns of number and invariable words, were completely familiar to them; that they knew and could reproduce methodically all the fundamental rules of Syntax; that they could translate with exactness, not only the *Epitome*, *Phædrus*, and *Cornelius Nepos*, entirely, as well as one third of *Quintus Curtius*, but also from the French version of these different authors, they could re-produce the latin texts with surprising sagacity, making with equal facility and precision, the grammatical and syntactical analysis of these texts.

The first part of the method of M. Ordinaire comprehends three sections. 1st. *Preparatory exercises* on the radical and latin terminations necessary to enable the pupil to comprehend and to translate the classic authors. 2. *Exercises in translation* accompanied with grammatical analyses, together with the recomposition of the latin texts without which the pupils acquire with great difficulty just notions of the character and genius of the latin language. 3d. *Exercises in themes* which can only be useful, when by the preceding exercises the scholar has obtained a sufficient share of preliminary knowledge to render his composition effective.

At the examination on the 16th June last, at which the Rector of the Academy of Paris presided, the more advanced pupils whose period of study, deducting all vacations, was 16 months, not only translated with correctness and rapidity, difficult latin texts upon which they had no preparation, but they turned into latin almost without the help of a dictionary, and with as much correctness as inteligence, French texts which required a thorough knowledge of all the rules of Syntax. The rector and examiners, among whom was the learned M. Burnouf, expressed the highest satisfaction with the results of this investigation. They were not less struck with the uniformity of the knowledge acquired by the numerous pupils whom they interrogated, than with the cheerfulness and pleasure which the pupils testified throughout an examination of nearly four hours. An establishment is spoken of at Fontenay-aux-Roses, which M. Ordinair will direct, agreeably to his system, and in which it will receive all the extent it is susceptible of. Let us hope that the public schools will not long be deprived of the great advantages it affords, and that the chief of the corps of instruction will promote its adoption in the elementary classes of our colleges. We have already announced that that of St. Barbe, Rue des postes, have admitted it, and that it is pursued with great success in the new institution of M. Auguste Michelot, Rue de la Chaise, No. 24 Faubourg Saint Germain.

Rev. Enc. Aug. 1823.

21. *Sulphate of Rhubarb.*—A preparation has been obtained by A. Nani, a Chemist of Milan which he conceives will be very useful in medicine, and which he names *Solfato di Rabarbarina* (Sulphate of Rhabarbarine.) His statement is the following. After having pulverized six ounces of Chinese Rhubarb, (*Rheum Palmatum*, Linn.) I boiled it during two hours in eight pounds of common water, acidulated by four drams of sulphuric acid. I filtered the decoction through flannel, and having pressed the residuum, I boiled it again in 6 ounces of water acidulated by two drams of acid.

The decoction, filtered, pressed and dried, weighed only two oz. having lost 4 oz. which remained dissolved in the filtered liquor.

To the united decoctions, I added, when cool, in small successive portions, three ounces of quick lime, recently pulverized, stirring the mixture frequently with a wooden rod, to promote the reciprocal action of the materials.

The decoction was of a fine yellow; and by the addition of lime it passed to blood red, communicating the same colour to the walnut stick. After one day's repose, I filtered off the precipitate and dried it in the sun. It weighed six ounces. I then added to it four pounds of alcohol at 36° and digested it two hours at an elevated temperature. The whole was again filtered and the residuum submitted to a second digestion in two pounds of alcahol. Uniting the two portions I filtered it through paper, and distilled it from a glass retort until about 5 lbs. of alcohol had passed over. The fluid in the retort was then evaporated in a capsule to dryness. This residuum weighed two drams. It was of a brownish red, intermingled with brilliant specks, and had a pungent and styptic taste. It was soluble in water, and its odour was that of native Rhubarb.

I presume that this preparation will be useful in medicine, and will deserve the attention of physicians. 1st, because the different kinds of Rhubarb have qualities so various, that in many cases the ordinary dose is very uncertain. 2d. because this extract will be of uniform strength wherever the same process is followed. 3d. because it may be given very safely in solution even to new born infants to evacuate the meconium, one or two grains will be sufficient for this purpose. 4th, because the remedy is thus deprived of its ligneous and mucous portions, which if not injurious, are at least useless.

I shall esteem myself happy if the process which I have thus pointed out, shall furnish a new resource to the healing art; and if those of my brethren who have its progress at heart, shall concur with me in introducing this preparation into the practice of physic.

Bib. Univ. July, 1823.

22. *Schweinfurt Green.*—Dr. Liebig, in the *Annales de Chimie* of August 1823, states that the preparation of this fine colour, as recommended by Braconnot, being tedious and expensive, the following is much preferable.

Dissolve in a copper kettle by heat, one part of verdigris in a sufficient quantity of pure vinegar, and add to it an aqueous solution of one part of white arsenic; a precipitate of dirty green generally forms, which must be dispelled by adding more vinegar until the precipitate is perfectly dissolved.

Boil the mixture, and after a time, a granular precipitate will form, of the most beautiful green, which being separated from the liquid, well washed and dried, is nothing more nor less than the colour sought for. If after this, the liquor contains copper, more arsenic may be added; and if it contains an excess of arsenic, more copper may be added, and the process repeated. It often happens that the liquid contains an excess of acetic acid. It may then be employed for dissolving more verdigris.

The colour thus prepared, possesses a bluish shade; but the arts often call for a deeper shade, somewhat yellowish, but of the same beauty and elegance. To effect this change it is only necessary to dissolve a pound of common potash, in a sufficient quantity of water, and add to it ten pounds of the colour prepared as above, and warm the whole over a moderate fire. The mass soon deepens and acquires the requisite shade. If too long boiled, the colour approaches to Scheele's green, but always surpasses it in beauty and splendour. The alcaline fluid which remains may be used in the preparation of Scheele's green.

23. A *mineral spring* which issues from an Argilo-calcareous soil, near Sales, in Piedmont, Italy, has been found to contain *Iodine*. Its spec. grav. is 1.0502. It has a strong urinous odour, and a briny, pungent taste. Bubbles of air are constantly disengaged from it. Volta in 1788 found it to contain mur. of soda, and Romano in 1820, discovered in it, various earthy muriates, and a little oxide of iron. At length Angelini, an Apothecary at Voghera, by employing starch as a reagent, obtained the blue colour which indicates Iodine, and he succeeded in presence of Dr. Ricotti and Luc. Barenghi, in extracting a certain quantity of this substance by the process which is followed in procuring it from the mother waters of salt petre.

It is remarkable that for a long time, the mineral waters of Sales have been successfully employed in scrophulous affections, and especially in the dispersion of Goitres.

24.—*A new and curious variety of combustion.*—Dobereiner, professor at the university of Jenaa, has discovered that Platina, in a spongiform state, occasions, at common temperatures, the combination of oxygen and hydrogen, and that so much heat is developed from its action as to render the metal incandescent.

This singular and interesting result has been confirmed by Dulong and Thenard, who have varied and extended the experiment, with a view to discover the theory, but in this they have not succeeded to their own satisfaction. They find that platina sponge becomes incandescent when it is placed in a stream of hydrogen gas, at the distance from the orifice in which it mingles with the atmospheric air. In plunging a piece of this sponge in a mixture of two parts hydrogen and one oxygen, explosion of course ensues; but if the proportions of the mixture be very different from that which forms water, or if a gas, foreign to the combination, be present, such as azote, the combination takes place slowly, the temperature rises a little, and water is soon condensed upon the glass.

Platina sponge strongly calcined, loses the property of becoming incandescent, but in this case it produces slowly and without any sensible elevation of temperature, the combination of the two gases. Platina reduced to fine powder, has no action at common temperatures, nor has it in the form of wire or plates. But the French chemists, state, that when reduced to leaves as thin as the metal will admit, it acts at common temperature, and acts upon the mixed gases, with a rapidity proportionate to its thinness, in some instances causing detonation. But one thing is remarkable, viz, that a very thin leaf of platina, rolled upon a glass cylinder, or suspended freely in a detonating mixture, produces no sensible effect, though exposed during several days; but the same leaf compressed into a wad, acts instantly, and produces detonation.

Leaves and wire too thick to produce any action, when cold, will nevertheless, as Sir H. Davy had before determined, act at the temperature of 2 to 300°, according to their thickness. Palladium acts as well as Platina at the same temperature, and thickness. Rhodium occasioned the formation of water at 240°.

Gold and Silver in thin leaves act only at elevated temperatures, but always below that of boiling mercury. Silver is less efficacious than Gold.

Other gaseous mixtures were acted upon by the same means, oxide of carbon and oxygen combined. Nitrous gas was decomposed by hydrogen, at common temperatures, by platina sponge, forming water, and ammonia; olefiant gas mixed with a proper quantity of oxygen, is completely transformed into water and carbonic acid.

It is well known that iron, copper, gold, silver and platina have the property of decomposing ammonia at a certain temperature, without absorbing either of its principles, and that this property appears inexhaustible.. Iron is more efficient than copper, and copper more than silver, gold or platina, with an equality of surface. Ten grammes of iron wire is sufficient to decompose, within a few hundredths, a pretty rapid current of ammoniacal gas, kept up during eight or ten hours, without the temperature passing the limit at which the ammonia resists decomposition. Three times the quantity of platina wire produces far less effect, even at a higher heat.

These remarkable results depend, perhaps, on the same causes as those which occasion gold and silver to effect the combination of oxygen and hydrogen at 300°, platina in mass at 270°, and platina in sponge at common temperatures. Now, if it is observed, that iron which decomposes ammonia so readily, effects with so much difficulty the union of oxygen and hydrogen; and that platina which is so efficacious in this combination, hardly decomposes ammonia, we are induced to believe that among the gases, some tend to unite under the influence of metals, while others tend to separate, and that this property varies according to the nature of each. Those of the metals which produce one of these effects produce the other only in a very small degree. *Ann. de Chimie, Aug.* 1823.

In the original paper of Dobereiner, (translated in Tilloch's Mag. for Octob.) he remarks, " What useful applications of this discovery may be made in Oxymetry, the synthesis of water, &c. I shall hereafter state more circumstantially. I shall at present merely observe, that the entire phenomenon must be considered as an electric one, that the hydrogen and platinum form a Voltaic combination, in which the former represents the Zinc ;—the first established instance of an electric alternation formed by an elastic fluid, and a solid substance, the application of which will lead to further discoveries."

In another letter, dated Aug. 3d, 1823, he says, " If hydrogen gas be suffered to issue from a Gazometer through a Capillary tube bent downwards, upon the platinum contained in a small glass funnel, sealed at the bottom, so that the stream may mix with the atmospheric air before it comes in contact with the platinum, which is effected when the tube is from 1 to 1½ or 2 inches distant from the platinum, the latter becomes almost instantly red, and white hot, and remains so, as long as the hydrogen continues to flow upon it. If the stream of the gas be strong it becomes inflamed, particularly if it has already been mixed in the reservoir with some atmospheric air. The experiment is very surprising, and astonishes every beholder, when he is informed, that it is the result of the dynamic reaction of two species of matter, one of which is the lightest, and the other the most ponderous of all known bodies. I have already applied this new discovery to the formation of a new apparatus for procuring fire, and of a new lamp; and I shall avail myself of it for much more important purposes."

The platina sponge alluded to, is obtained by heating the muriate of ammonia and platina.

25. *Cutting of Steel by soft iron.*—This useful fact stated by Mr. Barnes of Cornwall, Con. in Vol. VI, p. 336 of this Journal, has been verified by our countryman, Jacob Perkins, in London. A piece of a large hard file was cut by him into deep notches at the end, where also, from the heat produced by friction, it had softened and been thrown out like a burr. On the other part of the file, where the plate had been applied against its flat face, the teeth were removed without any sensible elevation of the temperature of the metal. The plate which had previously been made true, was not reduced either in size or weight during the experiment, but it had, according to Mr. Perkins, acquired an exceeding hard surface at the cutting part.

Jour. of Science.

26. *Cleavelandite.*—From the examination Mr. Levy has recently made in Mr. Turner's collection, it appears that half the specimens which have hitherto been ranked under feldspar, belong to the species which had been called Albite, and has recently received the name of Cleavelandite, from Mr. Brooke.

It is rather curious that the crystallographical difference between this last substance and feldspar, should have been detected upon specimens laminated, but not regularly crystallized, and that the many crystals it presents should not have been noticed. The varieties of form of Cleavelandite are, however, at least as numerous as those of feldspar; the crystals are very distinct, of various sizes, but rather large than small; they are very frequently marked parallel to one of the primitive planes, viz. that which is the least easy to obtain by cleavage. Several of the forms greatly resemble some of the varieties of feldspar, being composed of the same number of planes disposed in the same manner, and it is only by using the Goniometer that the difference can be perceived. Notwithstanding this great anology, Mr. Levy believes that the forms of the two substances are incompatible. He considers the primitive of feldspar to be an oblique rhombic prism, and not a doubly oblique prism, as it had been supposed by Haüy, and he takes for the primitive of Cleavelandite a doubly oblique prism. The crystals of Cleavelandite are generally white, sometimes yellowish and reddish. They are transparent, sometimes translucent and opaque, and have a certain brilliancy which does not belong to Feldspar. Both substances are often found upon the same specimen, and sometimes both in large and well defined crystals. The localities of Cleavelandite are very numerous, and this substance seems likely to become one of the most important both in mineralogy and geology. All the rocks of which feldspar is considered as a component part, must be re-examined to separate those which really contain feldspar, from those which contain Cleavelandite. The localities derived from Mr. Turner's collection are the following: Dauphiny, St. Gothard, Tyrol, Piedmont, Baveno, Elba, Vesuvius, Saxony, Sweden, Norway, Siberia, Greenland, United States, and Rio Janeiro.

An. Philos. Nov. 1823.

27. *Chinese process for making sheet lead.*—The reduction of lead into thin sheets, is done by two workmen, one seated on the ground, having before him a large flat stone, very smooth, and holding in his hand another flat stone, a kind of muller; along side is a furnace in which is placed a crucible filled with lead. A second workman pours upon the stone, a quantity proportioned to the size and thickness of the intended sheet, and the other pressing his muller forcibly upon it, produces a leaf which is very thin, and of an equal thickness throughout. It is immediately removed and the operation repeated with extraordinary rapidity. When a certain number of sheets are obtained, they trim the borders which are always ragged, and tie them together.

M. Wadell, who has seen this process practised in China, has applied it successfully to the preparation of zinc plates for galvanic apparatus.

Bul. de la Soc. d'encour.

28. *Willis' lute.*—To prevent the materials contained in earthen crucibles and retorts from penetrating through their substance, the author prepares a lute composed of two ounces of Borax dissolved in a pint of boiling water, to which is added slacked lime in sufficient quantity to form a soft paste. This lute applied to the vessel by a brush within and without (if a crucible) vitrifies very speedily, and prevents the penetration of the melted ingredients, but it cannot prevent the fracture of the vessel. To accomplish this second object, the inventor covers retorts with a lute composed of linseed oil and slacked lime. This is applied by a brush to retorts, and left to dry during a day or two. It can be taken every time a retort is charged to cover it with this lute, it may be used four or five times without breaking. Cracks may be effectually stopped by the same composition, only powdering the surface with a little slacked lime. This may be done without risk even when the retort is very hot.

29. *Hydrogen gas apparatus.*—An instrument much used in Germany and Russia, resembles the bottle of Gay Lussac, except that the zinc is not suspended from the top, but supported from the bottom on a tripod of lead, which is not attacked by the sulphuric acid. When the stopper is opened, the gas escapes, the acid ascends and covers the zinc and the action is renewed; but as soon as the acid touches the zinc, the lead which before produced no change, furnishes on all sides a great quantity of little bubbles of gas, and more copiously than the zinc itself. This results evidently from the galvanic action arising from the contact of the zinc and lead; but what is the most surprising is the prodigious effect of this pile of a single element, compared with the weak effect of ordinary piles.

Journal des mines.

30. *Method of discovering very small quantities of mercury.*—All the oxides and saline compounds of mercury, placed upon gold in a drop of muriatic acid with a piece

of tin, promptly produces an amalgam of gold. A particle of corrosive sublimate, or a single drop of its solution may thus be tested. In this case the addition of muriatic acid is not necessary.

Samuel Parkes, Esq. F. L. S. &c. of London, has received the honorary degree of Master of Arts, from the President and Fellows of Yale College.

Professor Buckland of the University of Oxford, and Dr. J. Wright and Dr. J. I. Bigsby of the Medical Department of the British Army in Canada, have been elected honorary members of the American Geological Society.

N. B. The Title of Art. III. should have been; "Notices of the Geology of Martha's Vineyard and the Elizabeth Islands, by Rev. E. Hitchcock, A. M. Conway, Mass."

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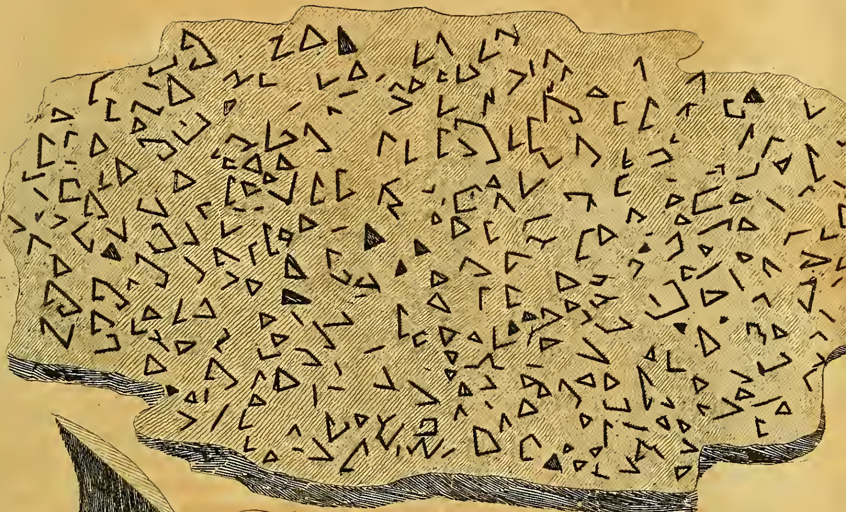
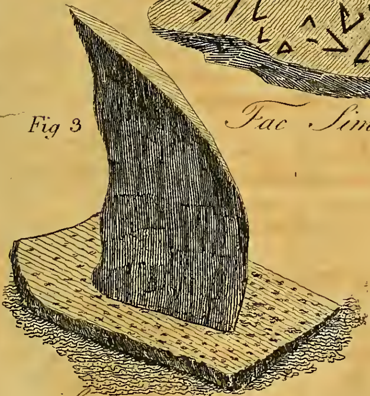
Fig. 1.



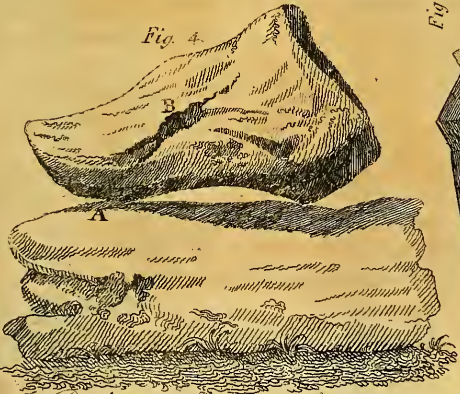
Fac Simile of Goshen Graphic Granite.

Fig 3



Lusus Naturæ.

Fig. 4.



Roxbury Rocking Stone: N.E. view

Fig 2

Pseudomorphous Granite.

Engraved by A.D.

Proteus of the Lakes.

Fig. 1. Back view.

Fig. 2. Side view

Fig. 3. Belly view.

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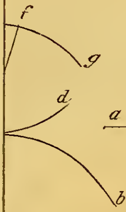

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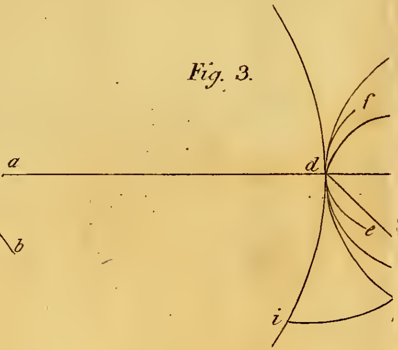

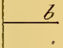

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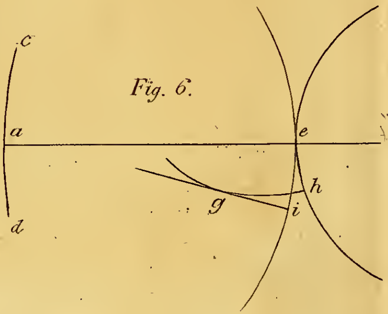


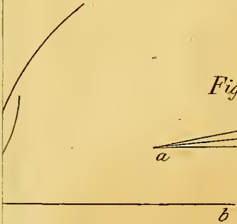
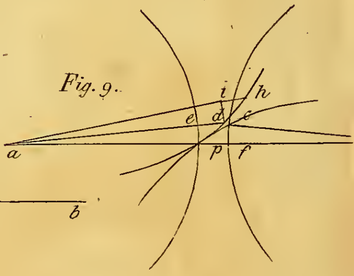
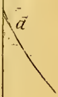


Fig. 9.





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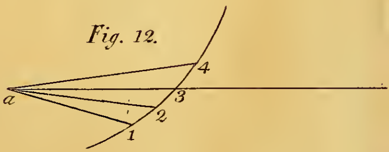

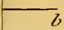

A.Doolittle sc

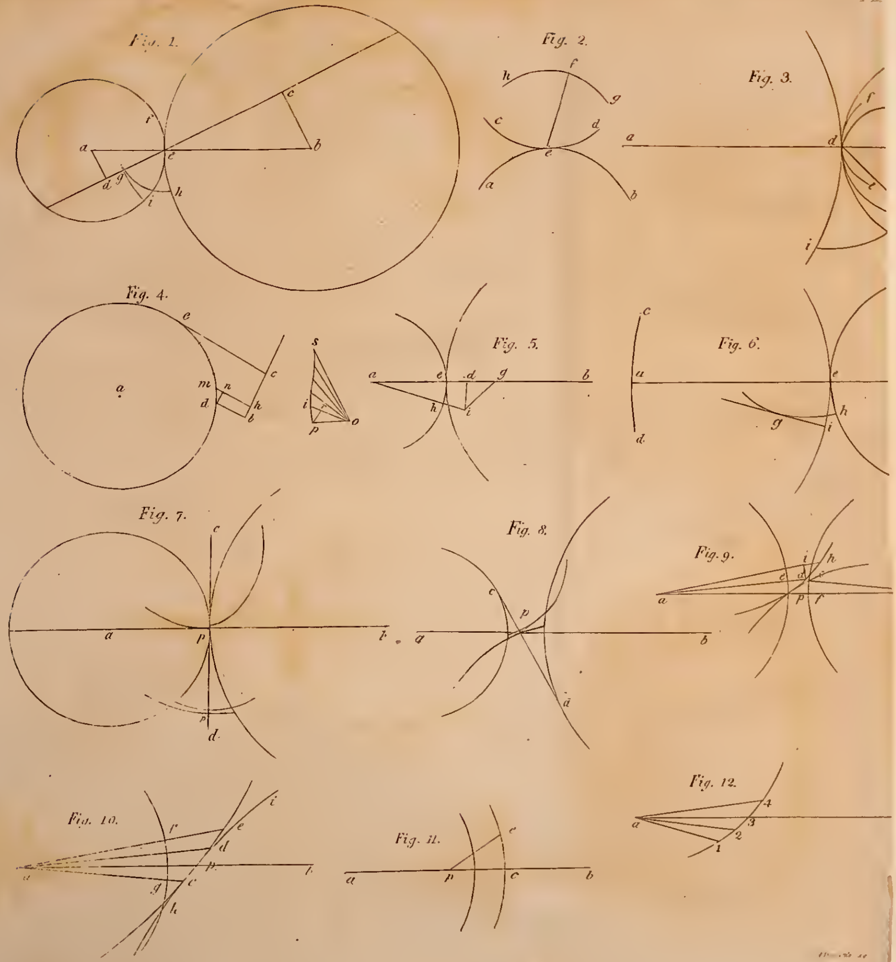
Fig. 1.
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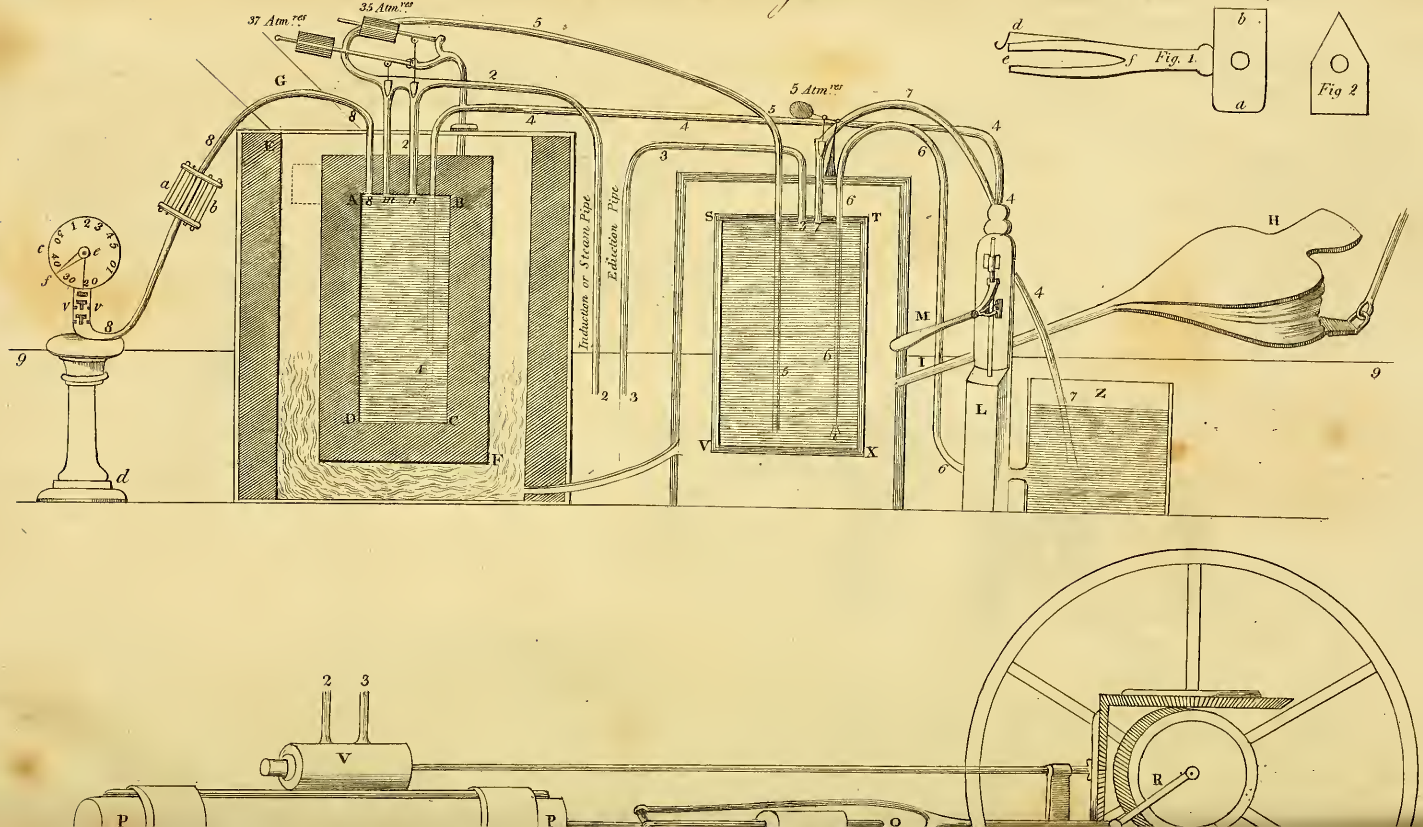
Fig. 11.
Fig. 12.

Perkins's new Steam Engine



Mineral. Hammer.

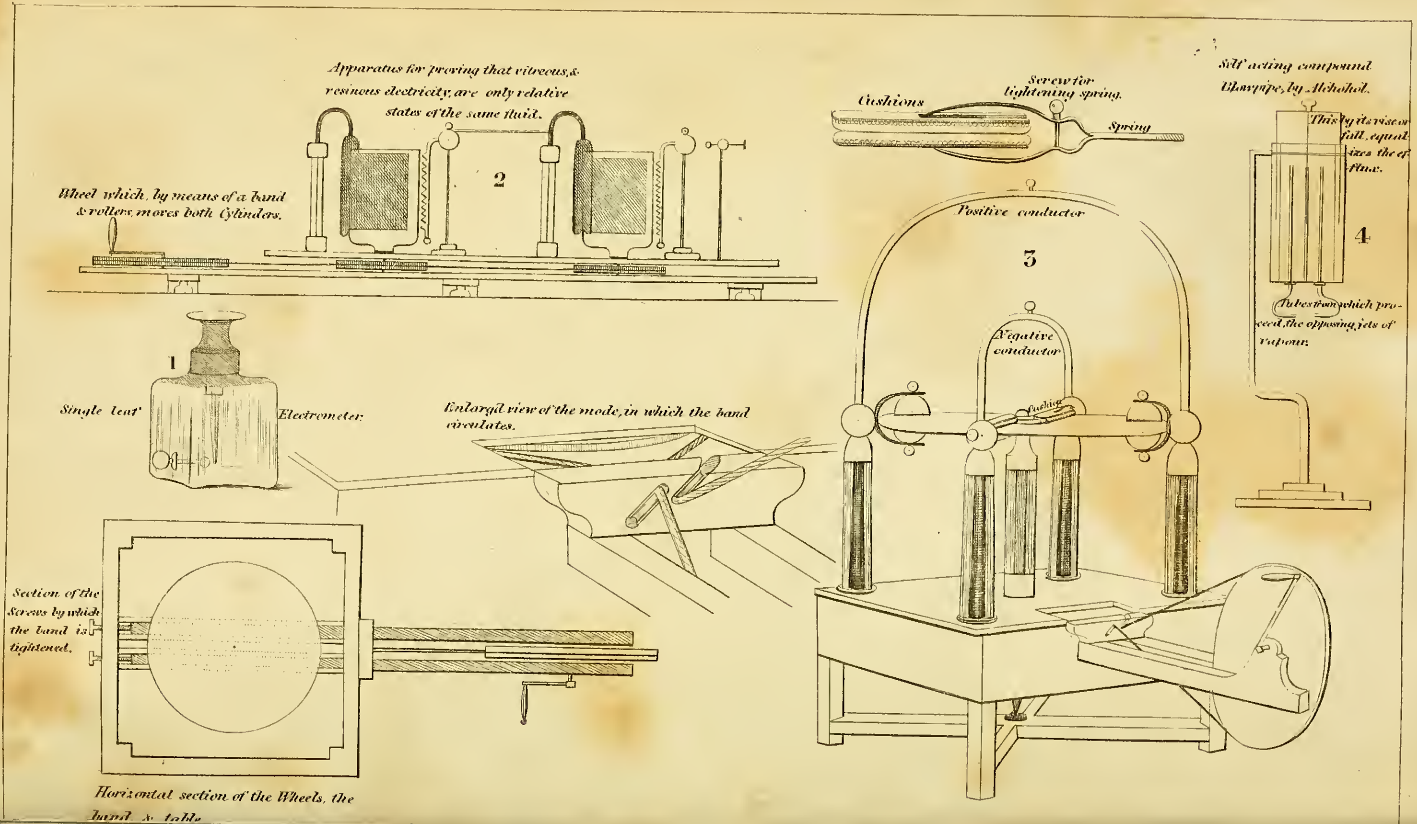

Apparatus for proving that vitreous, & resinous electricity, are only relative states of the same fluid.
2
Wheel which, by means of a band & rollers, moves both Cylinders.
Cushions
Screw for tightening spring.
Spring
Self acting compound Blowpipe, by Alchohol.
This by its rise or fall, equalizes the efflux.
4
Tubes from which proceed the opposing jets of vapour.
Positive conductor
3
Negative conductor
Cushion
1
Single leaf
Electrometer.
Enlarg'd view of the mode, in which the band circulates.
Section of the Screws by which the band is tightened.
Horizontal section of the Wheels, the band & table

PLATE 2.

Fig. 1.

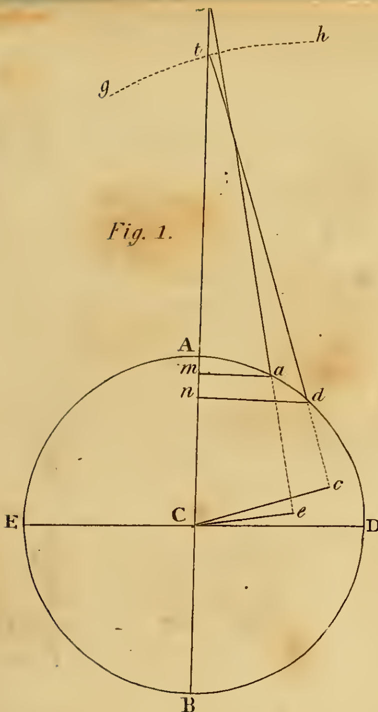


Fig. 2.

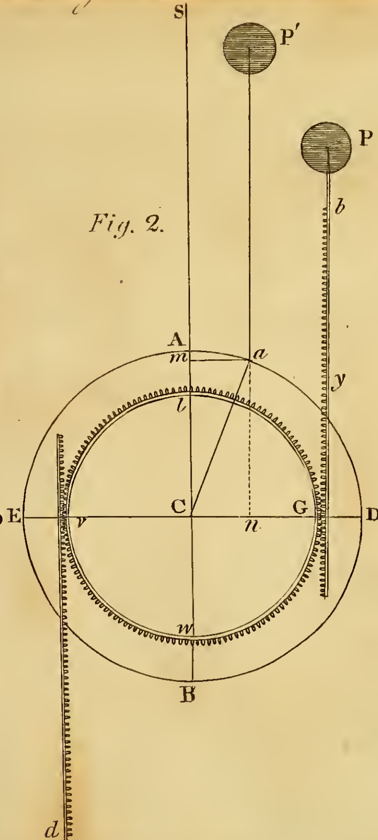
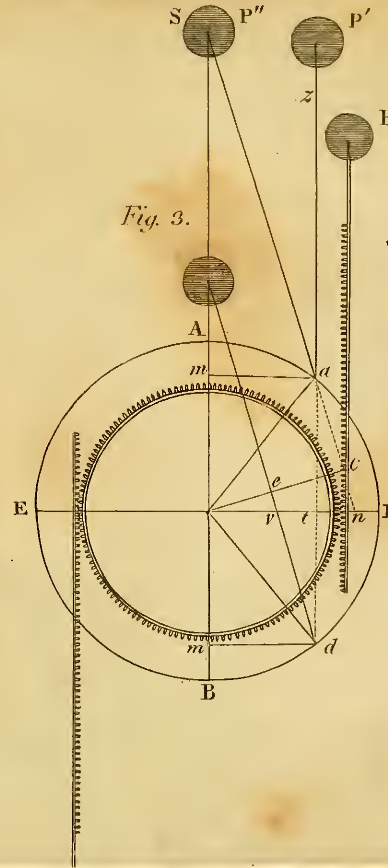
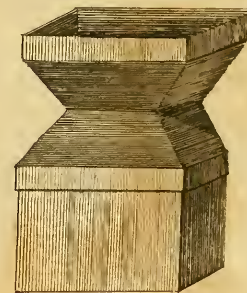


Fig. 3.



Mr Chiltons Rain Gage.

Fig. 4.



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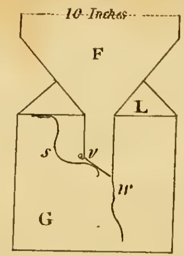
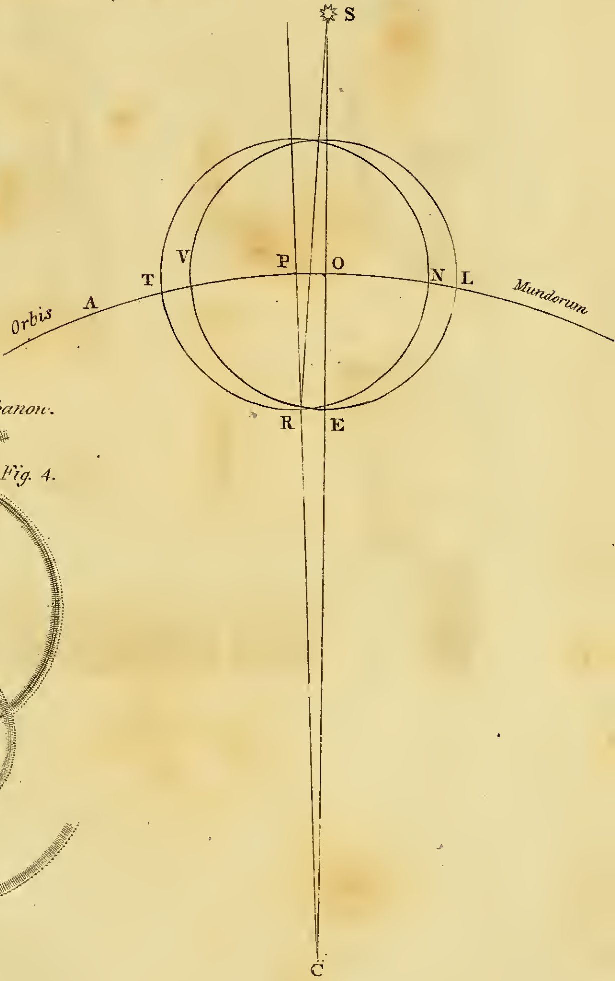


Precession of the Equinoxes.

PLATE 3.



Halo at New Lebanon.

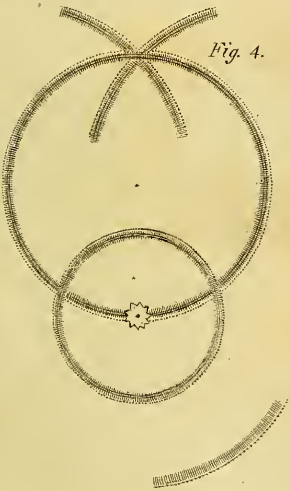
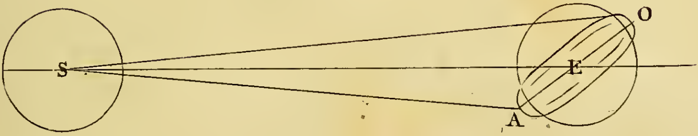
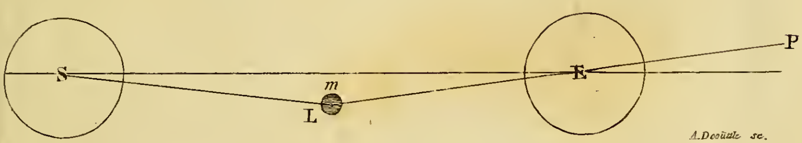


Fig. 4.





A.Doolittle sc.

PERKINS'S IMPROVEMENTS ON STEAM ENGINES

Fig. 1.

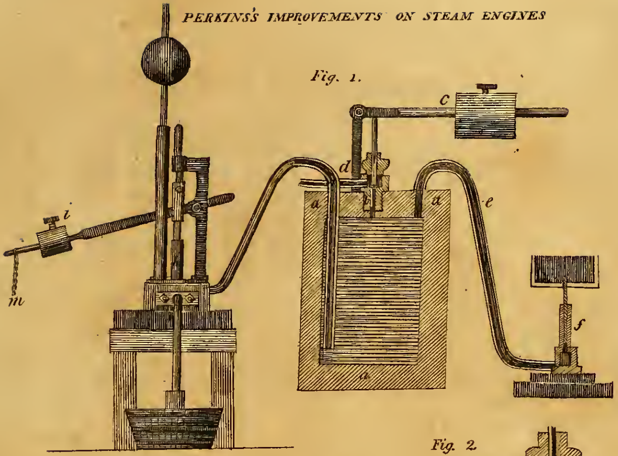


Fig. 2.

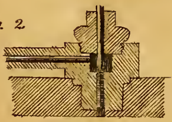
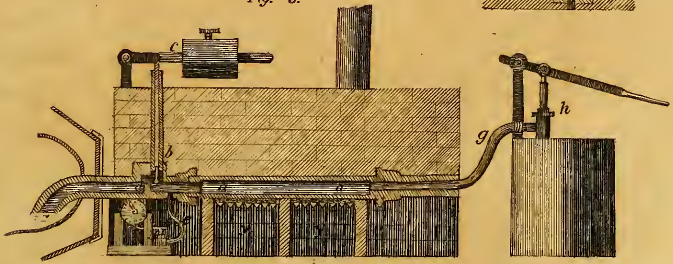


Fig. 3.



OUTLINES

of the

GEOLOGY

of

MARTHAS VINEYARD,

&c.

A.Doolittle sc.

IMPROVED DEFLAGRATORS BY DR. HARE.